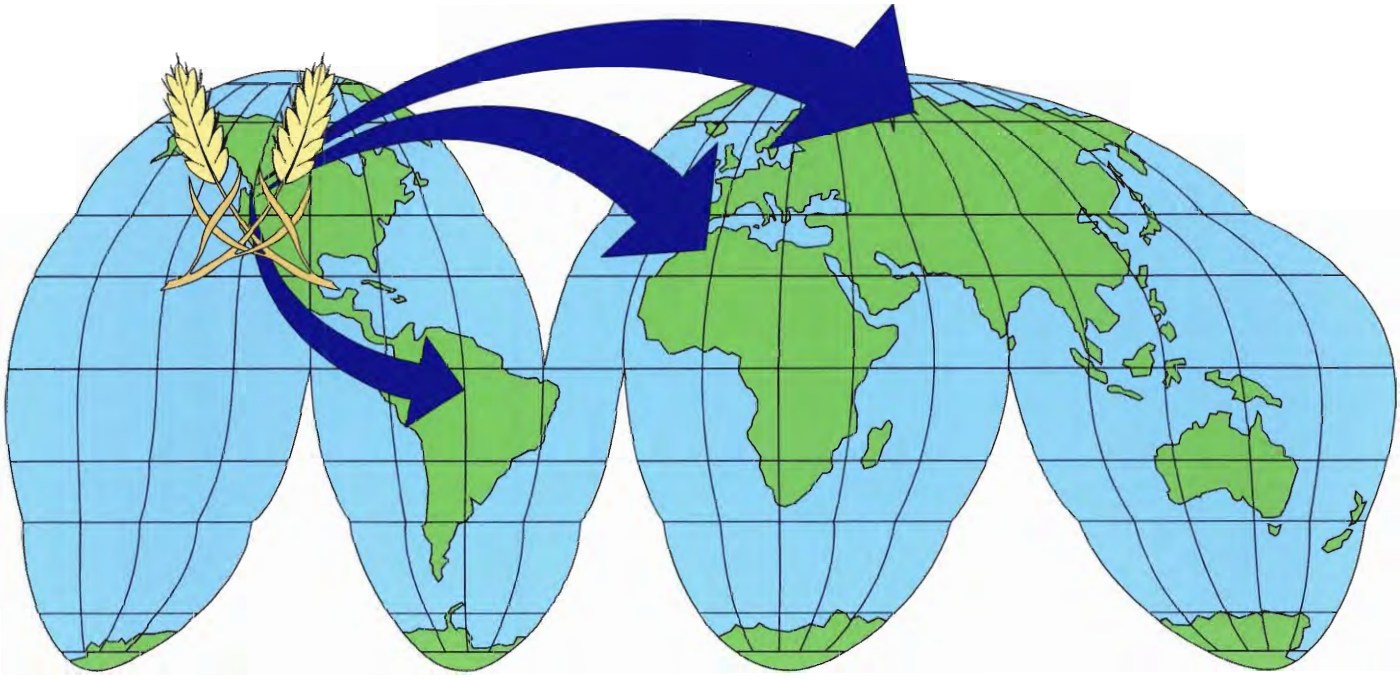
Appendices to the Final Report

July 1 1995 through June 30, 2000
Spring x Winter Wheat Project
LAG-0621-A00-5020-00
Project # 931-0621

Collaborative Interdisciplinary Research and Training Program
Using Winter & Facultative Wheat Enhanced Germplasm as a
Model to Stimulate the Agricultural Sector
in Less Developed Countries.



Contractor: Oregon State University
Warren E. Kronstad

Cooperating Agencies:
International Maize and Wheat Improvement Center (CIMMYT) Mexico and Turkey.
United States Department of Agriculture (USDA). International Center for Agricultural Research in the Dryland Areas (ICARDA)

BEST AVAILABLE COPY

Contents

Appendices

1. Keynote address to the 5th IWC — a1 – a11
2. Warren E. Kronstad Honorary Symposium — (Bound copy)
3. IWSWSN Cooperators — a12 – a28
4. Minutes of the WWEEYRT Coordinating Meeting — a29 – a40
5. Abstracts of Graduate Student Theses — a41 – a54
6. Major Trip Reports and Project Reviews — a55 – a100
7. Scientific Program of the 5th IWC — a101 – a104
8. Germplasm Submitted to the USDA National Small Grains Collection — a105 – a109
9. Results of the 18th through 20th IWSWSN — (Bound copies)

Appendix 1

Wheat: Prospects for Global Improvement

Proceedings of the 5th International Wheat Conference, 10–14 June, 1996, Ankara, Turkey

Edited by

H.-J. BRAUN, F. ALTAY, W.E. KRONSTAD, S.P.S. BENIWAL and A. McNAB

Kluwer Academic Publishers
Dordrecht / Boston / London

H.-J. Braun et al. (Eds.), Wheat: Prospects for Global Improvement, 1–10.
© 1998 Kluwer Academic Publishers. Printed in the Netherlands.

Agricultural development and wheat breeding in the 20th Century

W.E. Kronstad
Oregon State University, Corvallis, Oregon, U.S.A.

Key words: genetic diversity, germplasm exchange, wheat, yield plateaus

Summary

Tributes to wheat and its contribution to agriculture and humanity over the centuries can be found on carvings on utensils, pictographs from early civilizations, and in many religious writings. The Food and Agriculture Organization of the United Nations selected as their emblem a spike of wheat rising above the Latin inscription *Fiat Panis* ('Let there be bread').

With the development of high yield cultivars which respond to improved management practices, wheat production has increased over 100 million metric tons (mmt) per decade since the 1960s. Many examples can be cited to support the importance of genetic diversity and the role it has played in the improvement of wheat. Historically, the worldwide community of breeders have freely shared their genetic materials and depended on others for the development of contemporary cultivars. Any constraints which reduce the availability of genetic resources must be viewed with alarm. Genetic erosion, collection, preserving and maintaining the genetic integrity of existing germplasm collections, and factors which influence the free exchange of germplasm can all have a detrimental impact on future wheat improvement. Breeders and other public and private decision makers all must share a responsibility and an obligation to insure that future breeders will have the necessary genetic variability if wheat is going to continue to be a major contributor to world food production. Based on expected population growth and an increasing preference for wheat products, especially in developing countries, wheat will be even more important in the next century if an increasingly hungry population is to be fed.

Introduction

By planting a seed and domesticating plants, man moved from a nomadic existence, relying on wild animals and gathering native plants, to a stable agriculture. Thus, the breeding and cultivation of crops provided for the establishment of permanent settlements, resulting in the development of civilization as we know it today. Plant breeding, broadly defined, is the art and science of improving the genetic make-up of plants to better meet our needs. Prior to the rediscovery of Mendel's laws, plant breeding was an art. As noted by Burton (1966), the earliest plant breeders knew nothing of genetics, sex in plants, metabolic pathways, DNA or RNA. They had no microscopes, micro computers, written language, nor libraries. Yet, they were extremely successful in their selection and domestication of crop species due to the genetic variability present. Of a quarter of a million species of higher plants, 3000 species have been domesticated and 150 extensively cultivated, while the world's population relies on just 29 species for food.

The science of wheat breeding started early in the 20th century with several significant findings. Spellman in 1901 independently rediscovered Mendel's laws while investigating such traits as lax vs. club spike type and awn characteristics in wheat. Johannsen put forth the genetic basis for the pure line concept in 1904. Shortly thereafter, Nilssen-Ehle

Table 1. World food production (mmt), 1994

Commodity	Gross tonnage	Edible matter[1]	Dry protein[1]	Increase 1980-90[2] (%)
Cereals	1,950	1,623	162	22
Maize	570	501	52	19
Wheat	528	465	55	22
Rice	535	363	31	35
Barley	161	141	14	7
Sorghum/millet	87	78	7	–7
Roots & tubers	583	156	10	9
Potato	265	58	6	3
Sweet potato	124	37	2	–7
Cassava	152	56	1	24
Legumes, oilseeds, oil nuts	387	263	88	48
Sugarcane & sugarbeet[3]	133	133	0	21
Vegetables & melons	486	57	5	32
Fruits	388	53	2	28
Animal products	858	170	75	25
Milk, meat, eggs	760	143	57	21
Fish	102	26	19	34
All food	4,747	2,457	344	25

[1] At zero moisture content, excluding inedible hulls and shells.
[2] 1979-81 and 1989-91 averages used to calculate changes.
[3] Sugar content only.
Source: FAO Production Yearbook, 1994.
Source: LT Evans (Ed.), 1975; Borlaug & Dowswell, 1996.

opened the door to our understanding of transgressive segregation when he suggested that multiple factors influence quantitatively inherited traits. Sakamura, Kihara, Sears, etc. provided understanding of the genetics and cytogenetics of the wheat plant. Biffens reported in 1902 that resistance to stripe rust was due to a single recessive gene. This was the first explanation of the nature of inheritance of disease reaction. Vavilov's contributions to species origin, variation and plant breeding in 1935 emphasised the importance of genetic diversity. Others such as Wright, Fisher, Love, and Snedecor provided the statistical tools in experimental design and analysis of variance methods to enhance the interpretation of data. Another dimension to wheat breeding was provided by Kihara in identifying cytoplasmic male sterility in wheat and the subsequent discovery of pollen fertility restoration (Schmidt et al., 1962). Agriculture today is the result of many outstanding 20th century scientists who brought scientific methods to wheat breeding and related disciplines.

In Table 1 the global food production by the major commodities is presented for 1994. The total production was 4.74 billion metric tons of gross tonnage and 2.45 billion tons of edible dry matter. A significant feature is that the land provided 99% of the total food supplied, with inland waters and the ocean contributing 1%. Cereal grains alone accounted for 42%, with maize, wheat, and rice being the major crops. Based on future projections, the land will continue to be required to provide most of our food, thus shepherding these irreplaceable resources must be considered in any program to enhance food production.

Importance of wheat

Of the cereal grains, wheat is the most widely grown, occupying 17% of the total cultivated land (220 million ha in 1994). It is the stable food for 35% of the world's population and provides more calories and protein in the world's diet than any other crop. There is also more wheat and wheat flour

Table 2. Production (million tons) and yield of all cereals

Year	China		India		USA	
	Production (million tons)	Yield (t ha^{-1})	Production (million tons)	Yield (t ha^{-1})	Production (million tons)	Yield (t ha^{-1})
1961	147	1.4	87	1.0	164	2.5
1965	181	1.6	80	0.9	184	3.0
1970	209	1.8	114	1.1	187	3.2
1975	239	1.9	124	1.2	248	3.4
1980	285	2.8	145	1.4	270	3.8
1985	340	3.8	165	1.6	347	4.8
1990	389	4.2	197	1.9	313	4.8
1992	400	4.4	200	2.0	353	5.4

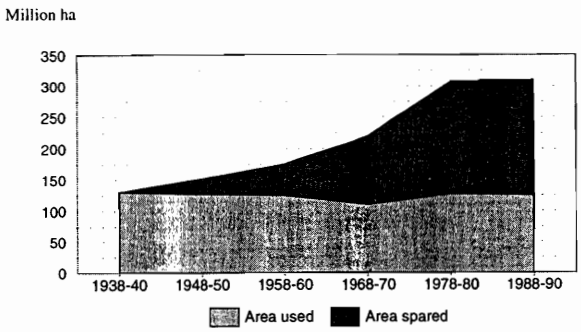
Source: FAO/Agrostat Files; Borlaug & Dowswell, 1996.

moving in world trade than any other grain. The uniqueness of wheat in contrast to other cereals is that the kernel contains gluten protein which, along with other quality attributes, provides a wide array of end product uses. Tributes to wheat over the centuries can be found on carvings on utensils, pictographs from early civilizations, and in many religious writings. It is interesting to note that the Food and Agriculture Organization of the United Nations selected for its emblem, one spike of wheat rising above the Latin inscription *Fiat Panis* ('Let there be bread').

It is not surprising then that wheat, with its many virtues, was one of the first major crop species to be domesticated. As noted by Ismail Serageldin, chairman of the Consultative Group on International Agricultural Research (CGIAR) and World Bank vice president for Environmentally Sustainable Development, 'Wheat is a real miracle crop of this century.' (Petrucci, 1995). He also noted that 'interest in wheat productivity has prevented widespread food shortages and stabilized the food security of Asia, Latin America, and to some extent, Africa.' Despite year-to-year variation, wheat production has reflected a steady growth from 1960 to 1990, ranging from a low of 225 mmt in 1961 to a record 593 mmt in 1990. Wheat production growth has averaged over 100 mmt per decade since 1960 with half of this increase being attributed to genetically enhanced cultivars. (Oleson, 1994). Improved management practices (tillage, fertiliser, weed control, irrigation, etc.) are responsible for the rest of the increase.

The importance of management and responsive cultivars was clearly demonstrated by the Turkish wheat program in the 1970s. High yielding spring wheat cultivars developed in Mexico were introduced into the annual cropping areas along the Mediterranean and Aegean coasts. These areas are characterized by high winter rainfall with mild winters and hot summer temperatures. Under these conditions, spring type wheat can be planted in the fall with the only major constraint being disease. Subsequently, a program was implemented for the Anatolian Plateau where the majority of the wheat is grown in Turkey. Due to limited winter rainfall, a summer fallow system is employed where moisture collected over a two year period is required to produce one crop of wheat. The winter temperatures are low, thus winter varieties are necessary. While improved cultivars were largely responsible for the yield increases in the coastal areas, timeliness of the tillage practice and weed control in the Anatolian Plateau, both of which conserve moisture, were the major factors in increasing the national wheat production in Turkey from 7 to 17 mmt yr^{-1} by 1978.

Borlaug & Dowswell (1996) further illustrate how improved high-yielding cultivars are responsive to improved management practices. A comparison of cereal production for China, India, and the United States is provided in Table 2 for eight years between 1961 and 1992. Recognizing differences in soils, climate, and weather between the countries, as well as the introduction of high-yield production,



1938-40 Production: 252 million tons

1988-90 Production: 596 million tons

Figure 1. USA total crop area spared by application of improved technology on 17 food, feed and fibre crops in the period 1938-40 to 1988-90.
Source: Borlaug & Dowswell, 1996.

China, the world's largest cereal producer has closed the yield gap with the United States. China is long noted for its recycling of organic matter, animal manure, night soil, and composted crop residue to maintain soil fertility. In 1961 the country achieved a 0.4 + ha yield advantage over India, where farmers burned most of their cattle manure as cooking fuel. Today, China is the world's largest producer, importer and consumer of nitrogen fertilizer, and ranks second and third, respectively, in the consumption and production of phosphate fertilizers.

In Figures 1 and 2, the impact of new technologies on reducing the amount of land necessary to produce cereals is presented for the United States, China, and India. As noted by Borlaug & Dowswell (1996), in 1940 the production of the 17 most important food, feed, and fibre crops in the United States totalled 252 million tons from 129 million ha. Compare these statistics with 1990, when American farmers harvested approximately 600 million tons from only 119 million ha, 10 million ha less than 50 years previously. If the United States attempted to produce the 1990 harvest with the technology that prevailed in 1946, it would have required an additional 188 million ha of land of similar quality. This theoretically would have been achieved either by ploughing up 73% of the nation's permanent pastures and rangelands, or by converting 61% of the forest and woodland area to crop land. This is a fact often overlooked by extremist environmentalists

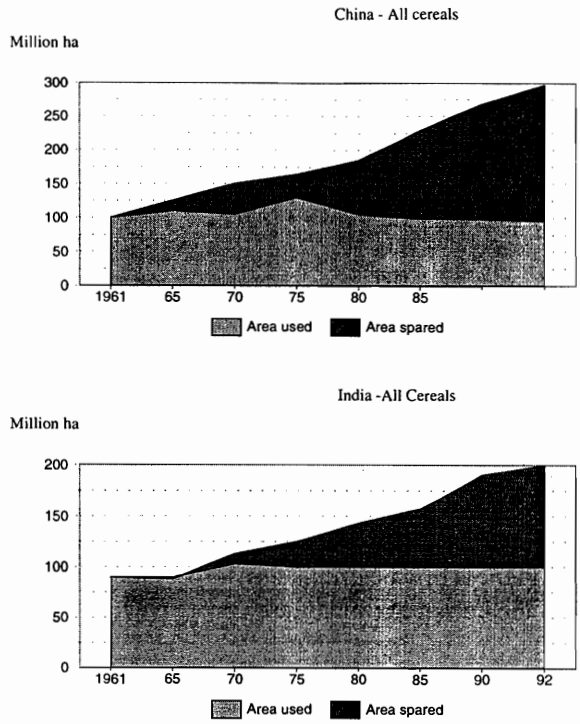


Figure 2. The land that Chinese and Indian farmers spared through raising cereal yields*
Source: Borlaug & Dowswell, 1996.
* The upper curve shows the area that would have been needed to produce 1992 cereal production, had 1961 yields still prevailed. The lower curve shows the area that was actually harvested.

who hold that modern technology is poisoning consumers out of existence and wish to return to the good old days of 'low impact' technology. Equally impressive savings in land use can be observed in China and India as the result of high yielding cultivars which are responsive to improved management.

In a recent World Bank News publication (Petrucci, 1995), people in developing countries now consume half the world's wheat and, according to CGIAR, within 10 years they will consume three-fifths of all wheat produced. Since the 1960s, wheat consumption has risen almost 5% a year in developing countries. As standards of living increase, people tend to turn toward more convenience foods, e.g. sandwiches, especially for the mid-day meal. This increased interest in wheat was observed when, in 1994, Asia harvested 217 million tons of wheat, far outpacing Europe's 119 million tons and

the 90 million tons produced jointly by the United States, Canada, and Mexico. During this same period, developing countries also accounted for over two-thirds of the world's total wheat imports, suggesting that demand in the developing world has risen even faster than domestic output.

Yield plateaus

The question frequently asked is, 'Have attainable yield levels been reached for wheat and other major food crops?' Evans (1986) observed that people at various periods in history have raised the same question even though wheat yields have increased 136% over the past 50 years. It has been suggested that under ideal growing conditions the absolute yield (only limiting factor is genetic potential) of the crop is 20 t ha^{-1} (Hansen et al., 1982). To date, the highest commercial attainable yields (possible yield for a given environment, location and year) reported are near 14 t ha^{-1} (Cook & Veseth, 1991). Unfortunately, the world average yield is much less, approximately 2 t ha^{-1}. In many countries the discrepancy between the actual yields achieved in experiment stations and by the best farmers, and the average yields of the majority of the farmers in the surrounding area is great. For the wheat breeder concerned with enhancing grain yields, the focus must be on actual and affordable yields (economic costs of inputs in relation to net income) and reducing the ratio between actual and attainable yields while maintaining profitable and environmental sustainability.

As previously noted, wheat yields have increased approximately 100 mmt per decade since the 1960s. However, in the 1995 CIMMYT publication, 'World Wheat Facts and Trends,' when the period 1951-94 was compared to 1985-94, there was a decrease in the percentage change in the growth rate of the area devoted to wheat, yields, and total production. For the growth rate of wheat area for the world, it was 0.4% from 1951-94 and -0.4% from 1985-94. Based on the same comparison of years, average increase for yield went from 2.3 to 1.5% and total production from 2.8 to 1.1%, respectively. The difference in growth between these periods in part reflects the impact the 'Green Revolution' had in the mid 1960s and 1970s. It might also suggest that breeders are spending more of their limited resources on maintenance breeding, with resistance and tolerance to various biotic and abiotic stresses being major objectives. There is also the possibility that the genetic diversity necessary for major breakthroughs in yield may no longer exist and only smaller increases in yield will be possible in the future. It must be remembered; however, that small increments in increased yield on extensive areas like the Anatolian Plateau of Turkey translate into large increases in production. There are still large unexploited 'yield crops' in virtually all low-income, food-deficit developing countries as well as in the former Soviet Union and Eastern Europe. Yield can still be increased by 50-100% in many areas of Asia, Latin America, the former USSR, and Eastern Europe, and by 100-200% in much of sub-Saharan Africa (Borlaug & Dowswell, 1996).

Genetic diversity

The major steps in all plant breeding programs are: 1) identifying the limiting factors, 2) determining if genetic variability exists, 3) selecting the most promising parents and subsequent progeny, 4) applying appropriate selection pressures, and 5) evaluating, multiplying, and disseminating germplasm and cultivars. Potentially of the five steps noted, the greatest barrier to enhancing all desired traits including yield, is the availability and identification of useable genetic diversity.

Many examples can be cited to support the importance of germplasm and the role genetic diversity has played in the improvement of wheat. Also, how the worldwide community of breeders have freely shared their genetic materials and depended on others in the development of their modern cultivars. Some examples include:

- Chinese Spring, a cultivar that must be regarded as the key to a greater understanding of the genetics and cytogenetics of the wheat plant
- the semidwarf genes from the Japanese cultivars Akokomugi and Daruma from which Strampelli, Vogel, etc., developed, and cultivars or selec-

tions like Ardito, Mentana, and Norin-10-Brevor, which ushered in the short-statured wheats

- sources of germplasm such as Gabo, which contributed day-length insensitivity, allowing wheat to be grown near the equator and along with short stature launched the Green Revolution from Mexico
- tetraploid emmer and durum wheats as sources for rust resistance
- PI 178383 and other accessions from Turkey for bunt *Tilletia* spp.
- Rescue and other solid stem wheats for sawfly (*Cephus cinctus* Nort.) resistance
- the carriers of the H genes for hessian fly (*Phytophagus destructor* Say.) control
- Early Blackhull and other wheats for earliness and high test weights
- Brazilian wheats for high grain protein and aluminium tolerance
- Russian cultivars such as, Kimba and Ukrainka and Hungarian cultivars, Banatka and Bankut 1201, which contributed both winter hardiness and quality to such cultivars as Bezostaja 1
- Bezostaja 1 itself, whose wide adaptation and extraordinary longevity combined with good winter hardiness and high quality, is found in many pedigrees of many modern wheat cultivars
- Kavkaz and Aurora which have contributed the 1B/1R translocation for wide adaptation
- Italian cultivars, San Pastore, Fortunato, Libellula, Argelato (T-22) and others that provided short stature and fertile spikes responsible for the higher yield potential of Yugoslavian cultivars such as Sava, Duna and Zlatna Dolina; and the European cultivars Heines VII, Cappelle Desprez, Nord Desprez, etc., that have been used extensively in winter wheat zones as sources of disease resistance and spike fertility.

These are only a few examples to illustrate how the international exchange of genetic materials have significantly enhanced wheat production.

Constraints

Since genetic variability and the free exchange of genetic materials are the foundation of all plant improvement programs, concerns expressed as to the fate of such biodiversity through genetic erosion must be taken seriously.

The problem of genetic erosion is the result of: 1) old heterogeneous land race varieties being replaced by higher yielding cultivars, 2) breeders' reluctance to use older varieties in their crossing strategies, 3) more exacting management practices dictating more genetically uniform crops, and 4) valuable genetic stocks being discarded due to changes in the leadership of the breeding programs. Thus, it is critical even with the newer approaches to enhancing genetic variability, i.e. interspecific hybridization, somaclonal variation, somatic hybridization, plant transformation, etc., that the progenitors which are close relatives of wheat including land race varieties be collected, preserved, evaluated, and freely disseminated.

Currently there are 28 major wheat germplasm collection centers in the world. Concerns have been raised regarding the genetic integrity of these collections. Factors such as: 1) outcrossing, 2) unsuitable growing conditions resulting in natural selection, 3) human error, and 4) inadequate facilities, may all contribute to this potential problem.

One of the most outspoken critics of germplasm centers is Mr. Paul Raeburn, who is a scientific editor for the Associated Press. In his recent book, *The last harvest* (Raeburn, 1995) he notes that while there have been extensive arguments in the United States over spotted owls and property rights, the importance of conservation to agriculture is never mentioned. He takes special issue with the lack of support for the National Seed Laboratory located at Fort Collins, Colorado, pointing out that the variability of many accessions has been lost and that the present staff cannot keep up with the growing number of new accessions. The subtitle of the book is 'The genetic gamble that threatens to destroy American agriculture.' He refers to seed banks as seed morgues and points out the consequences of the loss of biological diversity to future plant breeders. As evidence of his concern, he blames the most recent epidemic of grey leaf spot, a disease which reduced the US corn crop by an estimated 27% this past year, on the genetic uniformity of crop species. As a science editor for the Associated Press, per-

haps Mr. Raeburn's comments will help raise the public awareness of this issue.

On a more positive note there is the relatively new approach for managing biodiversity; an 'in situ' area for germplasm conservation has been established in the country of Turkey (Firat & Tan, 1995). The project emphasizes non-woody species (wheat, chickpeas, lentils, and barley) and fruit and nut species (pear, apple, walnut, chestnut, and pistachio). In contrast to 'ex situ' collections in gene banks, this approach avoids the loss of vital evolutionary processes by maintaining the desired biodiversity in its natural state, rather than maintaining genes and genotypes in their present state of evolution.

Will there be free exchange of germplasm?

In previous sections of the paper several factors were mentioned which might influence the free access of germplasm. There are even more immediate concerns in this regard, with more countries adopting laws governing the protection of germplasm, international agreements such as General Agreement on Tariffs and Trade (GATT), new products and protocols emerging from biotechnology, and public agencies joining the private sector in seeking protection and royalties for enhanced germplasm. All of these could have a negative impact on plant improvement programs.

Initially, Plant Variety Protection laws were designed to afford the opportunity to collect royalties on varieties which were largely developed in the private sector. In the US, utility patent laws were first passed in 1790 with plant patents for asexually propagated materials enacted in 1930. The European Economic Community in 1961 passed 'The International Union for the Protection of New Varieties of Plants' (UPOV), with the objective of defending plant breeders' rights, which included sexually propagated plants. A similar law was passed in the US in 1970 and was identified as the Plant Variety Protection Law. As of January 1990, 27 countries had adopted some form of plant patent laws. The intent of such legislation is to: 1) encourage the development of noval (superior) varieties of sexually reproduced plants, 2) to provide protection to those who breed, develop, or discover new varieties, 3) to provide opportunities to recover cost of research, and 4) to exclude others from selling the variety. It may also require that seed of a variety be sold as certified seed and by name only.

The Plant Variety Protection Law in the US permitted breeders to use protected varieties as parents in a crossing program. It also allowed farmers to sell protected seed to their neighbor. It became clear, however, that some farmers were selling 'brown bag seed' and those holding the patents could not receive any royalties following the initial release of a new variety. Frequently, such seed was sold without identification as to variety or as 'no name seed'. With new advances in biotechnology such as the use of RFLPs, it is no longer possible even to protect the parents involved in producing the hybrid. For these reasons and others, there is an effort in the US to further restrict the use and sale of genetic materials.

Initially promoted by the private sector, today many universities and other public institutions are expressing an interest in such opportunities as Plant Variety Protection and plant patents to generate funds. Terms such as intellectual properties rights, exclusive germplasm releases, and right of first refusal are becoming very common with universities acting as individuals or in conjunction with the private sector.

As new advances are made in biotechnology and specifically in plant transformation, new problems, with regard to free access to germplasm, emerge. All plant breeders, public or private, would agree that genetic resources collected and preserved in plant repositories should be freely available to everyone. However, when someone isolates an important gene from such collections and successfully develops a transgenic plant using plant transformation techniques, will both the gene and variety be protected? That is to say, can one patent genes or protocols or even breeder's methods? Will only cultivars be protected, or will laws prohibit such cultivars from being used as parents for hybridization, i.e. restrict the use of gametes? With all the uncertainty regarding what is patentable, it appears that only lawyers will profit.

Only time will tell to what degree such patent

laws will influence the free exchange of germplasm. The term *free* may be the question as enhanced germplasm may be readily available, but at what price, and who will pay the price – the breeder, farmer, and/or consumer? As support for public breeding programs decreases and they must compete for royalties based on the success of their varieties, will they be as willing to share their information and germplasm?

There is concern about the requirements a variety must have to qualify for Plant Variety Protection. Such a variety must be different from other existing varieties, stable, uniform and homogeneous. As Harlan (1972) noted, 'A pure line mentality, convinced that variation is bad, uniformity is good, and off types in the field somehow immoral developed, thus it was that we laid ourselves open to epiphytotics of serious dimensions.'

