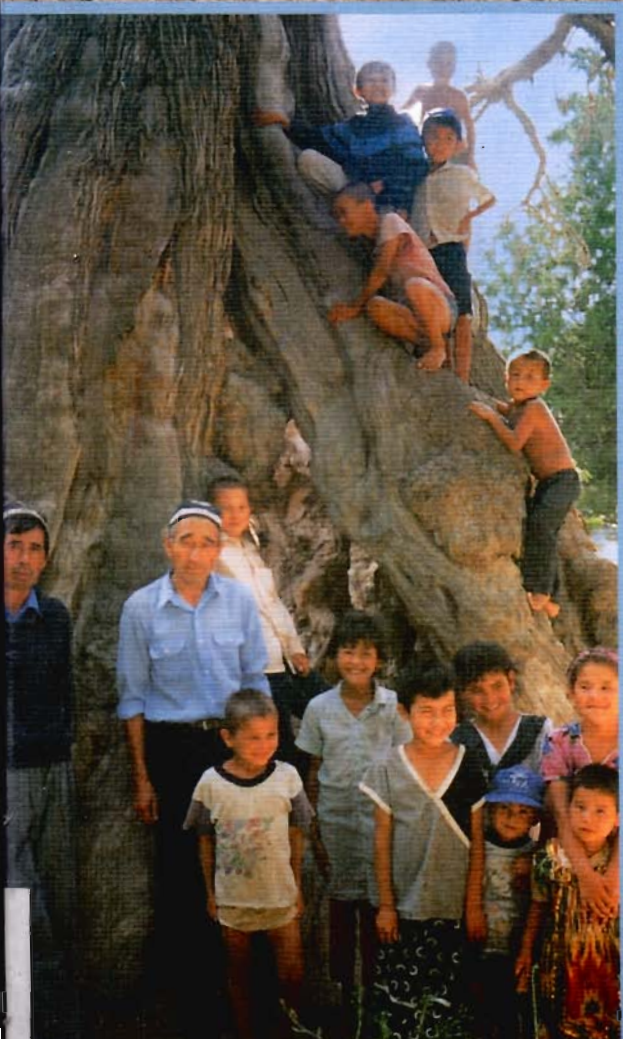
ICARDA Annual Report 1997

International Center for Agricultural Research in the Dry Areas



About ICARDA and the CGIAR

Established in 1977, the International Center for Agricultural Research in the Dry Areas (ICARDA) is governed by an independent Board of Trustees. Based at Aleppo, Syria, it is one of 16 centers supported by the Consultative Group on International Agricultural Research (CGIAR).

ICARDA serves the entire developing world for the improvement of lentil, barley and faba bean; all dry-area developing countries for the improvement of on-farm water-use efficiency, rangeland and small-ruminant production; and the West and Central Asia and North Africa region for the improvement of bread and durum wheats, chickpea, and farming systems. ICARDA's research provides global benefits of poverty alleviation through productivity improvements integrated with sustainable natural-resource management practices. ICARDA meets this challenge through research, training, and dissemination of information in partnership with the national agricultural research and development systems.

The results of research are transferred through ICARDA's cooperation with national and regional research institutions, with universities and ministries of agriculture, and through the technical assistance and training that the Center provides. A range of training programs is offered extending from residential courses for groups to advanced research opportunities for individuals. These efforts are supported by seminars, publications, and specialized information services.

CGIAR

The CGIAR is an international group of representatives of donor agencies, eminent agricultural scientists, and institutional administrators from developed and developing countries who guide and support its work. The CGIAR receives support from a wide variety of country and institutional members worldwide. Since its foundation in 1971, it has brought together many of the world's leading scientists and agricultural researchers in a unique South-North partnership to reduce poverty and hunger.

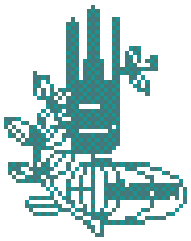
The mission of the CGIAR is to promote sustainable agriculture to alleviate poverty and hunger and achieve food security in developing countries. The CGIAR conducts strategic and applied research, with its products being international public goods, and focuses its research agenda on problem-solving through interdisciplinary programs implemented by one or more of its international centers, in collaboration with a full range of partners. Such programs concentrate on increasing productivity, protecting the environment, saving biodiversity, improving policies, and contributing to strengthening agricultural research in developing countries.

