

Turkey and ICARDA

Collaboration in Agricultural Research
since 1977

Ties that Bind



International Center for Agricultural Research
in the Dry Areas

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No. 22



International Center for Agricultural Research
in the Dry Areas (ICARDA)

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Donors to the Turkey/ICARDA Program

The Turkey/ICARDA collaborative research program covers such areas as cereal and legume crop production, natural resources management, capacity building for agricultural research, and integrated rural development initiatives. Though the Government of Turkey has supported much of the work, for instance the research and development activities under the Southeastern Anatolia Project, several other components of the program have been generously supported by the following donors.

Donor	Project
IFAD	Integrated Research and Durum Economics Network (IRDEN)
DFID, UK	Integrated pest management of Sunn pest in West Asia
USAID	Use of entomopathogenic fungi for the control of Sunn pest
USAID	Inheritance and mapping of winter-hardiness genes in lentil for use in marker-assisted selection
IFAD	West Asia and North Africa Dryland Durum Wheat Improvement Network (WANADDIN)
Government of Italy	Collaborative research project on durum grain quality
GRDC, Australia	International selection, introduction and fast tracking of kabuli chickpea with large seed size, high biomass, high yield and <i>Ascochyta</i> resistance
GTZ, Germany	A study of cost-effective seed delivery to small farmers in West Asia and North Africa
European Commission	Enhancing productivity and sustainability of crop production in the Mediterranean highlands
BMZ, Germany	Resource management for sustainable agricultural production in West Asia and North Africa
Government of Turkey	Southeastern Anatolia (GAP)/ICARDA Project

Partners in the Turkey/ICARDA Program

Adana Mustapha Kamal University, Turkey

Ankara Research Institute of Rural Services, Ankara, Turkey

CABI International

Central Research Institute for Field Crops, Ankara, Turkey

Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT), Mexico

Decle University, Turkey

Mediterranean Exporters Union, Turkey

Optimizing Soil Water-Use Consortium (OSWU), CGIAR

Plant Protection Research Institute, Adana, Turkey

Southeast Anatolian Regional Research Institute (SARRI), Turkey

Southeastern Anatolia Project (GAP), Turkey

University of Cukurova, Turkey

University of Greenwich, UK

University of Vermont, USA

TURKEY AND ICARDA

Introduction

Turkey is located in the Fertile Crescent, an area in the Mediterranean region where, some 10,000 years ago, barley, wheat, lentil, pea, flax and vetch were domesticated—indicating the country's rich experience in agricultural production. Though the agriculture sector's share of GDP has been declining, it remains an important contributor to Turkey's exports including cereals, pulses, sugar, nuts, fresh and dried fruits, vegetables, and olive oil produced on more than 40 million hectares of arable land.

Situated in Central and West Asia and North Africa (CWANA), ICARDA's regional geographic mandate area, Turkey has a subtropical, semi-arid climate with extremes of temperatures. In the east, summers are hot and dry, winters are cold, rainy and snowy. Along the coastal area, a Mediterranean climate is dominant with long, hot, dry summers and short, mild, rainy winters. Average annual rainfall is 643 mm, ranging from 250 mm in the southeast to more than 3000 mm in the north-east Black Sea area. About 70% of the rain falls in the winter and spring seasons. Thus, farmers in many parts of Turkey face similar agroecological conditions to those in other CWANA countries, making it valuable to share experiences and conduct collaborative research with ICARDA that benefits the entire region and beyond.

Since its establishment in 1977, ICARDA has had a mutually beneficial collaboration with Turkey.

HIGHLIGHTS OF THE COLLABORATION

Genetic Resources

Many of the crops that were originally grown in Turkey have adapted to cold and drought, pests and diseases, and can be useful in breeding varieties with similar traits. Given the country's diverse agroclimatic conditions, similar to those in various parts of the world, especially in the dry areas, ICARDA has a collection of 11,359 germplasm accessions from Turkey, the second-largest collection of germplasm from a single country kept in the Center's genebank (Table 1). This helps to preserve the unique crop biodiversity which could otherwise be eroded by unsustainable agricultural practices. In addition, ICARDA shares germplasm from its collections with various agricultural research institutions in Turkey; and as a result more than 100 improved crop varieties have been released in the country (Table 2).



Collecting wild relatives near Burdur in Turkey as part of a joint collection mission of ICARDA and the Aegean Agricultural Research Institute.

Table 1. Accessions from Turkey conserved in ICARDA's genebank.

