Review of the CIMMYT International Winter/Facultative Wheat Program and Its Relationship with National Agricultural Research Systems (NARSs)

June 4-15, 1990
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Reviewers

Prof. Everett Everson
Dept. of Crop and Soil Science
Michigan State University

Dr. Heng Li Wang
Research Professor and Wheat Breeder
Inst. of Crop Breeding and Cultivation
Chinese Academy of Agricultural Sciences

Dr. Khem Singh Gill
Vice-Chancellor
Punjab Agricultural University

Mr. Bertan Suzen
Wheat Breeder
Eskisehir-Turkey Representative

Dr. Sanjaya Rajaram-Leader, Germplasm Improvement Sub-Program, Wheat Program
CIMMYT-Base Representative
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Introduction

The International Maize and Wheat Improvement Center (CIMMYT) has had a long association with the wheat research institutions in Turkey. In 1971, CIMMYT became directly involved with Turkey's winter wheat improvement program through its association with the Rockefeller Foundation/Government of Turkey (GOT) wheat research program. This association resulted in new germplasm introductions to Turkey and the initiation of a large scale training program.

In December 1980, the GOT and CIMMYT signed an agreement on wheat research activities in Turkey. This was followed by an agreement in March 1984 which posted a CIMMYT staff member in Turkey to assist the National Wheat Research Program.

In 1986, the GOT and CIMMYT initiated a joint venture, an "International Approach to Winter Wheat Research." This cooperative international winter wheat research effort was jointly coordinated by the Turkish national wheat research program and CIMMYT and was implemented under the existing bilateral agreement between the GOT and CIMMYT. The purpose was to develop broadly adapted, high-yielding winter wheat germplasm for the extensive winter and facultative wheat growing areas of the world.

At the onset of this joint international winter wheat research effort, a 5-year review of progress was envisioned. However, several events have prompted an earlier review:

- The signing of a bilateral agreement between the International Center for Agricultural Research in Dry Areas (ICARDA) and the GOT.
- The signing of an agreement between CIMMYT and ICARDA.
- The departure of Dr. E.E. Saari, the CIMMYT team leader in Turkey.

In a memorandum to the review team, R.A. Fischer, Director of the CIMMYT Wheat Program, listed the issues for the June 1990 review of CIMMYT's Winter Wheat Program. He requested the team to review the achievements of the initiative in light of the objective stated above.

The review team was also requested to address a series of questions/future issues: These were:

- Is the overall objective still valid? From CIMMYT's view we believe that it is.
- Is the breeding/nursery methodology proposed for meeting the needs of winter and facultative wheat growing areas of developing countries an efficient use of CGIAR resources? What should be the balance of work inside and outside of Turkey? Should China and Chile be excluded as targets because of their unique agroecology?
- Does the program have enough resources to mount an efficient initiative, i.e., scientific manpower including disciplinary back-up (pathology, agronomy, etc.), field sites, field assistance, computing power, etc?
- What should be the relationship of the program to the joint CIMMYT/
ICARDA facultative wheat breeding initiative in Aleppo, Syria? Can common aspects of the two initiatives be rationalized in order to improve efficiency (see also the March 1989 Collaborative Agreement between CIMMYT and ICARDA). Would the facultative wheat breeding work be better based in Turkey?

- What linkages should there be with the CIMMYT-Base breeding program and with institutions in the USA (e.g., Oregon, Texas, Kansas) and Europe? (A possible role for the program in managing the International Winter Wheat Performance Nursery has become less urgent as Jim Peterson now feels there will be continuing support for this in USA).

- What should be the relationship with the Turkish national program?

- What about the role of future activities in the areas of training (Mexico and elsewhere), visiting scientists (to Turkey), traveling workshops, and conferences?

- Are there major plant quarantine issues that need to be addressed?

The team also reviewed the CIMMYT planning document "Towards the 21st Century: Strategic Issues and Operational Strategies of CIMMYT". Much of WANA's higher altitude wheat production falls in the category of marginal lands addressed in that report. Poor soils, low rainfall, cold winter temperatures, and spring frosts predominate in this area. Also considered were the marginal research commitment to these areas and low use of production inputs.

The team visited the ICARDA Research Center and interviewed a number of its scientists. We reviewed their past and present involvements with cereal improvements. With each, we discussed the problems of high altitude, rainfed winter wheat and program objectives and sought their advice on how and where research on winter/facultative wheat should be conducted in the WANA region. We also solicited advice on the role of CIMMYT and ICARDA in this region. The scientists interviewed and their current areas of research are listed in Appendix 1. The travel schedule of the review team is in Appendix 2.

Before leaving ICARDA, we discussed the ICARDA/CIMMYT Agreement and each center's role in serving the national programs of the WANA region with Dr. Nasrat R. Fadda, the director general of ICARDA; Dr. Aart van Schoonhoven, associate director of ICARDA-Research; and Dr. Habib Ketata, acting director of the Cereal Program.

In Turkey we visited the agricultural research institutes at Adana, Edirne, Izmir, Konya, Eskisehir, and Ankara. The director or an associate at each institute gave us an overview. We then toured the wheat research plots, reviewed staff and facilities, and assessed program needs and progress. Dr. H. J. Braun and Dr. E.E. Saari, CIMMYT Wheat Program staff based in Ankara, Turkey, accompanied us on these visits.

At the end of each institutional visit, the team met privately with the institute's director and the director of research. During this meeting, we encouraged candid discussions regarding the Turkish National Winter Wheat Program and the CIMMYT Program in Turkey and their views of the CIMMYT/ICARDA Agreement.
Finally, the team along with the CIMMYT staff in Turkey met with Mr. Husnu Poyraz, undersecretary of the Ministry of Agriculture, Forestry and Rural Affairs; Dr. Nazmi Demir, assistant undersecretary; and Mr. Alpaslan Pehlivanturk, head of the Research, Planning, and Coordination Council (APK). Our mission was carefully explained by Dr. Saari and the team leader. Discussions were frank and positive.

The team had access to all requested data and reports and was provided with position papers from both ICARDA and CIMMYT staff members and copies of all agreements. This report is the review team's alone, but we drew upon the expertise and knowledge of CIMMYT, ICARDA, and the Turkish scientists. We gratefully acknowledge this assistance.

Cooperative Ventures and Memoranda of Agreements

CIMMYT's global mandate and mission

The International Maize and Wheat Improvement Center (CIMMYT) is an autonomous, international, nonprofit scientific research and training institution. It is one of 13 research centers supported by the Consultative Group on International Agricultural Research (CGIAR).

From its headquarters in Mexico and offices at 20 other locations around the Developing World, CIMMYT operates a global program of maize, wheat, and triticale improvement. It conducts research on special concerns in crop management and protection, investigates economic issues related to its mandated crops, and provides training and other forms of support to about 100 national agricultural research programs responsible for maize and wheat in developing countries. Developing countries produce some 170 million tons of maize and 205 million tons of wheat annually, making these two of the three cereal crops that far surpass other food sources in importance in the Third World.

CIMMYT is best known for its broadly adapted germplasm products. The Center's role in facilitating the development and spread of high yielding wheat varieties in developing countries is well-documented. Some 60 million ha of wheat land in the Third World are now sown to varieties that contain CIMMYT germplasm.

At CIMMYT's inception, its mandate was broad and multifaceted:

"To promote and carry out, nationally and internationally, programs to improve in all its aspects of maize and wheat production and if advisable, the production of sorghum, rice, and other food crops, in order to obtain greater unit yields and better production and quality of these crops, through research, the distribution of germplasm training, scientific and technical meetings, and dissemination of information."

CIMMYT's current mandate is:

"To help the poor of developing countries by increasing the productivity of resources committed to maize and wheat whether in research or on the farms; improved germplasm, new knowledge and information, research procedures, training, and consulting services."
ICARDA's mandate and mission
The International Center for Agricultural Research in the Dry Areas (ICARDA) is also an international agricultural research center supported by the CGIAR. Its charter entrusts it with:

"Promoting improved and more productive agriculture in developing countries having a dry subtropical or temperate climate through research and training activities conducted primarily in the countries of the Near East, North Africa, and the Mediterranean region, in order to raise the standard of living and promote the social, economic, and nutritional well being of developing countries."

Within this broad mandate, ICARDA was, at the international level, to conduct research on the improvement of barley, lentil, and faba bean (Vicia faba) to which are added, at the regional level, wheat and chickpea. ICARDA has interpreted its mandate in the context of the physical and social environments of its region and the challenges they pose.

ICARDA exists to meet the challenge posed by a harsh, stressful, and variable environment in which the productivity of primarily rainfed agricultural systems must be increased to higher sustainable levels; in which soil degradation must be arrested and, possibly, reversed; and in which the quality of the environment is ensured. ICARDA meets this challenge through research, training, and the dissemination of information in a mature partnership with the national agricultural research and development systems.

CIMMYT/ICARDA memorandum of understanding on cereal improvement for the WANA region
To achieve efficient deployment of CGIAR resources for the benefit of the cereal researchers in national programs and cereal farmers of the WANA region, the Third External Program Review (EPR) of CIMMYT and the second EPR of ICARDA, and the CGIAR’s Technical Advisory Committee (TAC) strongly urged ICARDA and CIMMYT to reach a new formal agreement. Based on discussions commencing in May 1988 between CIMMYT and ICARDA scientists and managements, the two institutions arrived at a comprehensive collaborative agreement embracing all aspects of wheat, barley, and triticale research and training, germplasm distribution, and resource deployment. The agreement was approved by the directors general of CIMMYT and ICARDA in Washington, D.C., on October 26, 1988. The details of this agreement are summarized in the following:

- This new collaborative agreement takes precedence over all previous agreements between CIMMYT and ICARDA.