The World Bank, the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP), and the United Nations Environment Programme (UNEP) are cosponsors of the CGIAR. The World Bank provides the CGIAR System with a Secretariat in Washington, DC. A Technical Advisory Committee, with its Secretariat at FAO in Rome, assists the System in the development of its research program.

ICARDA

Annual Report

1997



International Center for Agricultural Research in the Dry Areas

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AGROVOC descriptors: *Cicer arietinum*; *Lens culinaris*; *Vicia faba*; *Hordeum vulgare*; *Triticum aestivum*; *Triticum durum*; *Aegilops*; safflower; *Lathyrus sativus*; *Medicago sativa*; *Pisum sativum*; *Vicia narbonensis*; *Trifolium*; *Trigonella*; chickpeas; faba beans; lentils; feed legumes; soft wheat; hard wheat; barley; clover; shrubs; agricultural development; dry farming; farming systems; pastures; steppes; rangelands; sheep; goats; international cooperation; research; training; germplasm conservation; plant collections; genetic maps; research networks; cold; temperature resistance; disease control; pest control; biological control; nutritive quality; irrigation; seed production; genetic resources; resource management; resource conservation; agroclimatic zones; remote sensing; geographical information system; water harvesting; tillage; stubble cleaning; controlled burning; soil water; uses; environmental degradation; grassland management; reclamation; harvesting; mechanical methods; poverty; rural population; malnutrition; human resources; development; training; computers; biometry; diffusion of information; plant collections; biodiversity; sustainability; agricultural development; Middle East; North Africa; Ethiopia; Sudan; Pakistan; Kazakhstan; Kyrgyzstan; Tajikistan; Turkmenistan; Uzbekistan; Armenia; Azerbaijan; Georgia; Latin America.

AGRIS category codes: A50, A01, E10, F01, F30, H10, H20, H60, L01, U30

Foreword

The year 1997 was an important milestone in ICARDA's life as it marked the 20th anniversary of the Center. It was a year for reflecting on the past—and looking forward.

If one were to identify the most significant achievement of ICARDA over the past 20 years, it is the close partnerships with national programs worldwide, particularly in the West Asia and North Africa region, for which the Center has been commended by its peers. With feedback from its partners, ICARDA's research program has continued to evolve to jointly address the key problems of increasing agricultural productivity, alleviating poverty, and developing human resources in the dry areas. By 1997 ICARDA had entered into 80 formal agreements for collaboration with ministries of agriculture and environment, universities, and advanced research institutes throughout the world.

Of the progress made through these partnerships, three major achievements deserve a mention here. By 1997, over 442 varieties of ICARDA-mandated cereal, legume, and pasture and forage crops had been released by our national partners for their farmers in Asia, Africa, Latin America, and several industrialized countries. The new, high-yielding varieties possess resistance to diseases and pests, and tolerance to environmental stresses. With policy and extension services support from national governments, and combined with improved, environmentally-friendly production practices, these varieties have helped change the face of agriculture in several countries.

To support crop-improvement research, ICARDA has built a strong, modern gene bank—the largest in the Mediterranean region, holding about 111,000 accessions of its mandate crops and their wild relatives. This has been possible through collection missions conducted jointly with national program partners and through donations received from other gene banks. A database on the evaluation and characterization of most of the accessions in the gene bank has also been developed. The material from ICARDA's gene bank is extensively used by researchers worldwide.

By 1997, ICARDA had trained over 7500 persons from 90 countries, and supported the research of over 350 students for MSc and PhD degrees. The impact of this achievement is seen in the establishment of strong research programs in many countries where they did not exist before, and in the maturity of several national programs which now work as ICARDA's equal partners. Several ICARDA-trained scientists now hold positions of responsibility in their countries or in regional and international programs. ICARDA, over the past 20 years, has thus succeeded in generating the necessary momentum—and setting the direction in the global context–for agricultural research in the dry areas and in developing the expertise to conduct that research.

