I N T E R N A T I O N A L   C O N S U L T I N G   D I V I S I O N

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CHEMONICS

INTERIM EVALUATION OF THE SPRING AND WINTER WHEAT PROJECT (931-0621)

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ACRONYMS

ARS	Agriculture Research Service
CIAT	International Center for Tropical Agriculture
CIMMYT	International Wheat and Maize Improvement Center
EEC	European Economic Community
ESAK	Ecole Superieure D'Agriculture
FAO	Food and Agriculture Organization
IARC	International Agriculture Research Center
ICA	International Columbian Agriculture
ICARDA	International Center for Agricultural Research in the Dry Areas
INAT	Institut National Agronomique de Tunisie
INRAT	Institut National de la Recherche Agronomique de Tunisie
IRRI	International Rice Research Institute
IWFBSN	International Winter and Facultative Barley Screening Nursery
IWSWSN	International Winter x Spring Wheat Screening Nursery
LAN	Local Area Network
LDC	Less Developed Country
MIAC	Mid America International Agricultural Consortium
NASA	National Air and Space Agency
OSU	Oregon State University
RFLP	Restriction Fragment Length Polymorphism
USAID	United States Agency for International Development
USDA	United States Department of Agriculture

DEFINITIONS

Spring and winter bread wheats belong to the same species, Triticum aestivum. They are different physiologically and have different growth habits.

Spring Wheat - Wheats sown at the start of a growing season (spring or autumn, depending on climate). Their continuous growth cycle brings them to harvest in three to five months. They cannot generally survive freezing temperatures.

Winter Wheat - On the other hand, "winter wheat" must have the interruption in growth brought on by continuous periods of low temperatures. Planted in autumn, winter wheat is ready for harvest the following summer, 10 to 11 months later. Without the intervening cold these plants will not tiller or producer flowers, heads, or stem.

Facultative Wheat - Wheat varieties that can be grown satisfactorily when planted in either spring or winter.

Winter x Spring Program - A winter and spring crossing program. In this particular project, the winter x spring program takes advantage of the vastly different environmental conditions and disease complexes observed between Oregon, Mexico, Syria, and Turkey. Every May, crosses are made in Toluca, Mexico, where the vernalization and day-length requirements for winter wheat cultivars can be satisfied, thereby providing the opportunity to nick with spring-type wheats. Thus, this problem that has historically isolated winter and spring wheat gene pools is avoided. Resulting F1 seed is divided and planted in October at Ciudad Obregon and Corvallis, Oregon. The F1 material at Ciudad Obregon is integrated into the spring wheat improvement program by three- and four-way crosses made with the spring-type material. Thus, the spring habit is retained while transferring many desired attributes from the winter wheat parent. After subsequent evaluation and selection, the advanced lines are disseminated through the existing international nurseries coordinated by CIMMYT to the spring wheat growing LDC programs. The earlier maturity and different disease complexes enable scientists from OSU to collect valuable agronomic information from the plots in Mexico prior to the crossing season in Oregon, thus providing an additional dimension in determining the most productive crosses to make. In Oregon, F1 populations representing the same winter x spring material are crossed using three- and four-way crosses back to winter-type wheats.

To take advantage of the great number of abiotic and biotic stresses observed in the state of Oregon, a shuttle breeding approach is employed. Crossing blocks, F1 and F2 generations are grown in the Willamette Valley where in addition to numerous disease complexes, the full genetic potential of the early generation progeny can be realized. The F3 populations are evaluated near Pendleton, Oregon, where, in addition to some of the same stresses, different physiological races and limiting factors are observed. Selected F4 lines are evaluated in the Willamette Valley. The F5 and F6 are grown in the Willamette Valley, Pendleton, and the dryland location at the Sherman Branch Experiment Station (Moro, Oregon). Yield trials are also grown at each of these sites. A modified bulk method of handling segregating populations enables a large number of crosses to be evaluated. To insure that adequate levels of infection are achieved, artificial inoculations are made at specific sites for Stripe rust (Puccinia striiformis), Leaf rust (P. recondita), Stem rust (P. graminis f sp. tritici) Septoria leaf and glume blotch (Septoria tritici and S. nodorum), Cephalosporium stripe (Cephalosporium gramineum), Strawbreaker foot rot (Pseudocercosporella herpotrichoides), and Common and Dwarf Bunt (Tillia caries, T. foetida, and T. controversa). Adequate levels of infection for diseases such as Barley Yellow Dwarf Virus can be achieved by modifying the planting dates.

Preliminary milling and baking quality evaluations for acceptable end product uses are routinely carried out in the laboratory on the OSU campus. Complete milling and baking evaluations are done in cooperation with the Western Quality Laboratory at Pullman, Washington.

Distribution of wheat germplasm derived from this program is utilized as shown in annex F. A similar program is currently being developed for barley.

Doubled Haploids - Pure lines that are obtained in one generation by isolating haploid plants and doubling their chromosome number, rather than by the traditional method of self-pollinating F_1 plants for six to eight generations. Haploid plants have one set of chromosomes that can be doubled to derive a diploid cultivated barley plant with an identical pair of chromosomes which, therefore, breeds as a pure line. This rapid method is possible in barley because a high frequency of haploids can be easily obtained from wide crosses with wild barley (Hordeum bulbosum).

RFLP or Restriction Fragment Length Polymorphism - Restriction fragments of plant DNA can be generated by cutting the DNA with specific enzymes called restriction enzymes. Each enzyme used will cleave the DNA at a specific nucleotide sequence, and a map of the DNA sites can be used as developed for use as gene markers to locate or identify genes of interest for specific agronomic traits.

Isozyme - Enzyme variants that can be used as molecular markers to locate or identify genes of agronomic interest in a plant breeding program.

AID EVALUATION SUMMARY

Project Purpose: The Winter x Spring Wheat Project (931-0621) is implemented by S&T/AGR/AP through a cooperative agreement with Oregon State University to: (1) collect, evaluate, enhance, and disseminate wheat and barley germplasm; (2) provide graduate training in cereal improvement; (3) establish relationships with LDC and international wheat and barley research centers; and (4) serve as a resource center for cereal improvement.

Evaluation Purpose and Procedures: The purpose of this external evaluation is to conduct a comprehensive examination of the performance and implementation of the project, specifically, to: (1) determine the capability of the contractor to develop enhanced germplasm of winter and facultative types of wheat and barley, and their effectiveness in distributing germplasm to LDCs to be utilized in national and local breeding programs, and (2) assess the graduate training program for M.S. and Ph.D. students in various phases of cereal improvement. This evaluation covers the period from the beginning of the current project, January 1986 to July 1988.

The three-member evaluation team, contracted by Chemonics International, arrived in Corvallis, Oregon on July 11, 1988 to begin a two-week intensive review of the project with Oregon State University Cereal Research staff, CIMMYT representativies from Mexico and Turkey, an AID/S&T/AGR representative, and with Oregon wheat growers and industry representatives. Site visits were made to Oregon research plots.

Findings and Conclusions: Generally, the evaluation team found the project to be exceptionally well implemented by a competent, mutually supportive OSU Cereal Research team. Specifically, the team found:

- An excellent working relationship exists between CIMMYT and OSU. Two representatives from Mexico and one from Turkey were present for the review. Sixty percent of CIMMYT spring wheat advanced lines can be traced to some spring x winter parentage derived from OSU germplasm. Furthermore, OSU has advised CIMMYT/Turkey on the computerization of their winter wheat database and CIMMYT/Mexico in the computerization of their field weighing system.

- Genetic diversity of wheat has been enhanced by the collection and evaluation of over 10,000 cultivars.

- Systematic crossing of winter and spring gene pools of wheat has significantly increased genetic variability for many traits including more durable disease resistance and higher, more stable grain yield.

- Genetic lines from several countries have resistance to diseases that may cause serious crop losses in the U.S. or other wheat producing areas.

- The barley breeding program, initiated in 1986, is in its initial stages but has already achieved some very significant results, the most exciting of these being the development of a doubled haploid technique.
- Developed a microcomputer database application for cereal breeding research. Through a shared database, project personnel can retrieve the most current agronomic, disease, quality, genetic, or yield information. Thus, poor performing breeding materials can be discarded as they are harvested.

- Fifteen international graduate students are currently enrolled in the program with three receiving stipends from AID project funds and others receiving thesis research support.

- The program is benifitting small farmers by selecting germplasm with greater stress tolerances obtained by combining genes from winter and spring materials.

- Spring habit varieties developed from OSU materials have been released by national programs in at least 19 developing countries. Worldwide, it is estimated that these varieties cover around 10 million hectare, or about 10 percent of the total developing country wheat area.

- National programs in Chile and Turkey have released winter habit varieties developed from the winter x spring program. Argentina, Peru, and Bolivia are very near release of varieties. South Africa has released a winter habit variety that has scored the most rapid increase of adoption ever recorded in that country.

- Because of the vernalization requirement, the winter wheat program has progressed more slowly than the spring wheat program. Several very promising cultivars have been developed.

- About 30 percent of the advanced lines now being developed for use in Oregon soft white winter wheat are derived from winter x spring crosses. A hard red winter wheat is nearing release to Oregon farmers.

- Financial support by the Oregon Wheat Growers League amounts to about 27% of the cereal research budget. They recently provided $500,000--together with a matching fund by the Oregon Legislature--to endow a wheat research chair at OSU. Dr. Warren Kronstad, manager of this project was appointed to the chair. The Wheat Growers League is vocal in support of the international aspects of the program and feel they are benefitting from the sizeable collection of barley and wheat enhanced germplasm at OSU.

Principal Recommendations: The evaluation team recommends:

- that project funding be continued for at least five years to allow time for release of enhanced winter wheat germplasm, now in advanced trials, to national wheat breeders;

- continuation of the germplasm enhancement program in winter barley with special emphasis on utilization of new genetic technologies that can be productively integrated with the crop improvement training and network building activities;

- a five-year funding horizon for the project with a mid-term review to assess future funding beyond the five-year contract. Promising new areas for winter wheat and barley research should be incorporated into a redirected future project;

- funds be included in the project for OSU staff to visit international screening nurseries, conduct in-country symposia, and visit LDC cereal breeders or that USAID project management seek other funding to observe the utilization of advanced breeding lines in LDC breeding programs and to provide OSU staff with feedback from LDC breeders on adaptability of breeding lines; and

- increased collaboration with appropriate Great Plains universities to provide more in-depth screening opportunities and occasional alternative degree training opportunities for wheat and barley scientists from LDCs.

Lessons Learned:

- Long-term financing is essential to the success of a cereal breeding program. Generally, it takes about 10 years to develop a new variety of spring wheat, longer for winter wheat. Scientists cannot do their best work if they are constantly scurrying for funds.

- Land-grant institutions can encourage support for international research efforts. OSU's international cereal research program receives both financial and verbal support from Oregon wheat growers. This has been encouraged by OSU staff by (a) arranging tours so that Oregon farmers may visit CIMMYT and meet with Mexican farmers and (b) informing them of the source of breeding materials with special characteristics. Screening nurseries are located in farm fields in various parts of Oregon; these are frequently visited by international guests.

- A graduate program coupled with a breeding program establishes a long-term relationship beyond international boundaries. Wheat breeders from many developing countries periodically visit Oregon trials to select breeding materials for their programs. In the 20-plus years that Oregon has participated in international wheat programs, 98 graduate students have completed training at OSU and many have returned to national wheat breeding programs. A healthy rapport exists with these former students and OSU. In addition, the relationship with CIMMYT and, more recently, with ICARDA has added a further international dimension.

SECTION I

INTRODUCTION AND BACKGROUND

A. Summary Scope of Work

The purpose of this evaluation is to conduct a comprehensive examination of the performance and implementation of AID project 931-0621 with Oregon State University since 1986. The evaluation team is (1) to determine the capability of the contractor to develop enhanced germplasm of winter and facultative types of wheat and barley, and its effectiveness in distributing these to LDCs to be utilized in national and local breeding programs, and (2) to assess the graduate training program for M.S. and Ph.D. students in various phases of cereal improvement. The previous external project evaluation, summarized herewith in section II, was conducted in July 1985. See annex A for the complete scope of work of the present evaluation.

The 1988 evaluation team members include:

Dr. John D. Axtell, Cereal Breeder
Dr. Paul W. Heisey, Agricultural Economist
Mr. Donald R. Mitchell, Team Leader

B. Methodology

The three members of the evaluation team arrived in Corvallis, Oregon, on July 11, 1988, to begin an intensive review of the Winter x Spring Wheat Project (931-0621) with Oregon State University's Cereal Research staff, CIMMYT representatives from Mexico and Turkey, Oregonian wheat growers, and industry representatives. Site visits were made to research plots in the Corvallis area, the Hermiston-Pendleton area in eastern Oregon, and the Moro-Madras area in central Oregon. (See annex B for the itinerary and list of people participating in the review.) After completing a draft report the team departed Corvallis on July 22, 1988.

C. Project Description

Recognizing the importance of wheat as a staple food crop in the LDCs, USAID has worked cooperatively with Oregon State University's cereal improvement scientists for over 20 years. The original contract in association with CIMMYT was to introduce into the coastal areas of Turkey semi-dwarf spring-type wheats developed in Mexico. Subsequently, USAID supported an OSU dryland wheat improvement program for the Anatolian plateau of Turkey. These programs resulted in a dramatic increase in wheat production in Turkey from 7 million metric tons in 1967 to 17 million metric tons in 1975. In the intervening years, USAID has provided funding in support of the OSU wheat germplasm enhancement and graduate training program.

The present project funding began in January 1986 and is currently approved for financing to August 31, 1989, with an extension to June 30, 1990, being requested. Funding for the current fiscal year is $300,000 with a total authorized contract funding level of one million dollars. Total planned life of project funding is $1,450,000. In addition to wheat, the present plan of work also includes a barley germplasm enhancement component.

The project places OSU in a collaborative mode with CIMMYT/Mexico, CIMMYT/Turkey, The International Center for Agricultural Research in Dry Areas (ICARDA), LDC wheat and barley improvement programs, other U.S. universities, USDA's Agricultural Research Service, and other regional and international cereal improvement projects, as well as private sector programs. Objectives for the project are as follows:

- To collect, evaluate, enhance, and disseminate wheat and barley germplasm with tolerance or resistance to the major biotic and abiotic stresses limiting optimal cereal production.
- To provide meaningful graduate training in various aspects of cereal improvement.
- To establish new and expand existing relationships with agencies and institutions in LDCs and major wheat and barley research centers throughout the world.
- To transfer technology by serving as a resource center for various aspects of cereal improvement.

D. Project Funding

USAID's funding for winter x spring wheat germplasm enhancement at Oregon State University has declined over the past several years. In an earlier related project, for example, USAID funding contributed 74% of the total OSU cereal research budget. Under the current project, USAID funding amounts to 47% of the OSU cereal research budget (see figure 1 on the following page). With the addition of the barley breeding program in 1986, USAID funding for the wheat breeding program was further reduced. Current funding is about evenly divided between the barley and wheat programs. Table 1 on page 6 shows project expenditures through June 1988 as well as total contributions made by others to the OSU cereal research program.

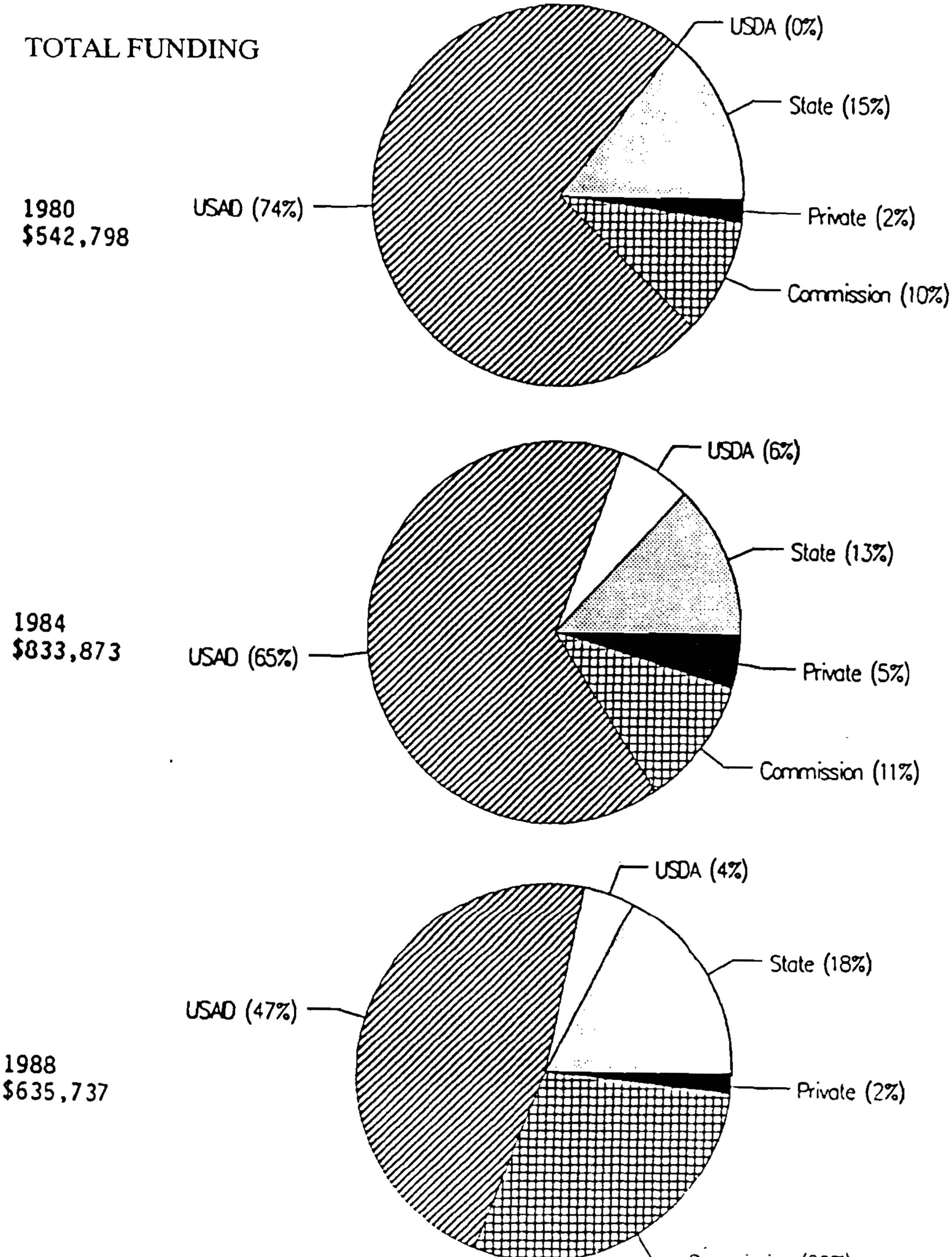


Figure 1. OSU Wheat and Barley Research Funding by Source --- 1980 - 1984 - 1988

TABLE 1. USAID/OSU SPRING X WINTER WHEAT PROJECT EXPENDITURE SUMMARY AND OTHER RELATED FUNDING JANUARY 1986 - JUNE 1988

SOURCES	CY 1986	CY 1987	1988 Jan-June
USAID			
Salaries and wages	$191,682	$186,581	$72,490
Fringe benefits	$39,026	$47,844	$20,675
Overhead	$13,065	$9,287	$19,629*
Travel	$17,664	$15,824	$7,019
Tuition	$14,526	$13,684	$6,963
Equipment/supplies	$71,966	$68,693	$62,819
Total	$347,929	$341,913	$189,595
OTHER SOURCES			
USDA	$53,523	$50,355	$14,179
State (OREGON)	$98,737	$108,481	$55,752
Private	$86,761	$41,850	$6,000
Wheat Commission	$197,578	$204,304	$91,937
Total	$436,599	$404,990	$167,868
TOTAL ALL SOURCES	$784,528	$746,903	$357,463

*To be adjusted at end of fiscal year (5%)

NOTE: USAID Funding is about equally divided between wheat and barley research

It is significant to note that the contribution made by the Oregon wheat growers amounts to approximately 27% of the OSU cereal research budget. The evaluation team met with several key wheat producers and all were enthusiastic over the wheat and barley breeding work being carried out by this project. Contrary to public statements by some commodity groups, the Oregon wheat growers expressed their support for a "full bellies" policy and could see that the total U.S. economy would benefit from more prosperous LDCs. They feel they are benefiting from germplasm received from other countries, an exchange that will increase their competitiveness in world markets. OSU's administration, in recognition of the benefits derived for Oregon farmers, reduced the normal overhead charge from 34% to 5%.