Crop	No. of accessions
<i>Aegilops</i> spp.	611
Barley	1508
Bread wheat	1128
Chickpea	973
Durum wheat	1855
Faba bean	230
Forage and range	259
<i>Lathyrus</i> spp.	365
Lentil	482
<i>Medicago</i> spp.	714
<i>Pisum</i> spp.	215
Primitive wheat	234
<i>Trifolium</i> spp.	558
<i>Vicia</i> spp.	1483
Wild Cicer spp.	153
Wild <i>Hordeum</i>	45
Wild <i>Lens</i> spp.	194
Wild triticum	352
Total	11359

Table 2. Improved varieties released in Turkey.

Barley	'Tarm 92,' 'Yesevi,' 'Orza'
Chickpea	'Güney Sarısı 482,' 'ILC 195,' 'Akcin,' 'Menemen 92,' 'Aydın 92,' 'İzmir 92,' 'Aziziye,' 'Damla-89,' 'Diyar 95,' 'Gökçe,' 'Sarı-98,' 'Çagatay,' INCT
Durum wheat	'Susf bird,' 'Balçalı,' 'EGE 88,' 'Cham 1,' 'Kızıltan,' 'Fırat 93,' 'Aydın 93,' 'Haran' ('Om Rabi 5'), 'Ankara 98,' 'Altın 98,' 'Gidara 2'
Faba bean	'Yılmaz 98'
Forages	'Seğmen-2002,' 'Tarmen-2002,' 'Baydurbey-2002,' 'Oğuz-2002,' 'Anadolu pembesi-2002,' 'Gürbüz-2001'
 Lentil	'Fırat 87,' 'Erzurum 89,' 'Malazgirt 89,' 'Sazak 91,' 'Sayran 96' 'Meyveci-2000,' 'Ali Dayı,' 'Kafcas,' 'Uzbek,' 'Cıfci'
Spring bread wheat	'Dogankent-1' ('Cham 4'), 'Kop,' 'Kaklıc 88,' 'Genç- 88,' 'Doğu 88,' 'Es14,' 'Yüregir,' 'Karasu 90,' 'Basrıbey 95,' 'Kasıfbey 95,' 'CEYHAN 99,' 'Genç-99,' 'ADANA 99,' 'BALATILLA,' 'TAHIROVA 2000,' 'NURKENT,' 'META 2002'
Winter facultative wheat	'Bdme 98-3K,' 'Bdme98-3S,' 'Gerek 79,' 'Atay 85,' 'Katia 1,' 'Gün 91,' 'GÜN 91,' 'Kutluk 94,' 'Dagdas 94,' 'Sultan 95,' 'Kırgız 95,' 'F//68.44NZT/3/CUC'5,' 'İkizce 96,' 'Pehlivan 96,' 'Suzen 97,' 'Kinaci 97,' 'Palandoken 97,' 'Kinaci 97,' 'Mizrak 98,' 'Türkmen 98,' 'Uzunyayla 98,' 'Yıldız 98,' 'Aytekin 98,' 'YAKAR 99,' 'KARAHAN 99,' 'Göksu 99,' 'SAROZ 95,' 'Cetinel 2000,' 'ALTAY 2000,' 'Nenehatun,' 'Sonmez,' 'Alpu01,' 'Alpaslan,' 'İzgi,' 'BAGCI2002,' 'DAPHAN,' 'YILDIRIM,' 'SAKIN,' 'YILDIRIM,' 'SOYER,' 'KONYA 2002'

Improving Wheat Production and Productivity

The International Winter Wheat Improvement Program

Turkey is the third largest producer of wheat in the developing world, producing on average 20 million metric tons annually on more than 9 million hectares of cultivable land. And, like in most parts of the



From left, H.E. Prof. Dr Sami Guclu, Minister of Agriculture and Rural Affairs, Turkey; Prof. Dr Adel El-Beltagy, ICARDA Director General; and Dr Masa Iwanaga, CIMMYT Director General, in Ankara, Turkey, February 2003.