- A joint CIMMYT/ICARDA breeding effort in the WANA region will be aimed at:
  1) spring bread wheat for drier rainfed conditions.
  2) spring durum wheat for drier rainfed conditions.
  3) facultative bread and durum wheats for high elevation areas.
  4) true winter bread wheats, which are presently handled through a joint Turkey/CIMMYT agreement. The two Centers will seek to reach a new agreement with Turkey to incorporate this activity into the overall joint high-elevation cereal research for WANA.
• Responsibility of developing wheat germplasm for irrigated and high rainfall conditions in the WANA region will rest primarily with CIMMYT-Base. Aleppo-derived germplasm will be evaluated under those conditions within the joint key location testing scheme.

• CIMMYT will post three wheat breeders at ICARDA (one more than at present) along with mutually agreed funding to support the joint program. One of the scientists will be designated as CIMMYT liaison for the joint program. Additional resources needed for the success of this collaborative program will be provided for by ICARDA.

• Both Mexico- and Aleppo-derived germplasm will be introduced to the WANA region through joint key location testing. Based on key location results, joint nurseries will be prepared at Aleppo and distributed to all cooperators in the WANA region. Where possible and appropriate, key locations will also be used for evaluating selected special-purpose nurseries developed at CIMMYT-Base.

• Germplasm generated by the joint program for areas outside WANA will be made available through CIMMYT’s global germplasm distribution and testing program with appropriate credit for the source.

• ICARDA will continue to post a barley breeder at CIMMYT-Base for breeding requirements not covered by Syria/ICARDA.

• Triticale breeding will remain the responsibility of CIMMYT. However, in view of NARSs’ interest in triticale, particularly in North Africa, some testing in this area may be jointly conducted within the wheat key location testing scheme.

• CIMMYT and ICARDA envision collaboration in genetic resources, training, plant physiology, biotechnology, and agroclimatic zoning. Specifically with respect to genetic resources, CIMMYT will take responsibility for the base collection in bread wheat and triticale and ICARDA will take responsibility for durum wheat and wheat wild relatives.

• ICARDA will be responsible for all crop management research and support in the WANA region. In the case of irrigated wheat, CIMMYT will provide backup services.

• In general, training at ICARDA will focus on cereal management research and improvement for drier areas. Training at CIMMYT will focus on higher rainfall and irrigated areas.

Turkey/CIMMYT agreement on an international approach to winter wheat research
This document proposes the establishment of a cooperative international winter wheat research effort to be jointly coordinated by the Turkish national wheat research program and CIMMYT. The purpose of the proposed cooperative venture, which would be implemented under the existing bilateral agreement between the GOT and CIMMYT would be to develop broadly adapted, high yielding winter wheat germplasm for the extensive winter and facultative wheat growing areas of the world.
The proposed cooperative effort would be international in scope involving selected agricultural research centers of excellence located in Turkey, Mexico, and the United States. The current cooperation with the spring x winter wheat program at Oregon State University would continue and research linkages between Turkey and the national programs of other developing countries that grow winter wheat would be strengthened. Turkey’s diverse wheat environments and its active national wheat research program make it an ideal location from which to conduct such joint international efforts.

Turkey/ICARDA memorandum of understanding
This document proposes the establishment of a collaborative regional research effort on rainfed agriculture in the highlands of West Asia and North Africa between the Turkish Ministry of Agriculture, Forestry, and Rural Affairs and ICARDA.

The GOT recognized in the 1920s that agriculture was important to the Turkish economy and that it could be improved by research. Therefore, agricultural research was started in Turkey from that period. To date, much valuable information has been gathered as a result of this research effort, particularly for those areas experiencing harsh environmental conditions.

The Ministry has a strong interest in putting further emphasis on rainfed agricultural research in order to assist in improving the livelihood of the rural population, especially those with low incomes. In addition, the Ministry has a strong desire for cooperation with international agricultural research centers to share research experiences and to help assist the countries of the WANA, which have agro-ecological conditions similar to Turkey.

ICARDA likewise has, as its major objective, research on rainfed agricultural systems, with an international focus on the improvement of barley, lentils, and faba bean; and as a regional center, in cooperation with other international agricultural research centers, for research on other crops of major importance in the region. Research covering the areas of cropping systems, animal husbandry, pastures, and forages is also included. Further major areas of responsibility include the dissemination of improved plant material, agricultural information, etc. and the development of trained manpower in the disciplines of agricultural science.

As a result of this common interest, and for their mutual benefit, the Ministry and ICARDA have decided to adopt this framework agreement within which further cooperative activities can be undertaken. Under the auspices of this framework, ICARDA will establish an office in Turkey with the responsibility of coordinating ICARDA research and training assistance to the highland areas of the WANA.

Common goals of the three agreements
As stated in the mandates and missions of CIMMYT and ICARDA, both Centers are committed to increase the productivity and production of winter cereals through research, training, and information development. The cooperative agreements between Turkey/CIMMYT and CIMMYT/ICARDA emphasize research on winter/facultative wheats for the WANA region. The Turkey/ICARDA agreement on high-altitude cereals indirectly focuses on winter/facultative wheats for Turkey and WANA. Because of these agreements, it is very clear that CIMMYT and ICARDA and the NARS of Turkey are highly committed to the germplasm enhancement of winter/facultative wheats for the WANA region.
Present Status

WANA and cereal ecological zones (Mega-environments)
The major highlands of the WANA region are in two distinct masses: one in the east, covering Afghanistan, Pakistan (Baluchistan and North West Frontier Province), Iran, Iraq, and Turkey; the second in the west covering the Algerian-Moroccan Atlas Mountain range.

In the WANA region, 40% of the agricultural land, extending over 6.8 million km², consists mostly of plateau at altitudes of over 1000 masl. These areas are subject to extremes of winter cold and summer heat and snow cover for up to 4 months of the year. The annual rainfall ranges from 200 to 600 mm, but in most areas is below 450 mm. The soils are degraded, being low in organic matter, with a high pH and poor moisture holding capacity. Soil erosion is common.

Twenty-one FAO soil groups have been described for the region, out of which five soil groups (Yermosols, Lithosols, Regosols, Xerosols, and Cambisols) dominate at the higher elevation of 1500 masl. Three basic climates in the area are: temperate, subtropical, and tropical. These can be further sub-divided by rainfall patterns, mean daily temperatures, and other characteristics.

Over 110 million people live in the highlands of the WANA area. In general, they still practice traditional farming and support financially disadvantaged segments of the population. The population growth and food requirements in this area are considered above average. Thus, the need for increasing food production in the WANA region is an issue of major proportions. It is estimated that, to meet the increasing demand for wheat in the region, productivity would have to increase 72% by the year 2000.

In general, the support to agricultural research, especially in funds and operations, is insufficient in the region. The investment on human resource development is also not adequate.

Agro-ecological zones
Based on the information provided by Tahir and Hayes (1988) and from elsewhere, five distinct agroecological cereal zones are suggested for the WANA region. These are:

- Atlas Mountains of Morocco and Algeria: Mild, cold climate; slow rise and fall of temperature; rainfall > 450 mm.

- Central Anatolian Plateau of Turkey: Fairly cold with some continental influence and mild summer; rainfall < 350 mm.

- Eastern Turkey and western Iran: Long and very severe winter and dry and warm summer; rainfall between 300 and 400 mm.

- Central Iran through Afghanistan and western part of Pakistan: Severe cold winter and severe hot summer with sudden temperature fluctuations. Severe moisture stress in the grain-filling period with less than 400 mm of rainfall.
• Thrace region of Turkey: Low altitude location comprising 0.5 million hectares with mild to cold winter and relatively high rainfall.

The diversity of agroecological situations in various parts of the WANA region is as follows:

• Afghanistan. Afghanistan is a land-locked country covered by rugged and high mountain ranges along with narrow valleys and sandy deserts. Only 8 million of its 62.33 million hectares are arable and 5 million are under cultivation; the remainder are permanent pasture. Roughly 2.5 million hectares have irrigation capacity. Average annual precipitation varies from 130 to less than 400 mm, depending upon the location. Summers are hot, sometimes reaching temperatures of 45°C and winters are cold and lengthy; temperatures can drop as low as -35°C.

• Iran. There are five agroclimatic zones based on climate and other characteristics. Seventy percent of the land area of Iran is above 1000 masl and 53% is between 1000 and 2000 masl (Akbari and Zolghadri 1988). Rainfall in the latter levels where winter and facultative wheats are dominantly grown varies from about 100 to 500 mm. Most of the area receives about 300 to 400 mm and is classified as intermediate in moisture supply.

• Baluchistan and NWFP of Pakistan. The agroecological information presented by Rees et al. (1988) would indicate that the Baluchistan environment for winter wheat does not differ substantially from parts of Afghanistan and Iran. It is an arid to semiarid climate with precipitation ranging from 50 to 400 mm. There are a series of mountain ranges and intervening valleys. The latitude of the province is comparatively low, 25°N to 32°N.

• Turkey. Turkey is surrounded by seas on three sides. The Central Plateau is separated from the seas by a mountain chain with altitudes between 2000 and 4000 masl. As a consequence of its topography, the climate is diverse. Annual rainfall varies between 250 and 2500 mm. The minimum and maximum monthly average temperature is -12°C and 32°C, respectively. There are nine recognized production zones in Turkey (Figure 1) and three basic wheat environments (Figure 2) as illustrated by Durutan (1988). Zones 1, 5, 6, and 9 depicted in Figure 1 represent the winter and facultative wheat areas.

• Iraq. Iraq lies along a wide depression running from the Turkish border to the Arabian Gulf and includes an extension of the Syrian desert in the west and the Arabian desert in the south. Iraq is divided into four main regions: Mountains with 400 to 1000 mm rainfall; foothills with 250 to 450 mm rainfall; alluvial plains with 50 to 200 mm rainfall; and desert plateau with only 50 to 200 mm rainfall. In the mountainous region (500-3600 masl), the land is stony with steep slopes and covered mostly by forest; it contributes to about 25% of the total rainfed wheat production.

• Algeria. The high plateau areas in Algeria are within the range of 800 to 1000 masl and these account for up to 85% of the land used for agriculture. The climate is dry and unpredictable and weather extremes occur each year. Temperature variations are high, from 36°C to -40°C. During the October to July growing season, the wheat crop might be damaged by scarcity of water,
Dominating habit in zones: 1,6,9 = Winter 2,3,4,7,8 = Spring 5 = Facultative

Figure 1. Nine major wheat growing zones of Turkey.