International germplasm exchange programs

The need to evaluate and exchange germplasm has long been recognized as critical to all breeding programs. In response to this need there have been several international nurseries established for wheat. Unfortunately, due to budget constraints or other priorities, many of these no longer exist. Many of these nurseries were supported by the Agricultural Research Service, United States Department of Agriculture. Nurseries which are no longer available include: 1) International Winter Wheat Performance Nursery coordinated by the University of Nebraska from 1969 to 1991, 2) International Septoria Nursery from 1971 to 1992, 3) International Powdery Mildew Nursery, 1960-1984, and 4) the oldest, the International Winter Wheat Rust Nursery, 1932 to 1986.

Current active international wheat nurseries are: 1) CIMMYT's spring wheat program headquartered in Mexico and the CIMMYT/ICARDA Facultative Winter Wheat Nursery (FAWWON) located in Turkey, and 2) the International Winter x Spring Wheat Screening Nursery (IWSWSN) conducted by Oregon State University and CIMMYT and funded by the US Agency for International Development. Even these active international programs face uncertain futures. The CIMMYT program has faced major budget reductions since 1989. Also, karnal bunt has raised seed health issues resulting in some restriction of seed being sent from Mexico to certain countries. The winter x spring program at Oregon State University also faces an unpredictable future even though the program has been extended for another five years, if funds are available.

International wheat nurseries are serving as effective vehicles by establishing lines of communication among wheat scientists, in addition to providing enhanced germplasm for the national programs to evaluate and use in their breeding programs. With the opportunities now provided through various internet programs, it is possible to share information in a timely manner. To a large extent, feedback from cooperators in the form of germplasm and data is responsible for the success of the international nurseries. Such nurseries are extremely important to insure to some degree the free exchange of germplasm and information.

Conclusions

As a result of breeding, improved technologies and the unique inherent characteristics of the species, wheat's contribution to agricultural development in the 20th century has been truly remarkable. However, even with all the accomplishments to enhance production, unfavorable weather conditions in the world's major wheat growing regions over the past two years have resulted in world reserves of only 40 to 60 days. This year-to-year variation makes the task of feeding an increasingly hungry world even more challenging. In Table 3 projections are provided as to where major population increases are anticipated, comparing 1990 with those expected in 2000 and 2025. Between 1990 and 2025, a 57% increase in population is expected with the largest percentage found in the low and middle income economies. As noted by Borlaug & Dowswell (1996), 'Even if current per capita food consumption stays constant, population growth would require that world food production increase by 2.63 billion gross tons by 2025'. Should diets improve among the poor (esti-

Table 3. World population projections

Region	Population (millions) Years			Increase %
	1990	2000	2025	1990-2025
Low and middle-income economies				
Sub-Saharan Africa	495	668	1229	148
East Asia & Pacific	1577	1818	2276	44
South Asia	1148	1377	1896	65
Europe	200	217	252	26
Middle East & N. Africa	256	341	615	140
Latin America & Caribbean	433	515	699	61
Sub-total	4146	4981	7032	70
Other economies[1]	321	345	355	11
High-income economies	816	859	915	12
World	5284	6185	8303	57

[1] This classification includes the former Soviet Union, Cuba, the Democratic People's Republic of Korea, for which inadequate and/or unreliable data is available.
Source: World Development Report 1992. Adapted from Borlaug & Dowswell, 1996.

mated 1 billion people) the world food demand could increase by 100% in the same time frame. For wheat the current production of 528 mmt in 1994 would have to increase to 1,200 mmt with yields going from 2.4 to 4.4t ha^{-1}. A formidable challenge.

Wheat breeders have relied on previous contributions made by several generations of scientists, starting with those who first domesticated plants. Each generation has significantly enhanced the genetic materials for future generations. Thus, with so many contributing to the existing genetic diversity, the question might be raised if one has the moral right to seek plant variety protection over genetic materials where the existing genetic construct has been only slightly altered? It perhaps does seem reasonable to seek patents on new cultivars to regain one's investment in research; however, when laws restrict the use of such materials for hybridizing, i.e. gametes, then regulations have gone too far.

To quote directly from the paper of Borlaug & Dowswell (1996), 'The only way for agriculture to keep pace with population and alleviate world hunger is to increase the intensity of production in those ecosystems that lend themselves to sustainable intensification while decreasing the intensity of production in more fragile ecosystems.' They go on to note, 'To achieve the needed production increases

Table 4. Current and projected world cereal production and demand (million tons) and yield requirements.

Years	Current production	Projected demand		Yield (t ha^{-1})		
				Actual	Required	
	1990	2000	2025	1990	2000	2025
Wheat	600	740	1200	2.4	2.8	4.4
Rice	520	640	1030	2.4	3.1	5.3
Maize	480	620	1070	3.7	4.1	5.8
Barley	180	220	350	2.3	2.7	4.1
Sorghum/millet	85	110	180	1.5	1.8	2.6
All cereals	1970	2450	3970	2.5	2.9	4.5

Source: FAO Production Yearbook, 1994; and authors' estimates.

and to distribute the food equitably in the low-income, food-deficit countries will require the sustained and focused support of governments, international development agencies, non governmental organizations, and the private-agri-business sector.' Finally, we who are privileged to have worked with Dr. Borlaug can close our eyes and hear him say, 'For those of us on the food production front, let us all remember that world peace will not be built on empty stomachs and human misery. Deny the small-scale farmers of the developing world access to modern technology and the worlds' needed agricultural expansion to help feed future generations (until the population monster is tame) and humankind will be doomed, not from poisoning and environmental melt-down, as some say, but from starvation, social and political chaos.'

Lastly, when accepting the Nobel Prize for Peace, Dr. Borlaug said: 'If you desire peace, cultivate justice, but at the same time, cultivate the fields to produce more bread; otherwise, there will be no peace.'

References

Borlaug, NE & C.R. Dowswell, 1996. The acid lands: One of agriculture's last frontiers. In: Proceedings of the 4th International Symposium on Plant-Soil Interactions at Low pH. Belo Horizonte, Brazil.

Burton, G.W., 1966. Prospects for the Future. In: Fry (Ed.). International Plant Breeding Symposium., pp. 391-406. Iowa State University Press.

CIMMYT, 1995. CIMMYT World Wheat Facts and Trends Supplement. Ongoing Research at CIMMYT: Understanding wheat genetic diversity and international flows of genetic resources. CIMMYT, Mexico, D.F., Mexico.

Cook, R.J. & R.J. Veseth, 1992. Wheat Health Management. APS Press, St. Paul, USA.

Evans, LT, 1986. Opportunities for increasing the yield potential of wheat, pp. 1-19. CSIRO Division of Plant Industry. Canberra, ACT, Australia..

Firat, A.E. & A. Tan, 1995. Turkey maintains pivotal role in global genetic resources. D. Strauss (Ed.), Diversity 11(162): 61-63.

Hansen, H., NE Borlaug & R.G. Anderson, 1982. Wheat in the third world. IADS Development Oriental Literature Series. Westview Press, Boulder, Colorado, USA.

Harlan, J.R., 1975. Our vanishing genetic resources. Science 188: 618-621.

Oleson, B.T., 1994. World wheat production, utilization, and trade. In: W. Bushek & Rosper (Eds.), International wheat production, properties and quality., pp. 1-10.

Petrucci, S., 1995. The wonders of wheat. International World Bank News. External Affairs Department, Washington, DC.

Raeburn, P., 1995. The Last Harvest: The genetic gamble that threatens to destroy American agriculture, pp. 269. Simon and Schuster, New York.

Schmidt, J.W., V.A. Johnson & S.S. Maan, 1962. Hybrid wheat. Nebr Exp Sta Quart 9(1):9.

Appendix 3

IWSWSN Cooperators

Appendix 3. International Winter x Spring Wheat Screening Nursery (IWSWSN) cooperators and addresses.

Country	Cooperator Name/Address
AFGHANISTAN (mail service temporarily suspended 8/97)	Dr. M.A. Ozmanzai Agriculture Research Institute Ministry of Ag. & Land Reforms Kabul, AFGHANISTAN
ARGENTINA	Ing. Agr. Juan Ramon INTA - E.E.A. Bordenave 8187 BORDENAVE, Prov. Bs. As. ARGENTINA
ARGENTINA	Mr. Ruben Miranda Estomba 458 8000 Bahia Blanca ARGENTINA
ARGENTINA	Ing. Agr. Jose Horacio Bariffi E.E.A. INTA Balcarce C.C. 276 - 7620 Balcarce Bs. As. ARGENTINA
ARGENTINA	Nestor Halbide Viamonte 377 Piso 9 (1063) Buenos Aires ARGENTINA
ARGENTINA	Ing. Agr. Carlos T. Bainotti Head Wheat Breeding Group EEA. Marcos Juarez - INTA C.C. No. 21 2580 Marcos Juarez (Cba.) ARGENTINA
ARGENTINA	Ing. Pablo Bergada Programa de Trigo Nidera Argentina Paseo Colon 505 CP 1063 Capital Federal ARGENTINA

Country	Cooperator Name/Address
ARMENIA	Dr. Papin A. Ghandilyan Armenian Agricultural Academy 74, Teryan Str., 375009 Yerevan ARMENIA
AUSTRALIA	Director R.A. McIntosh University of Sydney Plant Breeding Institute 107 Cobbitty Road, Cobbitty Private Bag 11 Camden NSW 2570 AUSTRALIA
AUSTRALIA	Dr. Gil Hollamby The University of Adelaide Plant Breeding Unit, Campus Roseworthy, SOUTH AUSTRALIA 5371
BELGIUM	Adrien Dekeyser Station d'Amelioration des Plantes 4, rue du Bordia B-5030 Gembloux BELGIUM
BRAZIL	Dr. Carlos de Oliveira Camargo Instituto Agronomico Av. Barao de Itapura, 1.481 Caixa Postal 28 13001-970 CAMPINAS Sao Paulo BRAZIL
BRAZIL	Dr. Milton Rocha Universidad Federal de Pelotas 96100 Pelotas R.G. Sul BRAZIL

Country	Cooperator Name/Address
BRAZIL	Mr. Ricardo Matzenbacher Centro de Experimental e Pesquisa-Feco Trigo Caixa Postal 10, Cruz Alta RS BRAZIL
BRAZIL	Luiz Hermes Svoboda Fundacep Fecotrigo Caixa Postal, 10 98100 – Cruz Alta, RS, Brasil BRAZIL
BULGARIA	Dr. Nina Stavreva, Dr. Ivan Panayotov Institute for Wheat & Sunflower Breeding Tolbuhin, near General Toshevo BULGARIA
BULGARIA	Dr. Ginka Ivanova Ratchovska Dr. I. Govedarov Institute of Introduction and Plant Genetic Resources, K. Malkov 4122 SADOVO NEAR PLOVDIV, BULGARIA
CANADA	Jean Collin Departement de Phytologie Pavillon Comtois Universite Laval Sainte-Foy, Quebec CANADA G1K 7P4
CHILE	A. Merino B. I.N.I.A. Wheat Program Attn: Dr. I. Ramirez A. Casilla 439/3 Santiago, CHILE

Country	Cooperator Name/Address
ENGLAND	Mr. F.M. Collins New Farm Crops Limited Market Stainton Hall Market Stainton Lincoln, LN3 5LJ ENGLAND
ENGLAND	Dr. S.J. Brown Plant Breeding International Maris Lane, Trumpington Cambridge CB2 2LQ PBI Cambridge Ltd. UK
ENGLAND	Paul M. Fenwick Nickerson (UK) Ltd. Joseph Nickerson Research Centre Rothwell, Market Rasen Lincolnshire LN7 6DT ENGLAND
ENGLAND	Dr. Phil Howell New Farm Crops Limited Pampisford Road, Great Abington, Cambridge CB1 6AH c/o Anglia Airfreight London Stansted Airport ENGLAND
ESTONIA	Dr. Anne Ingver Jogeva Plant Breeding Institute EE 2350 Jogeva ESTONIA
FINLAND	Boreal Plant Breeding Myllytie 10 FIN-31600 JOKIOINEN FINLAND

Country	Cooperator Name/Address
FRANCE	Dr. Jean-Pierre Josset W. Weibull S.A.R.L. Semonville Cidex 1824 28310 POINVILLE FRANCE
FRANCE	Dr. Pierre Niquet Head of Small Grain Cereals Verneuil Recherche Ferme de l□Etang - B.P. 3 77390 Verneuil-l'Etang FRANCE
FRANCE	Maxime Trottet, INRA, Centre de Recherche de Renne Station d'Amelioration des Plantes B.P. 29 35650 Le Rheu FRANCE
FRANCE	Dr. Jayne Stragliati Nickerson S.A. Station de Recherche 5, rue de l'Egalite Chartainvilliers, 28130 Maintenon FRANCE
FRANCE	HybriTech Europe SNC Guy Blache, Research Manager Ferme de Moranval – D335 60 350 Cuise-La-Motte FRANCE
FRANCE	Mr. J. Koenig Attn: INRA Domaine de Crouelle 234 Ave. de Brezet 63039 Clermont-Ferrand FRANCE

Country	Cooperator Name/Address
GERMANY	Dr. Joachim Lange Osterstrasse 71 20259 Hamburg 20 GERMANY
GERMANY	Dr. Peter G. Goertz Sudwestdeutsche Saatzucht Zuchstation Benshurst 2 77839 Lichtenau GERMANY
GERMANY	Dr. Richter Saatzucht Hadmersleben GmbH Kroppenstedter Strasse D-39398 Hadmersleben GERMANY
GREECE	Mr. Stylianos Stratilakis National Agricultural Research Foundation (NAGREF) P.O. Box 312 57001 Theemi GREECE
HUNGARY	Dr. Zoltan Bedo Agricultural Research Institute Hungarian Academy of Sciences H-2462 Martonvasar P.O.B. 19 HUNGARY
HUNGARY	Dr. Janos Matuz Cereal Research Non-Profit Co. H-6701 Szeged P.O.B. 391 HUNGARY
JAPAN	Mr. Yoichi Amano Regional Wheat Breeding Lab. Kitami Perfectural Agricultural Experiment Station Kunneppu, Tokoro-Gun, Hokkaido JAPAN

Country	Cooperator Name/Address
JORDAN	National Center for Ag. Research & Technology Transfer (NCARTT) P.O. Box 639 Baqa` - 19381 JORDAN
KAZAKSTAN	Dr. N. Rjabushkina Institute of Plant Physiology Genetics and Bioengineering 45 Timiryazev Street Alma-Ata, 480070 KAZAKSTAN
LATVIA	Vija Strazdina State Stende Plant Breeding and Agriculture Research Stn. POB Dizstende, LV-3258 Talsi region LATVIA
LATVIA	Sofija Kalinina State Stende Plant Breeding and Agriculture Research Stn. POB Dizstende, LV-3258 Talsi region, LATVIA
LEBANON	Dr. H. Machlab Head, Dept. of Plant Breeding Lebanese Agricultural Research Inststitute Tal-Amara, Rayak LEBANON
LITHUANIA	Dr. Vytautas Ruzgas Plant Breeding Center Lithuanian Institute of Agriculture 5051 Akademija – Dotnuva parish Kedainiai district LITHUANIA
MEXICO	Dr. Sanjaya Rajaram CIMMYT, Lisboa 27 Apdo. Postal 6-641 Col. Juarez Deleg. Cuauhtemoc MEXICO 06600 DF

Country	Cooperator Name/Address
NEW ZEALAND	Dr. W.B. Griffin Crop and Food Research PB 4704 Christchurch, NEW ZEALAND
PEOPLE'S REPUBLIC OF CHINA	Dr. Yang Zhou Director Wheat Institute of Henan Academy of Agricultural Sciences 1 Nongye Road Zhengzhou 450002 PEOPLE'S REPUBLIC OF CHINA
PEOPLE'S REPUBLIC OF CHINA	Huang Chengyan Head Wheat Breeding Program Crop Research Institute of Shandong Academy of Agricultural Sciences Sangyan Road 28, Jinan 250100 Shandong PEOPLE'S REPUBLIC OF CHINA
PEOPLE'S REPUBLIC OF CHINA	Mrs. Song He-xian Institute of Crop Science Academy of Agricultural Science Chengdou, Sichuan Province PEOPLE'S REPUBLIC OF CHINA
PEOPLE'S REPUBLIC OF CHINA	Yang Yanhua Deputy Director, Institute of Food Crops Yunnan Academy of Agricultural Sciences Kunming 650205 PEOPLE'S REPUBLIC OF CHINA
PEOPLE'S REPUBLIC OF CHINA	Dr. Ning Kun Head, Wheat Breeding Section Shaanxi Province Wheat Research Center Shaanxi Academy of Agricultural Sciences Yangling SHAANXI 712100 PEOPLE'S REPUBLIC OF CHINA

Country	Cooperator Name/Address
PEOPLE'S REPUBLIC OF CHINA	Shibin Cai Institute of Food Crops Jiangsu Academy of Agricultural Sciences Nanjing, Jiangsu 210014 PEOPLE'S REPUBLIC OF CHINA
PEOPLE'S REPUBLIC OF CHINA	Lecturer Li Anfei Department of Agronomy Shandong Agricultural University Taian, Shandong 271018 PEOPLE'S REPUBLIC OF CHINA
PEOPLE'S REPUBLIC OF CHINA	Pang Jiazhi Institute of Crop Breeding and Cultivation Chinese Academy of Agricultural Sciences Beijing 100081 PEOPLES REPUBLIC OF CHINA
PEOPLE'S REPUBLIC OF CHINA	Ms. Li Xingpu Institute of Cereal and Oil Crops Hebei Academy of Agricultural & Forestry Sciences Shijiazhuang 050031 Hebei PEOPLE'S REPUBLIC OF CHINA
PERU	Ing. Jose Calderon Castillo Pasaje Heroinas Toledo No. 164 Pio Pata - El Tambo – Huancayo PERU
PERU	Ing. Juan Mandujano Mieses Atahualfa No. 201 Janja – Junin PERU
PERU	Ing. Rafael V. Torres Moita Jr. Cuzco No. 669 Huancayo PERU

Country	Cooperator Name/Address
POLAND	Mr. Jan Bialoskorski Danko HR Sp zoo Laski 05-660 Warka POLAND
POLAND	Barbara Weiss DANKO Hodowla Roslin Sp. zo.o z/s w Choryn ODDZIAL CHORYN 64-005 Racot POLAND
PORTUGAL	Ing. Benvindo Macas Estacao Nacional de Melhoramento de Plantas Estrada Gil Vaz Apdo. 6, 7351 Elvas codex PORTUGAL
REPUBLIC OF SOUTH AFRICA	Dr. T. van A. Bredenkamp Small Grain Institute Private Bag X29 Bethlehem 9700 SOUTH AFRICA
ROMANIA	Dr. N. Saulescu I.C.C.P.T. Fundulea 8264 Jud. Calarasi ROMANIA
RUSSIA	Nikolai S. Vassiltchouk Agricultural Research Institute for South-East Regions 7 Toulaikov Strasse 410020, Saratov RUSSIA
RUSSIA	Dr. Alexandr Pryanichnikov Winter Wheat Breeder Agricultural Research Institute for South-East Regions 7 Toylaycov Strasse 410020, Saratov RUSSIA

Country	Cooperator Name/Address
RUSSIA	Dr. Y. Puchkov Quarantine Nursery Wheat Breeding Department Krasnodar Lukyanenko Research Institute of Agriculture Krasnodar, 350012 RUSSIA
(CZECHO-)SLOVAKIA	Dr. Viera Tisova Research Institute of Plant Production Bratislavska 122 92168 Piestany, SLOVAKIA
SWEDEN	Svalof Weibull AB Institute Attn: Gunnar Svensson SE-268 81 SVALOV SWEDEN
SWITZERLAND	Dr. Arnold Schori Station federale de recherches en production vegetale (RAC) C.P. 254 CH-1260 Nyon 1 SWITZERLAND
SYRIA	Dr. Osman Abdalla ICARDA Cereal Improvement Program P.O. Box 5466 AIRFREIGHT DAMASCUS AIRPORT SYRIA
TUNISIA	Dr. Amor H. Yahyaoui Departement d'Amelioration des Plantes Ecole Superieure d'Agricultures du Kef 7119 Le Kef TUNISIA

Country	Cooperator Name/Address
TURKEY	Hans Braun Turkish/CIMMYT Winter Wheat Improvement Program Ministry of Agriculture-Forestry and Rural Affairs, P.K. 39 EMEK 06511 Ankara TURKEY
UKRAINE	Dr. V.M. Sokolov Ukrainian Academy of Ag. Science Plant Breeding & Genetics Institute Ovidiopolskaya Road 3 Odessa – 270036 UKRAINE
UKRAINE	Dr. Nikolaj A. Litvinenko Ukrainian Academy of Ag. Science Plant Breeding & Genetics Institute Ovidiopolskaya Road 3 Odessa – 270036 UKRAINE
UKRAINE	Anatoli Palamarchuk Chief Laboratory Director Ukrainian Academy of Agricultural Sciences Plant Breeding and Genetics Institute Ovidiopolskaya road, 3 Odessa, 270036, Ukraine
UKRAINE	Victor K. Ryabchoun, National Centre for Plant Genetic Resources of Ukraine Deputy Director for Research Institute of Plant Production 310060, Kharkov Moskovskyi pr., 142 Ukraine

Country	Cooperator Name/Address
UKRAINE	Volodymyr A. Vlasenko Ukrainian Academy of Agrarian Sciences Myronivka Institute of Wheat P.O. Tsentral□ne Myronivka district, Kyiv region 256816 Ukraine
URUGUAY	Dr. Man Mohan Kohli Ing. Ruben Verges CIMMYT c/o IICA, CC 1217 INIA - Andes 1365, Piso 12 Montevideo URUGUAY
USA	Dr. Ron D. Barnett North Florida Research and Extension Center Rt. 3, Box 4370 Quincy, Florida 32351-9529 USA
USA	Dr. Aristeo Acosta-Carreon c/o Ermilo E. Richer Santos 802 Gale Street Laredo, Texas 78042-0551 USA
USA	Robert Bacon Department of Agronomy 115 Plant Science Building University of Arkansas Fayetteville, AR 72701
USA	Dr. Jose Costa University of Maryland Department of Agronomy Room 1129, H.J. Patterson Hall College Park, Maryland 20742

Country	Cooperator Name/Address
USA	J. Barton Fogleman Agripro Seeds, Inc. P.O. Box 2365 Jonesboro, Arkansas 72402-2365 USA
USA	Dr. Kim Garland Campbell Small Grain Genetics Department of Agronomy O.A.R.D.C./OSU 1680 Madison Avenue Wooster, Ohio 44691 USA
USA	Scott Haley Department of Soil and Crop Sciences Colorado State University Fort Collins, CO 80523 USA
USA	Jackie Rudd Plant Science Department, Box 2140-C South Dakota State University Brookings, SD 57007 USA
USA	Darrell Cox Crop and Weed Sciences Dept. North Dakota State University Fargo, North Dakota 58105 USA
USA	Dr. Oscar Rodriguez G.E. Pogue Seed Company, Inc. P.O. Drawer 389/Hwy 72 West Kenedy, Texas 78119
USA	Dr. Phil L. Bruckner Department of Plant & Soil Science Montana State University Bozeman, MT 59717-0312 USA

Country	Cooperator Name/Address
USA	Dr. Stephen A. Harrison Department of Agronomy 104 Madison B. Sturgis Hall Louisiana State University Baton Rouge, LA 70803-2110
USA	Joe Martin Fort Hays Branch Exp. Station 1232 - 240th Ave. Hays, Kansas 67601-9228 USA
USA	Jerry A. Wilson, Wheat Breeder Hybritech Seed International 5912 N. Meridian Avenue Wichita, Kansas 67204-1699 USA
USA	Sid Perry CARGILL Hybrid Seeds 2540 E. Drake Road Fort Collins, CO 80525
USA	Dr. C.J. Peterson 324 Keim Hall, East Campus University of Nebraska Lincoln, Nebraska 68583-0935 USA
USA	Dr. James S. Quick Agronomy Department Colorado State University Fort Collins, CO 80521 USA
USA	Dr. Rollin G. Sears Agronomy Department Kansas State University 122 Throckmorton Hall Manhattan, Kansas 66506-5501 USA

Country	Cooperator Name/Address
USA	Dr. David A. Van Sanford Department of Agronomy N-106K Agric. Sci. Bldg. N. University of Kentucky Lexington, KY 40546-0091 USA
USA	Dr. W. David Worrall Texas A & M University Agricultural Research & Extension Center P.O. Box 1658 Vernon, Texas 76384 USA
USA	Dr. Robert Zemetra Deptpartment of Plant, Soil & Entomological Sciences University of Idaho Moscow, IDAHO 83843 USA
VIETNAM	Director National Maize Research Institute Ministry of Agriculture and Food Industry Dan Phuong Ha Tay VIETNAM
YEMEN	Dr. Mohamed Al-Khawlani P.O. Box 87148 Agricultural Research & Extension Authority (AREA) DHAMAR REPUBLIC OF YEMEN
YUGOSLAVIA	Dr. Srbislav Dencic Cereals Department Institute of Field and Vegetable Crops Maksima Gorkog 30 21000 Novi Sad YUGOSLAVIA

Country	Cooperator Name/Address
YUGOSLAVIA	Dr. Srbislav Dencic Institute of Field and Vegetable Crops Cereals Department Maksima Gorkog 30 21000 Novi Sad YUGOSLAVIA
ZIMBABWE	National Tested Seeds Willie Ranby, General Manager P.O. Box 2705 Harare ZIMBABWE

CIMMYT
INTERNATIONAL MAIZE AND WHEAT IMPROVEMENT CENTER

OSU
Oregon State University

Appendix 4

Minutes of the

1st Winter Wheat East European Regional Yield Trial (WWEERYT)

Ankara
June 9 – 11, 1998

Content:

Introduction
1. Variety Release Mechanism and Code of Ethics
2. Royalties
3. Monitoring System
4. Private Companies
5. Distribution of WWEERYT to other cooperators and expansion of the WWEERYT
6. Inclusion of transformed wheat lines into the WWEERYT
7. Trial Methodology
   - 7.1 Material
   - 7.2 Traits to be observed
   - 7.3 Data Management
   - 7.4 Data utilization for Research and Publications
   - 7.5 Seed multiplication
   - 7.6 Seed shipment
   - 7.7 Pedigree
8. New entries for 2nd WWEERYT
9. Durum Wheat
10. Budget
11. Fund Raising
12. Research Initiatives
13. Location for 2nd Coordination Meeting in June 2000
14. Structure of the WWEERYT

App. 1 Participants
App. 2 Participating institutions
App. 3 Code of Ethics
App. 4 MTA for CIMMYT Research products

CIMMYT/Turkey Tel: (90) 312 - 287 35 95-6-7 Fax: (90) 312 - 287 89 55
P.K. 39 Emek EMAIL: CIMMYT-TURKEY@CGNET.COM or H.J.Braun-t@CGNET.COM
06511 Ankara Ref: MINWW.DOC

Introduction

The 1st coordination meeting for the WWEERYT was held in Ankara from June 9 –11,1998. Thirty two participants attended the meeting (App. 1). The meeting consisted of one and half day discussions followed by a half field visits to Haymana, Konya and ofr part of the group to Eskisehir.

The WWEERYT goes back to an initiative of Prof. Kronstad, Oregon State University and Dr. Rajaram, CIMMYT to establish a regional yield trial for Eastern-Europe, Russia and Ukraine. After the discontinuation of the International Winter Wheat performance Nursery, distributed by Nebraska and the collapse of the COMECON trials, no regional yield trial existed to test wheat germplasm adapted to East European Wheat Environments. The Elite Yield Trial distributed by TURKEY/CIMMYT/ICARDA is more targeted for West and Central Asia, where different diseases than in EE affect wheat production. USAID agreed to provide financial support to conduct this regional yield trial. The participating countries and institutes in the WWERYT were decided by USAID according to ecological needs and based of the agreement of the country representative of USAID. For this reason, several Central Asian Republics were included into the Founding Member Institutes, though the initial target area was exclusively E-Europe.

In 1997 a letter was forwarded to institutes to exploit their interest to participate in this trial and to submit wheat cultivars / varieties for inclusion and distribution. The distribution of the material will be conducted under the code of ethics, published in the Annual Wheat news Letter (for details see below). Each participating institution (PI) was requested to sign a letter in which it assured to recognize the code of ethics. A total of 23 institutions signed the agreement, agreed to grow the trial and submit lines (App. 2). The only institute which did not want to participate was the Rostov Agricultural Institute.