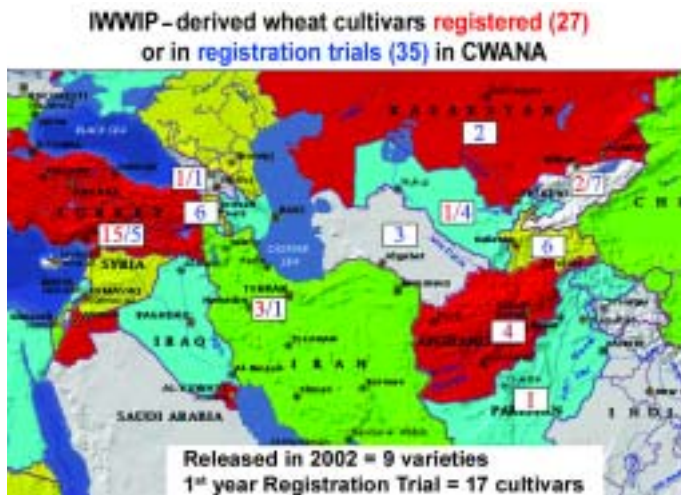
CWANA region, a large amount of wheat grown in Turkey comes from the highlands (at elevations above 900 meters), known for their harsh environments and poor accessibility, which account for their relative neglect when it comes to research. These areas face many problems, including low and uncertain rainfall, severe winters, isolation, low-yielding varieties of wheat, and a host of pests and diseases. Grain yields are usually less than 1.3 tons per hectare, winters are often long and cold, and seasons are short. Livelihoods of farmers in such areas are thus negatively impacted. This is why Turkey's Ministry of Agriculture, CIMMYT, and ICARDA joined forces in 1990 to conduct research on winter wheats through the International Winter Wheat Improvement Program (IWWIP).

In support of IWWIP, Turkey generously provides access to its research institutes and other infrastructure, enabling Turkish, CIMMYT, and ICARDA scientists to share new winter wheat varieties with more than 120 breeding programs in 50 countries. This is the largest international network for breeding winter wheat. Though much of the research is done in Turkey and at ICARDA, complementary research—for example, molecular fingerprinting and breeding for insect resistance—is done by CIMMYT and ICARDA.



Using both conventional and modern research techniques, this program has achieved great success in breeding high-yielding wheat varieties that are specifically adapted to cold areas. These improved wheat genotypes are also resistant to insect and nematode pests, and various fungal diseases. To date, 27 varieties developed by IWWIP have been released and 35 others are scheduled for release.

In addition to forging partnerships with scientists in the region's NARS and conducting capacity building and collaborative breeding activities, IWWIP also monitors the changing face of pests and diseases across the region. It conducts regular surveys to find out which pests and diseases are prevalent and where, and has set up screening nurseries across the region, using a standardized set of methods. In this way, the program plays a pivotal role in coordinating the deployment of appropriate wheat varieties—either directly to farmers in need (such as those in Afghanistan) or to national breeding programs to use as sources of resistance to pests and diseases threatening the crop in their countries.



The West Asia and North Africa Dryland Durum Improvement Network (WANADDIN)

WANADDIN, funded by IFAD, was implemented in the period 1996-1998 with the objective of achieving sustainable improvement in the productivity and production of durum wheat in the dryland environments of the WANA region through the establishment of a formal network involving the joint ICARDA/CIMMYT durum wheat research program and the NARS of Algeria, Morocco, Syria, Tunisia and Turkey. It aimed to continue the development of improved germplasm by incorporating new sources of tolerance and/or resistance against the major abiotic and biotic stresses; increase NARS self-reliance in germplasm and associated technology development; and strengthen the basis for improving transfer of technology activities of the NARS to dryland durum wheat farmers.

Some of the achievements of the WANADDIN project, in which Turkey played a major role, are:

- Identification of durum germplasm tolerant to drought, drought and heat, and drought and cold. Some of these cultivars have already been released.
- Pioneering research conducted in Morocco on Hessian fly resistance resulted in the development of durum germplasm combining drought tolerance and Hessian fly resistance and has now entered a phase of intensive on-farm testing.
- Sawfly resistance has been successfully incorporated into drought-tolerant durum wheat germplasm.
- Encouraging preliminary results on Russian wheat aphid resistance have been obtained.
- For the first time in the Mediterranean region, effective leaf rust resistance was introgressed into dryland durum germplasm, e.g., genotypes 'Bicrecham' and 'Moulchahba,' which were tried in Turkey.
- The genetic base of durum germplasm for yellow rust and common bunt resistance was substantially broadened.

In Turkey, varieties released under the WANADDIN project include 'Altin 98' (combining drought/cold tolerance with high yellow pigment) and 'Ankara 98' (combining drought/cold tolerance with high gluten strength). The project also helped to train NARS scientists, strengthen institutional linkages, and improve research infrastructure and inter-institutional, and inter-disciplinary networking.

The Integrated Research and Durum Economics Network (IRDEN)

IRDEN is a four-year project (2002-2006) funded by IFAD to foster wider adoption of low-cost durum technologies for increased income and improved household food security of smallholders in less-favored areas of WANA. Implemented by ICARDA in partnership with NARS in Algeria, Morocco, Syria, Tunisia and Turkey, IRDEN builds on achievements of its predecessor - the WANADDIN project.