Figure 2. The three basic wheat environments in Turkey.
frost, scorching heat, or hot winds. The winter rainfall broadly divides the country from north to south into three distinct zones: with rainfall over 450 mm, between 450 mm to 350 mm, and less than 350 mm. The pH levels vary from 7.3 to 8.2 in the different soils, which have tendency to crack.

- Morocco. The climatic and geographic characteristics of Morocco are highly diverse, partly due to the presence of high mountains. Although a large part of Morocco has an arid or semi-arid climate, the northwestern part of the country, and some areas in the Atlas Mountains are characterized by high rainfall. The Atlas Mountains cover about 6.5 million hectares. Some areas in the western and central high Atlas receive between 800 and 900 mm of annual rainfall. The monthly rainfall distribution is characterized by two peaks, one in November-December and the other in March-April. The lowest temperatures are usually encountered in December-January and the highest in July-August. Two types of soil are found in the mountains: red, slightly acid and brown calcareous. They are shallow and highly exposed to erosion.

Area and production
Highland wheat in the WANA region covers about 16.5 million hectares and accounts for about 54% of the total area of this crop in the region (Table 1). The highland's contribution to wheat production is somewhat low, being only 39% (18.9 million tons). Yields in the rainfed areas are generally low compared to the irrigated and higher rainfall areas. The irrigated and favorable areas account for the other half of the wheat area and represent the larger contribution to overall production. Much of the latter area is concentrated in the milder Mediterranean coastal areas where spring habit wheats are sown.

Table 1. Area and production of wheat (total and in high altitude areas).a

<table>
<thead>
<tr>
<th>WANA</th>
<th>Area (x 000 ha)</th>
<th>Production (x 000 t)</th>
<th>Yield (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Totalb</td>
<td>HAAc</td>
<td>Totalb</td>
</tr>
<tr>
<td>Algeria</td>
<td>1735</td>
<td>1040</td>
<td>1446</td>
</tr>
<tr>
<td>Morocco</td>
<td>2226</td>
<td>500</td>
<td>3809</td>
</tr>
<tr>
<td>Afghanistan</td>
<td>2100</td>
<td>1260</td>
<td>2500</td>
</tr>
<tr>
<td>Iran</td>
<td>6200</td>
<td>4500</td>
<td>6400</td>
</tr>
<tr>
<td>Iraq</td>
<td>700</td>
<td>320</td>
<td>800</td>
</tr>
<tr>
<td>Pakistan</td>
<td>7355</td>
<td>1350</td>
<td>13970</td>
</tr>
<tr>
<td>Turkey</td>
<td>10000</td>
<td>7500</td>
<td>19000</td>
</tr>
<tr>
<td>Sub-total for WANA</td>
<td>30316</td>
<td>16470</td>
<td>47924</td>
</tr>
</tbody>
</table>

|       | (54%) | (61%) | (39%) |

a Reproduced from Tahir and Hayes, 1988.
b Area and production of wheat in low and high elevation areas combined.
c Area and production of wheat in high-altitude areas (HAA).
In the WANA region, Turkey has the largest area followed by Iran, Pakistan, Afghanistan, Algeria, Morocco, and Iraq. The average productivity is the highest in Turkey followed by Afghanistan, Pakistan, Iraq, Iran, Morocco, and Algeria.

The use of high yielding varieties (HYV) in the spring wheat areas has been a major contributor to yield increases. The irrigated and high rainfall areas now have a high percentage of cultivars either directly derived from or hybridized with Mexican germplasm. Oram (1988) recently analyzed the status of HYVs in the WANA region and developed some estimates relative to the percent of area sown (Table 2). The area sown to traditional varieties in the higher altitudes and lower rainfall areas remains high by comparison. There are a number of factors contributing to this situation (ICARDA 1987, 1988; Tahir and Hayes 1988).

NARSs' scientific environment

Human resources

The shortage of skilled scientific human capital is still a major impediment to effective agricultural research in the NARSs of the WANA region. There are differences among the NARSs in this respect, but there is a need for enhancing the scientific knowledge of the researchers in most of the cases. Efforts, which are being made to improve the educational qualifications of the scientific staff, need to be continued.

The number of scientists actively engaged in wheat breeding and pathology at various research stations in Turkey include 4 PhDs, 6 MScs, and 10 BScs (Table 3). During the discussions held at various places and levels, the review team was informed that a number of qualified scientists have left the research stations and have joined the private sector because of better financial prospects and opportunities.

The insufficient support, especially funds for operations, also impinge on the progress of agricultural research. The investment on human capital development is inadequate and in many cases excessively delayed. The private sector is being encouraged to increase its participation in agricultural research activities in many countries. The investments by the private sector in Turkey are still confined to the more productive areas. The integration and cooperation of the public and private sector institutions have not yet developed into a coherent effort.

Infrastructure

The team visited the research centers at Adana, Edirne, Izmir, Konya/Cumra, Eskisehir, and Ankara/Haymana to review land resources, buildings, and equipment. Izmir, Eskisehir, Edirne, and Cumra Research Centers have been suitable for the production of seed and hybrid populations and for selection for disease resistance. At these locations, materials can be grown and selected under either irrigated or nonirrigated conditions.

The Eskisehir Research Center has an excellent environment for screening for drought or cold stresses. The current research station located at the edge of town adjacent to the research institute has excellent soil, which can be irrigated. Unfortunately, this land has been given to the local fair committee for exhibition purposes.

Several kilometers from the city, the GOT has established a 164-ha research center. The land has been leveled and irrigation has been developed for 60 ha.
Table 2. Area estimated to be under high-yielding varieties of wheat in West Asia and North Africa. (Reproduced from Oram 1988).

<table>
<thead>
<tr>
<th>Countries</th>
<th>Year of reference</th>
<th>Total 1983-85 area (x1000 ha)</th>
<th>Area of HYV (x1000 ha)</th>
<th>% of total</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afghanistana</td>
<td>1978</td>
<td>2320</td>
<td>433</td>
<td>19</td>
<td>Spring and winter wheat</td>
</tr>
<tr>
<td>Algeriaa</td>
<td>1983</td>
<td>1819</td>
<td>400</td>
<td>22</td>
<td>Spring; 81% durum</td>
</tr>
<tr>
<td>Cyprusb</td>
<td>1983</td>
<td>13</td>
<td>12</td>
<td>90</td>
<td>Spring, mainly durum</td>
</tr>
<tr>
<td>Egyptb</td>
<td>1985</td>
<td>516</td>
<td>259</td>
<td>50</td>
<td>Spring, mainly bread</td>
</tr>
<tr>
<td>Iraqb (79-81)</td>
<td>1985</td>
<td>1215</td>
<td>600</td>
<td>20</td>
<td>Spring bread, 90% irrigated area under HYV</td>
</tr>
<tr>
<td>Jordanb</td>
<td>1983/84</td>
<td>90</td>
<td>20</td>
<td>22</td>
<td>Spring bread</td>
</tr>
<tr>
<td>Lebanonb</td>
<td>1983</td>
<td>12</td>
<td>12</td>
<td>80</td>
<td>Spring and durum</td>
</tr>
<tr>
<td>Libya</td>
<td>1983</td>
<td>260</td>
<td>130</td>
<td>50</td>
<td>Spring, about 50% durum</td>
</tr>
<tr>
<td>Moroccoa, c</td>
<td>1983</td>
<td>1877</td>
<td>625</td>
<td>30</td>
<td>Spring: durum 75% (10% HYV); bread largely HYV</td>
</tr>
<tr>
<td>Omana</td>
<td>1980</td>
<td>1</td>
<td>1</td>
<td>100</td>
<td>Spring bread</td>
</tr>
<tr>
<td>Saudi Arabia b</td>
<td>1984</td>
<td>414</td>
<td>395</td>
<td>95</td>
<td>Spring bread, mainly irrigated (80% of irrigated area HYV)</td>
</tr>
<tr>
<td>Sudan</td>
<td>1982/83</td>
<td>106</td>
<td>100</td>
<td>94</td>
<td>Spring bread, irrigated</td>
</tr>
<tr>
<td>Tunisia</td>
<td>1983</td>
<td>954</td>
<td>344</td>
<td>36</td>
<td>Spring durum 90% (80% HYV), bread 10% (40% HYV)</td>
</tr>
<tr>
<td>Turkey</td>
<td>1983/84</td>
<td>9100</td>
<td>3910</td>
<td>43</td>
<td>Winter 75% (25% HYV); Spring 25% (85% HYV)</td>
</tr>
<tr>
<td>Yemen A.R.b</td>
<td>1983</td>
<td>60</td>
<td>No data</td>
<td>—</td>
<td>All durum wheat</td>
</tr>
<tr>
<td>Yemen P.D.R.</td>
<td>1983/84</td>
<td>10</td>
<td>4</td>
<td>35</td>
<td>—</td>
</tr>
</tbody>
</table>

| Total 25771 | 8977 | 35 |

a Source: CIMMYT (1985). Recent information on Afghanistan and Algeria limited. Some varieties named are not strictly HYVs.
b Source: Delany (1974). Area data cited for Iran (2.1 million ha irrigated, 1.34 million ha rainfed) is much lower than FAO. Varying Tunisian data on area of HYV in durum and bread wheats are quite conflicting. A similar problem exists with total area and estimated percent of HYV in Turkey.
c Source: ICARDA (1986a,b).

Table 3. Number of scientists working in wheat breeding on research stations in Turkey as of 1990a.