Building on its past achievements and experience, ICARDA developed a forward-looking Medium-Term Plan (MTP) for 1998 to 2000, which stresses the increasing importance of natural-resource management. And it further expanded and strengthened its collaboration with national programs. A major breakthrough in expanding partnerships was with the Central Asian Republics. In September, the first Regional Coordination Meeting for Central Asia took place at ICARDA Headquarters, and was attended by 24 senior research scientists and research administrators from the newly-independent republics of Central Asia. Subsequently, eight CGIAR centers formed a Consortium on Central Asia, with ICARDA as the focal point.

Priorities in the new MTP include soil, which is at risk from wind and water erosion, nutrient depletion and salinity from unsuitable irrigation. The world's dry areas face a worsening shortage of water, so research on water harvesting and on-farm water management will receive greater attention. The priorities also include biodiversity: the plant genetic resources needed to find sources of tolerance and resistance to changing pests and diseases, under a changing climate. ICARDA has learnt from experience that farmer participation in its research program is essential to find appropriate solutions to the problems and to ensure their application in farmers' fields.

Implementation of these priorities meant a review of on-going research and reallocation of resources in 1997. Since national programs, with their enhanced human resource capability in crop breeding, can now undertake greater responsibility, ICARDA is increasingly decentralizing its crop-improvement research. The Center is now involved only in pre-breeding work and development of early-generation material, while the national programs carry forward this research to produce finished cultivars. The resources thus freed are being redirected to research on natural- resource management. The Center has been successful in creating an awareness of the importance of resource management in the countries with which it works, and has introduced it as an important component of the research strategy and work plans of several national agricultural systems. Joint resource-management projects are now underway in those countries where the necessary expertise is available. These projects attach great importance to farmer participation, and to research into property rights and government policies to determine their effects on technology adoption by farmers for protecting the sustainability of the natural-resource base. The use of remote-sensing and geographic information systems (GIS) is also an important component of these joint projects.

The per-capita GDP of over 700 million people in the dry areas is less than USD 2 per day. Poverty in these areas can mean a progressive neglect of, and damage to, natural resources. The knowledge generated from agricultural research can help break the complex cycle of poverty and loss of natural resources. It can help in identifying the factors that lead to the creation of such a cycle, and in developing appropriate solutions. It can offer technologies that would not only help in increasing production but also in generating increased income. Through a participatory approach, agriculture can integrate the poor into the research process, better use their productive capacity, and generate a sense of ownership of natural resources in them. This is the path ICARDA has taken in its new Medium-Term Plan.

The pages that follow provide an overview of ICARDA's research and training activities during the 1996/97 crop season. The Center continues to strive to meet the challenges of sustainable food production, and is better placed than ever before to contribute to poverty alleviation and protection of the environment in the dry areas. The Center is grateful to its generous donors for their continued financial support to, and trust in its work.

Prof. Dr Adel El-Beltagy
Director General

Dr Alfred Bronnimann
Chairperson, Board of Trustees

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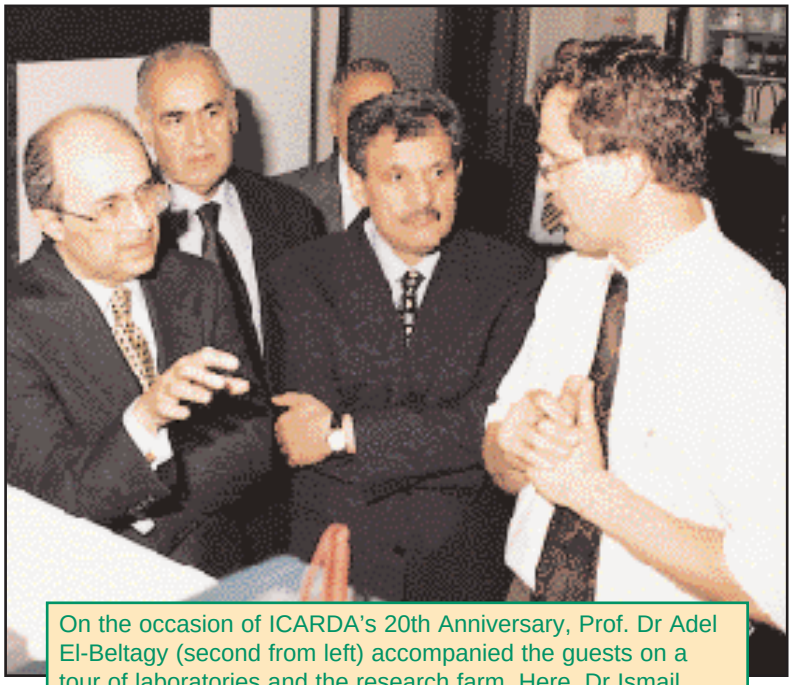
Major Developments in 1997

A Year to Remember

In 1997, ICARDA completed 20 years of its service to agricultural research in the dry areas.