The major aim of the project is to provide durum producers, especially resource-poor smallholders, with opportunities to improve their agricultural income and welfare by adopting productive, low-cost, sustainable technology options compatible with their production and consumption needs. It also provides feasible and low-cost alternatives for broadening the income base of smallholders through the development of income-generating activities, especially for women.



Traveling workshop in Turkey on winter wheat improvement.

IRDEN activities in Turkey are carried out in Diyarbakir and Gaziantep regions and cover baseline studies, site characterization, on-farm demonstration trials of durum varieties, farmers' field days, backup research on drought tolerance and grain quality of new durum germplasm, and on-job-training for scientists and farmers.

Controlling Sunn pest in West Asia

Sunn pest causes severe damage to wheat and barley crops in Central and West Asia, with infestations spreading over 15 million hectares. It causes the damage by feeding on leaves, stems and grains. Yield loss is commonly estimated at 20-30% in barley and 50-90% in wheat. Apart from the direct reduction in yield, the pest also injects chemicals that greatly reduce the baking quality of the dough. Control of Sunn pest by chemical insecticides is expensive, costing over US\$ 100 million annually in the countries of Central and West Asia, and poses a risk to human health, water quality and the environment. In Turkey, about 1.5 to 2 million hectares were sprayed against this pest in the past. Efforts to replace the insecticide-based strategies for Sunn pest control with integrated pest management (IPM) options have led to a reduction in the sprayed area to less than 1 million hectares.



Sunn pest infected wheat plants.



Sunn pest damaged grain (left and middle) and undamaged grain (right).

Turkey has been involved in various ICARDA projects aimed at controlling Sunn pest. One of the projects, funded by DFID, aims at reducing constraints to wheat production caused by Sunn pest through the development and application of appropriate, low-cost and environmentally acceptable IPM approaches. Since 2001, the project has been implemented in collaboration with NARS of Iran, Syria and Turkey and the University of Vermont (USA), CABI Bioscience and the University of Greenwich, UK. In Turkey, the collaborating institutions are the Plant Protection Research Institute, Adana; Adana Mustapha Kamal University; and the University of Cukurova.

The basic components of the project include research on economic threshold, sex pheromone, host plant resistance, parasitoids and entomopathogenic fungi. The work on insect-killing fungi has also been supported by USAID since 1998, and implemented by ICARDA in collaboration with the University of Vermont and NARS of Iran, Syria and Turkey. To identify fungi that infect Sunn pest, researchers concentrated their search on infected Sunn pest specimens under fallen leaves in foothills where the Sunn pest spends the winter. They collected several hundred strains of fungi in Kazakhstan, Kyrgyzstan, Syria, Iran Turkey and Uzbekistan. Several isolates have been collected from new generation adults in the field. This effort yielded the world's largest collection of fungi isolated specifically from infected Sunn pest.

Researchers have identified potentially useful pathogens. Some of the fungal isolates identified were so pathogenic that they killed all of the treated insects in less than ten days. The most prevalent species isolated was *Beauveria bassiana*. This can be produced on cereal grain and applied cheaply in cooperation with farmers. Based on laboratory and greenhouse bioassays and fieldwork, several isolates have shown great potential for use as biocontrol agents in overwintering sites. Promising fungal isolates with appropriate formulations will be tested, along with other IPM options, at the IPM pilot sites established in Iran, Syria and Turkey.

In Turkey, IPM options have been extended to farmers using farmer field schools formed around each of two IPM pilot sites. The main challenge to implementing IPM options for Sunn pest was reliance on chemical control. However, efforts by scientists from Turkey and ICARDA have led to some progress in the use of IPM. Starting from the 2004/2005 season, the Government of Turkey decided to replace the centralized aerial spray with ground application by farmers. This decision will encourage IPM implementation in the country. A national IPM program supported by the Government of Turkey was launched recently, through which farmer field schools will be established throughout the Sunn pest affected areas in the country.



Sampling of entomopathogenic fungi in Gaziantep, Turkey, for their persistence against Sunn pest.

Collaborative Research on Food Legumes

Collaboration between Turkey and ICARDA on food legume improvement has been ongoing since the establishment of the Center in 1977. As a result, 24 improved varieties of chickpea, lentil, and faba bean have been released in Turkey from ICARDA-supplied materials (Table 2).

Chickpea

Major activities have included evaluation of germplasm for cold tolerance at Hymana and Eskisehir research stations. A large number of cold-tolerant lines have been identified and used in the breeding program. In addition, a large number of chickpea lines resistant to *Ascochyta* blight have been identified from ICARDA-supplied materials for release in Turkey. One of these lines, 'Gokce' (FLIP 87-8C), which is large seeded, occupies more than 40,000 hectares.