SECTION II

SUMMARY OF PREVIOUS EVALUATION

A. Summary of 1985 Evaluation

The 1985 project evaluation team complimented OSU for excellent accomplishments in:

- collection of germplasm;
- generation of improved winter-type germplasm from winter x spring wheat hybridization;
- organization and wide distribution of international winter wheat screening and yield trial nurseries;
- development of the sophisticated computer-aided collection and programming of nursery data, enabling OSU to summarize and distribute data promptly to all cooperators; and
- high priority given to graduate student teaching program.

The evaluation team felt they had inadequate information and were unable to comment on the merits of cooperation with CIMMYT. Too, they were somewhat critical of the following aspects of the project:

- a high ratio of graduate students to senior staff meant that additional senior staff would be needed to provide greater depth for guidance of graduate student research;
- the research and graduate teaching program would benefit from closer cooperation with the Columbia Basin Research Center;
- though disease resistance is an important objective, only minor cooperation with a plant pathologist was observed;
- no entomologist was cooperating with the project;
- greater attention to cultural practices would be required if full benefit is to be derived from genetic improvements;
- the project encouraged the identification of genotypes with superior forage production;

- o the evaluators raised the question of whether OSU should be sharing a larger portion of the total budget since Oregon farmers are benefiting from the research; and
- o the evaluators were concerned about the adequacy of the wheat breeding technician training program and raised the question as to whether OSU should be participating in the training program.

B. 1985 Recommendations

The 1985 evaluation team made ten recommendations for actions to be taken by project management. Corrective action, in most cases, has been taken. See annex C for notes of specific actions taken on each recommendation.

SECTION III

EVALUATION OF THE PROJECT

A. Accomplishments

Progress in plant breeding depends primarily on three factors: genetic diversity; selection schemes to identify superior types among this diverse germplasm in appropriate environments; and skilled "hands" to make these selections in a well organized and cost effective manner. Success depends on doing all three very well.

1. Wheat

The winter x spring program has succeeded in enhancing the world wheat germplasm for the benefit of both LDC and U.S. producers by focusing on these key factors. Genetic diversity has been enhanced by collection and evaluation of nearly 10,000 wheat cultivars. At the same time, this diversity has been "unlocked" and made available to wheat breeders by a systematic crossing program between spring and winter wheat gene pools. A novel and effective "shuttle breeding" scheme has been adopted to selectively screen these new gene combinations for wheat cultivars with unique and superior characteristics for yield potential and resistance to biotic and abiotic stress factors. Finally, many new sets of "hands" to identify, select and propagate these new "gene combinations" or cultivars have been inspired, trained and motivated for service in both LDCs and developed countries. Specific accomplishments include the following:

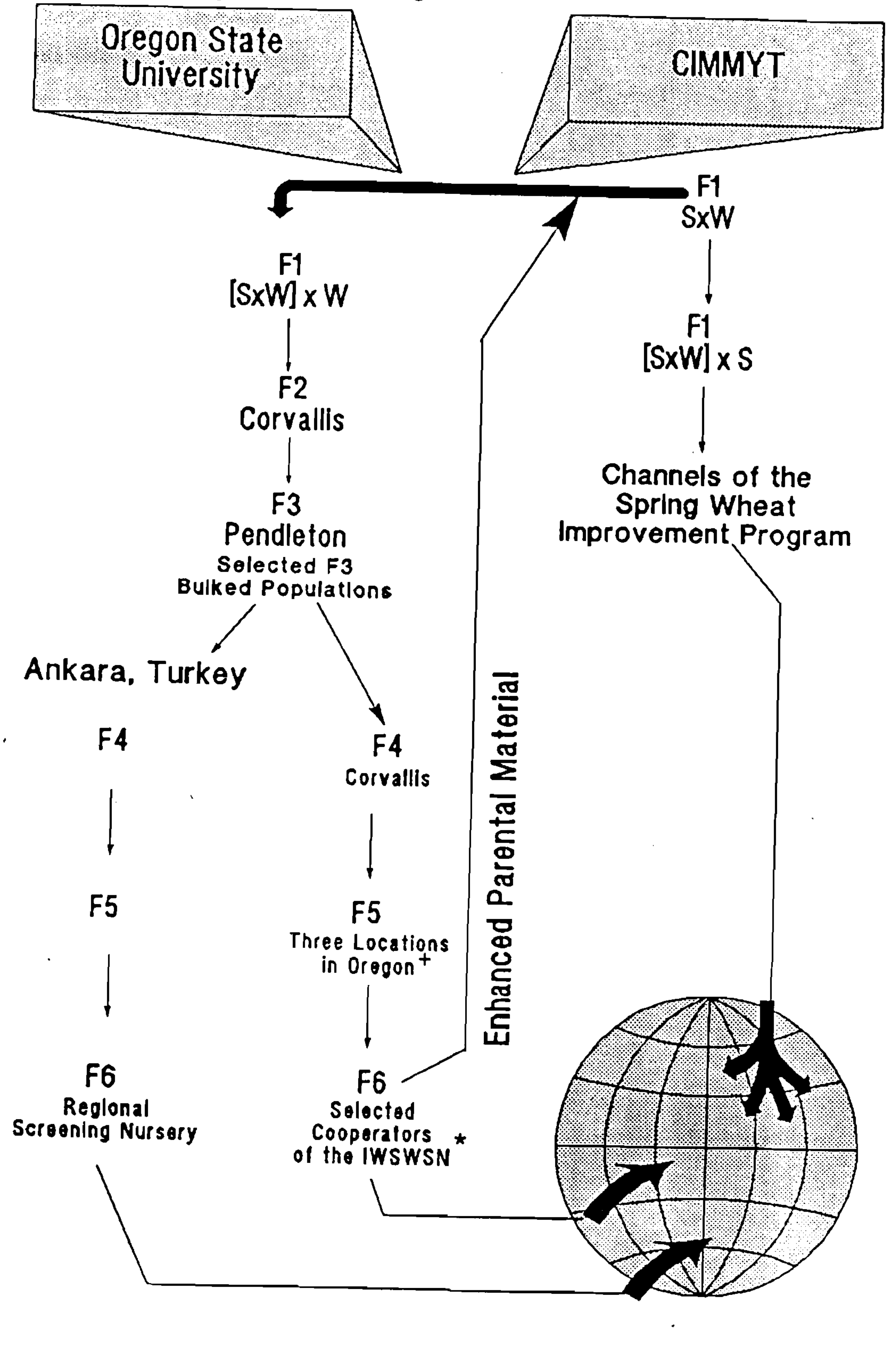
a. Breeding/Germplasm Enhancement

- Established that the systematic crossing of winter and spring gene pools of wheat significantly increases genetic variability for many traits including more durable disease resistance and higher, more stable grain yield. Enhanced winter wheat germplasm is being widely used as parent material (see figure 2 on page 13) and several entries have been released directly as new varieties in several countries (see table 2 on page 12).

- Enhanced germplasm from OSU is widely used in the CIMMYT spring wheat program, i.e. 60% of CIMMYT spring wheat advanced lines can be traced to some spring x winter parentage (see page 17).

- Developed seedling techniques to identify and select for aluminum tolerance and discovered major genes for aluminum tolerance in winter x spring wheat crosses tracing to

Figure 2. Material Flow Diagram for the International Winter X Spring Breeding Program at Oregon State University



+New Toluca/Turkey sub-shuttle. F5s from OSU are returned to Toluca and selected for photoperiod insensitivity by CIMMYT. 600 lines from this scheme are performing extremely well at all locations in 1988.

*International Screening Nursery discontinued in 1988 because of budget cuts. Selected F3 bulks released instead.

DEVELOPING COUNTRIES GROWING WHEAT ON 100,000 OR MORE HA
(includes bread and durum wheats)
(figures in '000 ha)

Country	Total Wheat Area	Winter	Facultative	Total W/F	Spring(Cold Tolerance)	Total [1] W/F/C	Total [2] Spring	Selections Made From IWSWSN [3]	Varieties Released From WXS Derived Winter Material	Varieties Released From WxS Derived Spring Material	Trade [4] Position
China	28970	11090	1320	12410	6060	18470	16560	*			SS
India*	22700				900	900	22700			*	SS
Turkey	9160	5785	465	6250	2320	8570	2910	*	*	*	SS
Pakistan*	7500				1150	1150	7500	*		*	SS
Iran	6060	3690	690	4380		4380	1680	*			I
Argentina	5940				2850	2850	5940	*		*	E
Afghanistan	2300	200	1100	1300		1300	1000	*		*	SS
Algeria	2150				605	605	2150	*		*	I
Iraq	1860				1860	1860	1860				I
Morocco*	1950				175	175	1950				I
Brazil*	1700						1700	*		*	I
Syria	1525				1350	1350	1525	*		*	I
Tunisia*	1310				195	195	1310			*	I
Mexico*	750						750	*		*	SS
Bangladesh*	695						695			*	I
Chile*	615	155	155	310	160	470	305	*	*	*	I
Egypt*	555						555			*	I
Ethiopia*	545				105	105	545				I
Nepal*	475	10		10		10	465				SS
Libya	250						250	*			I
Uruguay	210						210				SS
Sudan*	170						170				I
Paraguay	160				130	130	160				SS
Jordan*	155						155				I
Kenya*	110						110			*	I
Peru*	100				100	100	100			*	I
TOTAL	97915	20930	3730	24660	17960	42620	73255				

[1] All area under winter, facultative, and spring wheats requiring cold tolerance.
[2] All spring wheat area, including area requiring cold tolerance.
[3] Countries selecting material from IWSWSN for further use within their breeding programs.
[4] SS: Imported ≤ ± 15 percent of total production; I: Imported > 15 percent of total production; E: Exported > 15 percent of total production. Status is for 1984-86.

* Countries with an AID mission or an AID representative.

Brazilian germplasm. This research contributed significantly to the success of CIMMYT breeders and their Brazilian counterparts in releasing semi-dwarf wheat cultivars for the acid soils in Brazil (see page 26).

- o Dominant male sterile genes and chemical gametocides are used to facilitate recurrent selection for the accumulation of favorable alleles to achieve a more durable type of disease resistance.

b. Improved Disease Resistance

- o The International Winter x Spring Wheat Screening Nursery (IWSWSN) has identified new sources of genetic resistance to the major disease complexes. As a surveillance nursery, it has enabled breeders to anticipate changes in the physiological races of major diseases of wheat.

- o The shuttle breeding approach has resulted in much greater durability and acceptable levels of resistance to Septoria Leaf and Glume Blotch, in addition to Barley Yellow Dwarf Virus.

- o Materials from the People's Republic of China have provided excellent sources of resistance to Scab (*Fusarium* spp.) as well as earliness and spike fertility.

- o Genetic lines from Argentina are serving as excellent sources of resistance to *Xanthomonas translucens* (Black Chaff) which is becoming an increasingly serious bacterial disease worldwide.

- o Excellent sources of resistance to Cercosporella foot rot have been identified from France and England, and Turkey continues to contribute sources of resistance to the various races of Common and Dwarf Bunt.

2. Barley

The barley program was initiated in 1986 in recognition of the need for a crop suited to many marginal crop areas in LDCs. The program is only in its initial stages but has already achieved some very significant results. The most exciting of these results is the development of a doubled haploid technique that increases the efficiency of haploid production in winter barley. Doubled haploids are used to shorten breeding cycles, allowing alternative selection strategies such as recurrent selection and potentially allowing for more efficiency in the time required for the development of new varieties. The program has achieved the following principal results to date:

- Significantly improved efficiencies of haploid production were achieved using *in vitro* tiller culture and *in vitro* floret culture. The efficiencies achieved with either procedure are at least comparable to spring barley and frequently better than any values reported before. Values ranged from 63 to 86 percent for floret culture when expressed as number of green haploid plants per number of embryos cultured. Efficiencies of this magnitude mean that this very powerful technique has great potential in winter barley improvement.

- Molecular markers such as RFLPs, isozymes and storage proteins will be used to identify linkages that could be helpful in mapping cold tolerance genes.

- Three hundred and fifty-three accessions were evaluated for agronomic traits and disease resistance, with emphasis on Scald (*Rhyncosporium secalis*), Net blotch (*Phyrenephora teres*) and Barley Yellow Dwarf Virus.

- Cold tolerance nurseries were established with cooperators at ICARDA and were evaluated in Syria and Lebanon. Nurseries were also sent to three locations in Turkey.

- Established an international network of 45 winter and facultative barley research programs in 31 countries. A screening nursery consisting of 50 entries was distributed in 1988.

3. Computerization

The following results in the area of computerization were achieved:

- Developed a microcomputer database application for cereal breeding research. Utilizing commercial database software, a menu-driven application was written which provides access to all information on all breeding lines in the crossing block.

- A state-of-the-art microcomputer local area network (LAN) was installed for use by all project personnel. Data storage and retrieval for all germplasm in the program is on-line and interactive. Through a shared database, project personnel can retrieve the most current agronomic, disease, quality, genetic, or yield information.

- Advised CIMMYT/Turkey on the computerization of their winter wheat database in microcomputers, and

CIMMYT/Mexico in computerization of their field weighing system.

4. Training

The following results in the area of training were achieved:

- The support that USAID has provided to the graduate training program leveraged over a ten-fold increase in funding provided by other agencies in supporting graduate student stipends and their research. Other donor funds for graduate student training include the Rockefeller Foundation (23), Ford Foundation (1), National Science Foundation (1), NASA (1), CIMMYT (5), MIAC (1), ICA (1), FAO (3), ARS (1), and the governments of Mexico (2), Kenya (1), China (5), and Uruguay (1). A total of 98 scientists have received their M.S. or Ph.D. degrees in this program including 20 U.S. students whose exposure to international agriculture is reflected in their current research and teaching activities. Seven thesis research projects have been conducted at CIMMYT, IRRI, and CIAT.

- Excellent graduate student thesis research has been completed in many areas including the following:

  - development of new, more efficient breeding approaches in LDCs;

  - identification of constraints and cultural practices for the successful production of upland rice production systems for the savanna soils of Colombia;

  - evaluation of quantitatively inherited traits such as grain yield and its components, particularly as they are influenced by possible genotype x environment interactions and the use of combining ability to predict parental performance for improving complex traits;

  - the influence of vernalization, photoperiod response, and temperature on plant growth and development with special emphasis on rate and duration of grain fill;

  - the identification of electrophoretic screening techniques to identify desirable protein quality in bread and durum wheats;

- o regeneration of wheat and barley plants from callus.

B. Work in Progress

The winter x spring cereals program continues to generate enhanced germplasm, research results in both the wheat and barley programs, and trained students. The detailed and specific output is presented by objective in annex D.

Many of the current project activities are discussed in sections of this report on (1) germplasm utilization, (2) networking activities, and (3) research workers trained. A few comments on major research efforts with significant payoffs follow.

1. Wheat

Some wheat breeders have suggested that most of the usable genetic diversity has been exhausted and that in the future, only maintenance breeding or small advances in grain yield will be made. The systematic exploration of crosses between the winter and spring gene pools is a feasible way of enhancing the genetic variability available to wheat breeders. This was the hypothesis being tested by this program. Meaningful evidence now shows that the winter x spring wheat program is having a significant impact in both spring and winter wheat programs not only in Oregon and other U.S. wheat producing areas, but also around the world.

The CIMMYT wheat breeding team led by Dr. S. Rajaram in Mexico and Dr. Gene Saari in Turkey presented evidence that both spring and winter wheat breeding programs have benefitted substantially from this program. A total of 10 million hectares are now grown with spring wheat cultivars that trace their parentage to OSU's spring x winter program. (See table 2 and annex I for impact data.) Dr. Rajaram estimates that 60 percent of the advanced lines in the CIMMYT spring wheat breeding program may trace parentage to winter x spring crosses, so this trend is likely to continue in the future.