Each PI was asked to send 2 to 3 of their best elite lines / varieties for multiplication and distribution to CIMMYT/TURKEY. Fourteen PI sent seed in time for sowing. For 4 PI seed did not arrive in time, but seed of previously received cultivars was available for multiplication. These institutes gave approval for inclusion of these entries. Five other PI have expressed interest to submit entries in the future.

2. Variety Release Mechanism and Code of Ethics

Each participating institute had to sign a letter of understanding that it would recognize the code of ethics published in the annual wheat news letter as the basis to participate in the WWEERYT before it was accepted as a FOUNDING MEMBER. The code of ethics (App. 3) was accepted as basis but changes were made in paragraph 1. These changes were done, recognizing that they may not be included in the code of ethics published in the Annual Wheat News Letter.

The guidelines for variety release follow the regulations provided in the CoE. For those countries which are members of UPOV, UPOV regulations will apply. Following countries are members of UPOV:

Bulgaria, Czech Republic, Georgia, Hungary, Kazakstan, Romania, Russia, Ukraine, USA, Uzbekistan. Non-UPOV members are Armenia and Turkey.

In agreement with the CoE, following procedure was agreed on for the inclusion of entries from the WWEERYT into regional (multi-locational) and national registration trials:

a) In countries with a National Trial System the introducing institution has to obtain an authorization letter from the owner of the variety to enter the selected entry from the WWEERYT into registration and/or multi-locational trials. The letter used in Hungary is attached and will serve as model.

b) At the time of release a commercial agreement will be signed.

c) In countries without National registration Trials, the release is regulated in an agreement between the owner and the introducing institution. Approval for multilocational trials is also required.

d) Private companies can release varieties derived from the WWEERYT as long as they follow the regulations spelled out in this document.

e) The name of a released cultivar should not be changed once it is introduced in another country. No decision was made on naming advanced lines included in the WWEERYT.

The rules for lines derived from the International Winter Wheat Improvement Program are given in App. 4.

2. Royalties

Royalties are subject to the bilateral agreement between the owner of the variety and the releasing institute. The SC will not be involved in negotiating royalties.

3. Monitoring System

A monitoring mechanism is necessary for collection of royalties and to measure the impact of the WWEERYT. It was agreed that the responsibility for monitoring lies with the Coordinator and the Steering Committee. The Steering Committee should be informed which entries from the WWEERYT are selected for

a) further testing
b) inclusion into yield trials
c) inclusion into registration trials
d) inclusion into registration trials

If the owner of a variety gives the permission to include a variety/cultivar into yield trials, a copy of the agreement should be sent to the Steering Committee.

If an entry from the WWEERYT is released , the Steering Committee will be annually informed on the acreage covered by this variety.

If a commercial agreement is signed between the owner and an introducing institution, the Steering Committee should be informed. However, it is not necessary to send a copy of the commercial agreement itself.

4. Private Companies

can obtain release varieties originating from the WWEERYT. The release is subject to the commercial agreement between the owner of the variety and the private company.

5. Distribution of WWEERYT to other cooperators and expansion of the WWEERYT

Though the nursery has not been distributed, several wheat breeders have already expressed interest to receive the WWEERYT. The group agreed that the WWEERYT could be distributed to other cooperators, who were not among the initial group members. The benefit of growing the trial at more locations was emphasized. Following points were agreed on:

a) Provided funds are available, the WWEERYT can be forwarded to other cooperators, including private companies, aside the Founding Member Institutes. Before the WWEERYT is sent, the Material Transfer Agreement has to be signed and returned to the Project Coordinator.
b) Private companies can also receive the nursery
c) The trial consists presently of 64 entries. A further increase of the entry number would make logisitcs more difficult. Therefore, new cooperators (non – Founding Member Institute) can not submit entries for inclusion into the WWEERYT until the Founding Member Institute have agreed to. A modification can be considered after the trial was conducted for at least two years.
d) It is highly desirable that all entries of the WWEERYT will be fingerprinted. Washington State University, Plant Breeding and Genetics Institute in Odessa and CIMMYT will inform the Project Coordinator re the estimated costs. The SC will decide where and whether the fingerprinting will be done, depending on the costs involved.
e) Private companies can submit lines for testing, but would have to pay since public money is used to conduct the WWEERYT. No amount has been fixed since this issue will not be of importance until the next meeting in June 2000.

6. Inclusion of transformed wheat lines into the WWEERYT

Four participating countries, (Ukraine, Hungary, USA and Mexico) work on wheat transformation. Since many countries do not have safety regulations in place to handle transformed plants and since Turkey at this time would not allow multiplication of transformed wheat plants in Turkey at this time, it was agreed that transformed wheat can not be included into the WWEERYT. Modifications need to be agreed on in the Cooridnation Meeting. However, at this time none of the institutes had a transformed cultivar which could be submitted.

7. Trial Methodology

7.1 Material

a) The WWEERYT consists of 64 entries, including five checks (two local and 3 long term checks) with 3 replications submitted by Founding Member-institutes
b) The experimental design is a 8 x 8 lattice.
c) The long term checks are Bezostaya, Jagger and Seri 82.
d) Each institute will receive the seed amount requested (see separate table) and is responsible for dividing the seed according to the randomization plan provided.

e) Every year new entries will be distributed. However, each Founding Member-institute can submit the same entry again.
f) There is a maximum of 3 entries / Founding Member-institute.

Each Founding Member-institute received a list with the potential entries for the WWEERYT. All participants approved to include the lines which were submitted by their respective institute.

7.2 Traits to be observed

In addition to the traits winter survival, days to heading, grain yield, 1000KW, test weight, and disease resistance scores, which should be reported by all cooperators, following traits will be observed by individual institutes:

Dobrudja,	Bulgaria	3 Rusts, al*	Full quality analysis of selected lines
Sadovo,	Bulgaria:	Scab al	Leaf Rust, Stem Rust art. inoc.
Prague,	Czechia	Leaf rust al	
Szeged,	Hungary	Scab al	BYDV
Martonvasar,	Hungary	Cold resistance	Kernel hardiness
Almaty,	Kazakstan	Common Bunt	
Fundulea,	Romania:	Scab, al	
Ankara,	Turkey	Yellow rust al,	HMGW,
Eskisehir,	Turkey	Common Bunt	
Kharkov,	Ukraine	Cold resistance	
Uzbekistan		Heat Tolerance	
S-Dakota,	USA	Scab field	

* al = artificial inoculation

7.3 Data Management

In order to allow a fast report preparation and data analysis the following points were agreed on:

a) Data should be collected following the manual developed by Oregon State University. A copy of the manual will be forwarded together with the seed.
b) Data should be returned, if possible on floppy disk or as EMAIL. EMAIL address is CIMMYT-Turkey@CGNET.COM. A hard copy (printout should) be mailed separately.
c) CIMMYT/Turkey will forward cross and pedigree (if available) on floppy disk together with field book
d) Data should be returned not later than November 30
e) Data will be reported following the FAWWON format, i.e. each table will provide all data for one trait.
f) The report will be distributed not later than April of the following year.
g) The report will be distributed as hard copy as well as on floppy disk.

7.4 Data utilization for Research and Publications

a) Data generated through the WWEERYT can be used for publication by anybody as long as due credit is given to origin of data.
b) All data (including data of replications) will be forwarded on floppy disk to cooperators

c) Any publication should refer to the report as data source
d) In the publication a clear reference must be made to the report of the WWEERYT

7.5 Seed multiplication

The seed is multiplied at MIKHAM, Konya. Seed used for multiplication plots was treated with RAXIL® and sprayed two times during the growing season with Tilt®. Plots were inspected for diseases. Seed will be treated with a systemic fungicide (RAXIL®) prior to shipping the seed.

7.6 Seed shipment

Each institute was requested to provide information on seed shipping details. Nurseries for Bulgaria, Romania, Moldova and Ukraine will be forwarded to Dobrudja, Bulgaria as bulk shipment and further distribution will be handled by Dobrudja.
Georgia and Armenia will provide details on seed shipping after consultation with Humanitarian organisations, which will organise seed shipment. All other participating institutions will receive the shipment as requested. Cooperators in the US will receive the nursery from Oregon State University. Seed will be shipped mid-August.

Country	Plot Size m^2	Seed Amount (grams)
Armenia	24	2500
Bulgaria, Dobrudja	15	1000
Bulgaria, Sadovo	10	1500
Czech Republic,	10	800
Georgia,	15	2000
Hungary, Martonvasar	10	500
Hungary, Szeged	10	500
Kazakstan	15	1000
Moldova	10	1000
Romania, Fundulea	6	1500
Romania, Turda	6	1500
Russia, Krasnodar	10	1000
Ukraine, Mironovsk	10	1000
Ukraine, Kharkov	10	1000
Ukraine, Odessa	10	1000
Ukraine, Kiev	10	1000
Uzbekistan	10	1500
Tajikistan	15	1500
Turkey, Edirne	6	500
Turkey, Ankara	6	700
Turkey, Eskisehir	6	500
Turkey, Konya	10	700
CIMMYT/Mexico	6	300
Total		24500
To be prepared by Oregon State University		
USA, S-Dakota	4	200
USA, Texas	6	300
USA, Washington	10	500

7.7 Pedigree

Cooperators are encouraged to make pedigree of submitted lines available.

8. New entries for 2nd WWEERYT

New entries for the 2nd WWEERYT should be submitted to:

CIMMYT/TURKEY
P.K. 39 Emek
06511 Ankara
Turkey Tel: 90-312-2973595 FAX: 90-312-2878955

The seed should arrive not later than October 1. Inclusion of lines received after October 1 will depend on whether the nursery was sown already and wether weather conditions will permit sowing after this date.

9. Durum Wheat

Following institutions expressed interest to participate in a regional durum yield trial. Provided this nursery can be organized (issues of funding and locality needs to be cleared) participating institutions will be asked to submit 1kg/line, max 2 lines/institute.

Countries interested		Receiving Nursery	Submitting lines
Bulgaria	Dobrudja	Yes	Yes
Hungary	Martovansar	Yes	Yes
Romania	Fundulea	Yes	Yes
Kazakstan		Yes	Yes
Krasnodar		?	?
Turkey		Yes	Yes
Ukraine	Odessa	Yes	Yes
USA	Oregon State	Yes	
USA	Nebraska	?	?
Uzbekistan		Yes	Yes
IWWIP		Yes	Yes

10. Budget

The WWEERYT has been funded by USAID, which made a total of 100 000 US$ available for 1998/99. The project was initially planned for 5 years but eventually USAID committed funds for only one year. Fifty thousand US$ were available for 1999/2000 from OSU/USAID. Considering the financial constraints following agreement were reached:

a) Each IGP will receive 1500 US$ to conduct the trial in 1998/99
b) No meeting will be organised in 1999. The group clearly stressed that conductance of the experiment is most important and if necessary the meeting can be held at greater intervalls, not necessarily annually.

11. Fund Raising

The present funding allows to conduct the trial for two years. After this new funds must be raised or the entire approach (financial support to conduct trial, meetings. etc) must be reconsidered. The group felt that it is too early to make decisions on how to run the WWEERYT in two years from now on due to the financial uncertainties. The Steering Committee was asked to initiate fund raising projects, looking at all potential donors. While there was some initial reluctance to consider National Private Companies / Multi-Nationals as potential donors, the Founding Member Institute eventually agreed that National Private Companies / Multi-Nationals should also be considered as funding source. It was recognized that National Private Companies / Multi-Nationals will have an interest to market lines tested in the WWEERYT. The issues related to variety release / royalties are covered separately.

12. Research Initiatives

Following suggestions were made:

a) At next meeting every participant should talk about new *fantastic* ideas on wheat research (brainstorming)
b) F1 seed of crosses to this material can be forwarded to the IWWIP in Turkey.
c) The PBI-Cobbety, Australia (Dr. Park) and the Institute for Crop Research Prague-Ruziny (Dr. Bartosz) have expressed interest to cooperate on monitoring Leaf Rust, utilizing the WWEERYT. This project would be similar to what was done for W-Europe and includes collection of Leaf Rust samples, virulence testing and gene postulation. The analysis would be done by Dr. Pavel Bartosz, Prague. The group strongly supported this research initiative.
d) Research on Yellow Rust is of great importance only for Turkey and Tajikistan, and in some years for Romania. In all other countries, Yellow Rust is not a major threat.
e) No interest was expressed to initiate research projects on powdery mildew
f) CIMMYT/Mexico offered to analyse leaves of check varieties with ICP for micro-nutirent content. Dr. Monasterio will forward information on how to prepare leaves.
g) Institution which will do fingerprinting (see before) should also prepare dendrogram.
h) Classification of genotypes and environments.
i) Data of WWEERYT can be used for MSc or PhD thesis (see below publication)
j) Hungary (Dr. Kertesz) is the editor of Cereal Research Communication and offered to publish results from WWEERYT.
k) CIMMYT/Turkey asked for cooperators to determine the performance of isogenic lines for Vrn genes by growing a yield nursery consisting of approximately 20 lines for 2 years. This nursery is of interest for areas where both spring and winter wheats are grown. Eskisehir and Romania will participate. Texas A&M would be interested if multiple sets of seed can be obtained. Since the original seed came from UC-Davis it should be possible to get seed for identical sets from there.

13. Location for 2nd Coordination Meeting in June 2000

Three institutions, Dobrudja, Odessa and Martonvasar expressed interest to host the next meeting of the WWEERYT. Dobrudja withdrew its application. Eight participants voted for Odessa, 13 participants for Martonvasar. Therefore, the next coordination meeting of the WWEERYT will be held in June 2000 in Budapest in conjunction with the 6th International Wheat Conference.

14. Structure of the WWEERYT

The mode of conductance of the WWEERYT was decided by the participating institutions during the coordination meeting in June 1998 in Ankara. Modifications need approval from the participants during the next coordination meeting in June 2000 in Budapest. The WWEERYT is coordinated by a Steering Committee and a Project Coordinator.

Steering Committee Members:
S.Rajaram, CIMMYT/Mexico,
W.E. Kronstad, Oregon State University
H.-J. Braun, CIMMYT/Turkey,

Project Coodirnator
A. I. Morgounov, CIMMYT/Turkey

App. 3

Winter Wheat East European Regional Yield Trial (WWEERYT)

Code of Ethics

This seed is being distributed in accordance with the **"Wheat Workers' Code of Ethics for Distribution of Germplasm",** developed and adopted by the National Wheat Improvement Committee of the United States of America on 5 November, 1994. Acceptance of this seed constitutes agreement. The code of ethics is published in the Annual Wheat News Letter.

1. The originating owner (breeder, institution or company)[1] has certain rights to the germplasm that is included into the WWEERYT. These rights are not waived with distribution of seeds in the WWEERYT but remain with the originator.

2. The recipient of this germplasm through the WWEERYT shall make no secondary distribution of the germplasm without the permission of the owner/breeder.

3. The breeder, in providing the germplasm for evaluation in the WWEERYT, grants permission for its use in experimental tests under the recipient's control and/or as a parent for making crosses from which selection will be made. Uses for which written approval of the owner/breeder is required include:
   a) increase and release as cultivar;
   b) reselection from within the stock;
   c) use as a parent of a commercial F1 hybrid, synthetic, or multiline cultivar;
   d) use as a reccurent parent in backcrossing;
   e) mutation breeding;
   f) selection of somaclonal variants; or
   g) use as a recipient parent for asexual gene transfer, including molecular genetic techniques.

Paragraph 4 of the Code of Ethics[2] is not applicable, since participants in the WWEERYT are encouraged to use selected lines from this nursery for seed multiplication. The regulations for inclusion of selected lines into yield trials are spelled out under point 1 of this document.

---

[1] The text of the code of ethics published in the Annual Wheat News letter was modified. The original text reads: The originating breeder, institution or company has certain rights ....

[2] Paragraph 4 in the code of ethics reads:
"Plant materials of this nature entered in crop cultivar trials shall not be used for seed increase. Reasonable precautions to ensure retention or recovery of plant materials at harvest shall be taken."

CIMMYT/Turkey Tel: (90) 312 - 287 35 95-6-7 Fax: (90) 312 - 287 89 55
P.K. 39 Emek EMAIL: CIMMYT-TURKEY@CGNET.COM or H.J.Braun-t@CGNET.COM
06511 Ankara Ref: **MINWW.DOC**

CIMMYT Research Products (non designated)

1. CIMMYT is making the material described in the attached list available as part of its policy of maximizing the utilization of genetic material for research. The material developed by CIMMYT is made freely available for any agricultural research or breeding purposes.

2. Recipients are free to release for commercialization CIMMYT research products in the form they are provided. Prior to the application for any form of IPR on this germplasm or related information, written permission from CIMMYT must be obtained. If released without obtaining IPR, CIMMYT requests notification and acknowledgment. Moreover, while CIMMYT recognizes the validity of IPR, it reserves the right to distribute all material in accordance with paragraph 1, above.

3. CIMMYT makes no warranties as to the safety or title of the material, nor as to the accuracy or correctness of any passport or other data provided with the material. Neither does it make any warranties as to the quality, viability, or purity (genetic or mechanical) of the material being furnished. The phytosanitary condition of the material is warranted only as described in the attached phytosanitary certificate. The recipient assumes full responsibility for complying with the recipient nation's biosafety regulations and rules as to import or release of genetic material.

4. Upon request, CIMMYT will furnish information that may be available in addition to whatever is furnished with the seed. Recipients are requested to furnish CIMMYT performance data collected during evaluations.

5. The material is supplied expressly conditional on acceptance of the terms of this agreement. The recipient's retention of the material constitutes such acceptance.

CIMMYT/Turkey Tel: (90) 312 - 287 35 95-6-7 Fax: (90) 312 - 287 89 55
P.K. 39 Emek EMAIL: CIMMYT-TURKEY@CGNET.COM or H.J.Braun-t@CGNET.COM
06511 Ankara Ref: **MINWW.DOC**

Department of
Crop and Soil Science

WHEAT RESEARCH

OREGON
STATE
UNIVERSITY

107 Crop Science Building
Corvallis, Oregon
97331-3002

Warren E. Kronstad
Tel: (541)737-3728
Fax: (541)737-1589
Email:
warren.e.kronstad@orst.edu

WINTER WHEAT EAST EUROPEAN REGIONAL YIELD TRIAL (WWEERYT)

CODE OF ETHICS

1. The originating owner, breeder, institution, or company, has certain rights to the germplasm that are included into the WWEERYT. These rights are not waived with distribution of seeds in the WWEERYT but remain with the originator.

2. The recipient of this germplasm through the WWEERYT shall make no secondary distribution of the germplasm without the permission of the owner/breeder.

3. The breeder, in providing the germplasm for evaluation in the WWEERYT, grants permission for its use in experimental tests under the recipient's control and/or as a parent for making crosses from which selection will be made. Uses for which written approval of the owner/breeder is required include:

   a) increase and release as a cultivar;
   b) reselection from within the stock;
   c) use as a parent of a commercial F1 hybrid, synthetic, or multiline cultivar;
   d) use as a recurrent parent in backcrossing;
   e) mutation breeding;
   f) selection of somaclonal variants; or
   g) use as a recipient parent for asexual gene transfer, including molecular genetic techniques.

PLEASE DATE, SIGN, AND RETURN TO:

Wheat Research
Crop Science Building #107
Oregon State University
Corvallis, Oregon 97331-3002

Date: _____

Signature: _____

PLEASE GIVE US YOUR CURRENT SHIPPING ADDRESS;
Name, address, telephone, fax, email:

_____

_____

_____

wpdoc\seed\wweeryt

Appendix 5

Abstracts of Graduate Student Theses

1.	Ammar, K.	03/28/97
2.	Bedoshvili, D.	06/14/99
3.	Boru, G.	05/24/96
4.	Briceno Felix, G. A.	07/08/96
5.	Castro, M.	2000
6.	Cerono, J.	07/08/97
7.	del Blanco, I. A.	02/17/99
8.	Jobet, C.	05/07/96
9.	Larson, M.	05/09/97
10.	Lopez, C.	2000
11.	Mendoza, M.	09/14/98
12.	Rosa, A.	01/04/99
13.	Rosa Filho, O.	03/04/97
14.	Weight, C.	12/12/96

Gluten Protein Polymeric Composition and Allelic Variation as Related to Bread-Making Quality in Durum Wheat

Karim Ammar, Ph.D. in Genetics March 28, 1997

Attempts to develop dual-purpose durum wheat cultivars for both pasta and bread-making have been unsuccessful. To better understand this limitation, thirty durum genotypes, selected based on their diverse geographical origin, and five bread wheat cultivars were compared as to their flour mixing properties, dough physical characteristics and baking performance. The polymeric composition of gluten protein was determined using SE-HPLC of unreduced flour protein extracts and the size-distribution of the gluten polymer was estimated by determining the SDS-unextractable polymer (macro-polymer) content. Durum genotypes were characterized by a lower bread-making quality compared to bread wheats, in spite of higher total flour protein and gluten polymer contents. This was due to a weaker gluten and lack of dough extensibility. The stronger gluten characteristics of bread wheats were associated with a greater ability to form macro-polymers. However, two durum cultivars had a higher macro-polymer content than many of the bread wheats, suggesting that an additional property, unrelated to size-distribution of the gluten, contributes to the greater loaf volumes observed for bread wheats.

Considerable variability for most quality attributes was observed among durum genotypes. Gluten strength and dough extensibility were the most important factors associated with superior baking performance. These two parameters were not inter-related. Durum genotypes expressing LMWG-1 had the weakest gluten and the poorest baking performance. This allele contributed less protein to the glutenin fraction and the sub-units produced exhibited a reduced ability to form macro-polymers. Among the durum genotypes expressing LMWG-2, those carrying HMWG-(6+8) were characterized by a better baking quality than genotypes carrying HMWG-(7+8) or HMWG-20. Genotypes carrying HMWG-20 were characterized by a comparatively weaker gluten and a lower macro-polymer content. The better baking performance of genotypes expressing HMWG-(6+8) relative to that of genotypes carrying HMWG-(7+8) was attributed to the greater dough extensibility characterizing the former group, but not to differences in gluten strength-related parameters. There was no indication of differences in the gluten polymer's size-distribution between the two groups.

Possible Compensations of the Components of Grain Yield in Wheat (*Triticum aestivum* L.) as Influenced by Genotype by Environment Interactions

David Bedoshvili (Dato), Ph.D. June 14, 1999

Despite many investigations genotype by environment interaction remains one of the least understood factors in plant improvement. Understanding genotypic differences responsible for such interactions could assist in making more informed breeding decisions. The components of yield being less complex than grain yield per se may be useful for selection to improve adaptation of genotypes and enhance grain quality. However, the potential compensatory response among the components of yield could compromise their usefulness as selection criteria.

To evaluate this aspect fifteen cultivars, including Soft White, Hard White and Hard Red wheats, were planted at three diverse locations over two growing seasons. Genotypes were ranked based on measurements for specific traits in each environment. The genotype by environment interaction for grain yield, protein concentration and hardness were investigated according to the AMMI model. Influence of environmental factors and genotype by environment interactions on associations among selected traits were determined.

The results of this study showed that genotypic differences in adaptation to the Pacific Northwest and resistance to *Septoria spp.* were responsible for interactions for grain yield. However, no consistent patterns of response were found among the similar cultivars for quality traits. Those environments that favored expression of biomass and grain weight potential provided for enhanced performance of the adapted cultivars. The environments with suppressed biomass accumulation and grain filling interacted positively with the unadapted cultivars. A large compensatory relationship between tillering and apical growth was detected. No or low compensation was observed between grains per spike and thousand kernel weight. Two different strategies were proposed for improvement of Soft and Hard White wheat cultivars under the conditions of the Pacific Northwest. Both strategies accentuate importance of increasing biomass while maintaining harvest index. When selecting for higher yielding Soft White cultivars, plants with larger leaves, stronger stems, larger spikes, and heavier grains should be emphasized. For Hard White – higher number of tillers and grains m^{-2} is desired, as they provide for harder grains with higher protein content.

Expression and Inheritance of Tolerance to Waterlogging Stress in Wheat (*Triticum aestivum* L.)

Getachew Boru, Ph.D. May 24, 1996

To obtain genetic information pertaining to the inheritance of tolerance to waterlogging in wheat, three tolerant (Prl/Sara, Ducula and Vee/Myna), and two sensitive (Seri-82 and Kite/Glen) wheat lines were crossed in all possible combinations. F_1, F_2, F_3, and backcross generations obtained from these crosses were studied under field conditions. Flooding was imposed when plants were at the first internode stage, and basins were drained after 40 days of flooding. Data were collected on percentage leaf chlorosis (four times at intervals of seven days starting at Zadoks' DC scale 41), heading date, plant height, biomass, yield, and kernel weight. Leaf chlorosis was used as a measure of tolerance to waterlogging.

The expression of tolerance to waterlogging was not influenced by the maternal effect as no differences between reciprocal crosses for percentage leaf chlorosis were observec. The F_1 generations were intermediate for the symptom of leaf chlorosis, indicating that resistance was additive. Broad sense heritability ranged from 58 percent to 83 percent. In an attempt to estimate the number of genes that control tolerance to waterlogging, F_3 populations for symptoms of leaf chlorosis were analyzed using chi-square method. The segregation ratios of F_3 lines indicated that four genes control tolerance to waterlogging stress. Selection of segregating lines at early generation for tolerance to waterlogging stresses would be effective.

Laboratory experiments were designed to provide information about the morphological and anatomical basis of tolerance to anaerobic conditions. In these experiments the five parents were evaluated for differences in root anatomy and O_2 transport from shoot to root. Plants were grown either for four to five weeks under continuousl aerobic conditions, or for two to three weeks aerobically followed by two to three weeks of anaerobic treatment in aerobic and anaerobic hydroponic culture.

Tolerant cultivars showed a higher percentage of root porosity than the sensitive cultivars. This was evident when well-developed aerenchyma was observed under light microscopy for the tolerant cultivars. Oxygen transport from the shoots to the roots was observed for both tolerant and sensitive cultivars. The anatomical differences were not associated with the differences observed between tolerant and sensitive cultivars in O_2 transport. The differences in aerenchyma formation combined with the processes (enzyme activities and substrate supply) controlling the glycolytic flux and respiration rate may have accounted for the differences observed between tolerant and sensitive wheat cultivars.

Wheat Genotypes Selected under Optimum Conditions and their Response to Water and Heat Stress

Guillermo Ariel Briceno Felix (Memo) Ph.D. July 8, 1996

Concerns have been expressed that wheat (*Triticum asetivum* L.) cultivars selected under optimum conditions may lace adequate adaptation for stress environments. Experimental populations were grown under three environmental conditions 1) optimum, 2) reduced irrigation, and 3) high temperature. Field experiments were conducted at the Center for Northwest Experimental Station (CIANO), in Cd. Obregon, Sonora, Mexico, during 1992-93 and 1993-94 cropping seasons. An analysis of variance for each environment and a combined analysis over environments for a single year and for two years were calculated for 130 selected lines from six crosses. To examine the magnitude of the possible genotpye x environment interaction and its implications to yield stability, three stability methods were employed. A stress index was computed to evaluate the sensitivity of the genotypes to water and heat stress. Correlations coefficients and path-coefficients were calculated for yield and selected agronomic traits to determine if specific traits were associated with stable genotypes.

Single and combined analyses of variance across environments confirmed that differences existed among the genotypes in their response to changes in environments. The genotype yield performance suggested that the selection under optimum management conditions was effective in identifying germplasm with relatively better grain yield under moisture and heat stress. The relative magnitude of genetic to environmental variance was found to be low for several genotypes by both the stability variance (S^2) and the genotype grouping technique. Stress index values and the results of the genotype yield performance suggested that selection under optimum management conditions could lead to the selection of genotypes with tolerance to drought and heat. Correlations coefficients and path-coefficients indicated that biomass, grains m^{-2}, and spikes m^{-2} were the most important components associated with grain yield under each environmental condition evaluated.

Results of this study confirm that most genotypes selected under optimum management conditions retain their yield potential advantage when exposed to moisture and heat stress. However, it will be necessary that genotypes selected under optimum conditions be evaluated under stress environments to identify the most promising individuals.

Influence of Nitrogen Fertilization on the Bread Making Quality of Different Wheat Genotypes

Marina Castro, MS 2000

Hard white wheats are being developed in the Pacific Northwest of the USA, having shown acceptable bread baking quality, and promise in Asian noodle product evaluations. If management practices can increase the quality and quantity of protein, the end use of these wheats could fit better a domestic bread market as well as explore other export markets. Breeders, farmers and the Industry are interested in this kind of information in order to diversificate the production of these genotypes (noodles and bread making).