Researchers, farmers, extensionists, and processing industry representatives evaluate chickpea for producing leblebi (a popular snack) in Turkey.

Within the framework of the project on "International Selection, Introduction and Fast Tracking of Kabuli Chickpea with Large Seed Size, High Biomass, Yield and *Ascochyta* Resistance" (1997-2001), funded by the Grains Research and Development Corporation (GRDC) of Australia, a large number of elite chickpea breeding materials developed at ICARDA were evaluated at Menemen and Izmir research sta-

tions in Turkey for *Ascochyta* blight and seed size. Fifty lines with large seed size and *Ascochyta* blight resistance were identified and shared for future use by the collaborating institutions. In 2004, Australian scientists identified three lines from these for possible release. Some of these lines are also undergoing on-farm trials in Syria and Turkey.

Lentil

Turkey is the third largest producer of lentil in the world. About 500,000 hectares of arable land is devoted to lentil cultivation, producing more than half-a-million tons every year. The key areas of Turkey/ICARDA collaborative activities on lentil are genetic enhancement, human resource development and germplasm exchange. ICARDA's key collaborators on lentil improvement in Turkey are the Southeast Anatolian Regional Research Institute (SARRI), Diyarbakir; the Central Research Institute for Field Crops (CRIFC), Ankara; and GAP, Urfa. Ten improved varieties of lentil (see Table 2) have been released in Turkey and are widely cultivated by farmers as a result of this collaboration.

Performance of spring- and winter-sown lentil in Eskishehr, Turkey. The winter-sown crop (right) reached maturity, while the spring-sown crop was vulnerable to terminal drought and heat stress.



Southeastern Anatolia, where lentil is grown on about 350,000 hectares, mostly the red type, is the most intensive lentil-growing area in the world. However, the region faces a major problem of wilt, which limits production. SARRI is working with ICARDA to develop wilt-resistant, high-yielding red lentil varieties for winter planting. Among the varieties released, 'Firat 87' and 'Syran 96,' which combine wilt-resistance with good standing ability for machine harvest, have been adopted by the farmers in Southeast Anatolia. 'Firat 87,' locally known as "Commando," is popular with consumers for its roundish seed shape. Recently, ICARDA supplied 19 tons of a popular variety 'Idlib-3,' released in Syria, to Turkey to increase adoption and impact. SARRI has also selected a large number of ICARDA germplasm from international nurseries for use in hybridization and further evaluation in various parts of the region.



'Firat 87,' a red lentil variety having wilt resistance and good standing ability for machine harvest is cultivated by the farmers of Southeastern Anatolia.

In the cold-prone highlands of Central Anatolia—Ankara, Tokat, Konya, Yozgat, Corum, Sivas, Karaman, and Nevsehir—lentil is grown on about 150,000 hectares. The areas range in altitude from 608 to 1400 m above sea level, and in peak winter the temperature varies from -12°C to -30°C . In order to improve yields in these areas, there is a need to shift from traditional spring to winter planting. To achieve this, scientists of CRIFC—using material supplied by ICARDA—have made commendable progress in selecting winter-hardy cultivars for the region. Recently, three high-yielding, winter-hardy varieties with a high level of resistance

to *Ascochyta* blight, and two high-yielding, early-spring varieties were released for Central Anatolia. The varieties are being disseminated among farmers mostly by the Mediterranean Seed Export Company. In addition, CRIFC researchers have identified some winter-hardy lines, which are now at various stages of evaluation.



ICARDA and Turkish scientists evaluate the performance of 'Kafkas,' a high-yielding and winter-hardy lentil variety in Turkey.

Integrated Rural Development Initiatives

The GAP-RDA/ICARDA Project

The Southeastern Anatolia region of Turkey (GAP) extends over 75,000 square kilometers, approximately 10% of the entire country. The region has a population of about seven million people, and is situated between the Tigris and Euphrates rivers. It has enormous agricultural production potential, but is one of the less developed regions in the country. It has 3.1 million hectares of crop land, 1.1 million hectares of forests and 2.4 million hectares of pasture and rangeland. To improve the livelihoods of people in the region, the Government of Turkey established the multi-billion dollar GAP project in 1977, one of the largest inte-

grated rural development projects in the world. This is a very ambitious project, expected to make available 1.7 million hectares of land for irrigated farming, enabling farmers to harvest twice or even three times a year. This double crop production output from the region will increase incomes for farmers and improve livelihoods.