Dr. Gene Saari reported that two varieties of winter wheat from the winter x spring program have been released in Turkey and that each occupies approximately 50,000 ha. The variety 'Atay' dominates in the more favorable areas with better soils in the Central Plateau. Yields of up to 10 tons per hectare are reported under irrigated conditions. The variety 'Kirk Penar' is grown in the Thrace area near the European border because of its superior winter hardiness.

Progress in developing winter wheat varieties from the program is necessarily slower because of the longer breeding cycle of winter wheats in comparison with spring wheats. There is strong evidence that the next few years will see higher adaption rates and greater impact of the winter wheats from the winter x spring program. A test conducted in 1988 of 600 advanced winter lines has shown excellent line adaptation and performance in Turkey, Mexico, and Oregon. Many of these lines have traits and yield potential of excellent quality and should be suitable for release either as parents or varieties in the near future.

In Oregon, a hard red winter wheat experimental line identified as OR CR8313 has shown excellent performance at all locations. The protein levels are good under proper nitrogen management conditions. This experimental variety originated from a cross between an Austrian winter wheat (Probstdorfer Extrem) and a spring wheat from CIMMYT (Tobari 66), and was selected by the characteristic multi-locational shuttle breeding system used by the project. The Oregon wheat growers are very interested in this hard red winter wheat since white wheats are predominantly grown at present and the hard red varieties will expand future marketing opportunities.

2. <u>Potential New Research Areas</u>

Three new areas of research seem especially promising for the future:

a. <u>Durum Wheats</u>

Durum wheats are a major component of the diet in many countries, especially those in northern Africa. Preliminary data obtained from CIMMYT and OSU suggest that the systematic crossing of spring and winter gene pools would enhance the genetic variability for durum wheat improvement. There also is strong evidence that durum x bread wheats would result in the mutual improvement of both.

b. <u>Drought Tolerance</u>

Preliminary studies have been conducted to study drought tolerance focusing on molecular and physiological mechanisms in wheat. A 28 Kd protein has been observed to accumulate in large quantities at low tissue water potentials. Of special interest, this is the same molecular weight protein observed for the heat shock proteins in soybeans. By developing nucleic acid probes it may be possible to identify wheat cultivars and progeny with greater drought tolerance. (Collaborative effort with Connie Bozarth, OSU Agricultural Chemistry Department.)

c. Bacterial-Plant Interactions

Techniques for cloning large fragments of fungal DNA and procedures for efficiently transferring within and between species, have opened up new approaches to studying host-pathogen interactions in wheat and barley. By isolating avirulent genes using molecular cloning techniques from barley that will be expressed in transgenic wheat plants may infer resistance to wheat pathogens. Recent evidence from bacterial-plant interactions suggest that such an approach is possible in affording more durable type resistance. (Collaborative effort with Dallice Mills, OSU Botany and Plant Pathology Department.)

3. Barley

The objective of the winter x spring barley program is to realize the unexploited potential of winter and facultative barley through a synthesis of new genetic techniques and classical plant breeding strategies. This program is a collaboration with ICARDA. Doubled haploid recombinant inbred lines, molecular markers, and novel sources of genetic variation are being used to develop germplasm with high yield potential and tolerance to an array of biotic and abiotic stresses. The International Winter and Facultative Barley Screening Nursery (IWFBSN) has been distributing this germplasm since 1987. A network of 46 collaborators has been established for testing and exchanging enhanced winter and facultative growth habit germplasm.

The application of new genetic technologies has presented some exciting new opportunities for the barley program (see annex D). Several promising avenues of research are being pursued, including:

- Doubled haploid techniques and tissue culture strategies, including doubled haploid recurrent selection populations for malting quality traits, grain yield, tolerance to scald, and exotic germplasm introgression.

- Biotic and abiotic stress tolerance, including a planned extensive genetic analysis of cold tolerance in winter barley using doubled haploid recombinant inbred lines and RFLP markers. Control of scald using varietal mixtures, and yield and quality losses attributable to scald epidemics, are being studied.

4. Computerized Germplasm Bank

The current working collection of 10,904 wheat cultivars and advanced lines has been obtained from breeding programs located in the facultative and winter wheat growing areas of the world. This number has increased from 6,500 wheat

TABLE 3

DEVELOPING COUNTRIES GROWING BARLEY ON 100,000 OR MORE HA

Country	Total Barley Area ('000 ha)	Winter Barley Area ('000 ha)
Turkey	3500	2350
Morocco*	2470	500
Iran	2200	1600
Syria	1550	NA
India*	1380	80
Iraq	1250	370
China	1100	NA
Algeria	1050	570
Ethiopia*	800	NA
Tunisia*	440	NA
Afghanistan	300	250
Mexico*	280	NA
Pakistan*	190	95
Argentina	135	NA
Libya	130	NA
Peru*	100	NA

NA: not available

* Countries with an AID mission or AID representative.

cultivars in July 1985, the date of the last project review. A significant factor is that many of these superior genetic materials have been received from countries that in the past have rarely shared their experimental material (Eastern Europe, Middle East, People's Republic of China). This exchange has been a direct result of their collaboration on research projects with the winter x spring program. A list of introductions from specific countries and continents for the past eight years is in annex E.

Computerization of the germplasm bank entries has made the breeding effort more efficient and the collection more readily available to the cooperators. The plant breeder can search the database to:

- identify lines exhibiting certain strengths;
- display the disposition of all progeny of specified parents;
- schedule emasculations and pollinations based on the latest heading and flowering data;
- print identification tags for new hybrids; and
- track parental combinations for the current crossing season as well as previous seasons to avoid duplications and reciprocals.

The LDC cooperator can utilize the data bank by requesting a listing of all germplasm with specific disease resistances and appropriate environmental adaptation. For example, at the time of this review, Mario Mellado, an excellent wheat breeder from central Chile, was visiting OSU. He requested seeds of the best stripe rust resistant lines and also made selections in segregating populations for his program. Recently, Hans Braun requested extensive germplasm for his new CIMMYT winter wheat program for the Anatolian Plateau in Turkey, and Lisaido Gonzales selected germplasm for his program in Argentina. These are only brief examples of responses to specific germplasm requests.

The volume of germplasm exchange with cooperators during the past eight years is presented in annex F. In 1986, 179 germplasm sets were distributed to cooperators in 89 countries. A total of 132 enhanced germplasm sets were distributed to 59 cooperators in 1987. Budget reductions forced the program to delete the International Winter X Spring Wheat Yield Trial (IWSWYT) in 1986 and the International Winter X Spring Wheat Screening Nursery (IWSWSN) in 1987. Selected F3 bulks have replaced these nurseries.

The value of enhanced wheat germplasm to LDC cooperators can be quantified in two ways. First, a recent survey designed to assess the impact of the winter x spring program reveals that 80% of the LDC respondents have used entries from the IWSWSN. Most have used the entries as parental material rather than for direct release as cultivars. However, several cultivars have been released directly attesting to the value of the germplasm to cooperators (see p. 26).

The winter x spring program supplements the world germplasm collection of wheat now being maintained by USDA and FAO. It differs from these collections in that most recently developed cultivars and selections from active research centers are added each year.

This activity complements a similar role that CIMMYT plays in developing a working collection of spring wheats. Between CIMMYT and OSU, over 200 spring and winter wheat research programs are now involved in a network of sharing germplasm and information on spring and winter wheat respectively.

5. <u>The Value of Networking</u>

The winter x spring program has forged linkages with 20 institutions in developing and developed countries, in addition to 54 countries in the wheat germplasm network and 46 cooperators in the barley germplasm network.

The extensive networking activities of the program continues to be a valuable contribution to the project as well as to the LDCs. The barley research network has been expanded to include 46 cooperators representing developed and developing countries. Germplasm from target and non-target AID countries has been evaluated, enhanced, and distributed. A multi-disciplinary approach for cereal enhancement in the semi-arid regions of Tunisia and the OSU/AID winter/spring wheat and barley program was signed in November 1987. The collaborative research project, which is supported by MIAC, has three objectives:

a. Establish interdisciplinary linkages between INAT, INRAT, and ESAK in Tunisia and Oregon State University to enhance barley and wheat production for the semi-arid regions of Tunisia through strengthening research on management practices and adapted germplasm development.

b. Increase the pool of scientists with cereals expertise for dryland agriculture in Tunisia through specific research projects involving students and staff. This will be implemented through:

- strengthening of individual research program, providing training experiences in new technologies; and

- collection, evaluation, and utilization of specific genetic factors from current land races of wheat and barley in Tunisia.

c. Reinforcement of relationships between researchers and extension agents of the semi-arid regions through seminars, demonstrations, field days, and training of extension staff.

Three significant symposia papers were presented recently: (a) "Enhanced Genetic Variability Resulting from Winter x Spring Wheat Crosses" at the first National Wheat Symposium, Mexico, and (b) "Enhancement of Winter and Facultative Wheat Germplasm for Rainfed Environments" and (c) "Application of Doubled Haploid Techniques to Winter and Facultative Barley Germplasm Enhancement," in a symposium in Ankara, Turkey, on July 6-10, 1987.

As a result of the Ankara symposium, barley linkages expanded to include the following target AID countries in the Middle East and North Africa: India, Jordan, Lebanon, Morocco, Nepal, Pakistan, Tunisia, and Turkey. Non-target countries that may be key sources of useful stress tolerance genes were also enrolled in the network. The barley network complements the established wheat network which now involves 117 locations in 54 countries.

A significant limitation to the project networking activities has been caused by reduction in funding. International travel has been minimal, greatly reducing follow-up on the utilization of germplasm distributed. It is very difficult to obtain accurate and meaningful information on the extent to which project germplasm is being used as parental material in crossing programs without site visits. It is also difficult to learn about limitations of distributed germplasm since some cooperators are reluctant to report bad news. A breeder needs to see the material in the field at appropriate intervals.

The IWSWSN and IWSWYT have also been discontinued because of funding limitations. LDC cooperators who are never visited by the project personnel are frequently less than enthusiastic about conducting the trials with good diligence. Likewise, the cancellation of in-country symposia has caused a loss of many significant networking opportunities. Some alternative arrangements need to be made to rectify these losses in outreach programs. There is <u>no substitute</u> for visits to LDC cooperators by senior project personnel at appropriate times. The experience of 25 years of international research and trial activities by the IARCs will support this conclusion.

C. Acreage Planted to Improved Wheat Varieties

Estimated acreage planted to improved wheat varieties in the post-Green Revolution period is subject to a great deal of sampling as well as measurement error. Most crop reporting services have as two of their primary goals the estimation of crop areas and production, not answering subsidiary questions such as varietal coverage. They may provide data on 'high yielding' and 'local' varieties, but not the more specific information required to evaluate the effects of major research efforts. Even in the U.S., detailed information on wheat varieties is only collected every five years and this may soon be curtailed for budgetary reasons. Information on area under given wheat varieties in the developing world often relies heavily on estimation by knowledgeable wheat researchers in specific areas. Furthermore, the great contributions that germplasm development at one institution may make leading to eventual varietal release at another institution are not always recognized.

1. Spring Habit Germplasm Originating from Winter x Spring Crosses

Spring habit wheat developed from winter x spring germplasm through collaborative efforts between OSU and CIMMYT have provided the greatest measurable contribution to developing country wheat production to date. Winter wheats originating from the OSU program are utilized in CIMMYT's winter x spring program. Spring habit varieties developed from this material have been released by national programs in at least 19 developing countries, including the 15 countries noted in the last column of table 2. Ten of these 15 countries have AID missions or AID representatives. Worldwide, it is now estimated that these varieties cover around 10 million ha, or about 10 percent of the total developing country wheat area.

One of the most successful winter x spring crosses was made initially in Mexico in 1973 and 1974 (table 4). Varieties deriving from this cross, the 'Veery' wheats, now cover approximately 5 million ha. In yield tests over many locations throughout the world, they have out-yielded local checks by an average of 8 percent. Furthermore, they tend to maintain their yield superiority under low yielding as well as high yielding conditions. The Veerys, as well as many of the other winter x spring crosses, carry the 1B/1R chromosome translocation from rye, which entered the material through the winter parent. This chromosome is associated with good stress tolerance, particularly for drought. It also confers an initial phase of resistance to all three major rusts, although, as with any such resistance, evolving pathogens

TABLE 4
DEVELOPMENT AND SPREAD OF VEERY WHEATS

Year	
1973	Winter* x Spring cross made at Toluca, Mexico
1974	Initial cross top-crossed with spring line at Obregon, Mexico
1974-1978	Material advanced through Toluca-Obregon shuttle
1978	CIMMYT and worldwide testing through screening nursery begins
1980	Line is an entry in Elite Spring Wheat Yield Trial nursery
1981	First release of varieties selected from advanced Veery lines by some national programs
mid-1980's	Varieties approach maximum area coverage in Mexico
early-1990's	Variety approaches maximum area coverage in Pakistan

*Winter parent identified by OSU program with different genetic properties may eventually overcome this source of resistance.

Area under varieties derived from winter x spring crosses may be expected to increase beyond the levels currently estimated. At the time of the initial national program varietal release from winter x spring material (1981), about 30 percent of CIMMYT's advanced lines consisted of winter x spring germplasm. At present, the figure is about 60 percent. Furthermore, bottlenecks in seed marketing and distribution may contribute to initial slow uptake followed by extremely rapid diffusion. For example, a Veery variety in Pakistan's Punjab covered under 500,000 ha in 1985-86, over 900,000 ha in 1986-87, and is expected to peak at somewhere around 3 million ha in the early 1990s.

Another direct contribution to winter x spring varieties has been the work on aluminum tolerance. Germplasm developed by Brazilian and CIMMYT researchers relied on seedling techniques and gene discovery emanating from the OSU program (page 14). One variety, Alondra, though not truly aluminum tolerant, performed well on acid soils and was released in Brazil in 1980. Ten varieties with true aluminum tolerance were released in the mid-1980s. They have a yield potential above other commercial Brazilian cultivars of approximately 25 percent, and an area potential of at least 1.7 million ha.

2. <u>Winter Habit Germplasm Originating From Winter x Spring Crosses</u>

National programs in Chile and Turkey have released winter habit varieties developed from the winter x spring program. In addition, Argentina, Peru, and Bolivia are very near the release of varieties. One country not defined as 'developing' for present purposes, South Africa, has released a winter variety from the winter x spring program. This cultivar has recorded the fastest increase in adoption of any new winter wheat variety ever released in that country. Furthermore, the 12 countries indicated in column 8 of table 2 have selected material from the now-discontinued IWSWSN for further advancement or crossing. Four of these countries are AID countries. Six additional AID countries have particular potential to use IWSWSN-type materials because they have requirements for either winter habit or cold-tolerant spring habit germplasm. Finally, an additional 22 countries, many of them developed, have also selected such material. There is a very high probability that some of these countries will release other winter habit varieties soon, if they have not done so already.

One major reason that varietal release for winter habit wheats originating in the OSU/CIMMYT winter x spring program has been less widespread than in spring habit wheats is the fact that winter material advances more slowly (one cycle per year, caused by the 10 to 11-month period from planting to harvest) than spring material. Spring material can be advanced two cycles per year by the original shuttle between Toluca and Obregon, Mexico. (Winter material might be advanced more quickly through the use of growth chambers and artificial vernalization, but this is not practical for the advancement of the large number of lines required by a successful breeding program.)

Even for spring materials, the time from initial cross to maximum varietal coverage for the very best lines can be lengthy. The effect of the single cycle advancement per year for winter habit wheats is to double the amount of time listed for advancement in the table. (Four years would become seven or eight years). Another factor that affects eventual varietal release for both winter and spring wheats is that advanced material from international programs may be used for crossing to promote greater local adaptation rather than being selected for varietal release. Selections are usually released as varieties more quickly.

Another reason why the release and diffusion of high yielding varieties may differ between winter and spring wheat environments may relate to gross differences in major stresses. In developing countries worldwide, 60 percent of the winter or facultative wheats are grown in areas where moisture stress is frequent, while only 32 percent of the spring wheats are grown in such environments. The initial impact of high yielding varieties was in areas where variety, water, and fertilizer could interact effectively. The greater stress tolerance of the winter x spring material holds great promise, however, as being one of the keys to unlock higher yield potential in lower moisture areas. On the other hand, the threat of genetic changes in rust pathogens tends to be greater in irrigated environments, shortening useful varietal life and necessitating a faster rate of varietal release. This is one reason it is fortunate that spring lines for many of these environments can be advanced at a faster rate.

3. <u>Developed Country Impacts</u>

The OSU program has greatly increased the international exchange of winter wheat germplasm and winter materials derived from winter x spring crosses. It has been noted that around 20 developed countries have made selections from the IWSWSN. Substantial benefits to developed countries will accrue as the result of this germplasm exchange. More concretely, about 30 percent of the advanced lines now being developed for use in Oregon in white winter wheat are derived from winter x spring crosses. In hard red winter wheat, a breeding effort designed to give Oregon farmers a higher protein alternative that could command a price premium of $10/mt, over 90 percent of the advanced lines are now derived from winter x spring materials.

That this material shows great promise is indicated by the past success of the OSU team in releasing varieties in the Pacific Northwest. One variety (a winter x winter cross) released in 1977 presently covers over three-quarters of the wheat area in Oregon and one-fifth to one-quarter of the wheat area in Washington and Idaho. Because of the concrete benefits realized, and because of an outstanding educational effort on the part of OSU, Oregon farmers are strongly supportive of the OSU breeding program, including the international work. They have raised money that, with a matching grant from the Oregon legislature, has been used to create the first endowed chair for wheat research funded at an American university. (See annex G.)

D. Impact on Target Populations

1. Contribution of Germplasm to Improving the Welfare of Small and Marginal Farmers

A germplasm enhancement program is one of the most effective ways to increase the productivity of USAID's target population, the small farmer. As has often been pointed out, seed, in and of itself, is a technological component that is of neutral scale. It is a relatively small proportion of the farmers' production expenditure and can be utilized effectively by both small and large farmers. Thus, with regard to seed, the thorny question of defining the 'small farmer' may initially be avoided.