<table>
<thead>
<tr>
<th>Station</th>
<th>Position</th>
<th>Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adana</td>
<td>1 Breeder/Pathologist</td>
<td>PhD, Cukurova University</td>
</tr>
<tr>
<td>Adapazari</td>
<td>1 Breeder</td>
<td>PhD, Ege University</td>
</tr>
<tr>
<td>Ankara</td>
<td>1 Breeder; 1 Breeder; 1 Breeder; 1 Pathologist</td>
<td>BSc, CIMMYT trainee in 1987</td>
</tr>
<tr>
<td>Diyarbakir</td>
<td>2 Breeders</td>
<td>BSc both CIMMYT trainees in 1987</td>
</tr>
<tr>
<td>Edime</td>
<td>1 Breeder</td>
<td>MSc from Kansas State in agronomy CIMMYT trainee in 1990</td>
</tr>
<tr>
<td>Erzurum</td>
<td>1 Breeder</td>
<td>BSc CIMMYT trainee in 1985</td>
</tr>
<tr>
<td>Eskisehir</td>
<td>1 Breeder/Path Ass. Dtr. 2 Breeders</td>
<td>MSc from Oklahoma</td>
</tr>
<tr>
<td></td>
<td>1 Breeder BSc</td>
<td>MSc from Minnesota and N. Dakota</td>
</tr>
<tr>
<td>Izmir</td>
<td>1 Breeder; 1 Pathologist; 1 Breeder</td>
<td>PhD, Ege University</td>
</tr>
<tr>
<td>Konya</td>
<td>1 Breeder/Ass. Dtr. 1 Breeder</td>
<td>BSc</td>
</tr>
<tr>
<td></td>
<td>1 Breeder</td>
<td>MSc from Washington State BSc</td>
</tr>
<tr>
<td>Samsun</td>
<td>1 Breeder</td>
<td>BSc, CIMMYT trainee in 1987</td>
</tr>
</tbody>
</table>

a Note: Directors of stations are not considered, since they are mostly involved in administration.
Due to the recent land leveling, several soil problems are evident, probably due to micronutrient imbalance. With crop rotation, soil amendments, and irrigation, these problems will be corrected in the next 5 to 10 years. The GOT has recently obtained a "World Bank Loan" to develop a very extensive Crops Research Center on the new Eskisehir Research Farm. This is expected to be high class research center.

The Konya Crops Research Center is located on an old animal research farm. Large areas of this center have serious problems with waterlogging and boron and salt toxicities in the soil and thus are not suitable for crops research. In addition, there are very inadequate research facilities at this site.

The Cumra substation of the Konya center has 30 ha of very good land located at the Cumra Technical School that can be irrigated if necessary. It is a good test site, but does not have the infrastructure of a main station since no buildings are at this station.

The Edime Crops Research Institute is a very important test station and is situated in the Thrace region, which is a high yield potential environment. It is a good station for both seed increase and yield evaluation.

**Turkey/CIMMYT winter wheat/facultative wheat (WW/FW) breeding and pathology programs**

**Objectives**
The Turkey/CIMMYT WW/FW Project started in 1984 to develop improved germplasm for winter and facultative wheat areas, particularly in the WANA region of the developing world. This includes higher elevation and cold temperature areas.

The main objectives of this program are to:

- Develop a germplasm pool of winter and facultative wheats with wider adaptation and stability of performance, resistance to biotic and abiotic stresses, and desirable quality characteristics. The materials from this pool can be used as a vehicle for transferring desirable characters to more specific environments.

- Develop breeding strategies appropriate to the selection criteria established.

- Establish a nursery network allowing free exchange of germplasm and data among WW/FW programs.

- Establish a monitoring system for diseases and insects in winter wheat areas to complement CIMMYT's breeding program and global surveillance system.

- Establish training opportunities on winter wheat that complement wheat training courses in Mexico.

**Locations/infrastructure**
The research stations in Turkey are located in the major agro-ecological zones. The WW/FW program cooperates with 10 stations working on wheat. The wide range of climatic and environmental conditions found within the boundaries of Turkey and the wide range of wheat diseases that are present in these environments allow for testing of a full range of winter and facultative wheats. The following is a brief
description of each station and its suitability to screen winter and facultative wheats.

- **Adana.** This station represents a spring wheat environment with very high yield potential (10 t/ha). Winter wheats receive enough vernalization to be screened for leaf rust and Septoria tritici (if inoculated). Due to low staffing, only the International Winter Wheat Screening Nursery (IWWSN) is screened at this location.

- **Adapazari.** This station represents the spring to facultative wheat environment with high rainfall and a yield potential of around 9 t/ha. Winter wheat is easily vernalized. Temperatures at maturity are lower than in Adana and allow screening for phenotypes under good conditions. Lodging is a major problem in this area, even for semidwarf wheats. Common diseases are leaf rust and less frequently powdery mildew.

- **Ankara.** Ankara uses two stations, Lodumlu and Haymana. Ankara, until 1987, was the national wheat research coordinating center. The main research station of Ankara was moved three times during the last 5 years and is currently located 7 km outside of the city. There is no irrigation capacity and the land is very heterogeneous and hilly. The GOT intends to turn this station into a recreation area. The Haymana station is located 40 km outside of Ankara. Soils are heterogeneous, do not allow uniform screening, and irrigation facilities are limited. The old Haymana station, which has good, level lands and was developed within the Rockefeller/OSU/CIMMYT Project, was given to the University of Ankara. Wheat material sown at Haymana can be screened for drought tolerance and, in some winters, for winter hardiness. There are no diseases present. This environment is too dry for effective artificial rust inoculation. All of the Turkey/CIMMYT cooperative nurseries are received by the Ankara Institute. All quality analysis of wheat germplasm is done in Ankara. Lines from the Turkey/CIMMYT winter wheat program are tested here as well. The laboratory is very well equipped, efficient, and can run large numbers of analyses.

- **Diyarbakir.** This station has a spring to facultative wheat environment with low rainfall and fast rising temperatures from flowering to maturity. Soils on the research station is in need of land leveling. Diyarbakir allows screening for earliness and heat tolerance. Yellow rust is a problem and sometimes tan spot has been present. True winter wheats are too late for this environment. This area is located in the Southeast Anatolian Project (GAP), which will become an extensive irrigated area currently being developed. With irrigation developments, high yield potentials are anticipated as well as numerous second generation problems with diseases and insects. The irrigated area will eventually amount to 1.5 million hectares and about half of this area will be sown to wheat.

- **Edirne.** This station is located in the European part of Turkey and is the most productive winter wheat area in the country. The highest yielding lines are winter wheats from Bulgaria. Wheat in Edirne matures about 2 weeks earlier than on the Central Plateau. The yield potential is around 9 t/ha in breeders’ plots. Wheats from the programs in Eskisehir and Ankara (Central Plateau) are too tall in Edirne. There are no major disease problems, but
powdery mildew and root rots can occur sporadically. The major pest is Suni bug which affects wheat quality.

Edirne allows screening for lodging resistance, earliness, and yield potential. Temperatures rise fast during the ripening stage. Test weight and thousand kernel weight are good indicators for lines that can fill the grain under these conditions. The candidates for the IWWSN are multiplied at Edirne. This is a backup for the multiplication plots in Cumra (see below). Edirne receives all Turkey/CIMMYT winter wheat nurseries.

- **Erzurum.** This station is located in eastern Turkey at 2000 masl. Winters are extremely cold (down to -40°C) and long. Wheat cannot survive here without snow cover. However, this reduces the screening ability for winter hardness. During the last 5 years, Gerek 79, the dominating variety on the Central Plateau with medium winter hardness, was among the highest yielding lines in regional trials.

- **Eskisehir.** This station is recognized as having developed many of the important Turkish wheat varieties and besides Cumra the most important testing site for the Turkey/CIMMYT program on the Central Plateau. Eskisehir has received new land and is currently developing a new 300-ha station with irrigation facilities and buildings for all kinds of wheat research activities. Unfortunately, there are some unknown soil problems (most probably boron toxicity and/or other elements), which occurred after land leveling. The soil problem was so severe that during the last 2 years a significant number of nurseries were lost. If this soil problem cannot be resolved by means of irrigation and application of organic matter, proper screening of the material will be difficult. Evenso, recognizing the land problems in Ankara and the infrastructure problems in Konya, Eskisehir could be considered as the principal station for winter wheat breeding in Turkey—if the soil problems can be solved.

The environment in Eskisehir allows screening for adaptation to the Central Plateau, drought tolerance, and yield potential. Screening for leaf and stem rusts is possible if artificial inoculation is used. Soilborne wheat mosaic virus is a problem in an irrigated area close to Eskisehir. Eskisehir receives all nurseries from the Turkey/CIMMYT program.

- **Izmir.** This spring wheat area has proved to be an outstanding location in supporting winter wheat improvement in Turkey and is considered to be absolutely essential for the Turkey/CIMMYT winter wheat program for the following reasons:
  a) Izmir is a high-yielding environment, ideal for seed multiplication of all classes of wheats with irrigation facilities.
  b) Izmir is basically a spring wheat area. However, temperatures are sufficiently low to satisfy vernalization of all winter wheats.
  c) Environmental conditions permit artificial inoculation and good development of epidemics for all three rusts. This is the only location in Turkey that allows annual screening for yellow and leaf rust.
  d) The pathology program at Izmir screens for common bunt and loose smut.
  e) Crossing in Izmir is mid-April to the beginning of May and about 5 to 6 weeks earlier than the Plateau. This early crossing period frees
CIMMYT staff during crossing on the Plateau, which occurs at the end of May. This is important since this period can be used for visits to programs outside of Turkey.

- **Cumra.** This substation of Konya is a high yielding station with relative mild winters situated 40 km south of Konya. Cumra is the principal breeding site of the Turkey/CIMMYT program. All nurseries and increases are planted there. Cumra allows screening for yield potential and it should be possible to develop rust epidemics by artificial inoculation.

**Breeding methodology**

The approach from the beginning of the Turkey/CIMMYT Winter Wheat Improvement Program was mainly to test germplasm at several locations in Turkey. Only limited number of crosses were made. F3 or F4 populations from other winter wheat programs were received and selected in Turkey.

The National Winter Cereal Research Project (NWCRP) of Turkey makes between 2000 and 2500 winter/facultative wheat crosses a year. These are targeted mostly toward rainfed environments. The variability within these crosses is primarily targeted for Turkey. The screening of the segregating material is done without disease screening except for the program in Eskisehir. Some germplasm originating from NWCRP is included in Turkey/CIMMYT international nurseries.