ICARDA has had collaborative research and development activities with the GAP project since 1999. The ongoing collaborative activities involve two projects: On-Farm Demonstrations and Seed Multiplication, and Improvement of Natural Pastures and Forage Crops and Small Ruminant Production.

On-farm demonstrations and seed multiplication

A key constraint to agriculture in the GAP region is lack of quality seed of improved varieties. ICARDA has introduced improved and adapted varieties of wheat, barley, lentil, chickpea and vetch, along with improved production practices for these crops, including the use of raised beds in irrigated fields of wheat to increase yield and water-use efficiency. These are being introduced and adapted through on-farm demonstrations in cooperation with progressive farmers.

The introduced material is monitored and evaluated by GAP staff, local extension personnel and ICARDA scientists. Improved cultivars of these crops in demonstration fields produce higher yields than local cultivars. Varieties derived from ICARDA germplasm that are now popular with GAP farmers include 'Gidara 2,' an improved durum wheat variety, chickpea varieties 'Gokce' and 'Diyar 95,' and lentil variety 'Firat 87.'



On-farm technology demonstration/testing and seed production.

ICARDA provided technical backstopping to establish a seed technology center at Declé University, including a processing plant for cleaning and treating seed. In addition, in 2004, ICARDA provided the GAP project with one ton of quality seed of lentil variety 'Idlib 2' which will be released in Turkey soon. ICARDA has also enhanced mechanical harvesting of lentil in the GAP region by providing improved varieties that are upright, thus enabling farmers to harvest using combines or tractor-powered, side-mounted cutter bars.

Improving small ruminant production

In collaboration with GAP researchers, extension personnel, and farmers, ICARDA initiated a program aimed at improving the productivity of small ruminants to enhance the livelihoods of livestock farmers in the region. Focus was on the improvement of feeding systems, enhancement of the fodder base through improved management of the rangelands and cultivated fodder, and capacity building. Livestock production systems were characterized and their constraints analyzed through surveys conducted by the GAP/ICARDA team. The analysis led to the identification of necessary research interventions.

An on-the-job training program was then implemented for farmers, extensionists and researchers on improved technologies for small ruminant production. Four courses were conducted, one at ICARDA headquarters and three in the GAP area. The training efforts led to the introduction of new technologies such as use of agricultural and agro-industrial by-products, feed blocks, urea-treated straw, strategic feeding and



Improving range, forage and small ruminant production.

flock management. The target was to promote better milk and meat yields. Researchers were also trained in strategies for collecting and recording data from farmers. To further enhance the experience and information exchange, ICARDA organized a visit of the GAP research/extension



Determining the weight of a lamb during surveys conducted by the GAP/ICARDA team.

team to Jordan to see the cooperative milk production sector involving small-scale sheep milk producers.

Efforts were also made to improve marginal and rangeland, reverse erosion, improve natural resource productivity and conserve valuable genetic resources.

ICARDA has provided 1100 fodder shrub seedlings of 30 species for planting at Haran University. Seeds of

Atriplex species and new forage legumes were also tested. This is likely to lead to a productive, sustainable, environment-improving crop/livestock system that will raise farmers' income.

Sustainable development of small-scale farmers of the Taurus Mountains of Turkey

The Taurus Mountain region of Turkey is home to more than two million people dependent primarily on agriculture for their livelihoods. A study in 1988 indicated that farmers in the Taurus Mountain villages were poorer than those in other parts of the country, and this was attributable to the harsh environmental conditions. The main crops grown in the area are wheat and barley, while for most farmers, livestock rearing and cheese production is an important source of income.

ICARDA, in collaboration with Cukurova University, conducted a collaborative research and development project during the period 1990-1998 to examine the existing farming systems, develop new and/or improved technologies through on-farm experimentation to fit the local systems of Taurus Mountains, test new technologies with farmers, and disseminate the research findings among farmers and related organizations for larger areas in the other mountain regions. Activities were conducted using the farming systems approach through various stages including diagnosis, planning of field experiments, application of on-farm trials, and extension, in a continuum with multi-disciplinary field visits. More than 50 such visits were conducted each year.



Measuring milk yields in the Taurus Mountains, Turkey.

The project led to the development of improved varieties of wheat, barley and chickpea which have been widely adopted by the farmers. Also, new enterprises were introduced to diversify the incomes of farmers. These included the vetch-oat combination, triticale, sainfoin, and new fruits such as cherry and grapes. Livestock production was also improved. The changes of breeds in animals (cattle, sheep and goat) significantly increased the incomes of farmers. As a result of these technological changes, the incomes of the farmers involved in the project increased by 65%. This project may be considered a model for agricultural development through research, with the participation of farmers, extensionists and researchers.