The situation is complicated when one considers fertilizer and water, the inputs most complementary to the original high yielding varieties of wheat and rice. Fertilizer, too, is technically scale neutral but other factors, such as credit availability may make it less accessible to the small farmer. (Too, large farmers may have better access to seed than small farmers because of their better education, better contact with extension services, and greater knowledge of where to get it.) In irrigated areas, larger farmers may have greater access to canal water or more ability to invest in groundwater development. These factors, as well as the interaction between new varieties and mechanization, have been hotly debated. The complex interactions between asset distribution in agriculture and technology have often been oversimplified in these debates.

It is often not recognized that evidence exists that smaller wheat farmers in environmentally less favored areas can and have made use of high yielding varieties. In Pakistan, for example, high yielding varieties were first planted in some of the northern rainfed and mountain areas in the early 1970s, without the large-scale campaign that accompanied the initial introduction of high yielding wheat varieties in the irrigated areas. The research system released one semidwarf variety for rainfed areas in 1973. In its zone of adaptation, this variety is now being almost completely replaced by the Veery-derived variety described on page 24, even though this latter variety was initially recommended for use in irrigated areas. This is doubtless a result of the greater stress tolerance of the winter x spring material noted in that section.

2. The OSU Program and Marginal Environments

To the extent that smaller farmers in LDCs live in lower yielding environments,[1] the OSU program is making two major contributions that benefit them. The first is the greater stress tolerances that can be obtained by combining genes from winter and spring materials. This has been discussed in earlier sections. The second is the development of a complimentary program in barley. Major barley growing areas in developing countries are shown in table 3. A large proportion of the barley is grown on more marginal lands in the countries that devote large areas to wheat production. Barley is often grown in areas where wheat production is limited by moisture or a shorter growing season.

As with the wheat program's collaboration with CIMMYT, the barley program is developing linkages with ICARDA. The OSU program concentrates on developing winter habit materials out of winter x spring crosses, while ICARDA emphasizes spring habit materials. Barley regions have not been as completely defined as wheat regions, but OSU is actively collaborating with ICARDA in this exercise.

3. Marginal Environments and Research Returns

It must be clearly recognized that one useful definition of a 'marginal environment' might be one with a lower level of expected returns to research. Programs designed to benefit small or marginal farmers for reasons of equity[2] may show lower rates of return. The art of administration lies in choosing between conflicting goals; it is better if they are recognized from the start.

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[1]That there is not a simple worldwide correlation between farm size, wheat yields, and wheat income can be easily seen by comparing dryland wheat production in the U.S., Canada, Australia, and Argentina with wheat production in the EEC.

[2]There may also be long-run efficiency arguments for projects showing lower rates of return in the short run.

E. Cost/Effectiveness of Project in Accomplishing Program Objectives

1. Objectives, Measures of Output, and Alternative Means of Achievement

The four objectives of the project have been listed above (page 4). Success in meeting these objectives has been documented throughout the report. All of these objectives indicate that OSU is part of an international network improving and distributing improved germplasm in wheat and barley. Worldwide, the benefits of the research conducted by this network may be experienced by producers; by consumers, through lower prices; or by both groups.

The many outputs of the project lend themselves to quantification in different degrees. Germplasm enhancement can have tremendous payoffs that are not always visible, but without it the final release of varieties by national programs or private sector institutions would not be possible. Investment in human capital also has a large payoff. By implementing the training and technology transfer objectives, the OSU project has made this kind of investment. The present and continuing return on this investment is attested to not only by numbers trained, but also by the leadership roles that former students and visiting scientists play in many countries and international organizations.

Evaluation of the economic benefits of the project is likely to be complex. Some of the reasons are outlined in annex H, and others will be discussed immediately below. Many of the benefits are likely to be missed or not measurable. In such situations, the best criterion for economic evaluation is to compare alternative means of meeting the same objectives. Nonetheless, the next section outlines a brief exercise looking at the benefits realized to date in developing country wheat production through the development and spread of winter x spring germplasm.

Evaluation of the returns to research often begins by looking at the changes in consumer and producer surplus as the supply curve for a commodity shifts outward. Within individual countries, given this framework, the relative balance of these benefits is determined by the trade position with respect to the particular commodity. In countries where crops are traded on international markets producers are likely to be the primary benefits of research and extension. Most developing countries growing substantial amounts of wheat are net importers (Table 2). Developing countries growing the largest areas of wheat tend to be near self-sufficiency, however, although they are still more likely to import than to be completely self-sufficient or to export. In self-sufficient countries, using the consumer-producer surplus framework, consumers benefit from an outward shift in the supply curve through lower prices. Producers may benefit or lose depending on relative supply and demand elasticities.

In table 2, using the criteria defined there, one country is an exporter, nine are near self-sufficiency in wheat, and 16 are importers. Of the 15 AID countries, four are near self-sufficiency and 11 are importers. For both the total group and the AID group, only 20 percent of total wheat area lies in the importing countries, because of the dominance of the near-self-sufficient countries in the area figures. If China, India, Turkey and Pakistan are removed, 16 of the 22 remaining countries are importers; two of the remaining 13 AID countries are importers. Furthermore, 67 percent of the remaining total wheat area is now in importing countries, or 87 percent when AID countries are considered alone.

Trade figures for barley are both harder to come by and less reliable, since barley is a less widely traded crop than wheat and production variability from year to year is great in the barley producing countries. In Table 3, however, Turkey, Morocco, and Syria may be net exporters. The other countries do import some barley, or they may be in the self-sufficient category.

In addition to the problems of attributing the gains from research to specific sources, noted in Appendix H, there are complicating factors to using a simple supply-demand framework to analyze research benefits. First, in the short run, world wheat prices are affected as much by U.S. and EEC agricultural policy as by underlying supply and demand conditions. Nonetheless, the long run trend for real world price for wheat is likely to be downward, despite upward movements such as the one initiated this year by the North American drought. As a result, worldwide consumers may be more likely to benefit than producers as the result of wheat research, although, as has been seen, this position is likely to be reversed in many of the developing countries.

Second, policies in the developing countries also affect the measurement of benefits from research. For example, Egypt and Tunisia maintain producer prices for wheat lower than the free trade equilibrium prices, although they import substantial amounts of wheat. In other Middle Eastern countries, producer prices may discriminate in favor of wheat and against barley in areas in which they compete in production.

Third, many small farmers are both producers and consumers of grain. Under assumptions usually made in evaluating research benefits, net social benefits do not change in this situation. Although changes in consumer surplus with an outward supply shift are somewhat less, this is exactly equal to added producer surplus retained by the small producer-consumers.

Fourth, some countries may import grain of a different quality than they produce or export; this also complicates welfare evaluation.

Finally, an added consumer benefit not captured in the traditional economic surplus framework is the reduction in risk that may be possible through increased domestic supply.

2. Benefits From Spring Habit Winter x Spring Wheat and Research Expenditures

As noted, the area planted to winter x spring-derived materials in developing countries has now reached about 10 million ha. Several very crude assumptions, as outlined in annex I, were made in order to answer the following question: Given the benefits realized to date, how much research expenditure on winter x spring wheats could have been justified during the 1970s? These assumptions included an assumed pattern of area expansion as outlined in annex I, a base yield of around 1500 kg/ha, a yield increase of 8 percent attributable to the use of winter x spring wheats, and an opportunity cost of research funds of 15 percent. In addition, countries receiving these benefits were assumed to be net importers. In the absence of detailed information about supply, demand, and trade in the countries involved, foreign exchange savings were used as measure of benefits, rather than changes in economic surpluses.

On the basis of these assumptions, the benefits realized in the 1980s through the use of winter x spring wheats would have justified research expenditures in excess of $10 million each year throughout the 1970s. This figure is far greater than the combined wheat research budgets of OSU and CIMMYT during this period. Furthermore, this result is achieved by discounting benefits in this decade to the previous decade before comparing them with costs in the 1970s. These methods are extremely crude and subject to caution, but the weight of the evidence favors the conclusion that increased production has already brought large returns to earlier research and development in winter x spring wheats.

3. Non-Measurable and Potential Benefits

Within the scope of this review, one of the major non-measurable benefits is the value of the human capital developed through the OSU graduate training program and technology transfer activities. The benefits from these efforts are synergistic with the germplasm development gains as the flow of germplasm through the international system is greatly facilitated by trained individuals in national programs who have collegial relations with individuals involved in the international germplasm development programs at OSU and CIMMYT.

Potential benefits from germplasm enhancement include: further diffusion of spring habit winter x spring materials; diffusion of winter habit winter x spring materials; and diffusion of new varieties within the U.S. or other developed countries. In the first category, area planted has probably not reached a maximum. Even if it had, benefits would continue to flow for some time in the future.

Winter habit varieties derived from winter x spring germplasm, as noted, take longer to develop, but are poised to make their impact in the winter wheat areas of developing countries. In 1984-85, a comparison of materials from OSU and CIMMYT's screening nurseries with local checks was used over all environments (winter and spring) to estimate that with appropriate cultural practices, LDC wheat production could possibly be increased by 38 percent. Using an international wheat price of $176/mt, this would translate into annual benefits of over $10 billion.

These assumptions are overly optimistic since, for example, they assume new varieties emanating from winter x spring material would be planted on all LDC wheat area and would produce the same spectacular yield increases over all that area. Furthermore, it assumes that an increase in world wheat production of nearly 60 million mt would have no effect on wheat prices. It is by no means necessary to make these assumptions to see that potential benefits in winter wheat areas alone can be far in excess of research expenditures. If, for example, wheat production on half of the winter wheat area in LDCs were to increase by only 4 percent[3] as the result of the use of improved winter x spring-derived germplasm, and the world price were assumed to be a more current value of only $124/mt, the value of the increased production would be over $100 million annually. This is certainly far more than necessary to justify the costs of an international network generating improved materials. They will be delayed in realization, however, if disruptions occur in the worldwide network of wheat researchers.

The most likely immediate benefit from the winter x spring program to be felt within the U.S. would be through the introduction of a successful hard red winter wheat for the Pacific Northwest, although, as noted, some advanced lines in the soft white program also derive from winter x spring crosses. One hard red winter wheat from the OSU program is near release (see

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[3]The figure of 4 percent in winter areas, as opposed to the 8 percent figure used for spring wheat areas, is intended to reflect possibly less favorable growing conditions in the former.

p. 18). Assuming that Northwest growers of hard red wheat can meet the same quality levels as those reached by farmers in the Great Plains, and that market demand for hard red wheat continues to grow in the Pacific Rim countries, this would offer substantial returns to Northwest growers because of the premium price of hard red wheat. Over 50 percent of the wheat shipped out of Portland is now hard red, mostly from the Rocky Mountain states. Northwest growers could obviously compete with respect to transportation costs if they meet the high quality standards. OSU researchers project that hard red winter wheats could potentially cover 20 to 30 percent of Oregon's wheat acreage.

4. Alternative Means of Producing OSU Project Outputs

The success of the OSU project in meeting or progressing toward the stated objectives could be weighed against other ways of meeting these objectives. Some alternative means are considered briefly here.

a. Collection, Evaluation, Enhancement, and Dissemination of Wheat and Barley Germplasm

The collaborative winter x spring wheat program between OSU and CIMMYT has worked well in the past, and has already produced substantial benefits for wheat producers in developing countries. Alternatives to this system would be to develop a network of collaborators (U.S. universities and other institutions worldwide, plus CIMMYT), or to vest all responsibilities for winter as well as spring wheats at CIMMYT. The review team was impressed with CIMMYT's strong degree of support for the present arrangement (see p. 17). Some reasons for this support may be the following:

- The OSU collection of over 10,000 facultative and winter accessions is valuable because it adds recent varieties and selections from active research centers worldwide. OSU has received materials from many countries that in the past might not have shared materials, often due to political reasons. CIMMYT also enjoys this relative freedom from political considerations in the exchange of germplasm, but it would be difficult to duplicate it elsewhere in the developed countries. Although CIMMYT-Mexico has an advantage in making initial winter x spring crosses, in the opinion of CIMMYT wheat program administrators it would be difficult to maintain a large winter wheat collection there because of the limited environment for winter-habit wheats within Mexico. Such a winter wheat collection would probably have to be maintained in Turkey, and would require a substantial strengthening of the Turkish national program staff and storage facilities. The value of the current arrangement can be attested to by the fact that CIMMYT breeders based in Turkey frequently request material from OSU.

- OSU combines the process of germplasm enhancement with an advanced degree training program. This combination of a practical breeding program with degree training could not be duplicated at CIMMYT, and would be difficult to reassemble at another university.

- The logistical aspects of the winter side of the program have been organized very well, enhanced both by the computerization of the OSU program and by the cohesive, dedicated staff at OSU. In the opinion of CIMMYT personnel, the CIMMYT/Turkey winter wheat program is complementary, not competitive with OSU. The CIMMYT winter wheat program in Turkey is fairly recent and the Turkish national program is in the process of reconstituting itself after the departure of several senior researchers to the private sector.

In the opinion of the review team, the development of an equivalent system of winter germplasm collection, evaluation, enhancement, and dissemination elsewhere would result in annual costs far more than current or past annual expenditures by the OSU project because of the substantial amount of human, organizational, and physical capital built up at OSU. If an alternative system for the future is desirable, the transition should be planned over a sufficient period of time--say, five years--and not done abruptly or by default. If possible, however, stronger ties should be forged with universities in the Great Plains region of the U.S. having interests in winter wheats.

Specifically, the OSU team is now composed of ten individuals who have some responsibilities for the winter x spring project. Several assumptions can be made; where possible, they will be made fairly conservative. First, assume that on average project staff divide their time between the winter x spring project and more specific Oregon-related activities roughly in accordance with the current budget allocation. That is, half their time is spent on winter x spring project activities. Second, exclude the two senior plant breeders from consideration on the assumption that their activities would be covered by the current CIMMYT/Turkey or ICARDA staffs. This assumption is the first conservative one. Then assume that the resulting four person years would be shifted to international staff based either at CIMMYT/Turkey or ICARDA/Syria. Ignoring salaries, and making another somewhat conservative assumption that it costs roughly $10,000 per person/month to support international staff overseas would result in an annual expenditure of $480,000. This is some $130-$140,000 higher than the entire current USAID allocation to the winter x spring project. In the long run, of course, this kind of expenditure could be reduced by greater reliance on national program staff in the countries in which the international centers are working. This reliance would be justified if a directed, long term effort were made to rebuilding national capability, particularly in Turkey.

The barley component of the project is of very recent origin. Collaboration with ICARDA has been initiated and is likely to increase in the future. The direction the barley program takes in germplasm development will be very much determined by the strength of a long-term commitment to funding.

b. Provision of Meaningful Graduate Training in Various Aspects of Cereal Improvement

The combination of advanced graduate training with practical work in cereal improvement make the OSU program very difficult to duplicate elsewhere. The synergy from this combination has contributed to its cost effectiveness. This kind of training is likely to be of very high value to students from LDCs in the foreseeable future.

In recent years it appears that perhaps $40-$45,000 of USAID funds are used directly or indirectly for graduate student research; an additional $14,000 goes directly to tuition. Through leveraging of funding from other sources, the OSU program has been able to support around 15 graduate students in winter x spring activities. Dividing $60,000 by 15 gives an annual expenditure of around $4000 in USAID funds per student per year. If USAID bears the entire cost of a year of graduate training at a U.S. university, on average the expenditure is over $20,000. It is the USAID support of the winter x spring project, however, that has been the main factor in OSU's ability to obtain graduate student support from other sources.

c. Establishment of New and Expansion of Existing Relationships With LDC, Developed Country, and International Donors, Agencies, and Wheat and Barley Research Centers

In the opinion of the review team, these relationships have been developed in a cost effective manner, but important linkages have been loosened due to funding reductions. International travel to visit collaborators or hold workshops, and the IWSWSN were relatively low-cost items with high payoffs. (See pp. 22-24, table 1, and annex F.) Alternative ways of funding these activities might be explored. For example, CIMMYT might take a more active role in organizing and funding workshops of the type originally sponsored by OSU. Title XII strengthening grant funds might be another way of financing international outreach travel.

d. Transfer of Technology by Serving as a Resource Center for Various Aspects of Cereal Improvement

This has been a very low-cost activity as many visits to OSU are sponsored by other institutions, e.g., visits by public or private wheat breeders from developing countries. Consultancy visits by OSU personnel depend very much on the interest of USAID missions and coordination with CIMMYT and ICARDA.

SECTION IV

CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

- A comfortable working relationship exists between OSU and CIMMYT to the mutual benefit of both organizations. The shuttle testing program between CIMMYT/Mexico (two sites), CIMMYT/Turkey, and Oregon enable shortened generation intervals and a much greater selection pressure than could be achieved at any one site. The obvious advantage to such a testing program is the creation of varieties of wide adaptability.

- The strong support expressed by Dr. Rajaram, CIMMYT's bread wheat breeder, and by Dr. Gene Saari, a wheat breeder from the CIMMYT/Turkey program, during the review documents the significant contributions of the OSU winter x spring wheat program to international wheat improvement programs.

- Collegial rapport among OSU's cereal research personnel is outstanding. Staff members are supportive of each other and of the graduate students.

- Significant new evidence is accumulating that the genetic diversity generated by crossing winter x spring gene pools has already substantially improved spring wheat yields in LDCs and that the impact on winter wheat yields has begun and will accelerate during the next five years.

- Fifteen graduate students are currently enrolled in the program with three receiving stipends from AID project funds and others receiving thesis research support. Minimal AID funds have been well used to leverage support for an extensive graduate student training program.

- The Micro Computer Data Base Application for Cereal Breeding Research program has made a significant contribution to the management of breeding data and germplasm collection. The portability of the system for field use enables scientists to discard unpromising lines in the field and devote more time to the more promising lines. All staff in the wheat and barley program at OSU utilize the system. CIMMYT/Turkey is utilizing the software package and Tunisia and Yemen have requested the program and each have a person at OSU being trained in it.