**The role of spring x winter crosses in winter wheats**—The potential benefits from the spring x winter crossing program are well established in the CIMMYT spring wheat breeding program. The highest yielding and most widely adapted materials have originated from such crosses.

The Turkey/CIMMYT Winter Wheat Program makes extensive use of germplasm from spring x winter wheat crossing programs emanating from the Turkey Cooperative Program and from CIMMYT-Base. Spring wheats are the source of photoperiod insensitivity, wide adaptation, and resistance to several diseases.

The fact that cold hardiness and vernalization requirements are genetically independent offers the chance to develop cold hardy facultative wheats. Drought tolerance of Turkish germplasm can be combined with cold hardiness.

**Segregating Population Handling**—F1 spring x winter crosses utilizing Turkish winter wheats as one of the parents are made mainly in Mexico. Some simple crosses are made in Turkey.

- **F1:** F1 simple crosses are grown in Izmir to produce F2 and to make top crosses.

- **F2:** These are sown in Cumra under irrigation and at Ankara, Eskisehir, Erzurum, and Edirne as observation plots. Selected populations are bulked for multi-location testing.

- **F3:** Multi-locational testing at Cumra, Eskisehir, Edirne, Ankara, Izmir, and Erzurum. Head selections are carried out at Cumra and/or Eskisehir.

- **F4:** Head row selection is done at Cumra and Eskisehir if possible under artificial inoculation. F4s from other sources are evaluated as bulks at one or several stations and included in the F5 Turkey/CIMMYT nurseries.
Observation nurseries are grown at Cumra, Eskisehir, Izmir, Ankara, Edirne, and Erzurum. Best populations bulked at Cumra and Eskisehir. From each selected population, some heads are taken as a base for seed multiplication.

Preliminary yield trials are conducted under irrigation at Cumra and Eskisehir. Concurrently, observation nurseries will be sown at Edirne, Izmir, Ankara, Diyarbakir, Aleppo, Erzurum, and Mexico.

Yield trials are carried out at Cumra and/or Eskisehir and seed multiplication plots for the IWWSN are grown under irrigation.

International collaboration (networking)—The major winter wheat production areas in the developing world are located between 35° and 45°N (Figure 3). Turkey is located between these latitudes.

The environments in the target areas (mainly Turkey, Afghanistan, Iran, and to a lesser degree China) are highly diverse and require different kinds of germplasm, in terms of physiological and morphological traits, maturity, height, and disease resistance. Therefore, the International Winter Wheat Screening Nursery (IWWSN) was established in 1985-86 to offer cooperators a wide range of genetically different wheat lines and to gain information on the suitability of Turkish germplasm. The number of entries and distribution of the IWWSN are as follows:

<table>
<thead>
<tr>
<th>IWWSN No.</th>
<th>No of entries</th>
<th>No of sets distributed</th>
<th>No of countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>156</td>
<td>25</td>
<td>16</td>
</tr>
<tr>
<td>2</td>
<td>103</td>
<td>50</td>
<td>32</td>
</tr>
<tr>
<td>3</td>
<td>78</td>
<td>75</td>
<td>37</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
<td>86</td>
<td>43</td>
</tr>
<tr>
<td>5</td>
<td>160</td>
<td>93</td>
<td>42</td>
</tr>
</tbody>
</table>

IWWSNs 1 through 3 consisted mainly of germplasm originating from the NWCRP of Turkey. The results of the 1st, 2nd, and 3rd IWWSNs revealed that the Turkish germplasm does not offer the genetic variability to justify an international nursery for the long term. The Turkish germplasm is targeted too much toward dryland areas (lacks lodging resistance) and many of the Turkish winter wheat lines are susceptible to some races of rusts.

The development of germplasm with wider adaptation and better disease resistance is not possible within a short period. Therefore, other programs outside Turkey were encouraged to participate in the Turkish/CIMMYT program in terms of germplasm exchange. This would assure that cooperators receive a wide range of genetically different germplasm. A proposal was sent to several winter wheat research programs in the USA, eastern Europe, China, and the WANA region which requested submission of advanced lines to be tested under Turkish conditions and eventually to be included in the IWWSN.

The most active germplasm exchange takes place with Oregon, Kansas, Nebraska, Oklahoma, and Texas in the USA and Fundulea in Rumania. Segregating populations (F3, F4) are received from CIMMYT, Oregon, and Texas A&M. For
<table>
<thead>
<tr>
<th>United States</th>
<th>Europe</th>
<th>Asia</th>
</tr>
</thead>
<tbody>
<tr>
<td>45°N Portland</td>
<td>Belgrade</td>
<td>Krasnodar</td>
</tr>
<tr>
<td>44°N</td>
<td>Bucharest</td>
<td></td>
</tr>
<tr>
<td>43°N</td>
<td></td>
<td></td>
</tr>
<tr>
<td>42°N</td>
<td>Sofia</td>
<td></td>
</tr>
<tr>
<td>41°N Lincoln</td>
<td>New York</td>
<td></td>
</tr>
<tr>
<td>40°N Denver</td>
<td>Madrid</td>
<td>Ankara</td>
</tr>
<tr>
<td>39°N Kansas City</td>
<td></td>
<td></td>
</tr>
<tr>
<td>38°N</td>
<td></td>
<td></td>
</tr>
<tr>
<td>37°N</td>
<td></td>
<td></td>
</tr>
<tr>
<td>36°N Oklahoma City</td>
<td></td>
<td>Teheran</td>
</tr>
<tr>
<td>35°N Amarillo</td>
<td></td>
<td>Kabul</td>
</tr>
</tbody>
</table>

Figure 3. The altitude relationship of Ankara, ca. 40° ± 5°N, and cities located in winter wheat growing regions.
the 1990 cycle, advanced lines from China were received. However, these lines are
to be used for crossing only. Besides these programs, several others sent material
to Turkey, including cooperators from France, Switzerland, Sweden, Yugoslavia,
the USA (Colorado, Michigan, and Minnesota), and South Africa.

Resource allocation and coordination
The Turkish/CIMMYT WW/FW Program depends heavily on the availability of
locations in Turkey (as described earlier) and Turkish scientists engaged in wheat
research (Table 3). CIMMYT has based a breeder and pathologist team in Turkey
to actively participate and execute this program in conjunction with Turkish
national scientists. In addition to these, there are funds available for training,
visiting scientists, and equipment.

Results
This project has made good progress in:

• Establishment of the International Winter Wheat Screening Nursery.

• Exchange of germplasm with most of the important winter wheat programs
  in the developed and developing world.

• Identification of programs whose material could be of direct value for
  Turkey.

• Establishing that winter wheats developed in Toluca have potential in other
  parts of the world.

• Increasing the number of lines with rust resistance in the IWWSN.

• Identifying a potential boron toxicity soil problem in Turkey as a factor that
  needs to be evaluated.

• Demonstrating that multilocation testing and wide adaptation approaches
  are equally valid as breeding methodologies in the winter wheat region.

• More than 8000 wheat lines have been received from 34 countries and
  evaluated. About 3000 of the most promising lines were redistributed for
  testing throughout Turkey.

• Promising lines that were screened in Turkey were included in the 1st, 2nd,
  3rd, and 4th IWWSNs sent to 25 locations in 1985, 51 locations in 1986,
  65 locations in 1987, and 91 locations in 1988, respectively.

• Preliminary disease surveys and screening programs have been initiated for
  the important diseases. Rust screening has been routinely done by the
  Turkish National program. In 1987 a program was initiated to screen the
  winter wheats for resistance to common bunt and loose smut, a serious
  disease problem in many winter wheat areas.

ICARDA Winter and Facultative Wheat Project
The idea for a high-elevation cereal improvement breeding project at ICARDA was
conceived about the time the Center was formed in the mid-1970s. Impetus for the
idea was the recognition by ICARDA that, except for Turkey, agricultural
improvement in the vast mountainous and sub-mountainous WANA areas of the
ICARDA region had been traditionally neglected. Further, the technologies developed for lowland agriculture in various ecological zones were not applicable to the higher elevations where a majority of the population is engaged in agriculture. The crops endure severe cold winters and hot summers in vast areas of Turkey, Iraq, Iran, Afghanistan, and Pakistan. Similar agro-climatic conditions are found in extensive areas of Algeria and Morocco in North Africa. The various constraints encountered in the WANA region are given in Table 4.

Table 4. Various constraints encountered in the WANA region.

<table>
<thead>
<tr>
<th>Constraint</th>
<th>Algeria</th>
<th>Morocco</th>
<th>Iran</th>
<th>Iraq</th>
<th>Pakistan</th>
<th>Turkey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical manpower</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>*</td>
</tr>
<tr>
<td>Suitable varieties</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>*</td>
</tr>
<tr>
<td>Cold/frost</td>
<td>*</td>
<td>*</td>
<td>***</td>
<td>**</td>
<td>**</td>
<td>***</td>
</tr>
<tr>
<td>Moisture availability</td>
<td>*</td>
<td>*</td>
<td>***</td>
<td>**</td>
<td>***</td>
<td>*</td>
</tr>
<tr>
<td>Yellow rust</td>
<td>*</td>
<td>*</td>
<td>***</td>
<td>**</td>
<td>***</td>
<td>***a</td>
</tr>
<tr>
<td>Leaf rust</td>
<td>*</td>
<td>*</td>
<td>-</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Common rust</td>
<td>-</td>
<td>-</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Tan spot/septoria</td>
<td>***</td>
<td>***</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Insects</td>
<td>*</td>
<td>*</td>
<td>**</td>
<td>**</td>
<td>?</td>
<td>*</td>
</tr>
<tr>
<td>Production technology</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>**</td>
<td>**</td>
<td>*</td>
</tr>
<tr>
<td>Inputs availability</td>
<td>*</td>
<td>*</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>*</td>
</tr>
<tr>
<td>Socio-economic</td>
<td>**</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>*</td>
</tr>
</tbody>
</table>

* = degree of intensity.

a Little yellow rust seen during the last 5 years in Turkey.