Farmers and scientists work together to improve techniques of bee-keeping in the Taurus Mountains, Turkey.

Water Management Research

ICARDA and Turkish scientists have had collaborative studies on water management since 1996. The collaboration started with a study by ICARDA and the Ankara Research Institute of Rural Services on the potential of using supplemental irrigation (the addition of limited amounts of water to otherwise rainfed crops especially at critical crop growth stages) on wheat in the Central Anatolian plateau, a region with limited rainwater but a very important area for wheat production in Turkey. This study was followed by four-year trials at the Ankara Research Institute of Rural Services.

Potential role of supplemental irrigation in improving wheat yields

The objective of the study was to gain a better understanding of the potential, constraints, and possible research interventions needed for improving wheat production with supplemental irrigation (SI) in Central Anatolia. Specific objectives were to: assess historical rainfall characteristics in Central Anatolia region and its implications, together with other climatic factors, on soil moisture changes over wheat growing season and on crop yield; characterize existing practices of farmers under rainfed and SI conditions, farmers' perceptions of such practices, and priority constraints to the improvement of water management at the farm level; and, predict potential improvement of yield and its stability over years if SI and associated practices are applied.

The study had two interrelated research components: technical and socioeconomic. While the former was mainly concerned with the experimental technical investigations, the latter was focused on practical application. The technical study investigated potential yield improvement of wheat and predicted the response to different SI applications from experimental perspectives. The socioeconomic component investigated the farming systems within which wheat is produced and predicted probable applicability of the findings from the experiments. Synthesis of results of the two components would verify and validate the model, indicating the need for further experimentation.

Supplemental irrigation was found to have a substantial positive effect on crop yields. A research report was published in 2001 on this

collaborative activity under ICARDA's On-farm Water Husbandry series entitled "Supplemental Irrigation Potential for Wheat in the Central Anatolian Plateau of Turkey."



Supplemental irrigation trials at Ankara Research Institute of Rural Services.

Effect of early sowing with supplemental irrigation on wheat yield and water productivity

Four-year field trials at Ankara Research Institute for Rural Services (1998-2002) followed up the earlier modeling work—which indicated high potential for SI in the Central Anatolian cool highlands agroecology. Results showed that limited SI could double rainfed wheat grain yield. By applying only 50 mm of SI to rainfed wheat at sowing, farmers can increase grain yield by more than 60%, adding more than 2 tons/hectare to the average rainfed yield of 3.2 tons/hectare. The water-use efficiency of irrigation water reached 5.25 kg/m³ with an average of 4.4 kg/m³. These were the highest water-use efficiency values ever reported for irrigation water on wheat.

The substantial increase in wheat yield was a result of applying SI at sowing that allowed an early emergence and optimal stand of wheat plants before frosts in the early winter. Later in the spring, plants with good stand grew more vigorously and yielded much higher than those with late germination. SI water applied later in the spring and early sum-

mer increased grain yield further but with lower water-use efficiency. The results of this research could contribute to substantial improvement in water-use efficiency in Central Anatolia and, consequently, to improved productivity and income for farmers.

The Optimizing Soil Water-Use Consortium (OSWU)

ICARDA, together with ICRISAT and the national research organization of South Africa, is co-convener of the OSWU Consortium, a constituent of the CGIAR Systemwide Soil, Water, and Nutrient Management Initiative (SWNMI). The overall goal of the Consortium is to ensure sustainable and profitable agricultural production in dry areas, based upon the optimal use of available water. OSWU focuses on two broad agroecological zones and their associated production systems: the WANA systems of dryland annual cropping between 150 and 400 mm isohyets (Egypt, Iran, Jordan, Morocco, Syria, and Turkey); and sub-Saharan Africa systems of dryland annual cropping, between the 250 and 800 mm isohyets (Burkina Faso, Kenya, Mali, Niger, South Africa, and Zimbabwe). Turkey is an active partner in the OSWU Consortium, and has hosted a number of scientific workshops under this initiative.

Seed System Development

Development of an effective seed system is an area of strong collaboration between Turkey and ICARDA. During the period 1989 to 2004, a total of 122 Turkish scientists were trained by ICARDA on various aspects of the seed system. A collaborative study with the Mediterranean Exporters Union (MEU), a semi-autonomous body responsible for grain legumes export, provided recommendations on support mechanisms and institutional arrangements that could make the contract growers scheme commercially viable to small-scale farmers. This will facilitate and accelerate the adoption of food legume varieties and associated technologies. Moreover, under the GAP project, ICARDA's Seed Unit has provided technical backstopping in seed system development on alternative ways of introducing new crop varieties such as barley, chickpea and lentil, not covered by the formal sector.