- Financial support by the Oregon Wheat Growers League amounts to about 27% of the cereal research budget. They recently provided $500,000--together with a matching fund by the Oregon Legislature--to endow a wheat research chair at OSU. Dr. Warren Kronstad, manager of this project, was appointed to the chair. The Wheat Growers League is vocal in support of the international aspects of the program and feel it is benefitting from the sizeable collection of barley and wheat enhanced germplasm at OSU.

- Considerable progress has been made in the improvement of spring wheat largely due to the introduction of winter wheat germplasm. A shorter generation interval enables more progress to be made in a briefer period of time in spring wheats.

- Spring wheat developed from winter x spring germplasm through this collaborative effort has resulted in varietal releases by 19 national programs--10 with AID programs. It is estimated that about 10 million hectares, or ten percent of the developing country wheat area, are planted to these improved spring wheat cultivars.

- Improvement in the winter wheats has been somewhat slower due to the vernalization requirements and consequent longer breeding cycle. Several very promising lines are in the advanced testing nurseries, but will require approximately five more years before release to LDC plant breeders.

- Four countries with AID programs are using winter habit germplasm in advanced crossings and six additional countries have potential for utilizing the germplasm.

- Chile and Turkey have released winter habit wheat developed through this collaborative effort and Argentina, Peru, and Bolivia are very near variety release. South Africa has released a cultivar that has been adopted at an unprecedented rate.

- Of the 15 AID program countries, 4 are nearing self-sufficiency and 11 are importers.

- The benefits of the research conducted by OSU as a part of the international network will be experienced by both producers and consumers. The extent of the benefits will be related to the agricultural policies of the major exporters as well as the developing countries.

- The OSU collection of over 10,000 facultative and winter accessions is a valuable asset. Many countries have shared materials with OSU as a part of an international network, that, in the past, might not have contributed for political reasons.

- OSU holds a unique position in wheat and barley breeding efforts. While CIMMYT/Mexico has advantages in making initial winter x spring crosses, they have limited environment for winter habit wheats. Winter wheats could be maintained in Turkey, but would require substantial strenghthening of the Turkish national program.

- The current contract arrangement with OSU appears to be less costly to AID than doing similar work through and international institution.

- The barley germplasm enhancement program has just begun; however, with breeding technology being develop in the project, more productive barley cultivars could be found within the next five years.

- Improved wheat and barley varieties with disease and pest resistance and higher production capability will benefit the small farmers even without the use of other inputs. Barley in particular will benefit small farmers in the more marginal areas where wheat may be limited by moisture or a short growing season.

- The repeated visits of wheat and barley breeders from LDCs to Oregon breeding nurseries is a testimony to the value they place on the materials being developed by OSU.

- Utilization of distributed germplasm has been significantly limited by a drastic reduction in funding for travel. A breeder needs to see the materials in the field at appropriate intervals and discuss performance with cooperating breeders.

- The international screening nursery and the in-country symposia, a part of the previous project, were not funded in this project. This has materially reduced the impact and slowed the utilization of the improved germplasm.

B. <u>Recommendations</u>

1. The OSU/USAID winter x spring cereals program has had a significant impact on both spring and winter wheat germplasm. Enhanced spring wheat germplasm has moved

rapidly through the CIMMYT breeding program as evidenced by the fact that 60 percent of CIMMYT-advanced germplasm contain parentage from winter x spring wheat crosses. Several spring wheat varieties from this program have been released and occupy significant acreage in LDCs. The enhanced winter wheat germplasm requires a longer breeding cycle and is just now poised for a significant impact on winter wheat production. We therefore recommend that project funding be continued for at least five more years to allow time for the full impact of the project on the winter wheat production areas in the world.

2. The winter x spring barley program has made rapid progress in a relatively short time. The balance between new genetic technologies and more conventional breeding approaches is appropriate for a program aimed at serving both LDC and US clientele. The focus on developing new breeding technologies for an under-researched crop such as barley, which will also fit the overall breeding strategy for LDC winter barley improvement, is commendable. We recommend continuation of the germplasm enhancement program in winter barley with special emphasis on utilization of new genetic technologies that can be productively integrated with the crop improvement training and network building activities.

3. Continuity of funding is important in crop research programs. We recommend a five-year funding horizon for the project with a mid-term review to assess future funding beyond the five-year contract. Promising new areas for winter wheat and barley research should be incorporated into the redirected future project.

4. The utilization of the enhanced germplasm for wheat and barley cultivars is seriously hampered by the lack of travel funds for OSU staff to visit international screening nurseries, conduct in-country symposia and visit LDC cereal breeders. It is strongly recommended that funds be included in the project for such travel or that USAID project management seek other funding to assure rapid utilization of advanced breeding lines in LDC breeding programs and to provide OSU staff with feedback from LDC breeders on adaptability of breeding lines.

5. The OSU/CIMMYT/Turkey - CIMMYT/Mexico linkages have provided excellent opportunities for evaluating materials under different stresses and for developing photoperiod insensitivity. Nonetheless, the winter wheat growing environment of the Great Plains region of

the U.S. is particularly well suited for winter wheat types broadly similar to those grown in the West Asia/Mediterranean region of the developing world. We recommend increased collaboration with appropriate Great Plains universities in the interest of providing more in-depth screening opportunities and occasional alternative degree training opportunities for wheat scientists from LDCs.

ANNEX A

SCOPE OF WORK

Project Title: Spring & Winter Wheat

Objective: To provide a technical team of three experts to assess the degree of progress of the goals and purposes of project 931-0621, especially since January 1986, and make recommendations as appropriate.

Statement of Work:

The team will answer the following questions:

1. What progress has been made in relation to the intended outputs of the present cooperative agreement?
2. Has the germplasm bank been expanded and the computerized data bank developed for the compilation of data regarding varieties/lines to be utilized by plant breeders for crosses directed towards a specific goal? Is this data bank being utilized by plant breeders in LDCs?
3. What is the volume of the germplasm exchange to LDCs and developed countries? How important is the germplasm to LDC plant breeders? Are there other similar sources of germplasm available to LDCs?
4. What is the acreage planted to improved wheat varieties that has incorporated the project's enhanced germplasm and where are the major areas?
5. Has this project had any effect on AID's major target population, the small farmer?
6. What progress has been made in training? How many research workers have been trained under this research project? What is the impact of previous OSU trainees in LDCs?
7. What is the value of the networking activity of the project which OSU established with LDCs, IARCs, other international organizations, the US and other countries?
8. Describe the linkages of this project to other central and bilateral AID projects, e.g. tissue culture project, IBSNAT and post-harvest grain systems project.
9. Determine the cost/effectiveness of the project in accomplishing program objectives. The team will be expected to describe and evaluate the system put in place to develop and disseminate winter wheat germplasm. As appropriate, measures of effectiveness will be developed and compared to the unit cost of producing the program objectives. To the extent possible, an internal rate of return will be estimated for the project.

10. Determine the progress of the project since the last evaluation in 1985 and determine the degree to which the project has followed its recommendations.
11. The team will make recommendations as to future program directions considering the project's demonstrated or potential impact in the LDCs in light of the present and estimated future supply/demand conditions for wheat and barley; and the project's agreement with ST/AGR Office's Guidance Message Paper.

In order to perform this evaluation, the review team will:

a. Review background information such as Cooperative Agreement, budget/obligation information, scope of work, trip reports, quarterly progress reports, research reports, data bank, OSU survey regarding use of their germplasm, statistics regarding wheat yield increases in OSU cooperative LDCs.
b. Review the PP, extensions, program description annual work plans and previous evaluations.
c. The team will visit the OSU facilities in Corvallis, Oregon and their research stations.
d. Review CIMMYT's and ICARDA's evaluation of the project.
e. Review cables from Missions stating how they or their host-country national plant breeders evaluate the project.

ANNEX B

INDIVIDUALS INVOLVED IN THE REVIEW AND THEIR ITINERARY

OSU Administrative Officers

Dr. John V. Byrne	President, Oregon State University
Dr. George H. Keller	Vice-President for Research, Graduate Studies and International Programs
Dr. Roy G. Arnold	Dean, College of Agricultural Sciences
Dr. Mike J. Burke	Associate Dean, Resident Instruction, CAS
Dr. Ed C. Price	Associate Dean, International Programs

Department of Crop Science

Dr. Sheldon L. Ladd	Head, Department of Crop Science
Dr. Warren E. Kronstad	Project Leader & Professor, Wheat Breeding & Genetics
Dr. Patrick M. Hayes	Assistant Professor, Barley Breeding & Genetics
Dr. Steve L. Broich	Research Associate, Quality Evaluation
Ms. Nan H. Scott	Senior Instructor, Computer Applications and Software Development
Ms. Ann E. Corey	Senior Research Assistant, Barley
Mr. Randy W. Knight	Senior Research Assistant, Field Operations
Ms. Connie S. Love	Research Assistant, Plant Pathology
Mr. Mike D. Moore	Research Assistant, Seed Multiplication
Ms. Sonnia E. Rowe	Research Assistant, Administration
Ms. Mary C. Verhoeven	Instructor, Spring Wheat
Ms. Debbie K. Kelly	Durum wheats, Quality lab assistant
Ms. Karen I. Goulding	Secretary
Ms. Kathy T. McCarthy	Secretary

Off Station

Dr. Betty L. Klepper	ARS, Research Leader, Columbia Basin Res. Center
Dr. Richard W. Smiley	Superintendent, Columbia Basin Res. Center
Mr. Mat Kolding	Cereal Breeding
Mr. Mike Stoltz	Umatilla County Agent
Mr. Larry Kaseberg	Wheat Producer, Wasco
Mr. Frank Tubbs	Wheat Producer, Adams
Mr. Stan Timmermann	Oregon Wheat Commission
Mr. Ivan Packard	Oregon Wheat Commission
Mr. Quinton Rugg	Wheat Producer, Adams
Mr. Wes Grilley	Oregon Wheat League
Mr. Scott Duff	Oregon Wheat League
Dr. Norm Borlaug	CIMMYT
Dr. Al Scharen	ARS, Montana State University
Dr. Robert Ziegler	CIAT
Dr. S. Rajaram	CIMMYT

ITINERARY FOR USAID REVIEW TEAM

Monday, July 11, 1988

Arrive Corvallis. Lodging at Nendels.

Tuesday, July 12, 1988

8:30 a.m. Review itinerary - Crop Science Room 119

9:30 a.m. Meet with College of Agricultural Science Administration:
- Dean Roy Arnold
- Associate Dean Mike Burke, Resident Instruction
- Associate Dean Ed Price, International Programs
- Associate Director Calvin Koong, Ag. Experiment Station
- Professor Sheldon Ladd, Head, Crop Science Dept.

10:45 a.m. Dr. George Keller, Vice-President for Research, Graduate Studies and International Programs

1:00 p.m. Wheat Review - Crop Science Room 119:
- Oregon State University - Dr. Warren Kronstad
- Computerization - Ms. Nan Scott
- CIMMYT Program - Dr. S. Rajaram
- CIMMYT-Turkey - Dr. G. Saari
- Exchange of Germplasm - Dr. Norman Borlaug

3:00 p.m. Wheat Survey - Dr. Bob Mason, Study Director, Survey Research Center

3:15 p.m. Discussion

3:45 p.m. Break

4:00 p.m. Barley Program - Dr. Patrick Hayes

4:30 p.m. Tour of Campus Facilities:
- Doubled Haploid Laboratory - Dr. Patrick Hayes
- Cereal Quality Laboratory - Dr. Steve Broich
- Cereal Pathology Laboratory - Ms. Connie Love
- Greenhouse and Growth Chamber Facilities - Mr. Mike Moore

Wednesday, July 13, 1988

8:00 a.m. Graduate Training Program - Crop Science Room 119

8:30 a.m. Student Poster Session - Crop Science Room 138

10:30 a.m. Tour of Hyslop Farm - Mr. Randy Knight

3:00 p.m. Tour of East Farm and Chambers' Farm

Thursday, July 14, 1988

8:00 a.m. Leave for Eastern Oregon

2:00 p.m. Visit Hermiston Branch Experiment Station - Mr. Mat Kolding

7:00 p.m. Reception and dinner with representatives of wheat industry -Growers Oregon Wheat League, and Oregon Wheat Commission. Lodging at Tapade Motel.

Friday, July 15, 1988

8:00 a.m. Visit Columbia Basin Research Center (Dr. Betty Klepper and Dr. Dick Smiley) and Ruggs' Experimental Site (Mr. Quinton Rugg).

Travel to Biggs Junction. Lodging at Riviera Motel.

Saturday, July 16, 1988

8:00 a.m. Visit Kaseberg Experiment Site (Mr. Larry Kaseberg) and the Sherman Branch Experiment Station

Visit Central Oregon Experiment Station and return to Corvallis

Sunday, July 17, 1988

Free day. Several touristic options.

Monday, July 18, 1988

Write report (Crop Science Room 119)

Tuesday, July 19, 1988

Write report and review with OSU personnel (Crop Science Room 119)

Wednesday, July 20, 1988

Depart Corvallis

ANNEX C

SPRING X WINTER CEREALS 1985 EVALUATION

Recommendations	Notes on Action Taken
1. That the senior staff in breeding/genetics be increased in order to reduce the student/faculty ratio, broaden student research, and provide greater depth of expertise for the guidance of graduate students.	1. Budget reductions have prevented the addition of senior staff. The student/faculty ratio has been reduced by not accepting additional students. Also, representatives of the International Centers (CIMMYT and CIAT) and Dr. Al Scharen, ARS, USDA, Montana State University are serving on the graduate faculty for this project. This has strengthened the expertise available, especially in the cereal plant pathology area. Patrick Hayes replaced Willis McCuistion on the project and is carrying a greater role in the graduate training program.
2. Due to the importance of disease resistance in the breeding objectives, we recommend strengthening the research and graduate teaching by closer collaboration with plant pathologists.	2. Ms. Connie Love, who received her graduate training at Washington State University in cereal plant pathology joined the project. Her research includes foliar diseases and some of the root rot complexes. She is also working closely with several of the graduate theses where pathology is involved. Also Chris Mundt of the Botany and Plant Pathology Department, OSU and Al Scharen from Montana State University are closely involved with the project. Also, a cooperative research program with Dallice Mills in the Botany and Plant Pathology Department focusing on Smut diseases of wheat has been ongoing for many years.

3. That the importance of insect resistance and forage utilization of wheat in the LDCs be evaluated and that these objectives be included in the spring x winter wheat breeding program if such steps appear justified.

3. In a recent survey of the cooperators, insect resistance was not regarded as a major limiting factor internationally. Work has been established regarding resistance to the Russian Aphid and a long term program has been in place looking at the Oat Cherry Bird Aphid and the Greenbug as vectors for Barley Yellow Dwarf Virus disease of both wheat and barley. Also cooperative work with an entomologist at OSU (Glenn Fisher) and at WSU (Keith Pike) have been established.
No work has been undertaken to evaluate forage quality.

4. Considering the harsh climates in which winter wheats are grown in many LDCs, the team suggests that breeding for stress environments be intensified, and that close cooperation be established with the research group working on drought tolerance at the Columbia Basin Research Center, Pendleton.

4. The breeding effort for stress environments was increased, especially as topics for graduate student theses. Also a study was initiated to study drought tolerance focusing on possible molecular and physiological mechanisms involved. A 28 Kd protein was observed to accumulate in the cell walls of selected wheat cultivars under moisture stress. This may provide a selection criteria for breeders. Screening nurseries were established at four additional sites to further evaluate abiotic and biotic stresses. A variety x environment interaction is being investigated at the dryland site at Moro, Oregon. These experiments focus on identifying possible limiting factors associated with no-till systems to avoid soil erosion.

5. That OSU consider the need for putting together a package of production practices that may be utilized in order that varieties developed through the winter x spring wheat breeding program will produce up to their maximum genetic potential.

5. Prior to the budget reductions and the addition of barley to the objectives of the program, the project held in-country symposia in Peru, Tunisia, and Argentina. A fourth program was being developed for Pakistan prior to the reductions. These symposia covered all phases of the cereal program varying from breeding, pathology, weed control, management practices, extension methods, marketing and seed multiplication. The proceedings were published in two languages appropriate to the specific countries.

6. In view of the large number of countries cooperating with OSU in the winter x spring wheat improvement program, we suggest that additional workshops be conducted to disseminate information about utilization of the new germplasm among national research workers. The workshops will assist in development of a network among national research programs.

6. This was covered in the in-country symposium that was previously mentioned and had to be dropped due to budget reductions. The in-country workshops or symposia also included staff members from international centers, other national programs and Oregon farmers in an effort to provide desired and appropriate expertise.

7. That current training programs for participants be examined and, if considered desirable, that OSU participate in conducting the training programs.

7. The OSU Winter x Spring Cereals Program would be willing to expand both the degree and non-degree programs. In addition to the current graduate program, a number of senior scientists have visited the program, including a group from Pakistan where a formal short course was developed for them.

8. That the project would benefit from additional travel by senior staff to LDCs for monitoring the utilization of improved germplasm, for workshops and training programs, and for one-on-one contacts with wheat scientists in the National research Programs.

8. The OSU Winter x Spring Cereals program strongly agrees with this recommendation and places a very high priority on such interactions.

Unfortunately budget constraints have severely limited international travel.

9. The OSU program has been hampered by lack of continuity in funding. A long-term commitment in funding is needed due to the long term nature of the research. Long-term funding will permit planning for germplasm enhancement, facilitate germplasm utilization os that improved varieties finally reach the farmers' fields, and maintain continuity in the graduate teaching program.

9. This has been a major constraint to the program. The uncertainty of the future of the program has made it difficult in accepting graduate students, maintaining staff and moral of the people involved. The original mission involving wheat germplasm enhancement, graduate and non-degree training and the in-country symposia was effective in meeting the needs of both identifying and developing appropriate technology and disseminating it in a manner so it could be adapted by farmers in LDCs.

10. From our review of the USAID/Montana State University barley research program, we find that MSU is confronted with problems similar to those identified at OSU. We also observed that the two programs are complementary in certain aspects. Whereas, the MSU program is supported by a strong plant pathology staff but is weak in breeding support, the OSU program contains a strong breeding component and is weak in plant pathological support. Therefore, the Review Team strongly recommends that OSU and MSU examine the possibility of developing a cooperative program, and together with appropriate International Research Centers develop a network among LDC countries for cereal improvement.