ICARDA Headquarters, located at Aleppo, Syria (36°11’N, 37°13’E and 392 masl), is adequate for selection against certain winter wheat constraints, but has a major limitation in regard to selection for winter hardy wheats to fit the region’s
colder environments. Except for being somewhat colder and having less rainfall, Aleppo’s climate more closely fits that of the Mediterranean area than the mountainous areas of the region. Seldom does the lowest temperature at Aleppo drop below -8°C, which is inadequate to distinguish among genotypes for hardier types. For ICARDA breeders, the feasible alternative was to resort to multilocation testing for this trait. Sarghaya (33.5°N and 1445 masl), located in the mountainous area of southern Syria with minimum winter temperatures dropping to -15°C, was chosen as a winter hardness evaluation site for some segregating populations and advanced lines. Ankara, Turkey (40°N and 898 masl), in collaboration with the Turkish Ministry of Agriculture to evaluate F2 populations was another chosen site. Other winter hardness data were, of course, collected throughout the region at sites where frost inflicted damage on the ICARDA nurseries.

Location of the high-elevation wheat project at the ICARDA base at Aleppo has a number of mostly infrastructural advantages. These include:

- Availability of scientific assistance and research facilities of supporting disciplines of plant pathology, plant physiology, entomology, statistical laboratory, computing center, library, seed stores, equipment, seed stores, and farm shops.
- Availability of trained research technicians and secretaries and housing and other living necessities. Availability of well managed land and irrigation facilities.
- Good environments for efficient greenhouse operations (necessary for winter and facultative wheat improvement), providing well planned greenhouses are built (existing greenhouses are inadequate).
- Any class of wheat (winter, facultative, and spring) can be grown. Winter temperatures are low enough and of such duration to vernalize even the hardiest of wheats.

Disadvantages, mostly biological, include:

- Lack of opportunity to select for the most winterhardy strains.
- The shorter crop season and shorter daylength during spring maturation of crop may reduce the opportunity to select the best adapted germplasm for several areas of the higher latitudes.
- Maturity of the wheat crop occurs ahead of most harvest dates at multilocation sites in the high elevations, preventing or reducing utilization, at Aleppo, of useful data arising from those sites during the same crop season.

Planting, heading, and harvest time at key sites in various WANA countries are given in Table 5.

Research projects involving segregating populations were initiated at Quetta (Baluchistan) Pakistan, 30°N, and Anneceur, about 33°N, in the Atlas Mountains of Morocco in addition to those at Sarghaya and Tel Hadya in Syria. By 1984, six satellite sites for on-site testing and selection, i.e., Quetta, Pishin, Kan Mehterzai (Pakistan), Sarghaya (Syria), Terbol (Lebanon), and Anneceur had been successfully used. In 1986 Ankara and Eskisehir, Turkey, and Teheran (36°N) and Tabriz
Table 5. Planting, heading, and harvest time at key sites in various WANA countries.

<table>
<thead>
<tr>
<th>Country</th>
<th>Plant date</th>
<th>Head</th>
<th>Harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syria</td>
<td>15-30 Oct</td>
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<td>Turkey (Erzurum)</td>
<td>1-15 Sep</td>
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<td>Turkey (Central Anatolia)</td>
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<td>Turkey (Southeast)</td>
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<td>Iran (West)</td>
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<td>Iran (Middle/Northeast)</td>
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<td>Afghanistan</td>
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<td>Pakistan (Baluchistan)</td>
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<td>Morocco/Algeria (Atlas M)</td>
<td>Oct</td>
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Table 6. Scientific visits and training activities provided through the Turkey/CIMMYT winter wheat improvement project from 1985 to 1990.

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<td>Visiting scientists to CIMMYT/Mexico</td>
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<td>Visiting scientists to other programs</td>
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<td>Master students</td>
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<td>Science fellowships</td>
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<td>MSTAT course</td>
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<td>Agronomy course in Turkey</td>
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<td>Conferences</td>
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<td>Travelling seminar</td>
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<td>16</td>
<td>12</td>
<td>28</td>
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<td>Total</td>
<td>17</td>
<td>23</td>
<td>29</td>
<td>6</td>
<td>35</td>
<td>8</td>
<td>118</td>
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| Visiting scientists to:              |      |      |      |      |      |      |       |
| Turkey/CIMMYT                        | 2    | 3    | 3    | 6    | 5    | 4    | 23    |
| Others                               | 2    | 2    | 25   | 4    | 4    | 37   |       |
| Total                                | 4    | 3    | 5    | 31   | 9    | 8    | 60    |
(38°N), Iran, were added selection sites for some segregating populations, generally F2s. Unfortunately, the lower latitude sites in Pakistan and Morocco are not representative for WW/FV wheat in the majority of the WANA region.

Advanced lines were screened against various stresses at three sites: Quetta (Pakistan), Anseouer (Morocco), and Sarghaya (Syria). Supplemental sites in Syria provided additional information such as at Latakia, 33.3°N, (disease resistance), Breda (drought tolerance) and Hagla (salt tolerance). All material is planted every year at Tel Hadya for evaluation and crossing. The scheme for specific character evaluation at various sites is shown in Figure 4.

ICARDA developed close contacts and exchanged germplasm with many other winter wheat programs in the world, and by 1988 had tested more than 10,000 introductions; the best were selected for use in broadening the germplasm base through crossing. The scope of the project in terms of segregating populations at that time was: F2=1112, F3=867, F4=1208, F5=1845, and F6=541. The crossing block contained 154 entries and 850 crosses were made in 1985 of which about 100 were top, back, or double crossed with the intent to improve the F1s.

Selection data gathered from regional evaluation sites by the mid-1980s showed a very low frequency of commonly selected lines across sites. From this, ICARDA breeders concluded that breeding for specific adaptability was important for high altitude areas of the WANA region.

Another conclusion was that winter wheats for the high elevation areas should possess cold tolerance, a very long vegetative phase, and mature early to avoid terminal moisture stress and heat. Further, these should have a high tiller number and medium lax head with bold grain.

Training
As many as 118 scientists have participated in various training activities offered through the Turkey/CIMMYT winter wheat improvement project from 1985 to 1990 (Table 6). However, many of these trained scientists left the wheat project to join the private sector. The International Winter Wheat Travelling Seminar was first held in 1985 and again in 1989. One agronomy course was offered in Turkey in 1987.

Plant quarantine regulations of Turkey and the shipment of international winter wheat nurseries
Turkey has present within its borders most of the diseases of wheat and barley. Consequently, the regulations on restricting import of wheat seed for research with no commercial value are nominal. If seed sent to Turkey is properly addressed seed clearance is normally a routine procedure. Occasional commercial regulations are confused with experimental seed shipments when improperly addressed.

The quarantine law of 1989 cites restriction of wheat seed if they are found to be infected with the diseases flag smut, dwarf bunt, Kamal bunt, *Septoria nodorum*, ergot, or barley stripe mosaic virus or infested with gall nematode or khapra beetle.

There are no restrictions regarding the export of seed from the phytosanitary standpoint. Receiving countries may place restrictions as does most of the USA because of the presence of flag smut in Turkey. To date, plant quarantine and seed shipments from Turkey have not been a factor.
Figure 4. Scheme for specific character evaluation at various sites utilized by ICARDA.
Future Strategy

Linkages between CIMMYT, ICARDA, and Turkey and the issue of coordination
As stated previously, there are two breeding programs engaged on winter/facultative wheats. These are:

- The Turkey/CIMMYT Winter Wheat Breeding Program based in Turkey
- The CIMMYT/ICARDA Facultative Breeding Program based at ICARDA in Aleppo, Syria.

These two programs have similar objectives and the WANA region is their primary target area. Many times, their nurseries are planted at the same locations. We believe there is a high degree of redundancy in this operation both from the strategic and resource points of view.

We suggest that the cause and objective of winter/facultative wheats would be best served by merging all of the breeding operations in Turkey under the Turkey/CIMMYT-ICARDA umbrella. A part of the testing program should be done in other countries of the WANA region with the strategic support of ICARDA. In this scenario, the winter/facultative wheat breeder based in ICARDA should be transferred to Turkey to join the team of a breeder and a pathologist already in Turkey.

The CGIAR requires that the IARCs develop partnerships with selected NARSs to jointly develop certain types of germplasm, technology, or scientific information for the benefit of other NARSs. Turkey offers the environmental variability, a spectrum of wheat diseases, insects, germplasm resources, scientific human resources to be in partnership with CIMMYT-ICARDA for the enhancement of WW/FW as a cooperative venture. The partnership between CIMMYT and ICARDA for improvement of cereal production in the WANA region has already been accepted by the two IARCs. The reviewers believe a Turkey/CIMMYT-ICARDA partnership is in the best interest of the entire region.

The review team suggests the following points for consideration by both CIMMYT and ICARDA management:

- A team of two breeders and one pathologist supported by CIMMYT, based in Turkey. All three positions are recognized as essential.

- A cohesive linkage of ICARDA's high altitude coordinator in Turkey with the CIMMYT team to provide access to networking in other areas of the WANA region such as Iran, Afghanistan, Pakistan (Quetta), and the Atlas Mountain region of North Africa. ICARDA's representative based in Turkey should facilitate networking with regional programs of ICARDA and NARSs.

- ICARDA should provide agronomic, crop protection, and cereal technology research support to WW/FW either at its base in Aleppo or at its regional stations in the WANA region in addition to existing facilities in Turkey.

- The International Winter Wheat Screening Nursery (IWWSN) should be distributed on behalf of Turkey, CIMMYT, and ICARDA by the
Turkey/CIMMYT-ICARDA WW/FW Program. Seed multiplication would be the responsibility of WW/FW Program.

- The networking and multilocation testing scheme assisted by ICARDA is shown in Figure 5.

- In this joint WANA venture, CIMMYT's wheat team leader in Turkey, the coordinator of the Turkish national program, and the coordinator of ICARDA's highland project in Turkey would act as partners in the area of project definition and priority setting.