Hard red wheats are mainly produced in Uruguay, South America, for the milling and baking market. For several years, the Uruguayan government prohibited the importation of wheat until there was no more locally produced wheat in the country. This prohibition was eliminated when the Southern Common Market was established. Now, Uruguayan wheats have to be competitive with those of high industrial quality produced by other countries. Breeding for good industrial quality is the base for this change, with the National Institute for Agriculture Research (INIA) working on this problem for many years. The purpose of this study is to analyze the influence of management practices on bread making quality by applying different rates and timing of Nitrogen (N) fertilization to five selected spring wheat genotypes, in two locations (Corvallis and Pendleton) during growing seasons 1998 and 1999. Two hard red wheat entries were released by INIA's Breeding Program, Uruguay (INIA Mirlo and INIA Boyero); a third hard red one is from California (Yecora Rojo). A fourth hard white wheat entry was developed in Idaho (ID 377s), and the remaining hard white genotype (Winsome) was developed by the Wheat Breeding and Genetics Project, at Oregon State University. All of them proved to be well adapted to this region. This research into management practices is designed to complement the Breeding Program and improve the quality of Uruguayan wheat, as well as provide useful information for the Wheat Breeding Program at OSU.

Preliminary results show that there is a significant increase in grain protein content, SDS-sedimentation values and bread loaf volume, with a splitting of the N in these spring wheats. Thus, encourages focusing studies in this direction to provide producers with a useful management practice that can result in a crop with an enhanced quality result.

Possible Associations of Soluble Carbohydrates with Chemical Desiccation and Drought Resistance in Winter Wheat

Julio Cesar Cerono, Ph.D. July 8, 1997

Drought is a major limiting abiotic stress influencing wheat production in many parts of the world. The erratic nature of water deficits makes breeding and selection for drought resistance deficient. In environments with late season drought stress, yield losses are usually associated with kernel abortion or reduction in kernel growth. Remobilization of soluble carbohydrates from the stem has been associated with drought resistance. The objectives of this investigation were i) to asses the role of soluble carbohydrates in the determination of drought resistance, ii) their association with prouductivity, and iii) to evaluate a rapid technique to identify genotypes with higher capacity of soluble carbohydrate remobilization. Nine winter wheat cultivars differing in their response to drought stress were grown under irrigated and nonirrigated conditions during the grain filling period at the Sherman Branch Experiment Station, Moro. The cultivars were also grown at the Hyslop Crop Science Laboratory, where plots were chemically desiccated with Sodium Chlorate or left untreated. All control and treated plots were evaluated for soluble carbohydrates in two vegetative fractions, stem plus sheath and leaf blades. These values were correlated with the relative reductions in kernel weight and yield observed on the treated plots.

Differences among cultivars were observed for the concentration of soluble carbohydrates in the stem and leaf fractions. Time elapsed from anthesis was a major determinant of the variation in carbohydrates accumulated to a much greater extent than leaf soluble carbohydrates. The concentration of stem carbohydrates was not related with the reductions caused by chemical desiccation or drought stress. However, potential contributions from stem reserves (ration between potential spike weight and stem reserves) were marginally associated with drought resistance. Stem soluble carbohydrates were positively associated with productivity, suggesting that stems are not competitive sinks, but temporary storage organs of excess of assimilates. Under chemical desiccation most of the soluble carbohydrates were lost in respiration, and the reductions in kernel weight and yield observed were not correlated with those observed under drought. It was concluded that the technique did not reasonably simulate drought in terms of yield reductions nor carbohydrate remobilization.

Agronomic Potential and Physiological Performance of Synthetic Hexaploid Wheat-Derived Populations

Isabel Alicia del Blanco, Ph.D. February 17, 1999

Synthetic hexaploid wheats, obtained by crossing durum wheat [*Triticum turgidum* L. ssp. *Durum* (Desf.) Husn.] and goatgrass (*Aegilops tauschii* Coss.), have proven to be very useful as a source of resistance to biotic and abiotic stresses. Studies were conducted to investigate synthetic hexaploids as a source of variability for agronomic and physiological traits. Six different synthetic hexaploid-derived populations were evaluated for grain yield and the components of grain yield in two-year experiments (1995-96 and 1996-97) at the Agricultural Research Center for the Northwest (CIANO), Sonora, Mexico. Three different populations were evaluated for physiological traits, during the 1996-97 crop season at the same site.

For all agronomic traits there were syhthetic-derived lines significantly superior to their respective bread wheat recurrent parent. Kernel weight was the trait that showed the greatest gain in crosses with synthetic hexaploids. Overall population means were 12% to 20%, superior to bread wheat recurrent parental means, for the first and second year experiments respectively. For other traits, outstanding lines were observed in most populations. Some synthetic lines had 14% higher yield than their respective recurrent parent. Grains per m^2 and biomass were the traits with strongest association with yield. Path coefficient analysis showed a strong direct effect of biomass and harvest index on grain yield.

Differences in maximum photosynthetic rate were detected among genotypes. Most of the synthetic-derived lines showed higher photosynthesis compared to their recurrent parent. Senescence was not substantially premature in synthetic-derived lines compared to their bread wheat recurrent parents. Maximum photosynthetic rate was negatively associated with leaf area and leaf specific weight and positively associated with stomatal and mesophyll conductances, leaf temperature depression, grain yield, and above ground biomass. Differences in conductance in the diffusion pathway of CO_2 were the main reasons for the differences in photosynthesis.

Results indicate that synthetic-hexaploid wheats can be a very useful source of genetic diversity for agronomic and physiological traits if conveniently directed by breeding and selection.

Genetic Potential to Enhance French Bread by Introgressing Superior Pan Bread Quality in Selected Wheat Cultivars (*Tricticum aestivum* L.)

Claudio Roberto Jobet (Fornazzari), Ph.D., May 07, 1996

In the country of Chile, high yielding cultivars have been developed which lack the milling and baking desired quality for French bread. The objective of this investigation was to determine if the cultivars with good pan bread quality could be integrated with agronomically superior Chilean cultivars to enhance potential French bread quality. These two gene pools were hybridized, and F_1, F_2, and backcrosses of three crosses were evaluated as new sources of genetic variability for kernel weight, grain hardness, sedimentation volume, quality and quantity of protein, and grain yield.

Differences were observed among parents, F_1, F_2, and backcrosses within crosses for all traits. The coefficients of variation for the measured traits were low in all three crosses, except for grain hardness and grain yield. However, large genotype x environment interactions were observed for most traits, except sedimentation volume.

Due to the quantitative nature of inheritance and the predominancy of non-additive gene action for most traits (kernel hardness, grain protein content, and grain yield), selection would have to be delayed until F_5 or F_6 generations. The genetic variation associated with kernel hardness appeared to be under the control of non-additive gene action, except for the cross Karl x Temu-INIA where this trait appear to be influenced by genes which behave in a additive manner. Sedimentation volume was also control by genes which respond in an additive manner in all three crosses.

When evaluating the contribution of the different high molecular weight glutenin subunits, it was observed that the allele 1 in genome A, and alleles 7+8 for the B genome were associated with higher sedimentation volume and grain protein content. Those plants found to have bands 2* and 7+8 exhibited characteristics close to the profile for French type bread elaboration. Populations generated by crossing Karl x Temu-INIA represented more closely the profile for French type bread quality.

The integration of germplasm derived from crossing a cultivar with good pan bread quality into agronomic superior Chilean cultivars is a promising approach to enhance French type bread. However, as shown by other investigations using germplasm, traits associated with milling and baking quality are quantitatively inherited and are influenced to a large degree by the environment. These factors must be taken into consideration when determining selection strategies.

Genotype-Environment Interaction and Phenotypic Stability of Selected Winter Wheats (*Triticum aestivum* L. em Thell)

Mark Larson, M. S., May 9, 1997

Extensive research has been devoted to evaluating potential genotype-environment interactions. However, plant breeders are still in need of a simple way to describe how genotypes respond to different locations and years. In an environmentally diverse state like Oregon, significant genotype-environment interactions do occur. The resulting lack of association between actual and genotypic potential yield performances makes it difficult to select genotypically superior lines. This study was prompted to evaluate the extent of such an interaction and compare various yield stability models.

A significant genotype-environment interaction encompassing lines, environments, and years was discovered for each individual year analyzed and for the combined analysis of 1992, 1994 and 1995, and 1989 through 1994. Most lines evaluated during 1992, 1994, and 1995 were adapted to low yielding environments. However, two genotypes (OR880172 and OR880525) exhibited broad adaptation. Stephens and MacVicar were less adapted to the relatively high yielding Chambers site than the other genotypes tested during 1992, 1994 and 1995 due to *Septoria tritici* infections. The most stable genotypes during the combined 1992, 1994 and 1995 and 1989-1994 seasons were OR870831, Madsen and OR8500933H. Gene was the most desirable genotype based on stability and yield for both the combined 1992, 1994 and 1995 and 1989-1994 seasons. Due to an inability to adapt to higher yielding environments, the cultivar Rohde was the least stable genotype during the same combined periods. High and low temperature and precipitation had minor yet significant effects on yield responses at all three sites during various period identified.

Advanced winter wheat selections and cultivars were grown in three diverse environments and compared over different time periods. Due to trial design and the objective of identifying superior genotypes from a set tested in target environments a combination of two methods, stability variance and a selection index, emerged as the most appropriate techniques. These approaches are considered the most appropriate because they use the mean of the trial as a gauge for measuring stability.

Association Among Abscisic Acid, Dehydrin Proteins, and Drought Stress Tolerance in Wheat Cultivars

Cesar Lopez, Ph.D. 2000

Water stress is one of the most important environmental factors that affect plant growth and production. As the demand of food in the world increases, the development of drought resistant cultivars is taken importance as an objective in breeding programs. While breeders are still working to increase yields under highly productive cultivated areas, efforts are made to exploit marginal agricultural lands by improving the genetic adaptation of plants to extreme environmental factors such as temperature and water availability.

Three major drought patterns are recognized: Late drought common in Mediterranean regions, early drought found in Latin America and production on residual moisture in part of Australia and Indian subcontinent. In Mediterranean type climates, water deficit rises in the spring and increases in severity at anthesis and throughout grain filling. Nearly 32 % of the wheat produced in developing countries grown under varying levels of drought stress.

An observed biochemical response to a range of abiotic stresses, including drought stress, is an increase in the abscisic acid (ABA) concentration, which is generally recognized as an adaptation of plants to stress. Reduction in cell division and cell expansion, vegetative and reproductive growth, photosynthesis, pollen viability and seed set along with stomatal closure and alteration of gene expression are observed physiological responses related to ABA concentration increases in plant tissues.

One of the noted changes in gene expression is the accumulation of a distinct group of proteins known as dehydrins. Dehydrins, typically accumulate during the late stages of embryogenesis or in response to increases in ABA concentration, low temperature, or any stress that causes dehydration such as drought, salinity or extracellular freezing. Based on the known physical properties of dehydrins, a role of stabilizers of nuclear or cytoplasmic macromolecules under low water conditions is proposed. Dehydrins have been found in many plant species including wheat, barley, maize, sorghum, and rice.

The objective of the present study is to investigate the association of the ABA concentration and the presence of dehydrin proteins with drought stress response of wheat cultivars. Three soft white cultivars (Stephens, Gene, and Rod), two club cultivars (Hiller, and Rhode), one durum cultivar (Connie), and one hard red cultivar (TAM 105) were studied under non-stress (hydrated) and stress (dehydrated) conditions at seedling and adult plant stages.

Preliminary results indicate that increases in ABA levels in both, seedlings and adult plants under stress is a general response observed in all cultivars. Conversely, the presence of dehydrin proteins in stressed seedlings is observed only in Gene, Connie, and TAM 105, which are the three more tolerant cultivars.

Production of Haploid Plants in Selected Winter Wheat Genotypes through Anther Culture and Intergeneric Crosses with Maize

Maria Graciela Mendoza Agurto, Ph.D. September 14, 1998

A higher level of efficiency in the production of doubled-haploids must be achieved if this procedure is to be beneficial in plant improvement. Of equal importance is the development of protocols, which are not genotypic specific and result in progeny that represent a random sample of gametes from the parental lines.

To address these issues seven diverse winter wheat genotypes and a spring wheat, previously shown to be responsive in haploid plant production from anther culture, represented the experimental material. Two methods of generating haploid plants were employed. These were anther culture and the intergeneric hybridization of wheat with maize. Three induction media (MN6, P2 and Liang's) in liquid and semi-solid forms were employed with anther culture a direct culture. A modified floret culture along with different concentrations (20 and 100 ppm) and mode of application of 2,4-D were examined for the wheat x maize approach, Measurements included callus and embryo production and haploid plantlet regeneration.

Two winter genotypes 'Gene' and 'Yamhill' did not respond to the anther culture methodology. For responsive genotypes MN6 was superior to P2 and Liang's medium for the traits measured. In contrast 'Chris' the spring wheat was more responsive for plantlet regeneration on P2 medium. No differences in haploid plantlet regeneration for the traits were observed between liquid and semi-solid medium forms.

For the wheat x maize approach, direct culture was superior to the modified floret culture for embryo and haploid plantlet production. No differences were found in either 2,4-D concentration or whether 2,4-D was applied through tiller injection or placed as droplets on the florets.

The wheat x maize approach was superior to anther culture for both embryo and green haploid plant production based on the number of florets used. Albino plants were produced in all responsive genotypes with anther culture. In contrast, no albino plants were regenerated with the wheat x maize approach. All genotypes were responsive for both embryo production and haploid plant regeneration in the intercrossing approach. In addition no regeneration distortion was observed for specific population employing this protocol.

The wheat x maize approach was superior to anther culture for embryo production. This was also true for green haploid production based on the number of florets used. A higher proportion of albino plants was also observed when anther culture was employed. A further attribute of the wheat x maize approach was that all genotypes tested were responsive to embryo and haploid production. It was also revealed that no segregation distortion was present in three doubled haploid populations developed from wheat x maize crosses.

Pre-harvest Sprouting Tolerance of a Synthetic Hexaploid Wheat (Triticum turgidum L x *Aegilops tauschii* Coss.)

Andre Cunha Rosa, M.S., January 4, 1999

Pre-harvest sprouting in wheat costs farmers millions of dollars every year. Pre-harvest sprouting tolerance (PST) has minimized this problem, but improvement of PST is still necessary. Synthetic hexaploid wheats (synthetics) have been used as sources of genes coding for many useful traits. Two studies evaluated the PST of a synthetic (Altar 84/*Aegilops tauschii*) and investigated its potential as a source of PST in crosses with wheat cultivars.

The first study compared the synthetic with selected wheat checks for PST and with its parent Altar 84 for the germination response of these genotypes to controlled wetting treatments applied to field-grown intact spikes and threshed seed. Spikes were rolled in wet germination paper and the percentages of germinated seeds were determined after seven days. Threshed seeds in Petri dishes were wetted with water and vegetative floral tissues (chaff) extracts. Germinating seeds were counted daily for 14 days. The synthetic was more tolerant than Altar 84 and was classified as moderately sensitive. The improved PST of the synthetic over Altar 84 was attributed to *Aegilops tauschii*. Seed dormancy and water-soluble substances in the chaff of the synthetic and other genotypes appeared to contribute to their PST.

The second study used random inbred F_5 lines obtained from single and backcrosses between the synthetic (red-seeded) and the sensitive wheat cultivars Opata 85 (red-seeded) and Baconora 88 (white-seeded). Seed coat color and germination responses of the F_5 lines subjected to a five-day spike wetting treatment were evaluated. Pre-harvest sprouting tolerance was moderately to highly inheritable and largely controlled by additive gene effects in the studied populations. An association between red seed coat color and PST was observed but white recombinant lines more tolerant than their sensitive parent were obtained. The synthetic can be used to improve wheats with red and white seed coats. The potential use of the synthetic as a PST source was discussed and a breeding strategy suggested.

Effect of the six glutenin loci on selected bread quality traits in wheat

Ottoni Rosa Filho Ph.D. March 4, 1997

Wheat breeding for breadmaking quality has exploited most of the existing genetic variation in the High-Molecular-Weight glutenin loci (*Glu-1A, Glu-1B and Glu-1D).* This investigation was undertaken to examine the contribution of the Low-Molecular-Weight (LMW) glutenin allelic variation (*Glu-3A, Glu-3B and Glu-3D)* to breadmaking quality, as determined by the SDS-Sedimentation Test, Alveograph Dough Strength (W), Tenacity (P) and Extensibility (L). The effects of protein content, hardness, and wheat-rye translocations were also studied. Selected spring wheat populations were used in three separate studies. Two collections of cultivars and advanced lines developed in Southern Brazil were grown for two years at East Farm near Corvallis, Oregon. Large differences between LMW alleles at *Glu-3A and Glu-3B* for dough strength were found, while LMW *Glu-3D* did not exhibit much polymorphism. The most favorable LMW alleles were in low frequencies in these populations. Hard wheats were found to give higher dough strength values than soft wheats and a wheat-rye translocation (1BL.1RS) was found to adversely affect quality. Two recombinant inbred populations were developed from two crosses between lines with different LMW glutenin alleles. This provided the opportunity to avoid some confounding factors by making comparisons in more uniform genetic backgrounds. The differences in SDS-Sedimentation between segregating alleles at HMW and LMW loci confirmed the quality rankings observed in the former study. To further examine the impact of wheat-rye translocations on SDS-Sedimentation and Alveograph dough strength, tenacity, and extensibility, three cultivars and near-isogenic lines (1BL.1RS or 1AL.1RS) were compared for two years. Wheat-rye translocations reduced SDS-Sedimentation value, dough strength, extensibility and increased tenacity. LMW glutenin alleles seem to offer the potential to increase breadmaking quality by developing wheats with higher dough strength or by compensating for the negative effects of wheat-rye translocations.

Possible Associations Between Three Procedures to Measure Noodle Starch Quality in Winter Wheat (*Triticum aestivum* L.)

Chris Weight, M.S., December 12, 1996

Until recently, the viscoamylograph had been the primary method for measuring starch as it relates to noodle quality in wheat. This method requires a large sample of flour and is time consuming. With the introduction of the rapid visco-analyser (RVA) in 1986 and the more recent flour swelling volume procedure, both the time to determine starch quality and the sample size required have been reduced.

Parents, reciprocal F_2, and backcross generations from a cross involving two white wheat lines were space-planted to study the association among the three procedures for measuring noodle starch quality. Grain protein and hardness and plant height also were measured. Differences among the generations were observed from the viscoamylograph, flour swelling volume, and plant height. Coefficients of variation were low for both flour swelling volume and plant height.

A significant positive association was found between the viscoamylograph and RVA (r = 06.1). This indicates that for the populations evaluated in this study the RVA can be used in place of the visoamylograph to measure starch quality. The RVA values, however, varied greatly between years suggesting a large environmental influence. There was also evidence for a genotype by environment interaction. No maternal effects were noted between reciprocal crosses.

Conflicting results were found for the association between the flour swelling volume procedure and the RVA and viscoamylograph. Further experiments may have to be delayed until the F_4 or F_5 generations when adequate amounts of flour can be obtained from more genetically uniform lines.

Appendix 6

Trip Reports

June 10-22, 1995	Baltic-American Cereal Production Symposium and Research Review
October 16-26, 1995	Review of EMBRAPA at Passo Fundo, Brazil and concurrent Montevideo, Uruguay workshop presentation
February, 1996	Review of USAID-ATG Armenian Wheat Program
June 10-14, 1996	Fifth International Winter Wheat Conference, Ankara, Turkey
June, 1996	Visits to Dotnuva, Lithuania, Kaunas Variety Testing Station near Kidinie and Stende, Latvia cereal program
January 29- February 6, 1997	Ukrainian Organizations visited and people contacted – see listing

Baltic-American Cereal Production.
Symposium and Research Review
June 10 to June 22, 1995

General Comments:

The Baltic-American cereal production symposium was an extension of a visit to Oregon State University (OSU) Wheat Breeding and Genetics Program by six scientists from the three Baltic States. Subsequent discussions with Ms. Amy Odegaard of the USDA and a visit to Latvia by Dr. Kronstad, finalized the development of the symposium. The organization of the symposium was patterned after three successful programs held in Peru, Argentina, and Tunisia as part of the OSU-USAID wheat enhancement program. The current program was supported by USDA, OSU, and by the USAID-OSU contract.

Local arrangements for the program and research review were coordinated by Mr. Lindell Whitelock, a private consultant with USDA. Mr. Martins Roze, from the Ministry of Agriculture of Latvia, invited the participants from the three Baltic States. Unfortunately, people representing USAID and Foreign Agricultural Service were unable to attend either the research review or symposium.

A proceedings of the symposium is provided with this report. The itinerary of the research programs visited and a list of the American group and their areas of expertise can be found in Table 1. Five members of the team participated in both the cereal review and symposium, while two members were able only to attend the latter. Throughout the two weeks the hospitality and very professional manner in which the local scientists and directors presented the various programs was most impressive. The team returned to the United States with both pleasant memories and positive feelings regarding their Baltic State colleagues and their research programs, and yes, weighing a bit more as a result of the wonderful hospitality.

Each member of the American team provided summaries focusing on their observations related to their specialty. There summaries are included in this report. Contacts were made between scientists will be sustained through sharing of publications, information and germplasm. The following are some general conclusions surfaced by the American cereals group following their brief visit. More specific comments can be found within the individual reports.

1) The three Baltic States have the natural resources to become self-sufficient for most staple agricultural products with opportunities to compete on the world markets for several crop and animal products.

2) The Ministries of Agriculture in the three States must resist any attempt to discontinue national cereal breeding and production programs in favor of importing either commodities or technology (cereal varieties) from foreign countries. Food security and a dependable supply of food free of price fluctuations in world markets dedicated the need to maintain a sound agriculture in these countries.

3) Availability of credit for farmers at reasonable interest rates is a major barrier to increased agricultural productivity. It will be necessary to develop realistic credit policies for the rural areas to enhance the agriculture sector in all three countries to provide the necessary incentives.

4) There appeared to be a major discrepancy between the standard of living in the major cities and the rural areas. This could be changed through greater incentives so that people will not migrate to the urban areas.

5) In all three countries the dedication of the scientists to their work despite many obstacles was most impressive. Again, lack of incentives in terms of facilities including laboratories, equipment, and low salaries, made their tasks difficult. This is also a barrier to gifted young scientists selecting agricultural research as a profession.

6) The approach by USDA of using a private consultant to stimulate various agriculture sectors within the three States has had a positive and major impact. Mr. Lindell Whitelock has developed an excellent rapport with scientists, decision makers, farmers, etc. in all three countries through his efforts and the backstopping by USDA. This effort has set the stage for major changes both in terms of enhancing agriculture and promoting privatization as well.

7) It is the feeling of the team that to sustain Mr. Whitelock's contributions, a greater involvement by local people in leadership roles is required. To this end, USDA might consider identifying an individual such as Dr. Zenonas Dabkevicius of the Lithuanian Institute of Agriculture, or someone else of his stature and background, to provide the necessary leadership in cereal and forage production. Ms. Nora Kinna, Program Assistant Emerging Democracies Office USDA, is extremely capable and could handle the logistics for the total program from Riga. This would free Mr. Whitelock to focus his attention on animal husbandry with emphasis on dairy production in Estonia. The success of the program has reached the point where Mr. Whitelock is being stretched too thin. With the support of local people he could maintain an overall presence in all three countries over the next year while being able to provide more focus to specific areas. It would also provide for a degree of continuity after Mr. Whitelock's contract expires.

8) After 50 years of occupation, progress will be slow reaching the agricultural potential that exists in all three Baltic countries. However blessed with abundance of natural resources, dedicated people and with appropriate government policies including the proper incentives, these countries can and will provide a better and richer life for all their people.

Baltic Trip
R.S. Karow

This trip was successful in all respects. Trip participants gained new knowledge about the Baltic States, linkages were made with researchers having similar research interests in all three countries, Baltic participants gained new knowledge and made contacts that will be useful to them in the years ahead. The remainder of this report is categorized by topic.

Advisory Services

The only advisory service person I personally spoke with was Dr. Edwardis Makelis, Director of the Lithuanian Advisory Service (LAS). We spoke briefly one evening. The LAS is operated under the Ministry of Agriculture but has it's headquarters on the Lithuanian Agriculture Institute campus. Headquarters staff is ideally located for contact with researchers at the Institute. The Service was established less than three years ago with structural input provided by VOLKA volunteers (Harold Kerr, a former Oregon State University extension administrator among them) and Danish advisory service personnel. LAS has staff located in "counties" housed in rented or donated office space and in the headquarters building.

Makelis and Dr. Zenonas Dabkevicius, Deputy Director of the LAS, told me that the relationship between the advisory and research services was good. Researchers have written publications for the advisory service and have participated in field days organized by LAS. A possible point of friction is that advisors are much better equipped in terms of computer hardware and software, at this point in time, than their research counterparts (conversation with Makelis and Dr. Zenonas Dabkevicius). Overall funding for LAS appears to be better at this time.

Makelis was interested in information in two areas. He has hired several farm management advisors and would like them to receive training in the states on current softwares. He is interested in involving county advisors in applied research. I gave him information on on-farm testing we have done as part of the STEEP project. Training for advisors on field plot technique and statistics would be useful.

My presentation at the symposium on extension structure was well received. The idea of a research-extension-teaching combination will likely not be workable in the Baltics, but a close tie between research and extension staff should be possible. Co-location of extension staff at Agriculture Institutes or split extension-research positions would seem workable. Some research staff are already working in traditional extension roles though they do not have this specific assignment. Strong linkages between extension and research must be fostered.

The Agriculture Institutes are already under financial stress. Addition of extension responsibilities without funding will further erode Institute effectiveness. Could the land grant concept be used as a funding source for extension activity? Could Institutes be given federal land to sell or rent

as a means to generate capital for program operations? This opportunity would seem to exist as final decisions on land ownership are still to be made in all three countries.

On-farm Testing

European companies are introducing new crop cultivars and agriculture products (fertilizers, herbicides, seed treatments, etc.) to the Baltic States. They are suggesting that their products are vastly superior to those available locally. Agriculture Institutes are conducting small plot tests to evaluate some of these products. On-farm testing is ideally suited for this type of testing as well. Such tests could be coordinated by advisory or research staff. Companies interested in product promotion should be asked to donate materials and dollars for support of such testing.

Statistics

A short course on filed plot technique and basic agriculture statistics should be developed for research and advisory staff. Senior scientists seemed familiar with proper experimental design but some younger staff are not. Some of the experiments we saw in our field tours were not properly laid out. Availability of reference texts such as Little and Hills "Agricultural Experimentation" would be beneficial at all Institutes.

Organic Production

A serious effort should be made to evaluate market potential for organically grown grain. Organic production is being done in Estonia and parts of Latvia due to lack of funds for inputs. The organic fields we saw were relatively free of weeds and disease, likely due to the excellent crop rotations being used. Manures are available as nutrient source for some acreage. Organic crops should have a higher value which will offset lower yield potential. End-use quality standards for organic crops are often lower than those for conventionally grown crops. This would also be beneficial as producing high quality crops is problematic. European organic certification requirements and markets should be evaluated.

Oats

Oat breeding is being done in all three states. Access to the Cooperative Uniform Early Oat Performance Nursery coordinated by Howard Rines at ARS Plant Science Research Unit in St. Paul, MN, would be beneficial. Early maturing, crown rust resistant, short-statured lines will be available in this nursery for use as breeding stock.

Grain Drying

Late crop maturity and weather unfavorable for crop dry down are serious impediments to improving crop quality. We were told that available grain drying systems were inefficient and costly to operate. Flat storage aeration systems and addition of aeration systems to existing temporary grain holding bins should be investigated. I would recommend that someone with expertise in grain drying, storage and handling be brought over for consultation. This person should be specifically charged with trying to develop better drying systems using equipment already on hand. Another idea that should be considered for small acreage farms is shocking of grain - an old but workable idea.

Baltic Trip
Larry Kaseberg

Thank you for the opportunity to participate in and contribute to the American-Baltic Symposium in Latvia as a member of the visiting team which surveyed agriculture in Estonia, Latvia, and Lithuania.

My role was to share my experience as a dry-land eastern Oregon wheat farmer with the agricultural community in these Baltic countries. We have many shared concerns; available moisture, crop diseases, soil and water conservation, weed control, production costs, operating capital, fertilizer, marketing, crop research and farm machinery.