10. Dr. Al Scharen, ARS, USDA located at Montana State University has become a vital part of the OSU program. He is highly regarded for his expertise in foliar pathogens and especially Septoria spp. He served both on graduate student programs and interacts with the project research activities as well.

ANNEX D

SPRING X WINTER CEREALS (BARLEY AND WHEAT) PROJECT

(Quarterly Report Prepared April 14, 1988)

Project Purpose:

Interdisciplinary research and training program to enhance germplasm of selected cereal grains for less favorable environments in LDCs.

Major Project Outputs	Status to 9/30/87	Current Year Action
1. Maintenance and further development of the computerized germplasm bank	Micro computer software and network hardware purchased and installed. A database has been developed to keep track of current entries in the bank and in the breeding program as a whole. An on-line query system was developed to allow researchers to extract a particular subset of data rather than searching through printed data summaries. Project personnel were trained in the use of the computer to increase efficiency. More than 4000 candidates for the germplasm bank were evaluated. Outdated and less useful germplasm was culled and cold storage was reorganized. The germplasm bank currently consists of more than 5000 entries.	Main frame applications to manage field books and record keeping have been converted to MSDOS. Programs were written for the micro-computer network which track progeny from individual parental combinations over years. Approximately 800 new introductions were planted this fall from several foreign locations for evaluation and possible addition to the germplasm bank. Disease and agronomic data were added to the database for current entries in the germplasm bank.

Major Project Outputs	Status to 9/30/87	Current Year Action
23,000 new spring x winter wheat crosses for increased genetic diversity.	Previous year's restrictions on seed shipment from Mexico due to the disease Karnal Bunt have been avoided by making initial crosses at Toluca, Mexico rather than at Obregon. Crossing strategies are now focusing on more durable type disease resistance. Much of the winter parental material used in winter x spring by CIMMYT scientists for crosses represents enhanced germplasm from the OSU winter program. Significant improvement in Septoria spp. and Yellow Dwarf Virus resistance has been realized in the winter material. Acceptable levels of resistance to these diseases have not been previously achieved. Yield and yield stability also appear to be contributions by the OSU developed parental materials.	94 top cross populations and 788 F2 masa populations were planted representing spring x winter material. Several of the top cross parents represent new cultivars from Russia and the People's Republic of China. Also, a number of lines from eastern bloc countries appear to have good combining ability. Facultative lines from Argentina have proven to be good parents for enhanced protein. In addition, 205 F1s and 94 top crosses were planted for further evaluation. The source of parental material for these crosses came from the introduction nurseries which consisted of 525 lines from 10 countries. Data collected on entries in winter crossing block and Winter X Spring F1s growing at CIANO, Obregon, Mexico. Information will be used in making single and 3-way crosses in Oregon this May as the same populations are available. Most agronomically superior lines in CIMMYT winter crossing block are represented by winter germplasm enhanced at Oregon State University. Currently, 10 million hectares of spring cultivars developed by CIMMYT contains genetic material enhanced through the Oregon State program.

Major Project Outputs	Status to 9/30/87	Current Year Action
3.50 new breeding lines with superior bread quality.	In cooperation with the Western Wheat Federal Quality Laboratory, greater emphasis is being placed on protein quality as well as quantity. Electrophoresis banding patterns of the high molecular weight subunits of glutenins and gliadins have proven to be useful techniques in identifying promising parental lines and superior progeny in terms of enhanced protein. Now all international crossing blocks and selected F4s sent are being evaluated in such a manner. Materials introduced from Argentina appear to have excellent quality based on both the electrophoresis and subsequent baking tests.	A total of 1163 advanced breeding lines of winter and facultative wheat were introduced and planted this fall. The largest percentage of introduced germplasm came from Argentina, Bulgaria, Chile, France, Iran, Pakistan, People's Republic of China, Turkey, Mexico, and Syria. Also, 20 lines of barley were received from Russia. A minor amount of material was received from other countries including four lines from South Africa reported to have resistance to the Russian Aphid. Also to broaden the program, a winter durum crossing block and F2 masa populations were received from Mexico. Winter durum lines are also being received from Turkey and Nebraska. The germplasm collection is being catalogs as to agronomic and quality attributes with the information being put on floppy discs for accessability. Quality data including total grain protein and high molecular weight sub-units of glutenins can be obtained using electrophoresis. Hardness and sedimentation tests are being conducted on the most agronomically superior plant types.

Major Project Outputs	Status to 9/30/87	Current Year Action
4. The International Winter X Spring Wheat Screening Nurseries (12th - 15th)	Early and late maturing screening nurseries representing the 14th were sent to 111 cooperators. Results were summarized and sent to cooperators from the 13th screening nursery. The rate of return of data continues to run above 70%, which is excellent. Those not returning data had problems with quarantine laws or for some other reason did not plant the material. A large number of lines continued to outperform local check varieties. Most cooperators have selected lines for increase and further testing. Crossing blocks, F2 populations and selected materials with specific attributes were sent upon request with special emphasis given to LDC countries. The early and late section of the 15th screening nursery was sent to cooperators in the southern hemisphere in January of 1987 and to the southern hemisphere in June. The 14th screening nursery (early and late) were harvested at three locations in Oregon this summer. Data input has begun for analysis of the 14th nursery.	Late and early maturing F3 bulked lines or F4 seed were selected at the Pendleton site. This material was sent to 118 locations to further strengthen the regional CIMMYT-ICARDA effort in Turkey. 706 bulked F3 lines were sent for further selection and distribution. Additional requests are being received for crossing blocks and other populations. A new dimension to the program has been the systematic crossing of spring durum wheats with emphasis on the winter or facultative types. This effort will complement the bread wheat program. Data from the 14th IWSWSN, both Early and Late, were analyzed, summarized and printed. Results again reflect that a large number of entries were selected to be incorporated into national programs.

Major Project Outputs	Status to 9/30/87	Current Year Action
5. Development of early maturing cultivars for incorporation into a system of double or triple cropping annually.	Emphasis has been placed on materials from the People's Republic of China and daylength insensitive materials with acceptable levels of winter hardiness to modify the life cycle of the wheat plant. Days to flowering and rate and duration of grain filling period have been adjusted through selections to meet the needs of specific areas. Favorable responses have been received from cooperators regarding this material. Additional effort is also being conducted to identify lines which are better adapted to management systems to control water and wind erosion.	F3 bulked populations were selected on the basis of early maturity. These have been sent to cooperators in the Northern hemisphere. Current research is ongoing with regard to early maturity and acceptable winter hardiness levels along with frost tolerance. Data were obtained on winter hardiness levels of the F3s, F5s, F6s, and yield trials at the Pendleton site. Severe moisture stress continues at the Moro Site. A molecular approach to studying drought tolerance was initiated using what appears to be drought shock protein which are expressed in the cell walls.

Major Project Outputs	Status to 9/30/87	Current Year Action
6. Training of full time students from LDCs for M.S. and Ph.D. degrees. Fifteen students will be trained during this funding period.	Seventy graduate students have received or are receiving their M.S. or Ph.D. degrees. Currently, there are 15 students in the program with the equivalent of three assistantships being provided by this project. Research support has been provided to other students who receive their stipends from other funding sources (FAO, R.F.,etc.).	During the period, one student completed his Ph.D. degree and 2 completed their M.S. degrees. All have returned to their respective national wheat improvement programs.
7. Training of 5 non-degree cooperators and visiting scientists.	Two Yugoslavian scientists spent about one year each in training and have returned to their home country. The scientist from North Yemen, not funded on this grant, returned to his country. 20 visiting scientists from Pakistan toured the program this summer and attended as series of lectures on plant breeding provided by the project.	No new visiting scientists have arrived during this quarter.

Major Project Outputs	Status to 9/30/87	Current Year Action
8. Linkages with facultative and winter wheat and barley scientists in LDCs and major cereal breeding centers of the world.	Fifty-five researchers working with facultative and winter barley in 47 countries contacted. In 1986/1987, germplasm received from twenty cooperators in fifteen countries. A network of forty cooperators established for germplasm evaluation and exchange. A paper was presented on applications of doubled haploid techniques to winter and facultative barley germplasm enhancement at ICARDA/Turkey symposium on winter cereals in stress environments (Ankara, July 6-10, 1987). As a result of Ankara symposium, linkages expanded to include target AID countries in the Middle East and North Africa: India, Jordan, Lebanon, Morocco, Nepal, Pakistan, Tunisia, and Turkey. Non-target countries that may be key sources of useful stress tolerance genes were also enrolled in the network. The barley network complements the established wheat network which now involves 117 locations in 51 countries. In some instances similar national programs are involved for both wheat and barley.	Barley research network nourished and expanded to include 46 cooperators representing developed and developing countries. Germplasm from target and non-target AID countries evaluated, enhanced, and distributed. .A multi-disciplinary approach for cereal enhancement in the semi-arid regions of Tunisia and the OSU winter/spring wheat and barley program was signed in November. Funds for this project will be provided through USAID and managed by the MidAmerican International Agricultural Consortium's Agricultural Technology Transfer Project. An invitational paper on enhanced genetic viability resulting from Winter X Spring wheat crosses was presented at the first National Wheat Symposium held in Mexico.

Major Project Outputs	Status to 9/30/87	Current Year Action
9. Evaluation of 1000 barley cultivars and advanced lines representing diverse germplasm from different growing regions.	In the 1986/1987 season, 353 cultivars and advanced lines were evaluated. Approximately 65% of these introduction lines were advanced for further evaluation and for use as parents in the crossing program. Lines were characterized for maturity, winter hardiness, growth habit, disease resistance, and selected agronomic traits. For the 1987-88 cycle, 120 introductions were received as of this date.	198 advanced lines and cultivars planted in the 1987/1988 introduction nursery. Nursery rated for winter survival. An additional 113 entries arrived too late for planting and will be evaluated in the 1988/89 cycle. One year of systematic characterization of cold tolerance in 10 lines of diverse genetic and geographic diversity completed. Temperature lethal to 50% of the population (LT_{50}) computed for each genotype at each of four sampling dates. LT_{50} values ranged from -3° to -14° C. This study identified USSR germplasm as source of full-season cold tolerance need in LDC high elevation stress environments.
10. 250 to 300 single crosses annually between lines representing winter and spring barley gene pools and 100 to 150 top or double crosses of winter x spring F1s to facultative or winter type barleys.	A total of 289 crosses with potential for the germplasm enhancement effort were made in the field. Of these, 132 represented three-way crosses of winter or facultative parents with the spring x winter F1s provided by ICARDA/CIMMYT. An additional 96 crosses for doubled haploid recurrent selection population synthesis were made in the greenhouse.	262 spring x winter F1s from CIMMYT/ICARDA planted in November, 1987. Differential winter injury observed.

Major Project Outputs	Status to 9/30/87	Current Year Action
11. Multi-location testing sites and a shuttle system of breeding between locations to identify desired progeny of barley with appropriate facultative or winter properties.	Seven nurseries comprising over 350 advanced lines were evaluated at three locations in Oregon. These locations provide a full spectrum of environments, ranging from in excess of 1000 mm to less than 250 mm of precipitation. A disease nursery was evaluated at Toluca, Mexico for scald and BYDV resistance. Promising sources of disease resistance will be used by Dr. Hugo Vivar in the Spring x Winter crossing effort. Two nurseries were evaluated at Eskisehir and Ankara Turkey. The 6-row, compact-head feed barleys were of particular interest to the Turkish program.	8 nurseries and 2 special studies (cold tolerance screening and scald control through multi-component mixtures) planted at 3 locations in Oregon. 2 nurseries and the cold tolerance screening study were sent to ICARDA (Syria) for evaluation at 3 locations in Syria and Lebanon. 2 nurseries sent to Turkey for evaluation at Ankara, Hamidiye, and Eskisehir.
12. Beginning in 1987, screening nurseries of 50 lines (more if requested) will be sent to cooperators particularly in LDCs where winter barleys are or could be important. In 1988-89, segregating bulks will be sent and in 1989 double haploid recurrent selection populations will be sent.	Germplasm evaluated and selected for first International Winter and Facultative Barley Screening Nursery.	The First International Winter and Facultative Barley Screening nursery (IWFBSN) prepared and shipped to Southern Hemisphere cooperators.

Major Project Outputs	Status to 9/30/87	Current Year Action
13. In 1988, Crossing Blocks and F2 barley populations will be distributed.	Linkages established.	Crossing block candidates evaluated in 1986/1987 season. Spring x Winter F1s crossed to winter types to establish populations for subsequent distribution. Material planted for further evaluation.
14. Computer software to enable cooperators to have a complete evaluation of the performance of all experimental barley lines across locations prior to their subsequent crossing season. A data base will also be developed for all barley material in the program to meet specific needs of breeders in LDCs.	Micro-computer hardware and software has been purchased and installed. Personnel have been trained in its use. A barley data base was developed to access information on germplasm. Approximately 900 lines have been evaluated and are currently in the data base.	Software was developed to print out lists with available data to be sent to cooperators along with the germplasm. Database software upgrade has been installed.
15. Personnel will travel to assist in making selections and to more clearly identify limiting factors within a region.	The barley breeder travelled to Mexico in June, 1986 to establish linkages and work out lines of cooperation with CIMMYT and ICARDA staff. Hayes presented a paper at the ICARDA/Turkey symposium on winter cereals in stress environments in Ankara in July, 1987. Key traits for further selection identified and program priorities defined. Linkages established with Aleppo-based ICARDA personnel and with members of the Turkish national program.	Major concern with reduced funding has been the curtailment of international travel. Principle investigator traveled to Tunisia in October, 1987 to review current status of cereal research and develop multi-disciplinary approach for cereal enhancement. He a;sp travel to Mexico to collect data and present an invitational paper at the National Wheat Symposium on probing winter and spring gene pools for increasing genetic variability.

Major Project Outputs	Status to 9/30/87	Current Year Action
16. Facilitated Recurrent Selection (FRS) populations will be developed using male sterile genes and/or doubled haploids to accumulate resistant genes to the major barley and wheat diseases and various abiotic stresses.	Base populations have been developed using male sterile genes. Sources of resistance and tolerance previously identified in screening nurseries are being used as parental material. In the barley program, doubled haploids are used to facilitate rapid cycles of recurrent selection. Doubled haploid recurrent selection populations have been synthesized for Rhyncosporium secalis (scald) resistance, grain yield, and grain quality. Developing appropriate haploid protocols, selection criteria, and evaluation procedures for these doubled haploid populations has required supporting research in haploid synthesis (anther culture, ovule culture, and H. bulbosum). Work in wheat has involved backcrosses using the male sterile approach to incorporate the dominate male sterile gene into better agronomically adapted germplasm. From this material, 10 recurrent selection populations have been developed for hard red and soft white wheats to incorporate resistance to yellow dwarf virus (BYDV), Septoria, Dwarf Smut (TCK) and Cercosporella.	Doubled haploids extracted from recurrent selection populations in the fall greenhouse cycle using in vitro spike culture of gamete donors to increase the efficiency of H. bulbosum-mediated chromosome elimination. Dominant male sterile genes have been incorporated into selected populations to enhance the level of resistance to specific diseases of wheat. The third cycle of inter crossing is currently underway with selection pressures for several diseases being applied.

Major Project Outputs	Status to 9/30/87	Current Year Action
17. Increased genetic variability in both wheat and barley through the use of tissue culture techniques.	*Hordeum bulbosum*-mediated chromosome elimination is used to accelerate cycles of recurrent selection and capitalize on sexual variation for resistance to biotic and abiotic stresses. *H bulbosum* is the haploid producing method of choice, as it is free of the culture-induced variation associated with the callus phases of anther and ovule culture techniques. Primary bottlenecks to haploid production were identified during the screening of *bulbosum* clones. The results of an experiment comparing the effects of two media on the production of *H. bulbosum* haploids using *in vitro* culture of spikes of three genetically distinct winter barley cultivars were presented at the Thirteenth American Barley Researchers Workshop. Anther culture and ovule culture using several protocols across a range of winter barley genotypes were tested. Crosses between bread wheats and durum wheats are being investigated utilizing an embryo rescue technique to transfer drought tolerance and disease resistance from the durum to the bread wheats.	Efficiencies of doubled haploid production using the *in vitro* culture of *H vulgare* gamete donors pollinated with *H. bulbosum* ranged from 9 to 18% in a preliminary test using 2 media and 3 winter barley genotypes. Seed of the first doubled haploid plants increased for field evaluation in 88/89. 10 winter and 10 spring barley genotypes compared for efficiencies of haploid production using *in vitro* spike and spikelet cultures. Data analysis in progress. NNA appears to be important in the rapid formation of differentiated haploid embryos. Using funds from other grant sources, the barley program has equipped a laboratory for doubled haploid and tissue culture work. This facility will greatly enhance productivity and will lead to new directions in the barley germplasm enhancement process. The tissue culture in wheat had to be discontinued due to budget reductions.