Turkey also actively participates in the WANA Seed Network—coordinated by ICARDA—established to promote regional cooperation and

exchange of information, provide a regional forum for consultation, integrate national seed systems, and promote regional seed trade. The Network is also linked to the Turkish Seed Industry Association whose strong collaboration encourages private sector participation.



Prof. Dr Cuma Akinci, Plant Breeder at Declu University, Turkey, testing the seed processing line established at the University by ICARDA.

Raising efficiency and efficacy of seed production and marketing systems in the WANA region

Turkey participated in a collaborative research project on seed production and marketing systems implemented by ICARDA and NARS in WANA with funding from the German Government in 1999-2001. Other participating countries were Egypt, Ethiopia, Jordan, Morocco, Pakistan, Syria and Yemen. The purpose of the project was to analyze the problem of limited access, particularly of small farmers in the WANA region, to seed from formal delivery institutions and examine alternative ways of making quality seed of new varieties readily available to farmers. A key output of this project was a comprehensive report on "The Seed Sector and Changing Policies in West Asia and North Africa," comprising eight country reports. The report is a valuable reference and working document for technical and managerial staff in national seed programs and policy makers in the region.

HUMAN RESOURCE DEVELOPMENT



Training session for Turkish scientists on post-harvest technologies for seed-quality improvement at ICARDA in 2003.

One of the key components of ICARDA's work is the capacity building in national agricultural research institutions through training of scientists and supervision of post-graduate studies, short- and long-term training courses, conferences, traveling workshops and scientific seminars. More than 500 scientists from Turkey participated in training activities conducted by ICARDA from 1978 to 2004. Areas of training included seed production and technology, crop improvement, cereal physiology, biotechnology, food legume entomology, DNA molecular marker techniques, experimental station operations management, experimental designs and field plot techniques, expert systems, GIS/RS, natural resources management and data analysis, and scientific writing.

At least five scientists from Turkey have obtained PhDs at various universities through research carried out at ICARDA. Dr Ismail Kusmenoglu completed his PhD on screening methods for winter hardiness in lentil. Dr Ali Ramazan Alan, who was a Turkish PhD student at Cornell University in USA, studied genetic diversity in spring durum wheat based on restriction fragment length polymorphism, while Dr Belgin Gocmen, a student at Ankara University, Turkey, carried out research on genomic mapping of economically important traits for Mediterranean highland durum wheat. Drs Taner Akar and Bora Surmeli studied for their PhDs at Ankara University but conducted research at ICARDA on genetic diversity of durum wheat landraces and improving the seed system for resource-poor farmers in Central Anatolia, respectively.

A study to characterize and monitor pastoral and agropastoral systems and associated animal genetic diversity in the Antakia region was conducted in 2002/2003 in collaboration with the University of Cukurova. It was carried out by three graduate students enrolled at the University as part of their research work. The information generated will serve to identify market-oriented and production-improvement options that will integrate flock management, nutrition, range and forage crops, animal health and breeding technologies while maintaining the integrity of the resource base.

LOOKING TO THE FUTURE

The collaboration between Turkey and ICARDA, which has been strong and beneficial to the entire CWANA region and beyond, will develop further especially in areas of cereals and food legumes improvement, livestock production, agricultural products marketing, agrobiodiversity conservation, and capacity building for scientific agricultural research. The Southeastern Anatolia project, which is targeted to continue until 2010, will remain a major part of the Turkey/ICARDA collaboration. Also, collaborative activities within the framework of the joint Turkey/CIMMYT/ICARDA Winter Wheat Improvement Program will constitute a key element of the partnership.

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Acronyms

BMZ	Federal Ministry for Economic Cooperation and Development, Germany
CGIAR	Consultative Group on International Agricultural Research
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo, Mexico
CWANA	Central and West Asia and North Africa
DFID	Department for International Development, UK
GAP	Southeastern Anatolia Project, Turkey
GTZ	German Technical Cooperation Agency
GRDC	Grains Research and Development Corporation, Australia
IFAD	International Fund for Agricultural Development
IRDEN	Integrated Research and Durum Economics Network
IWWIP	International Winter Wheat Improvement Program
MEU	Mediterranean Exporters Union
NARS	National Agricultural Research Systems
USAID	United States Agency for International Development
WANA	West Asia and North Africa
WANADDIN	West Asia and North Africa Dryland Durum Improvement Network