The people we met in these beautiful countries have an added concern, the problems resulting from long Russian dominance. They eagerly and kindly shared agricultural ideas, concerns and information, obviously hoping to improve their technology in research, conservation, machinery and production, but with very limited capital and financing with which to build, progress is difficult.

I believe the agriculturists we met will use the information we shared with them to improve their economic situations. Within the Baltic region, certain research and developments must occur to:

* determine which crops are best suited in each region;
* determine the need for these crops and products;
* develop a market, domestic or foreign;
* develop standards of quality for crops and varieties to meet the needs of consumers (millers, bakers, domestic consumers);
* extend research results to the appropriate users - farmers, other scientists, and consumers;
* continue and improve international and regional scientific collaboration and exchange.

Improved standards are essential for the cereal grains in order to produce desired milling and baking qualities that will establish and retain markets. Cereal grain breeders must have goals and guidelines to achieve these standards.

Research and breeding programs for forage and cereal grain crops must be adapted to present industry and market needs and those of potential markets. These research programs must consider:

* available and seasonal moisture
* day length and growing season
* soil moisture and temperature
* soil type and condition
* present crops suitable/adapted to the regions conditions

* developing new varieties for regional conditions
* storage and transportation
* marketing, domestic and foreign
* seed availability
* fertilizers, pesticides and herbicides
* management practices
* financing

I see Baltic region needs for:

* a shared soil scientist
* a resource and networking agent who would serve as an "extension" of university and private research (an extension agent)
* cereal grain quality standards established by crop scientists, millers and bakers to ensure reliable, consistent grain quality
* malting barley standards
* a management program for forage, hay and grasses to maximize production and eliminate weeds
* establishment of a dairy cooperative to extend the product line and to better utilize forage products
* defining and establishing sanitation standards for dairy products as soon as possible
* consideration of specialty timber production
* development of vegetable and fruit production which has enormous potential.

It is simplistic to say that financial returns will be realized if the mechanical needs are improved or met and financing can be arranged. It will be a slow process, but the help and information needed is available in the international agricultural community.

The complexity of the task of organizing and educating researchers, farmers, and support groups is understood. Lindell Whitelock is providing outstanding service but he cannot be everything to everyone in his region. He cannot fully use his skill and competence if his work is not fully supported by USDA and other agencies.

Thank you for your continued support of Mr Whitelock and the enormous task you have before all of you in helping these wonderful people.

Small Grain Weed Control in the Baltics
A.P. Appleby

Most of our observations during June 12-22 were made on experimental farms. All of the farms apply herbicides, although there were no weed scientists, and which herbicides were used is uncertain. A partial list of available herbicides is as follows:

triasulfuron
fluorglikofen
terbutrin
propakozafop
bentazon
tribenuron
clopyralid
MCPA
glyphosate

The weed problem on the experimental farms is minor. The only grass weed seen was scattered Agropyron repens. Continuing rotation with potatoes, sugarbeets, clovers, peas, etc., seems to avoid the grasses, and the herbicides are effective against most broadleaves.

A partial list of weeds observed follows: These were primarily in borders and roadways. Those that were scattered in the grain likely would not reduce yields.

Fumaria
Potentilla
Artemisia
Galeopsis
Veronica peregrina
Cirsium arvense
Matricaria
Chenopodium
Capsella
Lamium amplexicaule
Lamium purpureum
Galium
Taraxacum
Poa trivialis

The weed situation on the experimental farms seems well in hand as long as crops and herbicides are rotated regularly. However, we visited one young, progressive grower who may need advice in the future. He has machinery only for grains so rotates very little. His weed problems are increasing. He has used Granstar tribenuron for almost four consecutive years. When I mentioned that this herbicide readily selects out resistant types, thus leading to resistant populations, he replied that he had already noticed a trend toward reduced effectiveness. I suspect this may not be uncommon on other farms.

The station at Dotnuva, Lithuania, mentioned a Plant Protection division, and I talked with a weed science graduate student, so perhaps some weed experimentation is being done. Representatives of major companies are a good source of information, but each country should have a small weed group to (a) verify industry claims on the various products, and (b) conduct extension programs so that growers are kept informed. Growers especially need to understand the factors influencing foliage and soil herbicides and the increasing threat of herbicide-resistant weeds. Because resources are limited, basic information on herbicide physiology and weed ecology could be gleaned from published literature from other countries.

Baltic Trip Summary
Chris Mundt

Alternatives were discussed to the use of single, major genes for disease resistance, which often lack durability due to genetic shifts in pathogen populations. This lack of durability both inhibits progress in breeding programs and places farmers in a vulnerable economic position. Examples of small grain diseases were used to demonstrate the effectiveness and feasibility of alternatives to the monoculture of single, major genes.

Quantitatively inherited resistance has a history of providing significant durability in the field, but the alleged complexity of inheritance of such resistance has often discouraged its use in breeding programs. A review of published research of several crops shows that the inheritance of quantitative resistance is much simpler than originally thought. This was confirmed with recent studies of slow-rusting resistance to leaf rust in CIMMYT wheat germplasm. Heritability was very high, gene action was predominately additive, and number of genes controlling the trait was relatively small (3-4). Though quantitative resistance is not complete, it provides substantial protection from disease in the field. Further, quantitative resistance performs much better in grower's fields than in small plot experiments, where spore dispersal from susceptible "checks" causes an underestimation of the value of resistance. Though quantitative resistance has been studied mostly for polycyclic, foliar diseases, it is also useful against monocylic, soil-borne pathogens, especially when quantitative resistance decreases inoculum levels over seasons.

The durability of major genes for disease resistance can be greatly enhanced through deployment in multiline cultivars and cultivar mixtures. Cultivar mixture require no additional breeding and provide a fast and practical means of achieving host genetic diversity. Examples were discussed of commercial success of cultivar mixtures for control of wheat yellow rust in Oregon, USA, and barley powdery mildew in the former German Democratic Republic. In both cases, mixtures have allowed for substantial reduction in the use of fungicides for disease control. Cultivar mixtures also been found to provide buffering against the effects of some soil-borne diseases and abiotic stresses. However, cultivar mixtures did not control Septoria blotch of wheat in Oregon. The use of mixtures has not caused significant problems in production or marketing of small grains.

The use of resistance gene pyramids (combinations of major genes in the same crop genotype) has been very successful in increasing the durability of resistance to stem rust, leaf rust, and the bunts of wheat. Potential mechanisms by which pyramids increase the durability of resistance include: a reduced probability of mutation to multiple virulence, specific virulence combinations that cause reduced pathogen fitness, and the accumulation of "residual effects" of major resistance genes that may impart race non-specific resistance. The probability of identifying favorable combinations of resistance genes can be increased by promoting diversity for resistance among parents, utilizing resistance genes with a history of providing durable combinations, and using the "lineage exclusion approach". The latter approach based on molecular analyses of evolutionary pathways and virulence associations in pathogen populations, and holds much promise for increasing durability of resistance. A serious drawback to pyramids is that they are most effective with resistance genes that have not yet been "broken" by the pathogen, yet any single, unbroken gene will mask the presence of others. In recent years, however, the use of molecular markers to tag resistance genes has provided tremendous potential to alleviate this difficulty.

In summary, there are effective and practical approaches available to increase the durability of resistance to small grain diseases. However, these approaches will require significant effort to provide a thorough evaluation of their effectiveness and to ensure their implementation.

Review of Cereal Breeding Programs in Baltic States

W.E. Kronstad

The breeding programs visited in June 1995 included: the Stende Plant Breeding Station and Priekuli State Selection and Breeding Station, both in Latvia, Jogeva Plant Breeding Institute in Estonia, and the Lithuanian Institute of Agriculture at Dotnuva. Despite foreign occupation for the past 50 years and the restrictions placed on the breeding programs, such as developing wheat varieties only for livestock feed, the projects are making significant progress.

Without question, the most positive aspects of the cereal research programs in the Baltic States are the scientists. The breeding strategies followed are sound and most appropriate considering the very limited resources available. It was apparent from the well maintained field trials that the researchers take pride in their efforts. To enhance these programs from a human resource point of view it is critical that the senior scientists be able to visit other breeding programs, both to interact with colleagues and to collect germplasm. It is also highly desirable that these scientists have the opportunity to participate in regional and international symposia. Younger scientists should be encouraged to obtain advanced degrees (M.S., Ph.D.), some of which should be obtained outside the Baltic countries, so that an exposure to different philosophies and new approaches can be obtained. A very critical issue, both for the current scientists and gifted young people who might select agricultural sciences as a profession, is that incentives be provided i.e. improved salaries, facilities, travel to meetings, opportunities for advanced degrees and avenues established to grow professionally.

The most obvious limitation to the breeding effort is the lack of milling and baking and malting quality laboratories. It would appear that funds will be available to enhance the existing wheat quality effort in Lithuania at Dotnuva. However, a similar effort must be made in Latvia and Estonia as well. Demands of the consumers and potential export markets make the establishment of such laboratories essential. Dr. Craig Morris, whose observations are included in this report, has provided some direction in establishing milling and baking evaluation for procedures for the wheat breeding programs. Dr. Patrick Hayes also had discussions with the barley breeders as to criteria for malting quality. Without such laboratories, the breeders have little or no opportunity to develop the desired varieties with acceptable quality of either wheat, barley, oats or rye.

A large contrast was observed between breeding programs regarding field equipment. At Stende the equipment is outdated with the planters and combines dating back to the dark ages. It is amazing how they are able to conduct such good field trials with such equipment. Besides frequent equipment break downs, the time consumed in seed preparation, planting, and harvesting is a limitation to the effectiveness of their programs. At Jogeva Plant Breeding Institute, the most advanced space planting and yield trial planters and the most recent plot combines were observed. The equipment at other stations was not seen, but upgrading of such equipment is critical to running an efficient breeding program in terms of timeliness of conducting various operations and obtaining meaningful data.

Very little disease was observed in the research plots this year. A major epidemic of Helminthosproeum sativum (Leaf blight) was observed in farmers' fields in southern Latvia. In

previous years Tilletia caries (Common Bunt), Erysiphe graminus (Powdery mildew), Septoria tritici and S. nodorum (Septoria Leaf and Glume Blotch) with the former being more important and Puccinia recondita (Leaf rust), Ustilago nuda f. sp. tritici (Loose smut) Fusarium nivole (snow mold) and other diseases having been of some importance depending on the year and location. The bunt work by the Stende plant pathologist, where she is artificially inoculating breeding material to determine response, was impressive. A set of differential hosts along with different sources of resistance to this disease will be sent from Oregon to assist in this program. A further plus at this location was the interaction between the breeders and plant pathologist.

Wheat selections made in Oregon by Baltic scientists and subsequent shipments of seed provided different responses when grown in the Baltic States this year. At Stende, the material suffered badly due to factors associated with winter conditions. A contributing factor was that the same Oregon material was planted quite late; however, to be useful, an acceptable level of winter hardiness is required. At Lithuania the materials from the OSU-USAID-CIMMYT international wheat program look very promising. In Estonia, the winter wheat program was not conducted at Jogeva Plant Breeding Institute, nor was there an opportunity to visit the winter wheat breeders. For spring wheat improvement, however, it was suggested that the breeder select the earliest facultative lines from OSU-USAID-CIMMYT screening nursery and plant the material in the spring next year. It would appear that to be successful in Estonia, varieties must be sensitive to day length and have a low heat unit requirement. Vernalization may also play a role in preventing premature flowering. Spring wheat developed by the International Maize and Wheat Improvement Center (CIMMYT) which are day length insensitive could be used as parental material, but would not be suitable as commercial varieties in this region.

Most breeding programs had a wide array of germplasm obtained from many countries. For spring cereals, wheats and barleys from the Nordic countries appeared best adapted. The programs need to continue introduction of genetic materials from many different countries. It must be remembered that such introductions can never replace the need for aggressive breeding programs in these countries. Such introductions can be effectively used as new sources of genetic variability for specific traits and as such used in the crossing programs. It is advantageous for these countries to also obtain the international screening nurseries from OSU-USAID and the CIMMYT Turkey-OSU program for winter and facultative wheats and CIMMYT Mexico for spring wheat.

Other areas where the breeding programs need support would be in seed processing between harvest and seed preparation for planting. Summer rain and the potential for preharvest sprouting further complicate the seed handling process. This rainfall pattern also points out the need to emphasize in the breeding program the necessity to select for high temperature dormancy to reduce the sprouting.

Also with the rapid advances made in software for microcomputers it is possible to reduce many of the routine activities (printing plot tags, field books, record keeping, etc.). There is so much information in the Internet regarding germplasm, monitoring diseases, etc. that the Baltic breeders would find it very beneficial. One area that should not be emphasized is biotechnology with a focus on plant transformation. This is very expensive research and the breeding programs in the Baltic States have more pressing and immediate needs.

Wheat, barley, oats and rye are all important crops in the Baltic States. After seeing the triticale program at the Priekuli State Selection Station, I believe, with support that this crop can also become significant for the area, especially for forage and grain as livestock feed. Both barley and rye offer potential for export possibilities.

Decision makers in the Baltic States must provide acceptable levels of support to the major breeding programs. They must resist any attempt by neighboring countries to suggest that their breeding programs can provide the necessary varieties. Food security and fluctuating world prices are compelling reasons why the Baltic States must take advantage of their natural resources and maintain a strong agricultural sector.

Table 1. Research cereal review itinerary and list of American participants

Itinerary	
Stende Plant Breeding Station, Latvia	
Priekuli Selection and Breeding Station,Latvia	
Jogeva Plant Breeding Institute, Estonia	
Lithuanian Institute of Agriculture, Dotnuva	
Symposium Vecauie, Latvia	
American Team	
Dr. Warren Kronstad	Wheat Breeding and Genetics
Dr. Patrick Hayes	Barley Breeding and Genetics
Dr. Russell Karow	Cereal Extension Specialist
Dr. Chris Mundt	Wheat Pathologist
Dr. Arnold Appleby	Weed Specialist
Mr. Larry Kaseberg	Cereal Producer
Dr. Craig Morris	Director of Western Wheat Quality Laboratory, USDA, Pullman, Washington

WEK/plm/sdw\saved as wpdoc\trips\baltic.trip report

Trip Report to Brazil and Uruguay
October 16 to 26, 1995
Warren E. Kronstad
OSU-USAID International Wheat Germplasm Enhancement Program

The purpose of this trip was four fold.
1) To review wheat research and related disciplines at the National Agricultural Research System (EMBRAPA) at Passo Fundo, Brazil and present a seminar to the staff. 2) To access public, private and cooperatively supported breeding programs in the rainfed state of Rio Grande Do Sol. 3) To evaluate the impact and potential contributions of enhanced germplasm resulting from the winter x spring international wheat program in Brazil and Uruguay. 4) To participate in an international workshop on Facultative and Double Purpose Wheats held at Instituto Nacional De Investigacion Agropecuaria (INIA) La Estanzuela, Colonia, Uruguay.

Brazil

Wheat production in terms of rate of growth in percentage in Brazil decreased when the period 1983-1992 was compared to 1951-1992. For the wheat area this decrease was 3%, for grain yield 0.8%, and total production 3.7%. In the state of Rio Grande Do Sol these decreases have been even greater. Several factors account for this, i.e. 1) open markets vs government control, 2) export opportunities for soybeans, 3) imported wheat from Argentina and other countries, including the U.S., and 4) the complexity of problems in terms of abiotic and biotic stresses resulting in an increase in the costs of imports, etc. (pesticides, including lime due to acid soils) However, with the current price of wheat on the world market one might anticipate an increase in wheat production in this region.
This year the state of Rio Grande Do Sol experienced a long drought period during much of the growing season followed by heavy rains, including hail in some parts of the state. The major abiotic stress is aluminum toxicity which is wide spread throughout the state. Any germplasm introduced into this area must have a high level of tolerance to soluble Aluminum, or be grown with seven tons of lime to determine their genetic potential for other agronomic traits. Of special interest is that the genetic sources of tolerance to this problem was identified by a Brazilian Ph.D. student participating in the winter x spring graduate program at Oregon State University (OSU). Where aluminum tolerant varieties have been released in Brazil yields have increased from 0.9 t/ha to approximately 1.8 t/ha.

It was also apparent that soil erosion due to the high rainfall was a major problem. Perhaps one of the most impressive features was the widespread adoption of no till management practices. In one region, over 90% of the farmers had adopted this practice. In visiting with one farmer, he had observed no adverse effects of no till management and was convinced it was the only way to farm. Throughout this area of Brazil, one could see the terraces being plowed up as farmers move to the no till system.

While at EMBRAPA, Augusto Bauer, the director, outlined the major focus of the research effort. He was a bit uptight as they were in the process of selecting the next director and he was a candidate.

During the morning, three laboratories were visited including, biotechnology, cytogenetics, and a germplasm and seed production program. I presented a seminar on various aspects of international wheat breeding and the importance of the free exchange of germplasm. This was followed by a review of the wheat breeding and pathology work including visits to the experimental fields and greenhouses.

The group in the biotechnology laboratory was focusing their work on identifying the high molecular weight sub units of gluten protein complex as they relate to end product use. They were hoping in the future to use RFLP and PCR protocols to identify specific genes and gene combinations; however, the laboratory was not yet equipped for this type of research and lacked the necessary expertise. It was noted that someone with such experience would be assigned to the laboratory in the near future.

The cytogenetic program had a long history of productive research. Of special interest was their work on chromosome instability, which traces to various abiotic factors inducing chromosome breakage. I encouraged Dr. Fernandes to publish a review paper on such work, since much of which is not known by the international scientific community. Currently, their efforts are focused on the development of double haploids using anther culture and crosses between wheat x maize. There were a number of impressive young people working in this laboratory.

Of special interest in the seed multiplication program was that one individual does both the seed multiplication and also maintains the germplasm bank. This program multiplied all the breeders seed which amounted to over 200 lines each year. There was a major problem maintaining the genetic purity of the lines which may trace back to the chromosome instability problem previously noted.

In visiting the breeding and plant pathology programs I was impressed with the complexity of the problems encountered by the breeders. The abiotic and biotic stresses were so severe that it would be difficult to make selections. The experimental trials were conducted on one, seven, and 10 tons of lime per hectare. One new race of leaf rust appeared last year which attacked many of the previously promising selections. Fortunately, there did appear to be genetic sources of resistance to this new race. Conditions in the greenhouse made it possible to follow the LR34 resistance complex to leaf rust with the tip burning associated with this source of resistance being very pronounced.

The private wheat breeding program of Ottoni Rosa located at Passo Fundo was very impressive with a great deal of promising material in various stages of testing. Unfortunately, an outstanding selection released last year was susceptible to the new race of leaf rust, but again, there was genetic resistance to this race in his program. Of

particular interest was their work in screening for P_2O_5 efficiency, which is important in acid soils. The cooperatively supported breeding program located near Cruz Alto also had a number of promising lines. Aluminum toxicity did not appear to be a major problem in this area. It was pointed out, and with much pride, that it was at this experiment station where much of the early work on no till management was conducted and disseminated to the growers in the region.

While in Passo Fundo, visits were made to the national seed multiplication and distribution program. This organization was responsible for distributing seed of all the major crop plants. Also, the opportunity to see the no till grain drills designed and built by the Semeato Company was made possible by Mr. Rosa. This company made drills both for field research and commercial plantings. I was very impressed with the design of these drills, especially to light weight and limited horse power required.

In summary, I was impressed with the research work related to wheat improvement and cereal grains in general. The number of abiotic (especially Aluminum) and biotic factors make plant breeding difficult. However, it was apparent that progress was being made. With the current government programs, which allow for the importing of wheat, plus the fact that wheat can only be grown one year in four in a given field suggests that wheat production may continue to decline. This may be offset by the current high world price of wheat. Perhaps, the most impressive feature was the widespread adoption of no till management systems by the growers. This is most encouraging due to the great loss of soil due to the heavy rains.

Uruguay

Uruguay is a country of 3.1 million people with a large percentage of the population located in or near Montevideo. They also have the smallest population growth rate (0.6) of any of the southern cone countries. The major agricultural activity is livestock production with only approximately 166,000 ha devoted to wheat. The average yield is 2.0 t/ha with the total production of 335,000 t annually. One might question why Uruguay should host an international workshop on Facultative and Double Purpose Wheats. However, because of the major interest in animal production, Uruguay has been using dual purpose wheat (grazing and grain) for several years. Also, the International Maize and Wheat Improvement Center representative for the southern cone countries, a sponsor of the workshop, is located in Montevideo.

The workshop included representatives from both the private and public sectors from Argentina, Chile, Brazil, Uruguay, Australia, and the United States. Formal presentations were made by individuals representing the different countries and organizations. In addition, three panel discussions were held on 1) Facultative and double purpose winter wheat germplasm, 2) selection and management of dual purpose wheat, and 3) international collaboration. I served as the chair of the latter panel and also made a formal presentation on "Current and Potential Barriers to the Free Exchange of

Germplasm." Visits were made to see wheat pasture associations and rotation experiments and to evaluate genetic materials obtained from the OSU-CIMMYT program and from other surrounding country programs. Following the formal phase of the program, an all day trip was made to commercial fields and experimental sites in the Dolores/Mercedes/Young areas of Uruguay.

Much of the discussions focused on the type of wheat required for the dual purpose management system. Such questions as vernalization period and day length insensitivity were mentioned, which often lead to disagreements as to what is a facultative wheat in relation to winter or spring wheats. It was generally agreed that day length sensitivity rather than vernalization would provide the desired long-cycle wheats which would have adequate forage production and then provide a quick grain filling period. Other questions such as, what if a farmer does not graze such wheats, what would be the outcome? It was generally agreed that lodging and a greater incidence of diseases would result. Concerns were also addressed as to how long animals can graze wheat without a major reduction in grain yield. This also resulted in discussion regarding the economics of dual purpose wheat vs either grazing or grain yield per se. Finally, it became apparent that there is a lack of long-cycle varieties available to the farmers in the southern cone countries and that enhanced germplasm from the OSU-CIMMYT international program offered the best opportunity to provide such materials. This observation then lead to how such material could best be incorporated into the national programs and which breeding procedure would be the most effective.

In general, the workshop was well organized, the accommodations were good, and the exchange among scientists was excellent. A contributing factor to the success was that the focus of the workshop was quite specific and avoided the pitfall of too many topics and no opportunity to develop appropriate strategies to solve a problem.

reports\brazil.doc (sdw)

Armenia Trip Report

Warren E. Kronstad
February 1996

Purifying Existing Wheat Varieties

A major concern raised by the Armenian farmers was that they could not obtain uniform seed stocks of local wheat varieties. After several years of production and saving their seed for replanting they could no longer identify what variety they were growing nor could they find another source of uniform seed to purify an existing variety such as Bezostoya, a modest effort could be employed to accomplish this objective. This would include obtaining a variety description, which Dr. Vache Avagian of the Academy of Genetics and Plant Selection, could provide. Select several spikes from a field of Bezostoya which fit the morphological description to be used as a standard. Once it is agreed that these spikes represent the variety, select 1000 to 2000 spikes of similar appearance. These spikes are thrashed individually and the seed morphology checked including color. Those not having the desired type are discarded. The seed from the spikes selected are planted in separate rows so that the progeny from an individual spike is maintained. Prior to flowering, rows which appear different in height or other characteristics are destroyed to prevent any outcrossing. This procedure is again followed just prior to harvest. The rows which remain are thrashed separately and those with similar seed characteristics are bulked to provide "elite" or breeders seed of the variety. This procedure can be repeated as often as necessary using as source material spikes from the previously bulked population. To insure that through selection the yield potential of the variety has not been lost, reselected seed can be grown in replicated yield trials with common or unselected seed of the variety.

Potential Joint-Venture Seed Production and Processing

Due to the limited acreage of and the nature of self-pollinated small grains there appears very little opportunity for foreign joint-venture seed production and processing with American and/or European firms. Even with hybrids of maize, sunflower, etc., other countries in the region have more favorable climate, soils, and access to markets. One area which might lend itself to joint-venture would be in grass and legume seed production. This would require a well-developed seed industry with a strong certification program to maintain quality standards. As countries in this region raise their standard of living, grasses for pastures, forages, and recreation (sport fields, lawns, parks, etc.) and legumes for pastures, silage, and rotations could become more important and offer potential markets.

Foreign firms who could be approached include International Seed, Turf Seed, Cal Approve Incorporated, Arnold Thomas, etc.

Training Program

The most successful element of the ATG 1995 Winter Wheat Program was the training of 33 HCN regional agronomists and their outreach with appropriate technology to the Armenian farmers. The

four technical advisors from ATG did an outstanding job in establishing this training program. As a consequence, there exists a well-trained group of extension grain specialists located throughout the country. Information on land leveling, seed bed preparation, fertilizer and herbicide inputs, combine adjustment, etc., were all critical ingredients to the success of the program. The introduced varieties served as the vehicle to attract the interest of the Armenian farmer; and were less important in the enhancing of yield.

To even be self-sustaining in grain production or other segments of agriculture, there needs to be a critical mass of scientists and extension specialists trained. There are several opportunities for such training at various levels of expertise. The Cochrane program provides short-term training in specific areas. Also for cereals there is the International Maize and Wheat Improvement Center (CIMMYT) where applied research experience in agronomy, plant pathology, cereal chemistry, and cereal breeding can be obtained. CIMMYT, through its donors provides for the support of this four month training. The International Center for ICARDA also provides short courses.

Opportunities also exist for non-degree and degree training at U.S. universities. The non-degree training periods are for several weeks to one year. Degree training at the M.S. level generally takes two years, and a Ph.D. three to four years. Programs like the Oregon State University-CIMMYT program supported by USAID has assistantships available for qualified students.

At this time, it is critical that gifted young Armenian scientists be identified to participate in such training programs. It is quite apparent that such people exist and would excel if given the opportunity. It is equally important that a positive environment be established with the desired inputs so that these people can make the needed contributions upon returning here.

A. In specific terms, what has been the impact of the USAID funded wheat program in total production and yield per hectare in Armenia and has the program been "cost effective"?

A number of assumptions must be made to try to estimate the impact the 5000 MT of seed imported into Armenia had on total production and even yields per hectare. For the approximately 2000 MT of spring wheat varieties there was no impact due to the problems of obtaining the seed, poor seed quality, and the late arrival of the seed. For the 3000 MT of winter wheat seed, the situation is clearer, but also with questions regarding the impact.

Foremost, did the Armenian farmers report their true yields. Faced with the tax inspection service trying to collect 20% value added plus 30% profit tax, there was an incentive to under-report yields. Even after ATG staff assured the farmers of confidentiality, a concern on the part of the farmers may have remained.

A further complication was trying to find accurate comparisons between American varieties and local check varieties, i.e. Bezostoya, Armianka-60, and Mironovian-808. Differences in the quality of the soil, land leveling, seed bed preparation, fertilizer and herbicide application, dates of planting, differential responses to diseases and insects, etc. All could have influenced any realistic comparisons. Likewise, acceptable experimental procedures were not followed, which further complicates any evaluation of impact.

With these reservations in mind, it would appear that with the exception of the variety Halton, the American varieties were superior if the necessary inputs were applied. In fact, it appears the American varieties are fertilizer dependent yielding less than Bezostoya when no inputs were involved. The latter variety only responded to fertilizer with an increase in yield of 0.82 mt/ha in contrast to 1.13 mt/ha for American varieties. The increased yields with inputs for the American varieties varied from .52 mt/ha for Rely to 2.63 mt/ha for Weston. However, with no inputs Bezostoya yielded more than the American varieties. (1.33 mt/ha vs 1.15 mt/ha).

A further assumption is that the introduced varieties will continue with inputs (if available) to provide higher yields. Recognizing that one or even two years data can be very misleading, there is a danger of extrapolating. This winter (1996) has been cold without much snow cover, thus differential winter injury. Based on limited observations, and in only one region of Armenia, it would appear that Eltan, one of the better performing introductions in 1995, is more prone to winter injury than either Hatton or local varieties. There were estimates of from 30 to 60% loss of winter wheat this year.

Based on yields reported by the farmers participating in the program and observations made by ATG technical advisors, the four varieties Rely, Weston, Neeley, and Eltan contributed 4,184 MT additional yield of which more than half or 2,092 MT should have been available for planting in 1996. However, when visiting the Asktarak regions the local farmers were forced to replant the variety Hatton for lack of any of the other American varieties. This variety is highly susceptible to yellow rust as noted in previous years and unless fungicides are imported, the farmers in this region will be in deep trouble.