ANNEX E

WHEAT GERMPLASM RECEIVED AT OREGON STATE UNIVERSITY FROM COOPERATORS IN DIFFERENT COUNTRIES AND REGIONS DURING EIGHT YEARS, 1980-88

Region	Number of Introductions	Major Genetic Strengths
Africa	108	SR,LR,SEPT,DRT
Australia	240	EAR,YLD,LR,QU
China	412	EAR,DWF,BYDV
Eastern Europe	634	PM,DR,LR,FUS,YLD,WH,DWF
Western Europe	970	CER,YR,SEPT,PM,LR,DWF,WH,YLD
Korea/Japan	180	EAR,DWF,WH
Mexico	3,160	YLD,LR,DR,PM,DWF,SEPT,BYDV
Middle East	1,486	LR,DR,LTFR,DRT,PM
South America	1,304	YR,LR,SR,SEPT,PM,YLD,BYDV
U.S./Canada	2,405	QU,WH,YLD,SEPT,YR,SR
South Africa	5	RA
TOTAL	10,904	

YR = Yellow rust
WH = Winterhardiness
LR = Leaf rust
SR = Stem rust
PM = Powdery mildew
QU = Quality
RA = Russian aphid
YLD = Yield
EAR = Earliness
DWF = Dwarf
CER = Cercosporella
FUS = Fusarium
DRT = Drought tolerance
SEPT = Septoria
BYDV = Barley Yellow Dwarf
LTFR = Late frost

ANNEX F

TOTAL NUMBERS OF COOPERATORS AND COUNTRIES RECEIVING GERMPLASM FROM THE WINTER X SPRING WHEAT PROGRAM AT OREGON STATE UNIVERSITY FROM 1980 TO THE PRESENT

Year	IWSWSN Cooperators/Countries	IWSWYT Cooperators/Countries	Crossing Block Cooperators/Countries	F2 Cooperators/Countries	F3 Cooperators/Countries
1980	102/50		15/6	24/18	
1981	104/54	15/12	18/7	25/19	
1982	107/47	15/12	19/8	25/19	
1983	109/47	15/12	26/9	25/19	
1984	111/47	18/14	24/9	25/19	
1985	106/47	18/14	25/10	26/22	
1986	110/43	18/14	25/10	26/22	
1987	81/28				51/31

ANNEX G

ESTABLISHMENT OF A CHAIR FOR WHEAT RESEARCH

Capital Press
Regional Agricultural-Forest Weekly

OSU's Kronstad gets endowed wheat chair

PORTLAND (UPI) — Wheat farmers, the state and Oregon State University have established an endowment fund for research aimed at developing new varieties of hard red and white wheats suitable for growing in the Northwest climate.

The endowment of a chair for wheat research at the university was announced Monday by Oregon Agriculture Director Bob Buchanan at the 60th annual convention of the Oregon Wheat Growers League.

Dr. Warren Kronstad, of OSU, an internationally respected professor of plant breeding and genetics, was appointed to the chair, which is financed by $500,000 in donations from wheat growers and others in the industry and $500,000 earmarked by the Oregon Legislature from the state's General Fund. The campaign was run by OSU's E.R. Jackman Institute.

The endowment will provide an annual interest income of $60,000 which will be used by Kronstad's team at OSU to develop new wheat varieties. OSU's total wheat research budget is about $600,000, said Kronstad.

"This joint venture partnership is a model for other industries to follow," said Buchanan. He added that the private money raised was evidence of the growers' willingness "to bootstrap themselves" in hard times.

Kronstad's research will focus on new varieties of higher protein hard red and white wheats suitable for Pacific Northwest growing conditions. Higher protein wheats are best for breads.

Most of the wheat grown in the Pacific Northwest is the soft white variety, a lower protein wheat desired for cakes, cookies and crackers. Most of that wheat is sold to Pacific Rim countries.

"To be more competititve in export and domestic markets, we will be developing higher protein red and hard white wheats," said Kronstad. "But we will not be forgetting the soft wheats."

Research done by Kronstad's team in the past 24 years has added $30 million to $40 million to wheat growers' annual profits in recent years, said Ione wheat farmer Eric Anderson, co-chairman of the fund-raising effort for the chair.

"Without Warren Kronstad, many growers would be down the tubes," said Anderson.

ANNEX H

CONCEPTUAL ISSUES IN EVALUATING THE RETURNS TO AGRICULTURAL RESEARCH

Reputable analyses of the returns to agricultural research have nearly always focused on total returns to agricultural research in a given country over a given period of time, or on returns to all research on a given commodity in a given country over a given time. They are usually based on an index number approach for total productivity or a regression approach with the dependent variable change in total productivity, and they have often shown very high rates of return to research. Wheat as a commodity is no exception; studies in Mexico and Pakistan have indicated annual internal rates of return of over 50 percent.[1]

Ex post economic analysis of agricultural research refined to components below the commodity level is not usually done. A major reason is that one of the main products of agricultural research is knowledge, which, for many research outputs, has the major characteristics of a public good. That is, once it is produced, use of this good by one individual does not reduce the amount available to others. Furthermore, for many outputs of

[1]Studies of wheat and rice in Bangladesh and wheat in Colombia also reported positive annual internal rates of return. One study o in Bolivia, found a negative annual return to wheat research.

plant breeding programs, it is difficult to restrict use of the product once it is released.[2]

Evaluating international research is particularly subject to these difficulties. In measuring the tremendous effects of the initial high yielding wheat varieties, how does one assess the separate contributions of the initial Rockefeller Foundation program in Mexico, the CIMMYT program which built on this, and the plant breeders in the U.S., Japan, Kenya, Brazil, and Italy who developed the material used by the Mexican program? Other factors to be assessed would include the development of suitable agronomic practices for the new wheats, and the extension and seed distribution systems required to make the seed available to farmers.

Robert Evenson (1977) has made perhaps the best known study of the returns to international research in wheat. He uses regression analysis as the basis of his benefit assessment, attempts to separate out contributions of international and national research, then compares the benefits from international research to annual expenditures by CIMMYT. He finds, as expected, that the benefits are enormous in comparison to the costs, but warns that his procedures are ad hoc, subject to numerous arbitrary assumptions, and should be avoided were it not for the tremendous policy importance of the subject. As an

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[2]This second condition is less true for hybrids such as corn, w one reason there is much greater private sector involvement in hybri production in corn than there is in seed production for self pollina crops like wheat.

example of the difficulty of doing this kind of analysis, Evenson's work does not explicitly look at the time dimension of the research process or calculate an internal rate of return.

From a micro perspective, the Australian economists David Godden and John Brennan (1987) have refined methods for estimating annual increases in wheat yield potential that can be attributed to plant breeding, taking into account the facts that management practices also change over time and that breeding may develop plants better able to take advantage of different management. Over short time periods, yield increases from plant breeding may average between 1 and 2 percent, but over longer periods of time, the annual rate in several countries (England, Australia, Pakistan) is usually not much over 1 percent. This approach, too, hides the fact that increases in yield potential as realized in farmers' fields often demonstrate a pattern of sharp increase followed by a plateau. The initial high yielding wheat varieties, for example, represented an extremely large increase. Initial evidence on material released deriving from winter x spring germplasm indicates that this represents one of the jumps in realizable yield potential in the post-Green Revolution period.

ANNEX I

ASSUMPTIONS USED TO CALCULATE 'MAXIMUM EXPENDITURE' IN WINTER X SPRING RESEARCH IN THE 1970'S

Weighted average wheat yield in developing countries where spring habit winter x spring derived material has been released: 1530 kg/ha

Increase in yield attributable to use of winter x spring material: 8%, constant over the 1980s. (This assumes that any advances in yield made in non-winter x spring material since 1980 have been met by advances in yield in winter x spring germplasm.)

Opportunity cost of funds invested in research: 15%

Average annual rate of inflation in the 1970's: 6%

Year	Developing Country Wheat Area Planted to Winter x Spring Derived Material ('000 ha)	Real World Import Price of Wheat (1982-84 US$/mt)
1981-82	250	207
1982-83	500	185
1983-84	1250	186
1984-85	3000	169
1985-86	5500	158
1986-87	9000	132
1987-88	10000	124

ANNEX J

USAID S&T/AGR PROJECT SELECTION CRITERIA

CROSS CUTTING SELECTION CRITERIA

The extent to which the problem constraints achieving the goals of the Agency's ARDN focus and Strategic Plan.

> Increased yields and improved qualities of wheat and barley benefit target populations.

The scientific merit of the program as reflected in its conceptual and technical soundness and scope for providing information to be used to solve development problems of priority concern to the Agency.

> The project is on target in utilizing the latest scientific knowledge and information in developing improved wheat and barley cultivars. The testing of breeding material at several sites in Oregon and in two climatically different areas in Mexico and Turkey provides the widest possible range of growing conditions. As a result, the improved germplasm will increase yields in most areas where wheat and barley are grown.

The extent to which other donor agencies and national governments are addressing the issue.

> The project cooperates with almost all international and national organizations dealing with production of spring and winter wheat and barley. Most notable is the cooperation with CIMMYT and ICARDA. Wheat and barley breeders from many countries visit the trial plots to select breeding material for use in their programs and many participate in screening trials.

The extent to which AID can exercise the intellectual leverage to facilitate the flow of resources from other US, LDC, developing country and international institutions.

By funding a portion of the wheat and barley breeding research efforts at Oregon State University, AID has supported the development of a very able breeding/research staff that is in direct communication with most wheat and barley breeders in the world. The graduate training program directed primarily at foreign students has developed a cadre of trained researchers who continue to communicate with OSU long after they have returned home.

The nature of AID Regional Bureau program priorities and their needs for improved technological underpinnings and ST/AGR funded support services in their grant and loan assistance programs at the field mission level.

The Scope for AID to work through the US scientific research community and international scientific networks to contribute to research and training activities in developing countries.

This project provides an excellent avenue for AID to access most scientific talent related to wheat and barley research worldwide. OSU has excellent professional relations with CIMMYT and ICARDA. In the more than 20 years that AID has provided some financial assistance to OSU about 70 international students have received graduate training in cereals research. Many of these students have returned to positions of importance in their countries and have provided continuing rapport with OSU. Further, the screening nurseries have provided a useful entre into national programs and have resulted in the addition of valuable germplasm from many of the countries.

Possible benefits to US agriculture.

The benefits to US wheat and barley growers have been many. Cultivars with pest and disease resistance have been brought into the breeding program most recently from Eastern Block countries and China. The crossing of winter wheats with spring wheats have resulted in some rather dramatic increases in yields of spring wheats. Improvements in winter wheats are slower to develop mainly due to vernalization requirements, but promising cultivars have been identified. OSU is very close to releasing a variety of hard red winter wheat adaptable to Oregon wheat growing conditions. Because of Oregon's proximity to the Pacific rim countries, this development could result in significant economic returns to Northwest farmers.

Relationship to and compatibility with other S&T Bureau programs.

Aside from the overall benefit of contributing to increased incomes of farmers in the wheat and barley growing areas of the world, the Winter x Spring Wheat Project has a tangential relationship with the IBSNET and Tissue Culture Projects.

The Winter x Spring Wheat Project contributes to the IBSNET project goals by testing the wheat and barley germplasm being collected and developed at a variety of geographic and climatical locations. Nurseries of germplasm materials are routinely tested at many locations in Oregon ranging from the damp coastal climate around Corvallis to the dry arid areas in Eastern Oregon. Additionally, materials are tested in Washington and Idaho as a part of a tri-state regional cooperative agreement. In cooperation with CIMMYT, cultivars are tested at Obregon and Toluca, Mexico, and in several locations in Turkey. By testing at these different locations, high-yielding cultivars can be identified that do well under certain soil and climatic conditions. Feedback from national programs also contributes to this effort; however, the inability of OSU scientists to visit national testing programs (due to funding restrictions) limits the information return.

CRITERIA FOR INCREASING INCOMES

The current and potential importance of the crop or animal products in LDC consumption and trade.

Wheat is, of course, the world's premier cereal crop and is consumed wherever bread or pasta is eaten. Barley, as a coarse grain, is not consumed directly by as many people as wheat, but it is an important crop to those living in marginal areas with harsh climates. Barley is a major grain in international trade for livestock feed and, of course, malt barley is a major ingredient in the production of beer.

The number of actual and estimated potential producers or laborers who stand to benefit through employment, lower costs and higher incomes.

It is difficult to provide exact data on the number of producers who are benefitting from the wheat and barley breeding programs. It is estimated that about ten percent of developing country wheat area is now planted to improved winter x spring gemplasm materials.

Potential savings in land, labor, capital, and other production resources that could be allocated to other agricultural activities or contribute to sustaining incomes by improving the natural resource base.

The use of improved wheat and barley germplasm merely improves the efficiency of production and makes more production possible using the same resource base.

The technical and economic feasibility of the innovation.

The development of improved varieties is perhaps the easiest form of technology to introduce into agriculture. Seeds are a very small portion of the cost of producing a crop. The introduction of winter and spring wheat and barley cultivars is a low cost technology that can provide a good economic return for those who adopt the improved seeds. Please see the text of the 1988 evaluation.

The strength of future market growth and income earning potential of a new or improved enterprise.

Whether the adoption of improved technologies is within the grasp of limited resource farmers given available local institutional (e.g. credit support).

The technology, i.e., enhanced wheat and barley cultivars, can be easily made available to farmers for very little, if any, additional cost over the seeds they currently purchase.

The extent to which a new or improved enterprise spreads the income benefits through its employment of labor and services.

The utilization of improved winter and spring wheat and barley varieties does not necessarily create new or improved enterprises but, rather, makes production a little more efficient. Improved varieties tend to produce more at low input levels, but are even more responsive to higher levels of inputs.

CRITERIA FOR AVAILABILITY AND CONSUMPTION OF FOOD

The contribution of the new technology to improvement of food consumption by utilization of more nutritional crop, livestock, or fish products or through the introduction of varieties with better storage or processing capabilities.

All of the wheat and barley germplasm being developed in this project are extensively tested for milling qualities, taste, protein quality, and other characteristics that will make them acceptable in trade.

The degree to which technological constraints limit LDC farmer diversification into new crop, livestock, or fisheries enterprises which offer special nutritional benefits.

The introduction of new varieties of crops farmers are already growing provides no technological constraints. The new varieties most likely have improved disease and pest resistance, improved grain quality, and improved agronomic qualities that will make them acceptable.

The value of crop, livestock, or fisheries products that are currently lost in post-harvest handling and marketing.

It is generally accepted that 10 to 30 percent of most cereal grains are lost due to post-harvest handling and marketing.

The relative contributions to increased food availabilities from equal investments made in post-harvest loss reduction and in crop yield increases.

The scope for improving consumption from new product utilization techniques.

Outside the scope of this project, although researchers are acutely aware of grain quality and include milling and nutritional qualities as a part of the germplasm enhancement program.

Scope for private sector participation in the provision of services and development of new food products for consumers.

The opportunity for private sector participation in the utilizations of improved wheat and barley cultivars is limited only by their ability to develop new products.

CRITERIA FOR MAINTAINING AND ENHANCING THE NATURAL RESOURCE BASE

The contribution of new crop, livestock, or fisheries technologies to the increased efficiency in natural resources use and maintenance of long-run productivity.

The introduction of improved wheat and barley varieties should have a neutral impact on the natural resources base although the improved varieties should yield more than existing varieties under similar conditions; hence, the long-run productivity looks promising.

The impact of increased efficiency of purchased inputs in crop production on cultivatable lands makes to resource use.

The use of improved varieties generally makes more efficient use of purchased inputs, returning a higher yield for a similar level of effort.

The contribution to the preservation, maintenance, and restoration of natural (biological and physical) resources including biological diversity of plant and animal genetic resources.

> Under this project OSU has amassed a collection of over 10,000 wheat cultivars from all parts of the world. They are maintaining this collection (no small job) and utilizing the varied characteristics in their breeding program. A similar collection of barley germplasm is being assembled.

The potential areas of coverage and the replicability of those improved crop cultivation and livestock or fisheries management practices that contribute to better natural resource use.

The contribution that interdisciplinary approach make to resource conservation and development, agrotechnology transfer, and protection of the environment.

> The development of improved varieties of wheat and barley (or perhaps the substitution of one variety for another) is only one part of the package of technology and has little impact in itself on soil and water conservation or on the environment. To be fully utilized the new varieties should be used in conjunction with other technology agricultural extension workers are providing.

ANNEX K

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UNCLASSIFIED

Department of State

OUTGOING TELEGRAM

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ORIGIN AID-00

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INFO FPA-02 ANDP-03 GCAN-02 FVA-01 OFDA-02 AMAD-01 AAPF-01
PPPB-02 GC-01 AIDF-01 ANTR-06 STHE-03 SAST-01 ES-01
STFA-01 ANME-03 RELO-01 /034 A3

INFO LOG-00 /000 R

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FM SECSTATE WASHDC
TO AMEMBASSY RABAT

UNCLAS STATE 155766

ADM AID, PASS TO ADO

E. O. 12356: N/A

SUBJECT: EVALUATION OF SPRING X WINTER WHEAT PROJECT

1. ST/AGR IS CONDUCTING AN EVALUATION OF THE SPRING X WINTER WHEAT PROJECT, WHICH HAS AN ANNUAL EXPENDITURE RATE OF DOLLARS 300,000. THE WHEAT BREEDING PROJECT, IMPLEMENTED BY OREGON STATE UNIVERSITY (OSU), ENHANCES WHEAT AND BARLEY GERMPLASM BY CROSSING OF SPRING WITH WINTER TYPE CEREALS AND AFTER FURTHER CROSSING, SELECTING FOR YIELDS, RESISTANCE TO BIOTIC STRESSES SUCH AS DISEASES, INSECTS AND ABIOTIC STRESSES SUCH AS WINTER HARDINESS, DROUGHT HARDINESS, SALT TOLERANCE AND ACID SOILS TOLERANCE AND NUTRITIONAL VALUES.

2. GERMPLASM IS BEING SENT ANNUALLY TO PLANT BREEDERS IN LDC'S FOR THEIR EVALUATION. THEY UTILIZE THE MATERIAL FOR INCORPORATION IN THEIR BREEDING PROGRAM, EVENTUALLY TO BE RELEASED AS NEW VARIETIES.

3. THE COLLABORATIVE RESEARCHER IN YOUR COUNTRY IS:

DIRECTOR, INRA
B. P. 415
RABAT, MOROCCO

4. THE EVALUATION TEAM IS INTERESTED IN KNOWING HOW THE MISSION VALUES THE PROJECT. HAS THE PROJECT ANY IMPACT ON THE COUNTRY'S CEREAL BREEDING PROGRAMS NOW OR WILL IT HAVE IN THE FUTURE? SHULTZ

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PAGE Ø1 RABAT Ø6212 2411Ø5Z 8546
ACTION AID-Ø2

INFO LOG-ØØ CIAE-ØØ EB-ØØ DODE-ØØ NEA-Ø4 TRSE-ØØ /ØØ4 W
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R 2411ØØZ JUN 88
FM AMEMBASSY RABAT
TO SECSTATE WASHDC 8893

UNCLAS RABAT Ø6212

AIDAC

FOR ST/AGR

E.O. 12356: N/A
SUBJECT: EVALUATION OF SPRING X WINTER WHEAT PROJECT

REF: STATE 155766

1. USAID IS FUNDING THE DRYLAND APPLIED AGRICULTURE RESEARCH PROJECT (6Ø8-Ø136) WITH THE INSTITUT NATIONAL DE RECHERCHE AGRONOMIQUE (INRA). THE MIDWESTERN INTERNATIONAL AGRICULTURAL CONSORTIUM (MIAC) IS THE PRIME CONTRACTOR FOR USAID ON THIS PROJECT. INRA AND MIAC SCIENTISTS ARE ENGAGED IN MAJOR CEREAL BREEDING AND SELECTION PROGRAMS.