- We believe that the above strategy is fully congruent with the mandates of the two Centers and agreements between CIMMYT/ICARDA, Turkey/CIMMYT, and Turkey/ICARDA. This strategy also recognizes the importance of the diverse locations and scientific resources of Turkey.

Breeding program--suggested methodology

Germplasm evaluation
To maintain a high level of favorable variability in the WW/FW germplasm, the Turkey/CIMMYT-ICARDA Program needs to promote a viable exchange with the following geographic regions. These are:

- Southern European countries: Rumania, Bulgaria, Italy, and Yugoslavia.
- Eastern European countries: Hungary and southern USSR.
- Western European countries.
- Great Plains of the United States: Texas, Oklahoma, Kansas, Nebraska, and Colorado.
- Pacific Northwest of the United States.
- Chile.
- China.

This germplasm needs to be evaluated for agronomic characters and biotic and abiotic stress resistances. The best lines should be selected and crossed with winter wheats of the WANA region and widely adapted spring wheat varieties.

Breeding methodology of the Turkey/CIMMYT-ICARDA Winter/Facultative Program
Figure 6 provides a schematic diagram of population management in the Turkey/CIMMYT-ICARDA WW/FW Program. This methodology links with the operations in Mexico and OSU in Oregon to shuttle genetically enhanced F3 populations to Turkey. The choice of location and methodology must remain flexible to satisfy future requirements.

Wide adaptation
The review team recommends that the central focus of future breeding for WW/FW should be based on wide adaptability due to the high degree of environmental variability in the WANA region. The methodology expressed in Figure 6 should assure this. In addition, networking and the international nursery
Multiplication and distribution of IWWSN to cooperators and distribution to the rest of the world

Selection of best advanced lines

Breeding program locations in Turkey

Crossing
Segregating populations
Evaluation of advanced lines

ICARDA Network

Iran
Afghanistan
Quetta (Pakistan)
Atlas Mountains
Aleppo (ICARDA) Field
Quality
Insect resistance

Evaluation of both $F_4$ and advanced lines for disease resistance, cold tolerance, heat tolerance

Figure 5. Networking and multilocation scheme assisted by ICARDA.
Figure 6. Breeding methodology of the Turkey/CIMMYT-ICARDA Winter/Facultative Wheat Program.
system should provide broad-based disease resistance data to be used in the crossing program. Ideally, high levels of biotic and abiotic stresses have to be combined in high yield genotypes to permit good performance in many environments.

**International yield trials and nurseries**

The review team is pleased to learn that the International Winter Wheat Performance Nursery (IWWPN) presently conducted by University of Nebraska and USAID/USDA would be continued. In our opinion, this yield nursery is very important in identifying adaptability of genotypes and in studying location performance. IWWPN’s continuation is highly recommended through University of Nebraska/USAID/USDA funding alone or through a cooperative undertaking with CIMMYT.

The International Winter x Spring Wheat Screening Nursery (IWSWSN) operated by Oregon State University, which was temporarily disrupted due to lack of funding, should continue to provide germplasm to high yielding, long season environments of The Third World including WANA. This germplasm has proven useful in eastern Europe and Chile and has served as a gene pool for crossing programs.

The International Winter Wheat Screening Nursery (IWWSN) distributed by Turkey/CIMMYT should be continued primarily for areas of WANA region. This nursery should be distributed on behalf of the Turkish National Program, CIMMYT and ICARDA and would replace ICARDA’s high elevation nursery.

**Linkage with Oregon State University (OSU) and CIMMYT-Base**

CIMMYT-Base has had a dynamic spring x winter crossing program since 1972 and has shared F1s of spring x winter types with OSU. CIMMYT-Base uses these F1s to top cross with other spring wheats for the improvement of spring wheats. OSU uses these F1s to top cross with winter wheats to enhance germplasm for the Third World.

To increase the variability of its base segregating populations, it is suggested that the Turkey/CIMMYT-ICARDA Program should receive F1 and F3 S x W germplasm from CIMMYT and F3 S x W germplasm from OSU.

Both OSU and CIMMYT-Base have coordinated their programs since 1972 and have developed superior germplasm for agronomic type, disease resistance, photoperiod insensitivity, and yield potential. Jointly, they conduct their breeding and testing programs in three environments in Oregon and another at Toluca in Mexico. Based on the performance of OSU/CIMMYT-Base lines in the WANA region, it should be desirable to continue to include these selections in the Turkey/CIMMYT-ICARDA Program.

**Linkages with breeding programs in eastern Europe and the Great Plains of the USA**

The variety Bezostaja from USSR has been widely grown in the WANA region from Turkey to Afghanistan. In general, varieties from Rumania, Bulgaria, and the Great Plains of the USA are adapted to the WANA region. As shown in Figure 7, it is advisable that the Turkey/CIMMYT-ICARDA Program have a continuous flow of germplasm from these sources to its base operation to increase variability in the crossing program and, if possible, to be included in the IWWSN.
Figure 7. Suggested continuous flow of germplasm in the Turkey/CIMMYT-ICARDA Program.
**Issue of China and Chile/Peru**

Even though China and Chile are two large producers of WW/FW in the world, their agroecological areas are different from the WANA region. China is a large country and has very well established WW/FW breeding programs at Beijing, Zhengzhou (Henan Province), Shi-Jia-Zhuang (Hebei Province), Tai-An and Yen-Tai (Shandong Province), Yang-Ling-Zheng (Shaanxi Province), Ling-Feng (Shaanxi Province), and Shu-Zhou (Jiangsu Province). However, there is large variability in Chinese materials which should be exploited by crossing to WANA germplasm. Similarly WANA’s IWWSN should be tested in China to gather information on adaptability. Lateness in non-Chinese materials is the biggest constraint. IWWSN can provide genetic variability to Chinese cooperators in relation to special traits.

In regards to Chile and the high plateau of Peru, the IWWSN of OSU has proven to be the better fit.

It is suggested that the Turkey/CIMMYT-ICARDA Program should primarily concentrate on the WANA region, however germplasm in the IWWSN should be made available to cooperators outside of WANA.

**Resource allocations**

**Staffing**

Even though facultative and winter types account for a significant share of developing country wheat production (29% of the total bread wheat; Table 3.2 in CIMMYT’s Five-Year Budget: 1990-94), these have been neglected in the past by CIMMYT. Winter wheats from western Europe or North American do not satisfactorily fulfill developing world varietal requirements, being either too late or disease susceptible. On the other hand, selected CIMMYT W x S progeny show good adaptation to many developing country WW/FW areas. Also, as an international entity, CIMMYT can facilitate seed and information exchange between developing countries. For these reasons, CIMMYT management assigned 2 person years to breeding work and 1 person year to plant pathology focusing on these materials.

We recommend that CIMMYT add one breeder from ICARDA to the existing team of one breeder and one pathologist in Turkey. All three positions are considered essential. This is deemed necessary as the program expands in breeding, seed multiplication, IWWSN distribution, and participation in networking. In addition, we recommend that additional support staff be based in Turkey to assist CIMMYT senior scientists.

**Training and visiting scientists**

The great progress that has been made in Turkey in institutional development, wheat germplasm enhancement, varietal development, agronomy, and ultimately national wheat production is a direct result of education and training in the preceding decades. The development of national universities and the encouragement of students to pursue higher degrees set the stage for the current progress.

The 1971 CIMMYT agreement, which sent many outstanding students to Western universities for advanced degrees and in-service training, has had great impact on agricultural research and development.

Education is a continuous process. It is a natural phenomenon that well educated and trained people will often outgrow their positions and move on to higher
positions in government and industry, so additional people must be trained. No program that the review team visited in the Turkish Research Institute was without personnel needs. Some programs lacked key scientific personnel. Usually, there were trained breeders, but often the supporting scientists who make up the interdisciplinary team, such as plant pathologists and entomologists, were lacking.

Most programs had a serious deficiency of trained, sub-professional technicians (BS or agricultural engineers) who assist in program execution. We believe the in-service training in plant breeding, plant pathology, and agronomy should be considered a joint responsibility of CIMMYT and ICARDA. The in-service training should be undertaken at Mexico for the time being and at Turkey if it becomes logistically feasible. Agronomy training should be conducted either at ICARDA or at Turkey. In the beginning, at least five total positions for breeding and agronomy should be made available annually for scientists engaged in WW/FW of the WANA region.

The visiting scientist program is a very essential component of international germplasm enhancement and networking. The scientist exchange should be made between all partners in the international network and participation in international meetings should be encouraged. At least six positions for visiting scientists should be assigned (i.e., 2 from Turkey, 1 from Iran, 1 from Afghanistan, 1 from Pakistan, and 1 from Atlas Mountain region). Some of these countries may have their own funding, as in case of Iran.

Conferences, seminars, and workshops
Conferences, seminars, and workshops are important components in the coordination of the germplasm enhancement network. These meetings bring a focus on areas of scientific interest and provide a forum for presenting research results, integration of programs, exchange of ideas and coordinated planning. These forums must be held with regularity, well advertised, and open to those scientists committed to a free exchange of ideas, data, and material and must be conducted at a high level of scientific integrity.

We recommend that at least one Winter/Facultative Wheat Workshop/travelling seminar be held each year and be attended by scientists in the Turkish network and selected scientists from the WANA region. This workshop/travelling seminar would be for the purpose of presenting data, exchanging ideas, selecting germplasm, planning, and overall coordination of efforts among scientists. This workshop/travelling seminar could rotate to different institutes each year (where and when feasible) and should be jointly coordinated by the Turkey/CIMMYT-ICARDA Partnership.

Every third year, a conference should be held in the WANA region on germplasm performance. This conference should provide germplasm performance data and discuss agronomic experiments and regional problems. It should provide a forum for the exchange of ideas, planning for the next 3 years, and overall coordination of scientific efforts in the WANA region. This conference would be planned and coordinated under the Turkey/CIMMYT-ICARDA Program. Several of the network programs from North America, Europe, and China could be invited to participate.

Seminars or workshops on specific subject matter, such as agronomy, yellow rust, etc. should be conducted on a periodic basis.
The review committee recommends that significant financial resources be allocated to this effort.