Many variables need to be considered in addition to those assumptions already made to determine the cost effectiveness of the program. The response of the varieties to inputs, land preparation, and combine adjust which provided an extra 85.3 kg/ha, the final ATG report suggests a total benefit of $1,243,000. providing an actual payback period of 92 years. Not counted were the costs associated with technical and training assistance, which is now in place in Armenia for future efforts. Using a similar analysis ATG extrapolates that the projected benefit in 1996 would be $2,472,930. If the necessary inputs are not made available immediately, should a different or even current disease become a problem, or if there is differential winter injury of American varieties, the Armenian farmer may well have been set up for a disaster.

B. Were the appropriate varieties imported for the production program? How have these done in comparison with Armenian and Russian seed produced in the country?

The 1995 USAID-ATG Armenian wheat program was an ambitious undertaking with substantial risks to enhance production through the introduction of spring and winter wheat varieties. Of the approximately 5000 MT of seed (2000 MT spring, 3000 MT winter) only the winter program will be discussed. In previous sections of this evaluation report, the problems which plagued the spring wheat program were identified.

Since 1992, ATG has evaluated 30 foreign varieties of wheat. The majority of these varieties or advanced breeding lines were from the Pacific Northwest (PNW) part of the U.S. A limited number of varieties were from the Great Plains. As a consequence, the genetic diversity of the materials tested was quite limited. From the trials conducted in Armenia, five varieties were selected for the 1995 program and were from the PNW. Thus, these varieties had been developed under a common and narrow environmental regime.

Appropriateness of varieties selected

In a paper by Ken Lyers, December 1996, involving the USAID-Armenian-Georgian agriculture, concerns were expressed as to whether or not appropriate varieties had been selected based on the experimental procedures under which the agronomic data had been obtained. In reviewing the materials provided by ATG staff and visiting with host county agents and Armenian farmers, it appears that many of the questions previously raised were justified. What appears to have started as a humanitarian effort became a demonstration program which included the introduction of large quantities of seed of foreign varieties.

There is precedent for such an approach, particularly in those countries which participated in the so-called Green Revolution involving wheat and rice. More recently in Africa, the Global 2000 program has successfully introduced new varieties of sorghum into several countries. The major difference between these programs and the Armenian wheat effort was that acceptable varieties of the crops in question did not exist. In contrast, varieties like Bezostoya, Armianka-60, etc. were well adapted and especially under the management practices the Armenian farmers could afford.

As previously noted the genetic diversity of the varieties or advanced lines tested prior to 1995 was quite limited. It would have been rewarding had those involved in the project contacted the International Wheat Germplasm Enhancement Program conducted by USAID-Oregon State University-CIMMYT. Through this program, a surveillance nursery of 150 genetically different lines are grown annually throughout this region with one location actually in Armenia. Information on various biotic and abiotic stresses and sources of resistance or tolerance to such limiting factors is available including where sources of potential varieties could be obtained from countries other than the U.S.

Of greater concern is the experimental procedures employed to determine which varieties would be best adapted. It would appear that the data were collected from isolated yield and agronomic trials (seeding rates) where no valid comparisons were made with local varieties serving as checks. Likewise, only in rare occasions were replications used to estimate the environmental influence on the performance of the varieties. Where a statistical sampling analysis was attempted to evaluate nitrogen and yield responses, many assumptions had to be made and data pooled over regions representing very diverse environments. Assessments of the potential disease and insect problems were restricted to observations made on the demonstration trials with only one or two years considered. Even so, two varieties Halton and Neeley, were still selected for the 1995 program, even though they had previously been observed to be susceptible to yellow and leaf rust.

It was not necessary to use elaborate experimental designs, but to obtain meaningful information in selecting the most appropriate varieties, such fundamental experimental procedures as replications, randomization, appropriate check varieties, uniform management practices, and data collected over locations and years are required. Thus, as a consequence of how the demonstration trials were conducted, including the limited number of varieties listed, it is difficult to judge if the most appropriate varieties were introduced. More importantly, the evidence suggests that without the necessary information, plus the lack of fertilizer in 1996, the Armenian farmers may be placed at even more risk than if they were growing local varieties.

Factors other than sound agronomic data appeared to influence the selections of the five introduced varieties in 1995. There was an urgency time wise as the program, for some reason, had a short implementation period. Thus to find large quantities of foundation seed was difficult. Since the backgrounds of several of the ATG technical advisors trace to the western states, it could also have been a factor in terms of their knowledge and contacts with the PNW seed programs.

Despite the short comings noted in terms of how the foreign varieties were selected, there are many positive aspects of the 1995 wheat enhancement programs. It appears that the actual role the foreign varieties played was not as important in enhancing yield, but serving as a vehicle to capture the interest of the Armenian farmer. This enabled the ATG technical advisors and 33 host county agents to conduct a very effective educational program. The ATG technical advisors did an outstanding job in providing information on land leveling, seed bed preparation, importance of inputs and properly adjusting combines. It is quite apparent that these people were extremely dedicated, spent long hours in the fields working with the farmers, and along with the farmers themselves, were the real significant aspect of the program. The respect the Armenians hold for these individuals will last much longer than the varieties which were introduced.

Comparison between American and local varieties

With the limitations previously noted regarding the experimental procedures, some general comparisons between introduced and local varieties can be made. When average yields across locations are made for the introduced varieties in terms of yield per hectare, Neeley, Rely, Eltan, Halton, and Weston were 2.14, 2.37, 2.68, 1.22, and 3.92 respectively. The overall average was 2.28 MT per hectare. These results combine both irrigated (282.8 ha) and non-irrigated (4657.4 ha) sites. However, 465.7 ha of the total 4946.2 ha was not harvested due to diseases, insects, and drought. It is unclear if such data were included in the overall averages. Where it was possible to make a rough comparison that average yield of Bezostoya was 1.94 mt/ha.

In an attempt to provide more exciting data, paired comparisons were made where similar soil types and management practices were available with information pooled over regions. The number of such comparisons between American varieties with Bezostoya were Neeley (20), Rely (9), Eltan (10), Hatton (4) and Weston (5). American varieties had improved yields ranging from .51 mt/ha for Neeley to 1.06 mt/ha).

Using a multiple regression to estimate the response to fertilizer and herbicides resulted in a positive coefficient. The average value of the fertilizer was 3.01 kg increase in yield per Kg of N

Ha No $_3$ applied. Bezostoya yielded 2.15 mt/ha with fertilizer and herbicide inputs, and 1.33 mt/ha without inputs. For American varieties with inputs the average yield was 2.55 mt/ha while with no inputs the value was 1.16 mt/ha. Response to fertilizer and herbicides of the Armenian varieties ranged from .52 mt/ha for Rely to 2.63 mt/ha for Weston.

Such differential responses to fertilizer and perhaps herbicides raises a very serious issue. What will be the consequences in 1996 if the Armenian farmer does not have access to such inputs for the American varieties which are input dependent? The farmers would have been better off with local varieties which, in the case of Bezostoya yielded more without inputs.

A question regarding the optimum seeding rate was raised as the Armenian farmer traditionally used 300 hg/ha. Prior to 1995 trials were established in different regions using seeding rates of 80, 100, 200 and 300 kg/ha. In general, due to the lower tillering capacity of the local varieties, they responded more favorably to the higher seeding rates. However, Eltan was similar to the local variety Mironovian 808 with the highest yield achieved at the 200 kg/ha rates. The yield responses obtained at 300 kg/ha were not economical. Observations made by one member of the evaluation team (February 17, 1996) in the Asktarak region that, due to poor stand establishment, Armenian farmers should use 200 kg/ha for all varieties. Perhaps with improved seed bed preparation and the use of $N_1P_2O_{51}K$ fertilizer applied prior to seeding may result in a lowering of the seeding rate. To date, no data were available of the possible influence of a fall application of fertilizer.

A comparison of American varieties was based on their response to different elevations. Even though there were no major effects there were some trends. Eltan did not yield as well below 1100 m, but did better up to 2150 m. Rely yielded less, about 1800 m, while Weston did well at all elevations up to 1800 m. Neeley did not appear sensitive to elevation with Hatton doing poorly at all locations.

Diseases are extremely important to wheat production in Armenia. Two varieties, Hatton and Neeley were both susceptible to the local races of yellow and leaf rust. Loose smut was noted on all local varieties which did not receive a seed treatment. A peace corp volunteer noted that in his area farmers did not plant winter wheat as their local varieties were badly infected with loose smut and they could not afford the more expensive seed treatment which was the only chemical available. It can be anticipated that as farmers are forced to grow wheat after wheat that a higher incidence of diseases will result. Also since in the Asktarak region the farmers could only obtain the variety Hatton, it will be necessary to obtain a fungicide to control the rusts, otherwise the farmers will have no wheat to harvest.

Lessons learned, concerns, and suggestions

Lessons learned

1. The introduction of large amounts of seed of varieties not previously evaluated within a country can be successful if local varieties are not satisfactory. This was not the situation in Armenia where acceptable varieties were available and what was needed involved a seed purification and multiplication program.

2. When introducing new varieties for testing it is important to maintain a wide range of genetic diversity for the initial testing phase. Also information is available from international germplasm enhancement programs as to the major attributes required in terms of desired plant life cycle, different biotic and abiotic stresses, etc., including sources of genetic materials which are more likely to be adapted.

3. To obtain meaningful data it is important to follow acceptable scientific procedures in conducting trials and analyzing data.

4. If the required expertise is not available within a country, short term consultants should be obtained at the critical periods.

5. In addition to evaluating potential varieties, agronomic trials regarding the necessary management practices must also be conducted in a scientific manner.

6. There needs to be a long term commitment with accountability by the local government. This includes the identification of a critical mass of researchers and extension people with adequate levels of support. A one shot program will not be sustained.

7. With subsistence farmers credit must be available to obtain the seed and necessary inputs.

8. Concerns regarding milling and baking properties must be addressed in the near future. The quality of the local varieties appears satisfactory for current end product uses; however the introduction of large quantities of soft, low protein varieties may not be in the best interest of the consumer.

9. The introduction of spring wheat should meet the existing needs and should also represent similar quality characteristics as the winter wheat.

10. The Armenian varieties introduced in 1995 are input dependent. Unless inputs are available in 1996 they will not do as well as local varieties.

11. Without snow cover there appears to be substantial winter injury resulting in poor stands, thus weed control will be critical and the necessary herbicides must be available. Preliminary observations suggest that the introduced variety Eltan might be less tolerant to low temperatures.

12. Many Armenian farmers replanted Neeley and Hatton both of which are very susceptible to yellow, or stripe and leaf rust. Fungicides will be required to protect these varieties.

13. Without credit or free fertilizer and herbicides, the Armenian farmer will be worse off and will be reluctant to accept new technology.

14. There appears to be no plan in place to follow up the 1995 wheat program.

Suggestions

There is a question with the limited number of hectares available for wheat production in Armenia is it realistic to support a breeding program. In the publication Facts and Trends in Wheat Production by CIMMYT in 1994, they provide a cost analysis with regards to breeding programs and the desired number of hectares. It would appear that Armenia falls well below the critical level. Of course food security for Armenia must always be foremost in evaluating research priorities. However it may be more cost effective to develop a responsive variety testing and seed multiplication program. This would require a program to be established in Yerevan with experimental sites established in all the major wheat growing regions. Such a program to be effective would need a truck and trailer, complete set of plot equipment and adequate support for salaries, travel and material and supplies. International germplasm enhancement programs can provide the necessary genetic materials for testing.

Major Diseases Observed in Armenia

Diseases:

Rank		
1	Stripe or Yellow Rust	*Puccinia striiformis*
1	Leaf Rust	*Puccinia recondita*
2	Stem Rust	*Puccinia graminis* f. sp. *tritici*
2	Powdery Mildew	*Erysiphe graminis* f. sp. *tritici*
1	Common Bunt (Stone Bunt)	*Tilletia caries*, *T. foetida*
1	Dwarf Bunt	*Tilletia controversa*
3	Ergot	*Claviceps purpurea*
1	Loose Smut	*Ustilago nucla* f. sp. *tritici*
2	Snow Mold	*Fusarium nivale*
3	Septoria Leaf and Glume Blotch	*Septoria tritici*, *S. nodorum*
3	Scab Head Blight	*Fusarium* spp.
3	Tan spot	*Pyrenophora tritici repentis*

Ranking by importance
1 = major problem
2 = can be problem
3 = not important

Insects:
Shughahat

reports/armenia2/96/WEK/sdw/plm

Fifth International Winter Wheat Conference, Ankara, Turkey
June 10-14, 1996

This report describes the 5th winter wheat conference held in Ankara, Turkey, from June 10-14, 1996. Sponsors of the conference included the Ministry of Agriculture and Rural Affairs of Turkey, International Research Centers CIMMYT and ICARDA, United States Agency for International Development (USAID) and Oregon State University (OSU), and German Agency for Technical Cooperation (GT2).

The first winter wheat conference was held in Ankara, Turkey in 1974 with 30 participants from a limited number of countries. Subsequent wheat conferences were held in Zagreb, Yugoslavia, Madrid, Spain, and Rabat, Morocco. The University of Nebraska through a USAID contract played a major role in organizing these conferences. In the initial conferences many of the speakers from national programs presented information on yields, number of hectares of wheat, diseases and insects, abiotic stresses, etc., with little or no discussions of research per se. With each subsequent conference more research and less production information was presented. In the 5th winter wheat conference the focus was structured with invitational speakers so that a highly productive program covering a wide range of researchable topics was developed.

The format for the conference evolved over a period of time beginning in 1992. During a trip by OSU and CIMMYT scientists reviewing research programs in Bulgaria, Romania, and Hungary, the need to bring scientists from the Eastern Block countries together became apparent. Of special interest was the desire to include scientists from the former states of the Soviet Union and Russia along with others from national programs in the region. Instead of 30 participants as in 1974, there were over 350 scientists representing nearly every major winter and spring wheat growing region in attendance for this conference.

The $20,000 contributed from the USAID-OSU wheat germplasm enhancement program provided travel and per diem for scientists from selected national programs and contributed to other costs of the conference. In Table 1, a breakdown of the expenditures along with the names of the participants supported and their countries are provided. Several of the participants were invited speakers or presented posters describing some of their research activities. One of those supported was Dr. Nicolae Saulescu from Romania. Dr. Saulescu serves as an effective bridge between the Eastern Block countries, former States of USSR, and Russia. Being an outstanding scientist, he is well respected by the wheat scientific community.

An additional reason for holding the wheat conference in Turkey was to celebrate the 75th anniversary of the establishment of the Eskisehir Agricultural Research Institute located near the city of Eskisehir. Initially the conference was to be held in Eskisehir, however finding housing for 350 people became a limiting factor and the conference was moved to Ankara. A day long field trip was made to Eskisehir where various research projects were presented. In this part of Turkey there is a serious deficiency of zinc in the soil and consequently in the wheat grain which has some implications to human health. Thus several projects at Eskisehir and Konya and addressing this problem. Researchers have found that Boron toxicity is also a problem in wheat

production in these regions. A very positive aspect was the construction of new buildings and greenhouses at the Eskisehir experimental site. An added bonus was seeing Professor Gerek, who was the former director of the station and whom I first met in 1967 as part of the USAID-OSU Turkey wheat program.

A copy of the formal program is also provided for your information. The presentations were translated simultaneously into either English or Russian depending on the speaker. Unlike the 1974 conference when the electricity kept going off and the projector totally destroyed the slides, the visual aids were of high quality with even computer assisted presentations. Likewise with the development of newer hotels, the meeting rooms were very good.

As noted from the program, a wide range of topics were discussed. A key factor were the keynote speakers of each section. Without exception every keynote speaker represented someone well known in his or her area of specialization. A significant factor was that every speaker initially identified accepted the invitation which contributed to the high quality of the overall conference. The discussion and questions which followed each section were interesting and sometimes created some excitement among the participants. When the proceedings are published, copies will be sent to you.

The local organizing committee did an excellent job, particularly since Turkey was without a government for three months prior to the conference.

Individual meetings with various national scientists did confirm that most programs in the region are in serious trouble due to lack of support. This was not totally a surprise after traveling in several of these countries, but the level of animosity which exists between the scientists in the former states of USSR and those in current Russia is real. As previously noted, Dr. Saulescu is a key player in interacting between these groups as part of the USAID-OSU-CIMMYT international wheat germplasm enhancement program.

wpdoc\reports\aid\turkey.doc

Trip Report
Wheat Research in Lithuania and Latvia

Warren E. Kronstad
Crop and Soil Science Department
Oregon State University
June 1996

This trip report reflects time spent at Dotnuva, Lithuania, visiting with Dr.Vytautas Ruzgas, the associate director and head of the cereals crop breeding program. Visits were also made to the Kaunas Variety Testing Station and an agricultural cooperative near the city of Kidinie. Subsequently, the cereal programs at Stende, Latvia, were reviewed.

Lithuania

Despite a stagnant research budget, the wheat breeding program at Dotnuva remains very active with well thought out objectives. Dr. Ruzgas has a very good assistant with an impressive knowledge of the germplasm and wheat breeding methodology. While visiting last year, we toured the milling and baking laboratory which was modest but adequate for early generation quality testing. No comment was made during this visit regarding the $100,000 that was supposed to be made available to enhance the laboratory. I spent time with their genetics people who, in the case of wheat, were using the wheat x maize double haploid approach. Their biotechnology laboratory was being updated; however, it was unclear what the research focus would be other than the development of wheat double haploids. The genetics group was also working with interspecific hybridization, mainly with grass species.

This crop year they had heavy rains and cool temperatures which resulted in some winter killing of sensitive wheat. These conditions also were responsible for a heavy infection of Powdery Mildew with many of the foreign introduced germplasm being quite susceptible. Germplasm previously selected in Oregon by Dr. Ruzgas, and more recent lines from the winter x spring screening nursery, looked promising in terms of disease resistance and overall adaptation. The more superior germplasm is being incorporated into their crossing strategies.

It was possible to spend time with Dr. Daphus, the director of the Dotnuva station. He provided an optimistic outlook in terms of Lithuanian agriculture. Winter wheat was still the more important crop with barley and sugar beets being major commodities. A key factor was that farmers were paid on time for their crops this year. Director Daphus, in responding to questions regarding the relationship between the research and extension people, provided a detailed and impressive list of joint activities. He also pointed out that a free trade agreement had been signed with the other Baltic States and Poland.

The exchange of wheat materials between Lithuania and OSU-CIMMYT is very positive in enhancing the genetic variability of both programs. It would also be good if Dr. Ruzgas could

again spend time at Kansas State University, Oregon State University, and at CIMMYT-ICARDA in Turkey.

The visit to the Kaunas Variety Testing Station was good and it was apparent that the staff takes a great deal of pride in their work. In addition to testing promising local advanced lines, they were evaluating materials from many different countries. The question was raised as to what the regulations were in releasing new cultivars in Lithuania. This was followed by asking if the same procedure would be required for both domestically and internationally developed cultivars. In general, two and most often three years were required in official state tests; however, it appeared that under some circumstances this was not always the situation. For foreign cultivars there had to be a Lithuanian representative before such material could be released. There was an official evaluation committee made up of 30 people including breeders, directors, etc., who made the final decision as to which cultivars would be released and put on the official list. There was some form of a provisional variety protection; however, it became very difficult in ensuing discussions to understand just what was involved. End use quality was also a consideration in releasing new cultivars. The seed testing station charged $150.00 (U.S.) annually for testing material.

The agricultural cooperative was a carry-over as it was a State Farm during the Soviet days. They have 3,100 hectares of land with very diversified farming operations. They have 600 milk cows, 1,800 cattle, 3,000 pigs, 1,000 hectares of cereals, 320 hectares of sugar beets, plus hay and pasture. A total of 1,100 hectares were under private ownership by individuals (1 to 2 ha). There were 300 people employed and a total of 500 share holders. The management, equipment and facilities were very adequate. The Head Agronomist had previously been a researcher at the Dotnuva research station. When asked where he obtained his technical information, the response was "from research scientists and not from extension people." Because he was formerly at the research center may be why he went directly to the scientists. However, as previously noted, Director Daphus outlined a very ambitious program in which extension and researchers interacted. It would be interesting to learn more in detail the impact the extension service has on the agricultural community. When looking at the commercial wheat field while traveling, it appeared that the farmers were following acceptable farming practices.

Latvia

In Latvia, the experiment station at Stende is always impressive in terms of the quality of the field research, especially when one recognizes the extremely poor field research equipment available. It is a testimonial to what hard work and dedication will do; however, coupled with low salaries, which often do not arrive in a timely fashion and the lack of other incentives, one wonders how long such an effort can be maintained. If the Latvian government is serious about enhancing their food supply, including the potential for export opportunities, a major adjustment in priorities needs to take place immediately.

Dr. Vija Strazdina is exceptional in what she has been able to accomplish in the wheat breeding program. She has modified her program to select spikes rather than whole plants in early

segregating generations and maintains an effective selection program. Her program reflects a broad base of genetic materials obtained from many countries, including the OSU-CIMMYT international program. The initial germplasm sent from the latter program lacked an acceptable level of winter hardiness required in Latvia. Subsequent material, including lines selected by Dr. Strazdina while in Oregon, appear much more promising. This year, Snow Mold and Powdery Mildew were the major disease problems along with lack of winter hardiness in the more tender genotypes. It was too early in the crop cycle to access the amount of Bunt infection, which appears to be a major problem.

A very positive aspect in terms of disease control is the effort made by Ms. Ilze Priekule, who is a plant pathologist. Ms. Priekule had just returned from OSU where she spent time with Dr. Chris Mundt. Last year we sent her the Bunt differential host cultivars so that she could identify the physiological races; unfortunately the material was lost at an airport in Finland. We do have some inoculation from Latvia and will know this fall something about the race picture for Common Bunt. We will send another set of the Bunt differentials through Mr. Whitelock. There is very close cooperation between the breeding and pathology programs, which is a real strength to the total effort in breeding resistant varieties for Latvia.

I would recommend that Ms. Ilze Priekule from Stende be provided with a six month study program to interact with Dr. Mundt in the Botany and Plant Pathology Department at Oregon State University. During her three week stay at Oregon State University this past June, she was most impressive in terms of interest and dedication. After visiting the three Baltic States the past three years, I find Ms. Priekule to be a most knowledgeable plant pathologist, who with adequate support, could have a major impact in identifying the disease complexes for the region.

The spring wheat program is modest in scope and appears to rely mainly on foreign introductions. However, Dr. Vija Strazdina, the winter wheat breeder, developed several promising lines while still working with both spring and winter wheats. The young man currently in charge of spring wheat is doing a good job, but lacks necessary breeding experience, since he has only been with the program a short time. It would be desirable, if his English improves, for him to visit breeding programs in the U.S.

Peteris Bulbiks, the oat breeder has a good program and will provide the growers with very good cultivars in the near future. Again, as with other cereals, the lack of a quality laboratory is a problem. This is especially true as Mr. Bulbiks emphasizes high protein oat cultivars for livestock feed.

The barley program is impressive, but Ms. Sophia Kalinina was away from the experiment station during our visit. It would be highly desirable to have her visit programs at the University of Minnesota, the germplasm repository at Aberdeen, Idaho, and Oregon State University. Such a trip would give her additional insights into malting barley quality, livestock feeding requirements, as well as some of the newer approaches in barley breeding.

Summary

Such opportunities as the request to breed cultivars of Buckwheat for breakfast food should be followed up at Stende, Latvia. We are currently identifying sources of Buckwheat germplasm to send to Dr. Strazdina.

The free trade agreement between the Baltic States and Poland will promote more positive relationships among the various breeding programs. Also, the sharing of cultivars will be possible unless some form of variety protection is imposed by the different states making this difficult.

It is important that key scientists in the agricultural sector be provided with the opportunity to visit other country programs. It was possible through an OSU-USAID grant to provide travel and per diem funds for several people from the Baltic States and surrounding countries to attend the 5th Winter Wheat Conference held in Turkey in June. This was an excellent opportunity to participate in the conference by presenting posters of their research work and interacting with other scientists. Of particular interest was their opportunity to re-establish contacts with other researchers in the Eastern Block countries, including the Soviet Union.

WEK/plmsdw/wpdoc\reports\trip.doc

Ukrainian Trip Report
W.E. Kronstad
Oregon State University

This trip was designed to determine how the Oregon State University--CIMMYT International Wheat Germplasm Enhancement and Training Program could make a positive difference by increasing wheat production in the Ukraine. The team consisted of S. Rajaram, Head of the CIMMYT Wheat Breeding Program, A. Morgounov, CIMMYT Wheat Breeder located at Ankara, Turkey, N. Saulescu, Wheat Scientist, Fundulea, Romania, and W. Kronstad, Project Leader USAID-OSU Wheat Enhancement and Training Program, Oregon State University. A list of institutions and individuals contacted is provided in Table 1. Detailed information is available; however, in this trip report only key issues as they influence a proposed OSU-CIMMYT program will be identified.

The observations and subsequent suggested work plan are based on information obtained in 1995, as a result of an in-depth cereal research review conducted by CIMMYT scientists in the Ukraine, two sites in Russia, and reactions obtained from the current trip. Background information provided by Harry Walters and Ken Lyvers USAID-PRIV., Robert Walker, USDA, and Philip Seitz, and Craig Runyan, USDA was extremely helpful in identifying the major economic, social, and political constraints. Unfortunately, such constraints are largely responsible for the annual wheat production in the Ukraine dropping from 50 m tons prior to the breaking up of the Soviet Union to less than 25 m tons today. Lack of credit, unfavorable tax structure, emphasis on collective farms rather than the private sector by the GOU, uncertainty over who actually owns the land, shadow money which avoids taxation, and the unfavorable ratio of input costs to product return are some of the problems which have destroyed the profit incentive. There is also a mind set which was clearly expressed by a group of workers at a collective farm near Odessa. When asked why they did not develop their own private farms, the response was that a tractor driver on their collective farm receives $70 per month while working nine months of the year. He also receives fodder for his animals and a small plot of ground to grow vegetables. Bread and other products from the farm were made available at a reduced price, thus all together he makes $200. a month. The comment was made that to make the same income on a private farm one would have to work too hard. However, as noted throughout this report, meetings were held with private farmers who were willing to confront the many obstacles and take the risk. Several had already arranged for joint ventures with foreign companies.

The team appreciated the open and frank discussions held with the Ukrainian scientists, private farmers, and the chairman and other members of the collective farms. In all cases, the people went out of their way to share their concerns, problems, and without exception, a willingness to fully participate in the program suggested and outlined at the end of this report.

Research

In terms of research, there are 1,965 institutions involved in some efforts directed toward agriculture with approximately 12 major and ten lesser wheat breeding programs (Figure 1). According to the Chief of the Department of the State Commission of Ukraine for Testing and Protection of Plant Varieties, there are over 60 varieties on the official registration list. Varieties developed at two institutes, Odessa and Mironovka, account for approximately 84 percent of the six million hectares of winter wheat and 100,000 hectares of spring wheat. This would suggest that there are too many wheat breeding programs and some of these resources could be better used to strengthen key breeding programs or related disciplines.

Discussions were also held with the same group as to the mechanism of releasing new varieties and the regional testing requirements. There are 80 locations for testing, 50 for wheat, and depending on the area of adaptation, a minimum of 16 sites must be included for evaluation of a new variety. For commercial production, a minimum of two years of testing is required. If patents are involved, a three year period of testing is necessary. Plant patents lead to questions regarding plant variety protection laws and the possibility of royalties. Ukraine is a member of UPOV and for certain crop species royalties can be collected. The wheat breeders at Odessa complained that other countries were using their varieties and even when specific agreements had been signed they were quickly broken. A further question asked was, if foreign varieties could be included in the official registration list, and if it was necessary to have a Ukrainian representative. Up to now, foreign varieties were tested, but new laws were expected to make it necessary to have joint ventures when foreign varieties were involved. Currently, there were only four foreign varieties on the approved list and they were from Germany and Hungary. Ninety percent of the elite and basic wheat seed is produced on collective farms associated with institutions belonging to the Academy of Agricultural Sciences.

Research Institutions

We were fortunate to visit many of the major research institutes involved in agriculture. Some of the visits were in the evenings or on Sunday and without exception, the openness and hospitality by the administrators and scientists was most impressive and appreciated. At all institutions, the economic problems were highlighted. One, however, had the impression that those research institutions associated with the Academy of Science were faring better than others.