2. ACCORDING TO MIAC AND INRA SCIENTISTS, THE GERMPLASM DEVELOPED BY THE REF PROJECT WILL HAVE A SIGNIFICANT IMPACT ON CEREAL BREEDING PROJECTS IN MOROCCO. GERMPLASM WHICH HAS ALREADY BEEN DEVELOPED FROM THIS PROJECT HAS BEEN USED TO A LIMITED EXTENT IN THE NATIONAL CEREAL BREEDING PROGRAMS. WE ANTICIPATE INCREASED USE OF THESE SPRING X WINTER TYPE POPULATIONS TO SUPPLY DESIRABLE GENETIC MATERIALS. THESE POPULATIONS COULD PROVIDE VALUABLE MATERIAL FOR SELECTION FOR INSECT AND DISEASE RESISTANCE AND DROUGHT TOLERANCE IN MOROCCO.

3. THIS PROJECT INVOLVES A UNIQUE PROGRAM FOR INCORPORATING GENES FROM BOTH WINTER AND SPRING TYPES INTO THE SAME GERMPLASM POPULATIONS. THE TECHNIQUES INVOLVED (PARTICULARLY VERNALIZATION) WOULD BE DIFFICULT TO ACCOMPLISH UNDER CONDITIONS PRESENT IN MOROCCO. NASSIF

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INFO FPA-02 ANDP-03 GCAN-02 FVA-01 OFDA-02 AAP -01 PPPB-02
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R 231056Z MAY 88
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TO SECSTATE WASHDC 3109

UNCLAS ISLAMABAD 11064

AIDAC

E. O. 12356: N/A
SUBJECT: EVALUATION OF SPRING X WINTER WHEAT PROJECT

REFERENCE: STATE 151319

1. THE MISSION THINKS THE PROJECT IS MAKING A USEFUL CONTRIBUTION TO WHEAT BREEDING PROGRAM IN PAKISTAN. THE MATERIAL SUPPLIED WAS INCORPORATED IN THE NATIONALLY COORDINATED WHEAT BREEDING PROGRAM. SELECTIONS ARE MAINLY BEING MADE FOR WINTER-HARDINESS, DROUGHT AND DISEASE RESISTANCE. SOME LINES ARE BEING SELECTED FOR EARLY PLANTING (SEP.-OCT.) AS WELL. A FEW PROMISING LINES HAVE BEEN IDENTIFIED. FURTHER WORK IS IN PROGRESS.

2. THE PROJECT ON COMPLETION WILL HAVE A SIGNIFICANT IMPACT ON THE COUNTRY'S WHEAT BREEDING PROGRAM TO INVOLVE SUITABLE VARIETIES FOR UPLAND AREAS OF BALUCHISTAN, NORTHERN AREAS, AND RAINFED AREAS OF PUNJAB. RAPHEL

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PAGE 01 BANGKO 25274 191154Z 2410 063828 AID4672
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R 191202Z MAY 88
FM AMEMBASSY BANGKOK
TO SECSTATE WASHDC 9976

UNCLAS BANGKOK 25274

ADM AID

E.O. 12356: N/A
SUBJECT: EVALUATION OF SPRING X WINTER WHEAT PROJECT

REF: STATE 155760

1. OREGON STATE UNIVERSITY (OSU) GERMPLASM BACK CROSS NOT ESPECIALLY HELPFUL TO THAI BREEDING PROGRAM BECAUSE OF HOT CLIMATE IN THAILAND. HOWEVER, THE REVERSE CROSS DONE BY CIMMYT FUNDED, BY AID AT SAME TIME AS OSU PROGRAM, HAS BEEN OF GREAT IMPORTANCE LOCALLY. IT IS LIKELY TO HAVE A POSITIVE IMPACT UPON CEREAL BREEDING PROGRAM. THAILAND WHEAT PRODUCTION, HOWEVER, IS VERY SMALL (LESS THAN 1000 TONS).

2. HOWEVER, OSU WHEAT BREEDING TRAINING PROGRAM HAS BEEN VERY SUPPORTIVE OF THAILAND'S WHEAT BREEDING PROGRAM. ONE KASETSART UNIVERSITY PARTICIPANT PRESENTLY AT OSU COMPLETING DEGREE PROGRAM. THIS TRAINING WILL HAVE CONTINUING POSITIVE INFLUENCE UPON CEREAL BREEDING IN THAILAND. BROWN

Rcv: @1IM/2.04341 Line: 2A

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6/19

#SECSTATE WSH##

RCA JUN 19 1139

331206 ICARDA SY

MSG NO. CP/745
ATTN: DR. FRANK MERTENS. ST/AGR/AP. AID. WASHINGTON. D.C. 20523
DEPT. OF STATE WASHDC 145503/L0591
FROM: J.P. SRIVASTAVA. LEADER CEREAL IMPROVEMENT PROGRAM

SUBJECT: SPRING X WINTER WHEAT EVALUATION

REYRTLX OF MAY 7.

AA) I AM SENDING A COPY OF MY EVALUATION AND EFFECTIVENESS OF THE SPRING X WINTER WHEAT PROGRAM CONDUCTED BY OSU BY POST.

BB) WE HAD GOOD WORKING RELATIONSHIP WITH THE PROJECT. THE PROJECT'S GRADUATE TRAINING ACTIVITIES HAVE BEEN VERY EFFECTIVE AND ITS IMPACT CAN BE SEEN AT THE NATIONAL PROGRAM LEVEL IN SEVERAL COUNTRIES. THE GERMPLASM DISTRIBUTED HAVE BEEN USED IN THE CROSSING PROGRAM BY ICARDA AND SEVERAL NATIONAL PROGRAMS. THE PROJECT IF ORIENTED TOWARDS STRESSES THAT LIMIT THE PRODUCTIVTY IN THE DEVELOPING COUNTRIES AS WELL AS INCREASED EMPHASIS ON GRADUATE TRAINING WILL BE HIGHLY DESIRABLE.

REGARDS.

#SECSTATE WSH##

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INCOMING TELEGRAM

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FM AMEMBASSY LIMA
TO SECSTATE WASHDC 9457

UNCLAS LIMA 08004

AIDAC

FOR ST/AGR

E. O. 12356: N/A
SUBJECT: EVALUATION OF SPRING X WINTER WHEAT PROJECT

REF: STATE 155816

1. MISSION WAS NOT AWARE THAT PROJECT WAS PROVIDING GERMPLASM MATERIAL TO PERU.

2. MISSION HAS CONTACTED NATIONAL AGRARIAN UNIVERSITY (UNA) RESEARCHERS WHO INDICATE THAT MATERIAL IS ARRIVING WITH ABOUT A SIX MONTH DELAY BECAUSE OF THE DIFFICULTY IN SECURING ITS RELEASE FROM CUSTOMS HERE.

3. UNA RESEARCHERS INDICATE THAT PROJECT MATERIAL IS VERY PROMISING AND THAT ONE LINE IS CURRENTLY SCHEDULED FOR FURTHER TESTS ON FARMERS FIELDS DURING THE NEXT GROWING SEASON. THEY FEEL THAT MATERIAL PROVIDED BY THE PROJECT IS A VERY IMPORTANT COMPONENT OF THEIR OVERALL SELECTION PROGRAM AND WOULD LIKE TO CONTINUE RECEIVING IT.

4. UNA RESEARCHERS EXPECT TO COMPLETE A REPORT ON GERMPLASM MATERIAL RECEIVED FROM VARIOUS SOURCES. SOMETIME DURING THE NEXT TWO MONTHS WE WILL FORWARD A COPY OF THE REPORT TO S&T/AGR AS SOON AS POSSIBLE.
WATSON

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INCOMING TELEGRAM

PAGE Ø1 AMMAN Ø6484 311143Z 5226 Ø69626 AID39Ø5
ACTION AID-ØØ

ACTION OFFICE STAG-Ø2
INFO AMAD-Ø1 ANTR-Ø6 SAST-Ø1 ES-Ø1 STFA-Ø1 ANME-Ø3 RELO-Ø1
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INFO LOG-ØØ CIAE-ØØ EB-ØØ DODE-ØØ NEA-Ø4 AMAD-Ø1 TRSE-ØØ
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R 311141Z MAY 88
FM AMEMBASSY AMMAN
TO SECSTATE WASHDC 9472

UNCLAS AMMAN Ø6484

AIDAC

FOR ST/AGR

E.O. 12356: N/A
SUBJECT: EVALUATION OF SPRING X WINTER WHEAT PROJECT

REF: STATE 155818

1. USAID UNDERSTANDS THAT THE GERMPLASM PROVIDED TO JORDANIAN PLANT BREEDERS UNDER THE ST/AGR PROJECT WAS TESTED. IT WAS FOUND TO BE NOT SUITABLE AND THEREFORE WAS NOT INCORPORATED IN THE LOCAL BREEDING PROGRAM. MISSION ALSO UNDERSTANDS THAT ANNUAL REPORTS ON THE TESTS CONDUCTED WERE SENT TO OREGON STATE UNIVERSITY.

2. MISSION FEELS THE PROJECT HAS HAD NO DISCERNIBLE IMPACT ON JORDAN'S CEREALS BREEDING PROGRAM TO DATE AND THE PROSPECTS FOR THE FUTURE ARE SLIM.
(DRAFT: FQUSHAIR, APPR: RCUMMINGS)
THEROS

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FM AMEMBASSY LISBON
TO SECSTATE WASHDC 1091

UNCLAS LISBON 04628

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FOR ST/AGR

E.O. 12356: N/A

SUBJECT: EVALUATION OF SPRING X WINTER WHEAT PROJECT

REF.: STATE 155820

1. NEITHER USAID/LISBON NOR THE EMBASSY AGRICULTURE COUNSELOR HAVE ANY CONNECTION WITH THE COLLABORATIVE RESEARCHER PARA 3 REFTEL. MISSION WAS NOT AWARE OF PROJECT OR COLLABORATION IN PORTUGAL.

2. AS USAID/LISBON IS PHASING OUT AND AGRICULTURE PRODUCTION PROJECT IS ALREADY COMPLETED, USAID/LISBON DOES NOT HAVE STAFF TO EVALUATE THE PROJECT OR TO RESPOND QUESTIONS PARA 4 REFTEL.
ROWELL

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PAGE 01 TUNIS 06292 151110Z 6132 079212 AID7771

ACTION AID-00

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P 151109Z JUN 88

FM AMEMBASSY TUNIS

TO SECSTATE WASHDC PRIORITY 6405

UNCLAS TUNIS 06292

AIDAC

E.O. 12356: N/A

SUBJECT: EVALUATION OF SPRING X WINTER WHEAT PROJECT

REF: STATE 155821

1. AS PERCIEVED BY MISSION AND GOT SCIENTISTS, THE SPRING X WINTER WHEAT PROJECT HAS AN OVERALL GOAL TO INCREASE WHEAT PRODUCTION IN WINTER RAINFED AREAS THROUGH THE FOLLOWING SPECIFIC OBJECTIVES:

A) TO CREATE GENETIC VARIABILITY
B) TO EXCHANGE GERMPLASM WITH COOPERATING PROGRAMS
C) TO EXCHANGE INFORMATION
D) AND TO ESTABLISH LINES OF COMMUNICATION BETWEEN
- WHEAT BREADERS.

2. AS A COLLABORATOR WITH THIS PROJECT THE TUNISIAN PROGRAM HAS CONTINUOUSLY RECEIVED EACH YEAR ONE SET OF THE SPRING X WINTER WHEAT NURSERY WHICH CONTAINS 220 TO 250 ENTRIES SELECTED AT OSU OR FROM OTHER COLLABORATING COUNTRIES. THESE NURSERIES ARE TESTED AT THE ECOLE SUPERIEURE D'AGRICULTURE DE KEF (ESAK) STATION. NOTATIONS ON NUMBER OF CHARACTERS ARE TAKEN AND RESULTS ARE REPORTED BACK TO OSU. OUT OF THESE NURSERIES SEVERAL LINES WERE IDENTIFIED AS HAVING POTENTIAL FOR THEIR SEPTORIA AND STRIPE RUST RESISTANCE AS WELL AS FOR THEIR COLD RESISTANCE. THESE LINES WERE USED EXTENSIVELY IN THE CROSSING PROGRAM TO SPRING WHEAT VARIETIES.

3. THE VISITS OF DR. W.E. KRONSTAD AND DR. W.L. MC CUISTION HAVE BEEN OF GREAT ASSISTANCE. KRONSTAD AND CUISTION ASSISTED TUNISIAN SCIENTISTS WERE HELPED TO ESTABLISH THE CEREAL BREEDING PROGRAM FOR SEMI-ARID REGIONS BETWEEN INSTITUT NATIONAL AGRONOMIQUE DE TUNISIE (INAT) AND ESAK AND TO SELECT BREEDING METHODOLOGIES SUCH AS THE USE OF SHUTTLE BREEDING SYSTEMS.

4. THE VISIT OF MRS. NANCY SCOTT HAS PERMITTED INAT TO INITIATE AND USE THE COMPUTER TO HANDLE BREEDING MATERIAL.

5. IN ADDITION, THE "TUNISIA CEREAL BREEDNG AND PRODUCTION SYMPOSIUM" HELD JOINTLY BETEEN TUNISIAN AND OSU SCIENTISTS IN TUNIS IN 192 WAS AN EXCELLENT OPPORTUNITY FOR THE TUNISIAN TEAM TO REVIEW ITS PROGRAM OBJECTIVES AND ITS APROACH IN THE EFFORTS UNDERTAKEN FOR THE ENHANCENT OF CEREAL PRODUCTION IN TUNISIA.

6. TH MAJOR IMPACTS OF THIS COLLABORATION WITH THE SRING X WINTER WHEAT PROJECT OF OSU ARE:

A) INCREASE OF YIELDING ABILITY OF NEW BREAD WHEAT ARIETIES THROUGH THE USE OF GENES FOR SEPTORIA, TRIP

RUST RESISTANCE AND FOR COLD TOLERANCE. THESE VARIETIES WILL HELP INCREASE CEREAL PRODUTION IN TUNISIA.

B) THE CONTINUOUS FLOW OF TRANSFER OF TECHNOLOGY THROUGH LINKAGES WITH THECEREAL TEAM OF OSU. THE MULTI- DISCIPLINAR LINKAGE PROJECT UNDERTAKEN UNDER MID AMERICA ITERNATIONAL AGRICULTURAL CONSORTIUM (MIAC) CNTRACT IS A FRUITFULL RESULT OF THESE CONTACTS.

C) THE COMPUTERIZATION OF THE TUNISIAN BREEDIN PROGRAMS AND THE INCREASE OF THE TUNISIAN CAPAITY IN HANDLING EXPERIMENTAL DESIGN AND IN INTEPRETING RESULTING DATA.

7. IN LIGHT OF TE ABOVE, MISSION CONSIDERS THIS COLLABORATIVE RESEARCH PROJECT VERY SUCCESSFUL AND WORTHWHILE. (DRAFTED BY PM:SMAHOUB, APPROVED BY PM:NMTUMAVICK). PELLETREU

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OUTGOING TELEGRAM

PAGE 01 STATE 155778 7795 059893 AID0145
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AMAD-01 AAPF-01 PPPB-02 GC-01 GCLA-03 AIDF-01 STHE-03
SAST-01 ES-01 STFA-01 RELO-01 /033 A0

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DRAFTED BY: AID/ST/AGR/AP: F. MERTENS: BW
APPROVED BY: AID ST/AGR: H. HORTIK
AID/LAC/DR: R. MOWBRAY (PHONE) AID/LAC/SA: M. MANLOUK (PHONE)
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R 140714Z MAY 88
FM SECSTATE WASHDC
TO AMEMBASSY QUITO

UNCLAS STATE 155778

ADM AID, PASS TO ADO

E. O. 12356 N/A

EVALUATION OF SPRING X WINTER WHEAT PROJECT

1. ST/AGR IS CONDUCTING AN EVALUATION OF THE SPRING X WINTER WHEAT PROJECT, WHICH HAS AN ANNUAL EXPENDITURE RATE OF DOLLARS 330,000. THE WHEAT BREEDING PROJECT IMPLEMENTED BY OREGON STATE UNIVERSITY (OSU), ENHANCES WHEAT AND BARLEY GERMPLASM BY CROSSING OF SPRING WITH WINTER TYPE CEREALS AND AFTER FURTHER CROSSING, SELECTING FOR YIELDS, RESISTANCE TO BIOTIC STRESSES SUCH AS DISEASES, INSECTS AND ABIOTIC STRESSES SUCH AS WINTER HARDINESS, DROUGHT HARDINESS, SALT TOLERANCE AND ACID SOILS TOLERANCE AND NUTRITIONAL VALUES.

2. GERMPLASM IS BEING SENT ANNUALLY TO PLANT BREEDERS IN LDC'S FOR THEIR EVALUATION. THEY UTILIZE THE MATERIAL FOR INCORPORATION IN THEIR BREEDING PROGRAM, EVENTUALLY TO BE RELEASED AS NEW VARIETIES.

. THE COLLABORATIVE RESEARCHER IN YOUR COUNTRY IS:

DR. SANTIAGO FUENTES
CIMMYT
BOX 2600
QUITO, ECUADOR
PHONE: 230354
CABLE: INIAP

4. THE EVALUATION TEAM IS INTERESTED IN KNOWING HOW THE MISSION VALUES THE PROJECT. HAS THE PROJECT ANY IMPACT ON THE COUNTRY'S CEREAL BREEDING PROGRAMS NOW OR WILL IT HAVE IN THE FUTURE? SHULTZ

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