**Equipment**
All stations visited in Turkey are in need of equipment. The review team was made aware of the financial constraints realized by different research institutes and their inability to buy new equipment.

The team believes that the Turkey/CIMMYT-ICARDA Program on WW/FW breeding will expand to execute suggested breeding methodology and to handle international screening nurseries. The review team recommends a substantial increase in resource allocation to this item of joint operation.

**Monitoring and evaluation**
During the review of the CIMMYT Winter Wheat Program in Turkey, a number of problems surfaced that will become serious if not addressed on an annual or biennial basis by a representative of the office of the Director General of CIMMYT. Most of these deal with interpretation of the agreement as to the role of CIMMYT staff in the administration of the program, allocation of resources, facilitation of training, distribution of seed in the network, and overall coordination.

The review team recommends that the director for wheat research or his representative visit the project annually with his Turkish counterpart to review progress and arbitrate problems in project program areas.

The review team further recommends annual reports on project progress and coordination.

The review team endorses the concept of in-depth project review every 5 years.

**Summary of Recommendations**

The review team believes the original overall objectives of the joint venture, "An International Approach to Winter Wheat Research" are still valid. Those objectives were to develop broadly adapted, high-yielding winter wheat germplasm for the extensive winter and facultative wheat growing areas of the world.

We studied the CIMMYT/ICARDA, Turkey/CIMMYT and Turkey/ICARDA agreements and relationships with great care. We feel there is a great opportunity for cooperative programs to avoid duplication and wisely utilize resources to serve the need of NARSs of high-altitude region of the WANA.

We have examined the breeding/nursery methodology for meeting the needs of the winter/facultative wheat growing areas of the developing world and the WANA region in particular and recommend some changes be made to improve the efficient use of CGIAR resources.

One area the review team found most troublesome and which it would like to highlight in this summary section is the serious land resource problem at the institutes in Konya, Eskisehir, and Ankara.

Eskisehir should be permitted to use their current site adjacent to the institute buildings for the next 5 to 10 years while the new farm is developed.
Ankara should be permitted to use 30 ha of the Haymana Farm each year. This farm was developed by the Ankara Crops Research Institute in cooperation with Rockefeller/CIMMYT in the early 1970s and later given to the University of Ankara for seed production.

The Konya situation is a difficult one and will require attention. The addition of the Cumra substation has greatly improved the situation, but infrastructure and facilities at both sites must be strengthened for the management of an international program.

The reviewers believe that Izmir, Eskisehir, and Cumra should be the principal stations for the WW/FW breeding program.

Other main recommendations of the review team include:

- The mandate and mission of CIMMYT and ICARDA and agreements between CIMMYT/ICARDA, Turkey/CIMMYT, and Turkey/ICARDA are congruent to launch a joint partnership venture for the improvement of the WW/FW program for the WANA region. It is suggested that two existing programs in Turkey and Aleppo be joined to make a Turkey/CIMMYT-ICARDA WW/FW Program for the WANA region.

- The winter/facultative wheat breeder currently stationed at ICARDA in Aleppo should be transferred to Turkey. Although the facilities at ICARDA are excellent, the environment was not adequate to carry out the germplasm enhancement and seed multiplication work. Furthermore, the linkage with the Turkish winter/facultative wheat breeders and support scientists enhances the entire germplasm development process.

- A team of two breeders and one pathologist should be based in Turkey. These three positions are considered essential.

- The major population development and selection must be executed in Turkey where the greatest array of agroecological climatic zones exist. Testing and networking should be carried out in the WANA region utilizing ICARDA's regional facilities.

- The International Winter Wheat Screening Nursery (IWWSN) should be distributed in the WANA region and internationally, on behalf of the Turkish National Program, CIMMYT, and ICARDA.

- Support staff positions are critically needed by the CIMMYT staff in Turkey for hybridization, germplasm management, notetaking, records, seed processing, nursery seed preparation, and shipment. One of the support staff should be a specialist in computer data processing.

- Linkages with external programs in the USA, Europe, and China should be maintained for exchange of technology and germplasm.

- High priority is given to training and visiting scientist programs. Additional resources should be devoted to this area—especially in the area of in-service training.
• High priority is also placed on funding workshops and traveling seminars. The coordination activities should be strengthened. Workshops, seminars, and conferences to present data, discuss research ideas, plan future research, discuss training, and coordinate activities would enhance information exchange and open lines of communications.

• Computer resources, support staff in this area, and the data processing capabilities of this project were assessed. Considerable strengthening is recommended, which will require resource allocation early in the next 5-year period.

• The Turkish system is favorable for the winter wheat development, but plant quarantine is a major issue and it should be carefully documented and studied.

• Finally, the review team was especially impressed with the advanced level of agronomic research and excellent packages of practices for the fallow-wheat system. Turkish agronomists should play a major role with ICARDA in the management of winter wheat production.

References


Acknowledgments

We, the members of the winter wheat review team, wish to acknowledge the spirit of professionalism we encountered at all institutions visited. The national programs have excellent scientists and support staff.

Thanks to the staff members who met us (some on weekends) and stayed late into the evenings to make our review meaningful.

To the ICARDA management team and Dr. Byrd Curtis, we express our appreciation for coordinating our schedule.

To the CIMMYT staff in Turkey, Dr. E.E. Saari and Dr. H.-J. Braun, we give special thanks for coordinating a very difficult schedule and making many arrangements. To the secretaries Olga Metya, Yuksel Erdil, and Murvet Canli, we owe much for the long, late hours assisting in typing and preparing our report. And we thank Gene Hettel, CIMMYT Information Services, and Kay Saari for editing the manuscript.

We would be remiss in not thanking fellow team member Bertan Suzen from Eskisehir for patiently answering our many questions on Turkish agriculture. To our many Turkish hosts, we wish much success. Turkey is a great country with tremendous agricultural potential.
Appendix 1. People met by the review team.

At each station, the review team met in closed session with the institute director and the head of the breeding department to discuss the interaction of the Turkey/CIMMYT Winter Wheat program with the National Winter Cereal Research Program of Turkey.

CIMMYT: Dr. George Varughese, Associate Director, Wheat Program

ICARDA: Dr. Nasrat R. Fadda, Director General
Dr. Aart van Schoonhoven, Deputy Director General
Dr. Habib Ketata, Acting Director, Cereal Program
Dr. Mohammed Tahir, Winter Barley Breeder
Mr. Joop van Leur, Pathologist
Dr. H. Makkouk, Virologist
Dr. Mariene Diekman, Seed Health
Dr. Sui K. Yau, International Nurseries
Dr. Ross H. Miller, Entomologist
Dr. Byrd C. Curtis, Facultative Wheat Breeder, CIMMYT/ICARDA
Dr. Guillermo O. Ferrara, Bread Wheat Breeder, CIMMYT/ICARDA
Dr. Miloudi Nachit, Durum Wheat Breeder, CIMMYT/ICARDA

Adana: Mr. Bayram Bolat, Director*
Dr. Gulsan Karatopak, Head, Wheat Breeding*

Edirne: Mr. Ahmet Bulbul, Director*
Mr. Halil Surek, Rice Breeder

Izmir: Dr. Ertug Firat, Director*
Dr. Noyan Kusman, Ass. Director*
Dr. Ahmet Akman, Ass. Director
Dr. Cetin Tuten, Head, Cereal Breeding*
Dr. Gulhan Turabi, Head, Cereal Pathology
Dr. Suleyman Guzel, Head, Barley Breeding
Dr. Nevin Acikgoz, Research Coordinator
Ms. Beyhan Akin, CIMMYT Technician
Ms. Nuray Kilic, Agronomist,
Ms. Meltem Dogan, Breeder

Konya: Mr. Engin Kinaci, Director*
Mr. Ali Kiral, Ass. Director, Head Cereal Breeding*
Mr. Nurettin Kayitmazbarit Head Statistics and Economics
Mr. Hassan Ekiz, Wheat Breeder
Mr. Suleyman Karahan, Wheat Breeder
Mr. Emin Donmez, Barley Breeder
Ms. Ozgur Yildirim, Agronomist
Mr. Ahmet Yildirim, Oat Breeder

Eskisehir: Mr. Turgut Cetinel, Acting Director*
Mr. Muffit Kalayci, Head, Agronomy*
Mr. Mesut Keser, Cereal Breeder
Mr. Necmetin Bolat, Cereal Breeder
Mr. Ergun Ozdemir, Cereal Breeder
Mr. Tugrul Ince, Cereal Breeder
Mr. Bertan Suzen, Ass. Director, Head, Cereal Breeding and review team member

Ankara:  Dr. Baydur Yilmaz, Director
         Dr. Mengu Guler, Head Agronomy*
         Dr. Nedret Durutan, Agronomist*
         Dr. Naile Kocak, Quality
         Mr. Huseyin Tosun, Head, Cereal Breeding
         Mr. Nusret Zincirli, Cereal Breeder*
         Mr. Lutfu Cetin, Head Pathology

MOA:     Mr. Husnu Poyraz, Undersecretary
         Dr. Nazmi Demir, Ass. Undersecretary
         Mr. Alpaslan Pehlivanturk, Head APK
         Dr. Mustafa Doyuk, APK, Dept. Head, Research and Statistics

* Persons who attended closed sessions with the review team.
Appendix 2. CIMMYT Winter Wheat Review Team members and their schedule.

Team members
E. Everson, Chairman, USA
K.S. Gill, India
W. Heng-Li, China
S. Rajaram, Mexico
B. Suzen, Turkey

Schedule
June 4: Arrivial at ICARDA.

June 5-6: Meeting with ICARDA scientists and CIMMYT scientists based at ICARDA.

June 7: Cukurova Research Station at Adana.

June 8: Agricultural Research Institute in Edime.

June 9: Aegean Research Institute in Izmir.

June 10: Bahri Dagdas Winter Cereal Research Institute in Konya and the substation at Cumra.

June 11: Agricultural Research Institute in Eskisehir

June 12: Field Crop Research Institute in Ankara.

June 13: Meeting with Representatives from the Ministry of Agriculture.


June 16: Departure from Ankara.