Poltava

Following discussion and lunch with the Administration Head Deputy for the Poltava Regional State, we visited the Poltava Agriculture Institute. Discussions were held with the Rector, Deputy Rector, and other faculty members including the wheat breeder. We were interested in their academic programs in addition to the research activity. They indicated that two new potential wheat varieties were currently in the regional testing program. Like other institutes visited, Poltava Agriculture Institute appeared to have an extensive research effort in many disciplines varying from basic to applied. There was also an opportunity to visit with the head of the farmer's union, where information on various aspects of production including the many limiting factors were discussed.

Kharkov

We were impressed with the research activity at the Institute of Crop Production at Kharkov. Of special interest was the Plant Genetic Resources Program. They had over 130,000 accessions involving 70 crops including improved varieties of cereals, grasses, legumes, oil crops, and vegetables. Materials are received from different climatic zones within the Ukraine and foreign countries. A very significant feature was their association with the Vavilov Germplasm Center at St. Petersburg, Russia. The latter houses one of the most extensive collections of plant materials in the world and unfortunately much of this germplasm is threatened due to the current economic situation in Russia. As part of the proposed work plan presented later, the importance of establishing linkages with other plant resource centers in the U.S. and Mexico will be identified.

The spring wheat breeding program was also very active. Starting in 1911, they have developed 31 varieties with 16 currently registered in Ukraine and Russia. Breeding programs in winter wheat and Durum did not appear as productive. The major attributes of the winter wheats were high levels of winter hardiness, yield potential, and milling and baking quality. For the latter, the critical tests are the falling number (sprouting tolerance), a 32 percent glutenin, and 14 percent protein, thus strong wheats are preferred. The major disease complexes were, Septoria leaf blotch, Septoria tritici; Fusarium head scab, Fusarium spp.; Brown or Leaf Rust, Puccinia recondita f. sp tritici; Common Bunt Tilletia caries; Powdery Mildew, Erysiphe graminis f. sp. tritici; and a root rot complex especially Foot Rot Pseudocercosporella herpotrichoides. Since winter hardiness is a major limiting factor, a special research project addressing this attribute was being investigated. Summer and fall drought were also noted as major abiotic stresses.

An evening meeting was held with a private farmer who represented 120 other private producers. Their major crops were wheat and hybrid sunflower. For chemicals they were involved with a company in Switzerland, had a contract with Cargill for 5,000 ha of sunflower seed, and with a French company for purchase of equipment. In addition, they were involved in establishing demonstration trials of maize, sunflower, and other crops. Of interest was that the president of this private farmers organization had a Ph.D. in physics. When asked where their group obtained the technical information, they went directly to the institute as the extension service was not effective.

Kiev

Upon returning to Kiev, we had dinner and an excellent discussion with Professor Olexiy O. Sozinov who is the director of the Institute of Agrobiology and Biotechnology. The institute also has its own wheat breeding programs. Professor Sozinov is one of the leading scientists in the Ukraine with an international reputation. He is a member of both the Ukrainian National Academy and the Russian Academy of Sciences. He provided an excellent overview of the current status of science in the Ukraine and was well versed in both applied and basic research programs being conducted in the country.

There was an opportunity to visit the Institute of Plant Physiology and Genetics and the Institute of Cereal Crop Production, which also included the Plant Protection department. Among a long list of research activities underway were such areas as photosynthesis, as it relates to C_3 and C_4 plants, mineral nutrition (20 percent of the land is deficient for zinc, a human health concern), nitrogen fixation in legume plants (including the identification of more efficient strains of rhizobium bacteria, degradation of herbicides, etc. In the area of genetics, work was underway in DNA transformation, genetic basis of heteroses, mutagenesis, etc. The latter topic lead to discussion related to the disaster of Chernobyl and the genetic consequences to plants, animals, and humans. In wheat, the resulting genetic variation induced through the higher mutation frequencies was being used in the breeding programs.

The Crop Protection Institute has 13 departments working on a wide array of topics ranging from integrated pest management, biological control of insects, to host-pathogen interactions. Both of these latter two institutes have cooperative research with the wheat breeding programs at the Institute of Crop Production at Mironovka.

Mironovka

Even though it was a Sunday, the scientists at the Institute of Crop Production at Mironovka were most gracious in sharing their research with us. The visit also provided an opportunity to visit with private farmers and the Franko Collective farm. The latter had a very close relationship with the institute, especially in seed multiplication.

The wheat breeding work started in 1914 with the release of the variety Ukrainka 0246, which was a reselection from a variety received from Bulgaria. As previously noted,

varieties developed at this institute now occupy approximately 40 percent of the wheat acreage in the Ukraine. Of special interest was the development of Mironovka 808, which has been extensively used for many years as a source of winter hardiness by wheat breeders throughout the world. It was developed at this institute through transformation by exposing spring wheat to low temperatures. The breeders mentioned that such studies were continuing, but that Mendelian genetics and more conventional breeding approaches were more important. The director emphasized that in addition to research, the institute was also responsible for all the social services for 460 people, 80 scientists and 130 technical staff. A similar situation was noted at some other institutes outside Kiev.

Although wheat breeding received the major effort, they were involved in the breeding of other cereals, grasses, and legume crops. Active research programs were under way in plant protection, physiology, biochemistry, and cytogenetics, cropping systems, etc. Detailed notes were taken on many of the research programs which varied from electrophoresis studies on wheat quality to the use of wide crosses with progenitors of wheat. The major biotic and abiotic stresses were similar to those identified at Kharkov. Due to the cost of energy, 6,000 sq meters of growth chambers were not operational, nor were most of the greenhouses.

The institute had seven seed processing facilities and a very extensive seed multiplication program. Concerns were expressed by the director in charge of seed multiplication that the necessary inputs to enhance yields were not available and the Russian equipment was not dependable.

The institute maintains a library which provided technical information to the collective farms and to private farmers. It was the only time such an opportunity was identified to provide information to producers.

A visit to the Franko Collective farm near the institute provided some insight as to their function. This farm worked closely with the Mironovka Institute in seed multiplication. Again, a common theme was the lack of inputs which reduced production. The chairman of the collective farm mentioned that with Russian combines 20 to 25 percent of the crop would be lost at harvest. They had leased or bartered for a German combine which costs $201,000 U.S. and was to be paid for with grain. The one German combine replaced three Russian combines in terms of the number of hectares harvested in a day. The collective farm was also a community unto itself. The chairman was very proud of a church they had just built. There were 600 people living on the farm with 300 being retired, thus to privatize would require some other way of providing for these retired people.

While visiting with the private farmers in the area we met one individual, formerly a medical doctor, who wanted his three sons to be private farmers so he elected to farm. He identified many of the constraints which have been previously mentioned, but it was apparent he had a strong commitment to be a private farmer especially for his sons' futures.

Odessa

The Institute for Genetics and Breeding was established 100 years ago and was the major wheat research center during the Russian period. They were also the most important center for international cooperation in wheat and other crops in terms of germplasm exchange, interaction with foreign scientists and participation at international symposiums. It was apparent they would like to re-establish this position of eminence. They have maintained their linkages with Turkey, Spain, Hungary, France, private companies (DeKalb, Van der Hoff, Micogene, etc.) and international programs with CIMMYT and Oregon State University. In fact, they had grown all but one of the 21 screening nurseries distributed by Oregon State University. The one year they missed, the material was lost in the mail.

As noted before 45 perent of the wheat acreage in the Ukraine is represented by varieties developed at this institute. They have breeding programs in both bread and durum wheat, barley, maize, sunflower, soybeans, alfalfa and sorghum. Strong programs are found in breeding, plant physiology (with an emphasis on vernalization and photoperiod response in wheat), pathology, wheat quality and molecular biology. They, along with Kharkov, have a large plant germplasm resource center.

Despite having only half the budget they had previously enjoyed, there was a large number of scientists and technical people in every laboratory visited. There was some question as to salaries and if the people were paid every month, and if in some cases, scientists had been lured away to other countries. A similar situation existed as was found at Mironovka, in that most of the growth chambers and greenhouses were shut down, due to lack of funds.

The institute had just acquired a collective farm for seed multiplication and was associated with seven other collective farms where a similar function was ongoing. However, it appeared that only those collective farms which were producing elite or basic seed stocks of new varieties were making a profit. A visit was made to two of these collective farms. Again, such farms were villages and were responsible for all aspects of supporting the people in terms of schools, roads, etc.

An interesting situation was observed at one of the collective farms where the director had arranged for a visit to a nearby private farm. The farmer owns 80 hectares of land and was leasing several hundred more. It appeared that there was a close linkage between his operation and the collective farm. Eventually, it came to light that the private farmer's father was the director of the collective farm. At the second collective farm, regarded as the most progressive, the director lived in a very impressive house and was very much concerned that we find him a partner to become involved in a joint venture. Based on the exposure at these two collective farms, it was a bit difficult to determine where the line was drawn between collective farms and the private sector. This became even more confusing when meeting with private farmers back at the institute in Odessa. The president of the farmers union, who did most of the talking, was not a private farmer

but a political appointee. However, there were other private farmers present who again noted the same constraints which seem to be a common concern throughout the private sector, and what appeared to be an intentional or unintentional effort by the government to support collective farms rather than private farmers.

After a lengthy discussion with the scientists at the institute, the question of plant variety protection and subsequent royalties was addressed. The immediate reaction from the group was that you could not trust even other institutes within the Ukraine in terms of sharing of germplasm and collecting royalties. It was pointed out that a private company in Canada had signed an agreement with the institute for the testing of several lines and had failed to honor their commitment. Other neighboring countries were also growing Odessa lines without paying royalties. Dr. Saulescu from Romania described the system they employ to collect royalties, which was working quite well. They were strongly in favor of participating in the proposed program suggested by OSU-CIMMYT outlined in this report.

Summary and Brief Outline of the Work Plan to be Proposed

The Ukraine, known historically as the breadbasket of the former Soviet Union, has a large wheat growing area of seven to ten million hectares. The region was known for the development of wheat varieties with high bread making quality, high levels of winter hardiness, drought resistance, etc. These varieties have been of interest for many other areas of the world, including the U.S.

Their success in wheat breeding was the result of high financial support and good scientific cooperation between countries in the former Soviet Union and Eastern European countries. Political changes in the region have resulted in a drastic reduction in the funding of wheat breeding and have interrupted practically all germplasm exchanges among the breeding programs in the area. This can have serious consequences on the genetic diversity of wheat. The present breeding institutions risk losing their ability to provide the varieties needed for a sustainable and secure wheat production.

Major economic, social, and political constraints have resulted in a lack of incentive to establish private farms and related industry activity. However, there appears to be a small and growing number of private farmers who could benefit by being exposed to farmer organizations in the U.S.. Especially how such organizations have influenced government policies on marketing, transportation, seed multiplication, etc. Also, the Ukrainian farmers would have the opportunity to visit financial institutions, cooperatives, and other private sector activities, which U.S. farmers rely on.

There appears, as well, a great opportunity to provide for joint ventures with U.S. companies. The great agricultural potential found in the Ukraine and neighboring countries, plus the emerging markets appears unlimited.

The proposed outline of a work plan suggested for the OSU-CIMMYT program focuses on enhancing germplasm and its distribution, including appropriate training, using wheat production as the vehicle to stimulate the economic development of the region. A brief outline of the proposed work plan follows:

1. Enhancement and distribution of wheat germplasm.

    a. The OSU-CIMMYT Winter x Spring Wheat Germplasm Enhancement Program will place greater emphasis on the biotic and abiotic stresses found in this region. Also, linkage between specific sites where desired selection pressure evaluations can be made; such as Fundulea, Romania, for Fusarium head scab, Kharkov for winter hardiness, and Odessa, Ukraine, for bread quality and drought tolerance, etc. will be established. Screening nurseries from OSU and CIMMYT-Turkey will be more focused to the needs of the region. The current shuttle breeding approach between OSU and CIMMYT-Mexico and Turkey, which has proven successful in identifying more widely adapted germplasm, will be expanded to include these sites.

Such an approach accomplishes both the distribution of superior germplasm, allows others to use such material in their crossing programs, and provides a financial return to further strengthen the breeding programs. Smaller countries like Armenia with limited hectares of wheat would be a participant grower rather than a contributor to such a program. To insure that there is compliance regarding collection of royalties CIMMYT-Turkey scientists would monitor production in the region. It is also suggested that annual or alternate year meetings be held at different country locations to discuss the program and share information. The chairmanship would rotate and would be representative of the location where the meeting is held.

    b. Establish a network of countries (Table 2) where each year major breeding programs would provide three to four advanced lines to be grown along with appropriate check varieties in replicated yield trials. It is estimated that each year there would be approximately 50 to 60 entries per location. The cooperator at each location would be held accountable for collecting the appropriate agronomic, disease and insect data and sending the information in a timely manner to CIMMYT-Turkey where it would be summarized and returned to all cooperators. In addition, each participating institution will be required to sign a breeders code of ethics (this allows that all materials can be used in making crosses) and must agree to accept a policy of Plant Variety Protection which provides royalties to both the country releasing the new variety and the institution within the country which developed the material.

c. Those involved in the plant germplasm resource centers located at Kharkov and Odessa will be invited to Ft. Collins, Colorado, and Aberdeen, Idaho, in the U.S. and CIMMYT-Mexico to establish a systematic exchange of genetic materials.

2. Training and establishing linkages between scientists and growers with counterparts in the U.S. will be undertaken.

It is the intent of this phase of the program to provide scientists and private farmers with an opportunity to establish linkages with counterparts in the U.S. by visiting land grant universities, and private sector enterprises with emphasis on both the scientific aspects of wheat production and the mechanisms to transfer appropriate technology. For the scientists, there would be an opportunity to exchange information on researchable problems of common interest with U.S. scientists, including sharing of protocols and germplasm.

The private farmers could also visit farms in Oregon, grower organizations such as the Oregon Wheat Growers League, and Oregon Wheat Commission, and see the function of farm cooperatives, marketing systems, equipment dealers, seed producers, etc. These opportunities could lead to joint ventures with U.S. companies, as well.

Another option would be to identify one or two reasonably large private farms in the Ukraine and establish a linkage with counterparts in the U.S. In addition to the Ukrainian farmers coming to Oregon, the Oregon farmers or extension specialists, in concert with some member of the USDA team now in the Ukraine could become involved in the Ukraine and develop one or more large demonstration farm experiences. Such an opportunity could also emphasize management practices such as minimum or no tillage, as water and erosion were identified as problems in some regions of the Ukraine.

wek/plm\wpdoc\trips\ukraine.doc.97

Table 1. Ukraine Trip: Organizations Visited and People Met
January - February 1997

Date	Name	Title	Institution	City
1/29/97	Lunochkin	Acting Director	State Commission for testing & protection of plant varieties	Kiev
	Zagynailo	Head of Cereals Dept.	State Commission for testing & protection of plant varieties	Kiev
	Kovalenko	Vice-president	Ukrainian Acad. of Ag Sciences	Kiev
	Martynenko	Head, Foreign Relations	Ukrainian Acad. of Ag Sciences	Kiev
	Walker	Advisor	MOA	Kiev
	Volkodav	Head, Cereals Production Dept.	MOA	Kiev
	Onipko	President	Ukr. Acad. of Sci. for Nat. Progress	Kiev
1/30/97	Shapran	Deputy Governor	Poltava Regional Administration	Poltava
	Pisarenko	Rector	Poltava Agric. Institute	Poltava
	Chapko	Deputy-rector	Poltava Agric. Institute	Poltava
	Moskalenko	Wheat Breeder	Poltava Agric. Institute	Poltava
	Andrienko	Head	Agric. Dept. of Regional Adm.	Poltava
	Kushko	Head	Union of farmers	Poltava
1/31/97	Bondarenko	DG	Institute of Crop Production	Kharkov
	Ryabchun	Director	Nat. Center for Plant Genet. Resources	Kharkov
	Golik	Spring Wheat Breeder	Institute of Crop Production	Kharkov
	Elnikov	Winter Wheat Breeder	Institute of Crop Production	Kharkov
	Ryabchun	Head, W. Hardiness Dept.	Institute of Crop Production	Kharkov
	Lukyanenko	Head, Quality Lab	Institute of Crop Production	Kharkov
	Sherstjuk	Director	Ukrainian Gardens	Kharkov
2/1/97	Sozinov	Director	Institute of Agrobiology & Biotechnology	Kiev
2/2/97	Vlasenko	Deputy DG	Mironovka Wheat Institute	Mironovka
	Remeslo	Wheat Breeder	Mironovka Wheat Institute	Mironovka
	Ignatenko	Chairman	I. Franko Collective Farm	Mironovka
2/3/97	Walker	USAID-Priv.		Kiev
	Lyvers	USAID-Priv.		Kiev
	Seitz	USDA		Kiev
	Morgeen	National Academy of Sci.	Plant Physiology & Genetics	Kiev
	Lysenko	National Academy of Sci.	Institute of Crop Production	Kiev
2/4/97	Lisovoi	National Academy of Sci.	Plant Breeding & Genetics Institute	Odessa
2/5/97	Visited two collective state farms associated with Institute located near Odessa			
2/6/97	Reviewed research at Institute			
	Heiejiko	President	Private Farmers Association	Odessa
	Sokolov	Director & Maize Breeder	Institute for Genetics and Breeding	Odessa

Table 1. continued

Date	Name	Title	Institution	City
2/6/97	Litvinenko	Deputy Director & Wheat Breeder	Institute for Genetics and Breeding	Odessa
	Stelmak	Wheat Geneticist (Vrn & Ppd)		Odessa
	Lyfenko	Wheat Breeder		Odessa
	Palamarchuk	Durum Wheat Breeder		Odessa
	Babeyentz	Phytopathology		Odessa
	Subota	Germplasm		Odessa
	Poperelyo	Wheat Quality Electrophoresis		Odessa
	Khokhlov	Wheat Quality Protein		Odessa
	Sovolap	Molecular Biology		Odessa
	Nedelko	President	Odessa Farmer Association	Odessa
	Kutovoy	Farmer		Odessa
	Runyan	USDA		Odessa

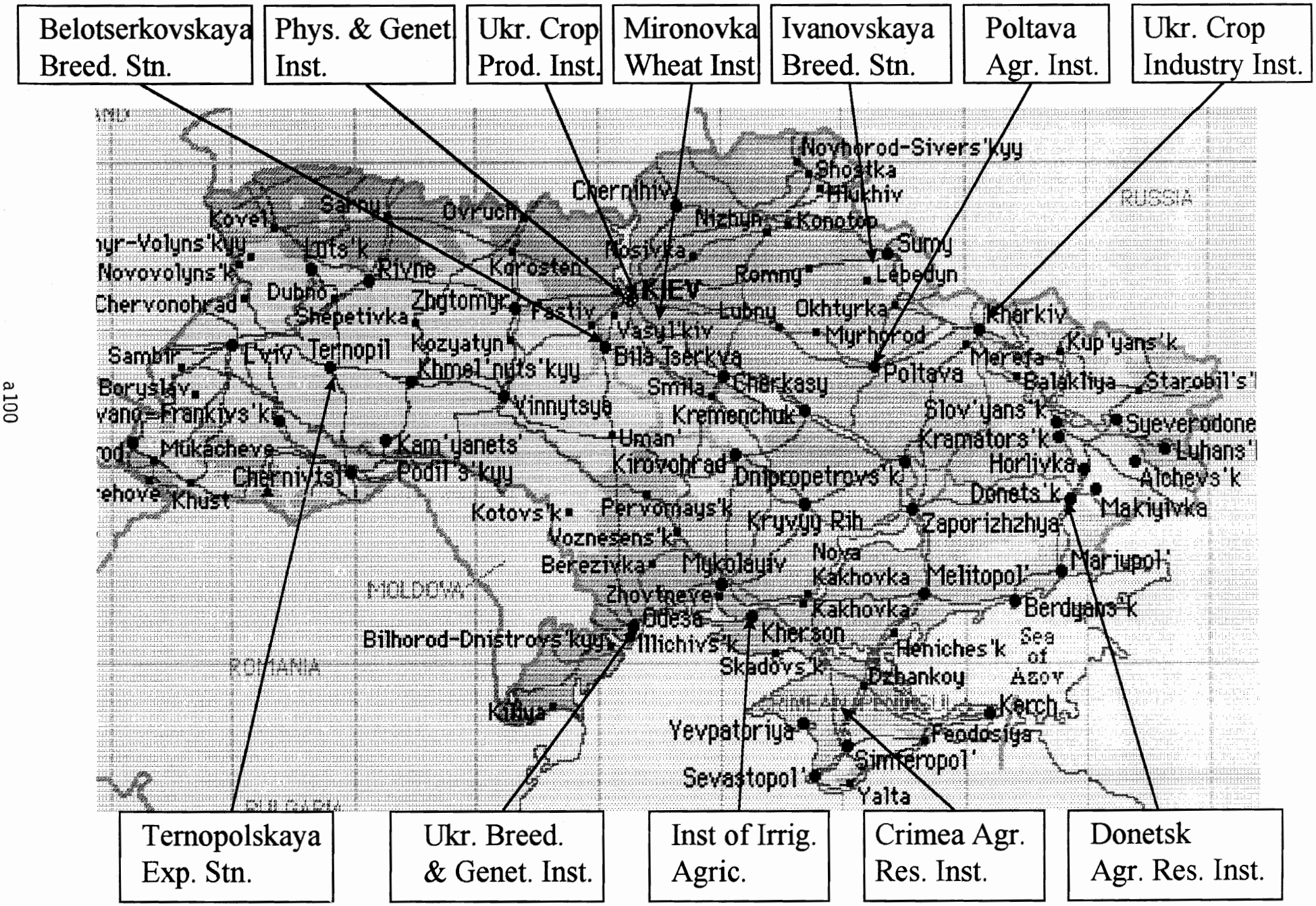
wpdoc\trips\TBL.doc and visited.doc

Table 2. Institutions Involved in Proposed Wheat Network

1. Armenia	Armenian Agricultural Academy Erevan
2. Azerbaijan	Azerbaijan Institute of Agricultural Research Baku
3. Bulgaria	Wheat and Sunflower Institute General Toshevo
4. Bulgaria	Institute of Introduction and Plant Genetic Resources Sadovo
5. Georgia	Georgian Agricultural Research Institute Mtskheta
6. Hungary	Cereal Research Institute Szeged
7. Hungary	Agricultural Research Institute Martonvasar
8. Mexico	CIMMYT Mexico
9. Moldova	Field Crop Research Institute Beltsy
10. Romania	Research Institute for Cereals and Industrial Crops Fundulea
11. Romania	Agricultural Research Station Turda
12. Russia	Krasnodar Agricultural Research Institute Krasnodar
13. Russia	Rostov Agricultural Research Institute Rostov
14. Turkey	International Winter Wheat Improvement Program (Turkey/CIMMYT/ICARDA), Ankara
15. Ukraine	Mironovka Wheat Institute Mironovka
16. Ukraine	Ukrainian Crop Production Institute Kharkov
17. Ukraine	Ukrainian Plant Breeding Institute Odessa
18. USA	Oregon State University
19. USA	Kansas State University
20. USA	Nebraska State University
21. USA	Texas A & M University
22. Yugoslavia	Novi Sad Agricultural Research Institute Novi Sad
23. Poland	
24. Macedonia	
25. Albania	

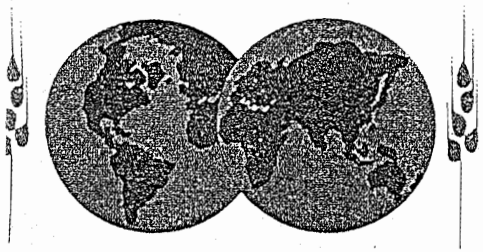
wek/plm.sdw \wpdoc\trips\ukraine.doc 5/1/97

Wheat breeding institutions in Ukraine



Appendix 7

5th International Wheat Conference



Ankara, Republic of Turkey

Hilton Hotel June 10 -14, 1996

June 10, 1996

Opening of Conference
C. Aysun - Chairman

Welcome

0930 Dr. Fahri Altay, Organizing Committee, Republic of Turkey

Dr. Sanjaya Rajaram, Director, Wheat Program, CIMMYT, Mexico

Prof. Dr. Adel El-Beltagy, Director General, ICARDA, Syria

His Excellency, Dr. Werner Zimprich, Minister of the Embassy of the Federal Republic of Germany

Dr. Gürbuz Mızrak, Director General for Agricultural Research, Ministry of Agriculture and Rural Affairs, Republic of Turkey

His Excellency, Ismet Attilla, Minister of Agriculture and Rural Affairs, Republic of Turkey

His Excellency, Mesut Yılmaz, Prime Minister, Republic of Turkey

His Excellency, Süleyman Demirel, President, Republic of Turkey

1045 Coffee break

Scientific Commencement
Ş. Erdoğan - Chairman

1115 Prof. Warren E. Kronstad, Distinguished Professor, USA
Agricultural Development and Wheat Breeding in the 21st Century

1200 Dr. Nusret Zencirci, National Cereal Coordinator, Turkey
Wheat Research in Turkey

13:00 Lunch

Main Session 1: Breeding for Yield
E. Kün - Chairman

1430 R. G. Sears (USA), Key Note Speaker
Strategies for Improving Grain Yield in Wheat

1510 R. Bruns (USA)
Yield and Stability Factors Associated with Hybrid Wheat

1530 N. A.Litvinenko (Ukraine)
Breeding of Common Winter Wheat of Intensive Type for Adaptation Potential under the South Ukrainian Environment

1550 Z. Kertesz (Hungary)
Traditional and Novel Methods in Wheat Breeding at the Cereal Research Institute, Szeged

1610 Z. He (China)
Progress of Wheat Breeding Research in China

1630 Discussion

1645 Poster Session 1

June 11, 1996

Main Session 2: Breeding for Biotic Stresses
E.E. Saari - Chairman

0800 R.A. McIntosh (Australia), Key Note Speaker
Breeding for Resistance to Biotic Stresses

0840 M. Ittu (Romania)
Strategy for Improving Fusarium Head Blight Resistance of Wheat in Romania

0900 S. P. Karov (Bulgaria)
Bacterial Diseases on Wheat in Bulgaria

0920 R. P. Singh (Mexico)
Comparison of two Crossing and four Selection Schemes for Yield, Yield-Traits, and Slow Rusting Resistance to Leaf Rust in Wheat

0940 O. Mamluk (Syria)
Smuts and Bunts of Wheat in North Africa and the Near East

1000 Discussion

1015 Coffee Break

Main Session 3: Breeding for Abiotic Stresses
J. Quick - Chairman

1045 A. Blum (Israel), Key Note Speaker
Improving Wheat Grain Filling Under Stress by Stem Reserve Mobilization

1125 M. P. Reynolds (Mexico)
Evaluating Physiological Selection Criteria to Compliment Empirical Breeding in Warm Wheat Growing Environments

1145 N. El Bassam (Germany)
A Concept of Selection for "Low Input" Wheat Varieties

1205 Y. P. Fedulov (Russia)
System Analysis of Winter Wheat Frost Resistance and Its Use in Breeding

1225 M. van Ginkel (Mexico)
Plant Traits Related to Yield of Wheat in Early, Late or Continuous Drought Conditions

1245 Discussion

1300 Lunch

Concurrent Session 1. Durum Wheat
P. Ruckenbauer - Chairman

1430 S. R. Verma (India)
Breeding for Yield and Quality in Durum Wheat

a101

1445 B. Beke (Hungary)
Durum Wheat (Triticum Durum Desf.) Breeding at the Cereal Research Institute, Szeged, Hungary

1500 E. Porceddu (Italy)
Occurrence of Unusual Storage Proteins Electrophoretic Patterns in Durum Wheat and their Effect on Gluten Strength

1515 M. Nachit (Syria)
Network for Integrated Research to Improve Durum Productivity in the Mediterranean Region

1530 A. Al Hakimi (Algeria)
Direct and Indirect Selection for Drought Tolerance in Alien Tetraploid Wheat Durum Wheat Crosses

1545 Discussion

Concurrent Session 2: Wheat Agronomy and Mineral Nutrition
H. van Niekerk - Chairman

1430 W. K. Anderson (Australia)
Grain Yield and Quality. Does There Have to Be a Trade Off?

1445 P. R. Hobbs (Nepal)
Reduced and Zero-Tillage Options for Establishment of Wheat after Rice in South Asia

1500 M. Pala (Syria)
Response of Some Bread and Durum Wheat Varieties to Supplemental Irrigation, Nitrogen and Date of Planting

1515 R. Schlegel (Bulgaria)
Screening for Zinc Efficiency Among Wheat Relatives and their Utilization for an Alien Gene Transfer

1530 M. Souleimenov (Kazakhstan)
Continuous Spring Wheat Growing under Semi-Arid Conditions of Northern Kazakhstan

1545 M. Kalaycı (Turkey)
Boron Toxicity on Wheat in Central Anatolia

1600 A. T. Campbell (Australia)
Breeding Wheat for Tolerance to Soil Boron

1615 Discussion

Concurrent Session 3: Vernalization and Photoperiod
C. Qualset - Chairman

1430 A. F. Stelmakh (Ukraine)
Genetic Systems Regulating Rate of Developments in Wheat

1445 N. P. Goncharov (Russia)
Genetic Resources of Related Species of Wheat: The Vrn Genes Controlling Growth Habit (Spring Vs Winter)

1500 G. Ortiz Ferrara (Syria)
Photoperiod and Vernalization Response of Mediterranean Wheats and Implications for Adaptation

1515 A. J. Worland (England)
Influence of Photoperiod Genes to the Adaptability of European Winter Wheats

1530 A. I. Morgounov (Turkey)
The Possibility of Selecting Winter/Facultative Wheat Genotypes from Spring x Spring Crosses Using Segregation for Vrn Genes

1545 Discussion

1630 **Poster Session 2**

1930 Departure from Hotel
Turkish Night and Conference Reception

June 12, 1996

0730 Departure from Hilton Hotel to Eskişehir

Visit Transitional Zone Agricultural Research Institute, Eskişehir

2200 Return to Ankara

June 13, 1996

Main Session 4: Biotechnology
A. Börner - Chairman

0800 J. W. Snape (England) Key Note Speaker
Golden Calf or White Elephant? - The Contribution of New Biotechnologies to Wheat Breeding

0840 H. Lörz (Germany)
Molecular Wheat Breeding by direct Gene Transfer

0900 I. Karsai (Hungary)
Relationship between Anther Culture Response and Aluminium Tolerance in Wheat (Triticum Aestivum L.)

0920 E. A. Salina (Russia)
New Family of the Tandem DNA Sequences for Analysis of Triticeae Genomes

0940 Discussion

1010 Coffee Break

a102

Main Session 5: Wheat Physiology
J. Peacock - Chairman

1040 E. Klepper (USA) Key Note Speaker
The Physiological Life Cycle of Wheat: Its use in Breeding and Crop Management

1120 I. Çakmak (Turkey)
Differential Response of Wheat Genotypes to Zinc Deficiency in Calcareous Soils of Turkey

1140 L. S. Bolshakova (Russia)
Effect of Nitrate Nutrition on Nitrate Compartimentation, Nitrate Assimilation Capacity and Productivity in Spring Wheat (Cv. Ivolga)

1200 S. Dencic (Yugoslavia)
How to Increase the Sink Capacity in High Yielding Wheat Cultivars

1220 L. A. Hunt (Canada)
Recent Attempts to Evaluate and Apply Wheat Simulation Models, and to Simplify the Storage and Exchange of Experimental Data

1300 Lunch

Concurrent Session 4: Wheat Cytogenetics
I. Panayotov - Chairman

1430 L. A. Pershina (Russia)
Biotechnology and Genetics Aspects of Production of New Genotypes of Common Wheat Using H. Vulgare X T. Aestivum L. and H. Geniculatum All. (= H. Marinum Spp Gussoneanum) X T. Aestivum L. Hybrids

1445 M. Inagaki (Mexico)
Polyhaploid Production in Hexaploid Wheat Crossed with Stored Perl Millet Pollen

1500 V. K. Simonenko (Ukraine)
The Use of Wheat-Alien and Aegilops-Rye Amphyploids for Introgression of Alien Genetic Material to Wheat

1515 J. B. Thomas (Canada)
Genetic Segregation and the Detection of Compensated Wheat-Alien Translocations

1530 V. Eser (Turkey)
Characterization of Powdery Mildew Resistant Lines Derived From Crosses between Wheat (Triticum Aestivum) and Aegilops Speltoides and Aegilops Mutica

1545 H. Ekiz (Turkey)
Cytoplasmic effects on some quality traits of bread wheat (Triticum aestivum L.).

1600 S. V. Rabinovich (Ukraine)
Importance of Wheat-Rye Translocations for Breeding of Contemporary Cultivars of Triticum Aestivum L.

1615 Discussion

Concurrent Session 5: Wheat Pests
S. Beniwal - Chairman

1430 M. Torabi (Iran)
Pathogenic Races of Tilletia Controversa Kuhn in West- and North-West Iran

1445 A. J. Rathjen (Australia)
Breeding for Resistance to Nematodes, Heterodera Avenae and Pratylenchus Neglectus

1500 J. W. Johnson (USA)
Breeding Facultative Wheats with Hessian Fly Resistance

1515 E. Kınacı (Turkey)
Sunn Pest Problem in Central Anatolia and the Role of Varieties in Integrated Control

1530 A. Saidi (Iran)
Inheritance of Russian Wheat Aphid Resistance in Four Winter Wheat Cultivars

1545 M. Elmalı (Turkey)
Russian Wheat Aphid (Diuraphis Noxia (Kurdjumov) (Hom.: Aphididae) in Konya Province

1600 Discussion

Concurrent Session 6: Study Reports
M. Kohli - Chairman

1430 M. Perenzin (Italy)
F1 Hybrid Performance and Parental Diversity Based on Molecular Markers in Bread Wheat

1445 N. Saulescu (Romania)
Goals and Problems of Wheat Breeding in Romania

1500 G. N. Gamzikov (Russia)
Strategy of Wheat Breeding and Cultivation Technologies in Siberia

1515 Z. Bedo (Hungary)
Breeding for Breadmaking Quality Using Old Hungarian Wheat Varieties

1530 N. Howes (Canada)
Simulations and Practical Problems of Applying Multiple Marker Assisted Selection and Double Haploids to Wheat Breeding Programs

1545 A. Bayaner (Turkey)
Searching for a Suitable Functional Form in Wheat Yield Response to Fertilization

1600 H. Utku (Turkey)
Classification of Wheat Grains by Digital Image Analysis with the Use of Statistical Filters

1615 Discussion

1630 Poster Session 3

1930 Commemorative Dinner at the Occasion of the 30th Anniversary of CIMMYT

June 14, 1996

Main Session 6: Breeding for End-Product Use
A. Atli - Chairman

0800 W. Bushuk (Canada) Key Note Speaker
Breeding for End-Product Use

0840 B. Borghi (Italy)
Mediterranean Climate and Quality of Wheat: Effect of the Duration and Intensity of Heat Shock During Grain Filling on Protein Composition and Technological Quality

0900 I. R. Barclay (Australia)
Wheat Quality Requirements of Asian Foods

0920 J. C. Peterson (USA)
Baking Quality of Hard Winter Wheat: Response of Cultivars to Environments in the Great Plains

0940 J. M. Clarke (Canada)
Screening of Durum Wheats for Pasta Quality: The Canadian System

1000 Discussion

1015 Coffee Break

Main Session 7: Genetic Resources
J. Makoun - Chairman

1045 A. F. Merezhko (Russia) Key Note Speaker
Impact of Genetic Resources on Wheat Breeding

1125 S. Martynov (Russia)
Analysis of Genetic Profiles of Winter Wheats From Russia

1145 B. Skovmand (Mexico)
Integrating Research on Genetic Resources with the International Wheat Information System

1205 D. Tong (China)
Conservation, Research, Utilization and International Exchange of Wheat Germplasm Resources in China

1225 Discussion

1245 Lunch

Main Session 8: International Collaboration
A. Eryılmaz - Chairman

1415 S. Rajaram (Mexico) and S. Ceccarelli (Syria) Keynote Speakers.
Wheat Research and International Collaboration

1455 S. Nagarajan (India)
Impact and Expectations from International Collaboration for Wheat Germplasm Development

1515 Y. Zou (China)
Breeding strategies and recent progress of China - CIMMYT wheat shuttle breeding program in Sichuan Province, 1989 - 1994

1535 H.-J. Braun (Turkey)
Winter Wheat Breeding: Priorities and Importance of International Collaboration

1555 Discussion

1615 **Summary of Sessions Presented by the Chairmen**

1730 **Closing Ceremony**

a104

Appendix 8. Wheat germplasm submitted to the National Small Grains Collection Aberdeen, Idaho USA.

Nursery*	Entry	ID#	Name	Seed Class**	Reason Code***	Awns Present	Awn Color	Glume Color	Growth Habit
Discb	1	3870118	HYS//R37/GHL1/3	XW	R	Yes	Yellow	Yellow	W
Discb	2	3900394	NRPB 81-455/MERKUR	SW	R	No	-	Yellow-White	W
Discb	5	1992	ARMINDA	XW	L	No	-	Yellow	W
Discb	6	3930396	M 632/11988	XW	L	Awnletted	Yellow	Yellow	W
Discb	7	3930153	308 O 2-231	XW	L	Yes	Yellow	Yellow-White	W
Discb	11	900327	F12.71/COC//CARSTEN/GIGANT	SR	L	Yes	Yellow	Yellow	W
Discb	12	889294	NZT/BEZ1//ALD,F1/4/F1,NAD//TMP/CI12406/3/EMU	HR	L	Yes	Yellow	Yellow	W
Discb	13	3930324	3024.01/RONDEZVOUS	HR	L	Yes	Yellow	Yellow	W
Discb	15	899210	IONA/3/RONDEVOUS	HR	C	No	-	White-Yellow	W
Discb	16	3880045	VPM/MOS951//CI13438, 8815	SW	C	Yes	Yellow	Yellow	W
Discb	17	910102	RONDEVOUS/4/7C/CNO//CAL/3/YMH	XR	C	No	-	Yellow	W
Discb	21	880494	OR7946/HILL//HILL	SW	B	Yes	Yellow-White	Yellow-White	W
Discb	24	3900438	TCK82799*WAR//BURT/PI178383/3/HILL	XW	B	Yes	Brown-Bronze	Brown-Bronze	W
Discb	26	3880039	SPN *2/THUL III	SW	B	Yes	Yellow	Yellow	W
Discb	27	3890191	STEPHENS/HOHENHEIMER BT5	XW	B	Yes	White-Yellow	White-Yellow	W
Discb	28	3890209	SMUT1571-40	XR	B	Yes	Bronze	Bronze	W
Discb	29	3890210	SMUT1590-165	R	B	Yes	Yellow	Yellow	W
Discb	30	3930052	456 S 1-12	XW	B	Yes	Yellow	Yellow	W
Discb	31	3930053	650 R 1-21	XR	B	Yes	Yellow	Yellow	W
Discb	34	3930252	KOL/PME/317C/CN067//CAL/4/CLEO	XW	S	Yes	Yellow	Yellow	W
Discb	35	3930264	KS73H530/VEE"S"	XR	S	Yes	Yellow	Yellow	W
Discb	36	910147	TJB 841/1543//WA 5987/4/D6301/HN7//ERA/3/BUC	SW	S	Yes	Yellow	Yellow	W
Discb	37	908294	FIEF/PERNEL	SR	S	Yes	Yellow	Yellow	W
Discb	40	900438	SPN/4/D6301/HN7//ERA/3/BUC/5/MLC/ORCW8113=MLC	SW	S	Yes	Yellow	Yellow	W
Discb	41	861555	VS74-709/BUC	HR	S	Yes	Yellow	Yellow	W
Discb	42	890074	AU/MINN/HK/38MA/YMH/ERA/CLLF/BEZ/SU/CI13645/NAI/EMU	HR	S	Awnletted	Yellow	Yellow	W
Discb	43	3950707	LS 172	XR	S	Yes	Yellow	Yellow	W
Discb	44	3950719	P648.05/BRANDISH	XR	S	Yes	Yellow	Yellow	W
Discb	45	3950803	3950803	XR	S	Yes	Yellow	Yellow	W
Discb	46	3950804	3950804	XR	S	No	White	White	W
Discb	48	3930267	BUL 1687-1/LOV38//BUL 305-44	XR	S	No	-	Yellow	W
Discb	49	3930285	SAULESKU #11	XR	S	Yes	Yellow	Yellow	W
Discb	50	3920022	3920022	XR	S	Awnletted	Yellow	Yellow	W
Discb	51	3870552	TJB406.892/MON"S"	SW	S	No	-	Yellow	W

Nursery*	Entry	ID#	Name	Seed Class**	Reason Code***	Awns Present	Awn Color	Glume Color	Growth Habit
Discb	52	3890143	SAULESKU#13	XR	S	Yes	Yellow	Yellow	W
Discb	53	3930326	BATTEN/C6891	HR	S	Yes	Yellow	Yellow	W
Discb	54	3930330	C7205/3024.01	HR	S	Yes	Yellow	Yellow	W
Discb	55	908237	CARGL 62//TJB368-251/BUC	SR	S	Yes	Yellow	Yellow	W
Discb	56	899407	MOULIN//TJB368-251/BUC	XR	S	No	-	Yellow	W
Discb	57	908134	CARSTEN/GIGANT/5/AU/3/MINN//HK/38MA/4/YMH/ERA	SR	S	Yes	Yellow	Yellow	W
Discb	58	910379	CL/833//CL/3/TOP/FUND/4/CAMA/PAVONE	SR	S	Awnletted	Yellow	Yellow	W
Discb	59	2626	HYS//R37/GHL 1	SW	V	Yes	Yellow-White	Yellow-White	W
Discb	61	3870115	HYS//R37/GHL1	XR	V	Awnletted	Yellow	Yellow	W
Discb	62	3870634	HYS//R37/GHL1	XW	V	Yes	Yellow	Yellow	W
Discb	65	3930387	Rsk/VA 103,FW83102 B7046/VA103/SWM783787,FW83126 B7016	SR	V	Yes	Yellow	Yellow	W
Discb	68	3930257	AMI/ROA	XR	V	Awnletted	Yellow	Yellow	W
Discb	69	3950254	Australian Red - BYD	XR	V	Awnletted	Yellow	Yellow	W
Discb	70	3950255	Australian White - BYD	XR	V	Awnletted	Yellow	Yellow	W
Discb	71	3950865	PBI1267.175.1/P748.02	XR	V	Yes	Yellow	Yellow	W
Discb	75	899302	D6301/HN7//ERA/3/BUC.S/4/PRL.S/VEE#6	XR	V	Yes	Yellow	Yellow	W
Intcb	1	3890029	4TH IWWSN 57 TURKEY	XR		Yes	Yellow	Yellow	W
Intcb	2	1922	CARSTEN/GIGANT	HR		No	Yellow	-	W
Intcb	3	3900255	FUNDULEA 4	XW		Yes	White	White	W
Intcb	4	3870538	ND/P101//AZ	XW		Yes	White	Yellow	W
Intcb	5	3870432	78014-40	HR		Yes	White	Yellow	W
Intcb	9	3930024	6022 W 1	XR		-	Yellow	Yellow	W
Intcb	10	3930055	309 O 3-111	XR		Yes	Yellow	Yellow	W
Intcb	11	920548	8655/TSN/3/CARSTEN V/GIGANT//ADAM	HR		No	-	Yellow	W
Intcb	12	3920068	14IBWSN19/3417.04	XR		Yes	White	Yellow	W
Intcb	15	900327	F12.71/COC//CARSTEN/GIGANT	SR		Yes	Yellow	Yellow	W
Intcb	16	900192	AU/3/MINN//HK/38MA/4/YMH/ERA/5/85CB077	SW		Yes	Yellow	Yellow	W
Intcb	18	900381	85CB077/5/ND/P101//BB/GLL	SW		Yes	Yellow	Yellow	W
Intcb	19	908289	B8021/AMBASSADOR//CARGIDOC	SR		No	-	Yellow	W
Intcb	20	908164	TOPO S/NAR 59*2//BDFN/3/BOW S/4/PMF//CNO S/GLL	HR		Yes	Yellow	Dk. Yell-Bronze	W
Intcb	21	889303	NAI60/HN7//BUC/5/F59-71/BB/KAL//ALD/3/Y50E/3*KAL//EMU	HW		Yes	Yellow	Yellow	W
Intcb	23	3930402	LOV41	XR		Yes	Yellow	Yellow	W
Intcb	24	899511	MASTER/3/HYS/CERCO//YMH/HYS	XR		Yes	Yellow	Dk. Yell-Bronze	W
Intcb	25	908127	RONDEVOUS/3/PROBSTORFER EXTREM/TOB 66	HR		Yes	Yellow	Yellow	W

Nursery*	Entry	ID#	Name	Seed Class**	Reason Code***	Awns Present	Awn Color	Glume Color	Growth Habit
Intcb	27	910231	CLLF/BEZ//SU92/CI13645/3/NA160/4/EMU/5/TJB788-1089/ALDA	HR		Yes	Yellow	Yellow	W
Intcb	28	900031	AU/3/MINN//HK/38MA/4/YMH/ERA/5/BPRE/BRT,F1/6/HUQ/ALD	HR		Yes	Yellow	Yellow	W
Intcb	29	908110	RONDEVOUS/3/CARSTEN/GIGANT	HR		No	-	Yellow	W
Intcb	31	910262	GRTPL 85504//M1223-3D-1D(MI76-77-S29)/ALD	XR		Yes	Yellow	Yellow	W
Intcb	32	3940160	KAL/ODZI/3/TMP//D6301/NAI/4/TTM'S'	XR		Yes	Yellow	Yellow`	W
Intcb	34	3940177	KAVKAZ/CIGUENA//JUBILAR	XR		No	-	Yellow	W
Intcb	36	3940263	NEELKANT 'S'/TEMU 49-82	XR		Yes	Yellow	Yellow	W
Intcb	39	3950710	3950710	XW		No	-	Yellow	W
Intcb	40	3950712	3950712	XR		No	-	Yellow	W
Intcb	41	3950727	P748.02/C7205	XW		Yes	Yellow	Yellow	W
Intcb	42	3950728	P748.02/C7205	XR		Yes	Bronze	Brown-Bronze	W
Intcb	43	3950730	PBI1267.175.1/3024.01.2	XW		Yes	Yellow	Yellow	W
Intcb	44	3950733	CWW4643.28/3042.01.3//3024.01.2	XR		Yes	Yellow	Yellow	W
Intcb	45	3950750	3950750	XR		No	-	White-Yellow	W
Intcb	46	3950785	KW940713	XR		Yes	Yellow	Yellow	W
Intcb	47	9630216	KW940915-5005	XR		Yes	Yellow	Yellow	W
Intcb	49	9630093	AF92-3	XR		Yes	Yellow	Yellow	W
Intcb	50	9630136	MIRONOVSKAJA 27	XR		Awnletted	Yellow	Yellow	W
Intcb	51	9630145	KIJANKA	XR		Awnletted	Yellow	Yellow	W
Intcb	55	9630057	TJB801,1332/CHIL	XR		Yes	Yellow	Yellow	W
Intcb	56	9630058	TJB916.46/CB306//2*MHB/3/BUC	XW		Yes	Yellow	Yellow	W
Intcb	57	9630062	PI/FUNO*2//VLD/3/CO723595	XR		Yes	Yellow	Yellow	W
Intcb	58	9630064	PI/FUNO*2//VLD/3/CO723595	XR		Yes	Yellow	Yellow	W
Intcb	59	9630211	KW940599-5002	XR		Yes	Yellow	Yellow	W
Intcb	61	22	HOFF	XR		Yes	Yellow	Yellow	W
Intcb	62	9630132	MIRONOVSKAJA OSTISTAJA	XR		Yes	Yellow	Yellow	W
Intcb	63	9630134	MIRONOVSKAJA NIZKOROSLAJA	XR		Awnletted	Yellow	Yellow	W
Intcb	69	961680	GLOCHNER	XW		No	-	Yellow-White	W
Intcb	70	3960129	FLAIR	XW		No	-	Yellow-White	W
Intcb	76	SEG951041	4TH IWWSN 60 TURKEY//TX71A1039-V1*3/AMI/3/NRPB 88-3141	XW		Yes	Yellow	Yellow	W
Intcb	78	928132	RONDEZVOUS/6/NAI60/HN7//BUC/5/F59-71/BB/KAL//ALD/3/Y5	XW		Awnletted	Yellow	Yellow	W
Intcb	81	940005	BDFN/PVN.S//KS5210/3/VPM/MOS83-11-4-8//PEW	XW		Yes	Yellow	Yellow	W
Intcb	85	940043	BDFN/PVN.S//KS5210/3/VPM/MOS83-11-4-8//PEW	XR		Yes	Yellow	Yellow	W
Intcb	88	940214	RONDEZVOUS/5/ID#2619/6/ID#855301	XW		Yes	Yellow	Yellow	W

Nursery*	Entry	ID#	Name	Seed Class**	Reason Code***	Awns Present	Awn Color	Glume Color	Growth Habit
Intcb	89	940228	ID#3701/6/VPM/MOS83-11-4-8//PEW/7/BDFN/PVN.S	XW		Yes	Yellow	Yellow	W
Intcb	90	940078	ID#3870279/5/VPM/MOS83-11-4-8//PEW/6/PMF//CNO S/GLL	XW		Yes	Yellow	Yellow	W
Intcb	91	940079	ID#3870279/5/VPM/MOS83-11-4-8//PEW/6/PMF//CNO S/GLL	XW		Yes	Yellow	Yellow	W
Intcb	95	940447	RONDEZVOUS/3/VPM/MOS83-11-4-8//PEW	XW		Awnletted	Yellow	Gold	W
Intcb	98	940099	GRTPL 6121//TJB788-1089/ALDAN/5/ID#3870279	XW		Yes	Gold	Gold	W
Intcb	99	940105	GRTPL 6121//TJB788-1089/ALDAN/5/ID#3870279	XW		Yes	Yellow	White	W
Intcb	100	940205	RONDEZVOUS/5/ID#2619/6/ID#855301	XW		Yes	Yellow	Yellow	W
Intcb	102	940719	CER//YMH/HYS/3/PMF//CNO S/GLL	XW		Yes	Yellow	Yellow	W
Intcb	104	942732	1D13.1/MLT"S"//FASAN	XW		Yes	Yellow	Yellow	W
Intcb	105	942742	1D13.1/MLT"S"//FASAN	XW		Yes	Yellow	Yellow	W
Intcb	112	942969	F12.71/COC//BAU"S"	XW		Yes	Yellow	Yellow	W
Intcb	113	943065	GP3357/TUI"S"	XW		Yes	White	White	W
Intcb	114	943075	GP3357/TUI"S"	XW		Yes	Yellow	Yellow	W
Intcb	116	943302	TAM200/TRAP#1"S"	XW		Yes	Yellow	Yellow	W
Intcb	117	SEG95 739	4TH IWWSN 57 TURKEY/3/VPM/MOS83-11-4-8//PEW	XW		Yes	Yellow	Yellow	W
Intcb	120	SEG95 740	4TH IWWSN 57 TURKEY/3/VPM/MOS83-11-4-8//PEW	XW		Yes	Yellow	Yellow	W
Intcb	121	SEG95 740	4TH IWWSN 57 TURKEY/3/VPM/MOS83-11-4-8//PEW	XW		Yes	Yellow	Yellow	W
Intcb	124	SEG95 761	MIRONOVSKA 10//RMN F12-71/JUP S	XW		Awnletted	Yellow	Yellow	W
Intcb	125	SEG95 761	MIRONOVSKA 10//RMN F12-71/JUP S	XW		Yes	Yellow	Yellow	W
Intcb	126	SEG95 761	MIRONOVSKA 10//RMN F12-71/JUP S	XR		Yes	Yellow	Yellow	W
Intcb	129	SEG95 939	KS831374-141B/DYBR83-058/6/ID#889313/7/RMN F12-71/JUP S	XW		Yes	Yellow	Yellow	W
Intcb	131	SEG95 997	WIY910588/3/VPM/MOS83-11-4-8//PEW	XW		Yes	Yellow	Yellow	W
Intcb	133	SEG951007	CARGL 62/3/CARSTEN V/GIGANT//ADAM/4/NRPB 88 3141	XW		Awnletted	Yellow	Yellow	W
Intcb	138	SEG951032	TAM200/OPATA//Unknown	XW		Yes	Yellow	Yellow	W
Intcb	139	SEG951036	SHAANMAI 897/3/JCAM/EMU//DOVE/4/F1271/BZ	XW		Yes	Yellow	Yellow	W
Intcb	140	SEG951047	F12.71/COC//SAULESKU#14/3/AFG2/BUC,F1//KVZ	XW		Yes	Yellow	Yellow	W
Intcb	143	SEG951104	61.01/BN3447//WEAVER	XW		Yes	Yellow	Yellow	W
Intcb	144	SEG951128	PNR2548/NING8675	XW		Awnletted	Yellow	Yellow	W
Intcb	146	90812	RONDEVOUS/3/PROBSTORFER EXTREM/TOB 66	XW		Yes	Yellow	Yellow	W
Intcb	147	92813	RONDEZVOUS/6/NAI60/HN7//BUC/5/F59-71/BB/KAL//ALD/3/Y5	XW		Awnletted	Yellow	Yellow	W
Intcb	148	91022	RMN F12-71/JUP S//BPR689-71/TI	XR		Yes	Yellow	Yellow	W

Nursery*	Entry	ID#	Name	Seed Class**	Reason Code***	Awns Present	Awn Color	Glume Color	Growth Habit
Intcb	149	91023	CLLF/BEZ//SU92/CI13645/3/NA160/4/EMU/5/TJB788-1089/ALDA	XW		Yes	Yellow	Yellow	W
Intcb	150	91026	GRTPL 85504//M1223-3D-1D(MI76-77-S29)/ALD	XW		Yes	Yellow	Yellow	W
Intcb	151	92007	TEMU39.76/CHAT.S//CUCURPE86/3/M1223-3D-1D(MI76-77-S29)/AL	XW		Yes	Yellow	Yellow	W
Intcb	152	92045	PMF//CNO S/GLL/3/RONDEVOUS	XW		Yes	Yellow	Yellow	W
Intcb	155	94110	UNKNOWN 89SXWF1//VPM/MOS83-11-4-8//PEW	XW		Yes	Yellow	Yellow	W
Intcb	156	94320	ID800994-W/KAUZ"S"	XW		Yes	Yellow	Yellow	W
Intcb	157	94020	RONDEZVOUS/5/ID#2619/6/ID#855301	XW		Yes	Yellow	Yellow	W
Intcb	159	94137	RONDEZVOUS/3/VPM/MOS951//CI13438, 8815	XW		Yes	Yellow	Yellow	W
Intro	7	9800949	KS82W422/SWM754308//KS831182/KS821422/3/STEPHENS/BLUE BOY	XW		Yes	Bronze	Bronze	W
Intro	14	9800956	COPPERACION NANIHUE	XR	Q	Yes	Yellow	Yellow	W
Intro	16	9800958	COBA/H2005	XR	Q	Yes	Yellow	Yellow	W
Intro	18	9800960	3031.83/32.83	XR	Q	Yes	Yellow	Yellow	W
Intro	19	9800961	COCAL/CONA	XR	Q	Yes	Yellow	Yellow	W
Intro	35	9800977	QUALITAL	HR	R	Awnletted	Yellow	Yellow	W
Intro	91	9801033	NONEKTIVNAJA 1	XW	W	No	-	Yellow	W
Intro	92	9801034	MIRONOVCHANKA	XW	W	Awnletted	Yellow	Yellow	W
Intro	93	9801035	MIRONOVCHANKA JAROVAJA	XW	W	Awnletted	Yellow	Yellow	W
Intro	94	9801036	KOLLEKTIVNAJA 1	XW	W	Yes	Yellow	Yellow	W
Owmcb	4	3930280	1266/84-150+	XR		Yes	Yellow	Yellow	W
Owmcb	5	3930050	LOV41			Yes	Yellow	Yellow	W
Owmcb	21	3950679	NIZIJA			No	-	Yellow	W
Owmcb	24	3950689	NSR-5			No	-	Yellow	W

*Discb, Intcb, and Owmcb=disease, international and miscellaneous crossing blocks respectively, Intro=Introductions

**X=unknown, H=hard, S=soft, R=red, W=white seed

***Reason codes: R=stripe rust, L=leaf rust, C=cercosporella, B=bunt, S=septoria, V=virus, Q=quality, W=winter hardiness

Appendix 9

Annual Reports

of the

Winter X Spring

Wheat Screening Nurseries

1995-1996
1996-1997
1997-1998