The twentieth anniversary is certainly a significant year in the life of an institute. To celebrate the occasion, ICARDA organized a modest ceremony to review its successes and failures in the company of those who played a key role in its birth, and in developing its mission and program of work. The ceremony brought together some of ICARDA's Founding Fathers; donor representatives; members of the first Board of Trustees and former senior management, including two former Directors General; colleagues from the CGIAR System, including Dr Ismail Serageldin, CGIAR Chairman, Dr Donald L. Winklemann, TAC Chair, Dr J.G. Ryan, DG of ICRISAT, Dr Jeffrey Sayer, DG of CIFOR, Dr G. Rothchild, DG of IRRI, and Mr Alexander vor der Osten, Executive Secretary, CGIAR Secretariat; partners from national agricultural research systems (NARS); and a number of high-ranking officials from foreign missions in Syria. The guests heard presentations from key speakers and saw ICARDA's research in action in the field and laboratories.



On the occasion of ICARDA's 20th Anniversary, Prof. Dr Adel El-Beltagy (second from left) accompanied the guests on a tour of laboratories and the research farm. Here, Dr Ismail Serageldin (left), CGIAR Chairman, and H.E. Assad Mustapha (second from right), Syrian Minister of Agriculture and Agrarian Reform, discuss the use of biotechnology in crop improvement with an ICARDA molecular biologist.

Presentations were made on this occasion by: His Excellency Mr Assad Mustapha, Syrian Minister of Agriculture and Agrarian Reform; Dr Ismail Serageldin, CGIAR Chairman; Mr Abdellatif Y. Al-Hamad, Chairman of the Arab Fund for Economic and Social Development; Dr Mustapha Menouar Sinaceur, FAO Representative in Syria; Dr John van Dusen Lewis, Director of Food Security, USAID; Dr H.J. de Haas, Head of Agriculture Section, BMZ (German Ministry for Technical Cooperation); H.E. Tomio Uchida, Ambassador of Japan in Syria; and Dr Alfred Bronnimann, Chairman of ICARDA's Board of Trustees. All commended ICARDA's achievements and endorsed the future course of its research program.

Prof. Dr Adel El-Beltagy, Director General of ICARDA, summarized the key achievements of the Center and their impact on improving food production, protecting the environment, and strengthening human resources and research infrastructure in developing countries having dry areas.

Preparing for the 21st Century

Building on past achievements and experience, ICARDA took major steps in 1997 to prepare for the challenges of the 21st century. The year saw the completion of the Medium-Term Plan (MTP) for 1998–2000. The new MTP puts ICARDA's future research program in the context of changing global priorities, with a focus on the protection of the natural-resource base. Strengthening and expanding collaboration and partnerships constituted the basic framework within which ICARDA recast the mosaic of its research activities for the medium term.

ICARDA had the privilege of hosting the Mid-Term Meeting of the CGIAR in May in Cairo, Egypt. The Center took the opportunity to show the work of its Nile Valley and Red Sea Regional Program in Egypt to donor representatives,

colleagues from the CGIAR System, and others who participated in the meeting. ICARDA also coordinated an exhibition of the work of all 16 Centers as part of the Mid-Term Meeting. ICARDA's new MTP was approved for implementation at this meeting.

During the year, Center-Commissioned External Review Panels evaluated ICARDA's projects on cereal and legume improvement, genetic resources, information dissemination, and training.

Expanding Collaboration

Collaboration with the Central Asian Republics took a major leap forward. ICARDA accepted the responsibility of being the focal point for providing support through its Tashkent office to the CG-Center Consortium on Central Asia, which was formed at International Centers Week in October 1997 in Washington, DC. Eight CG Centers, including ICARDA, signed an agreement to join the Consortium for their activities in Central Asia. In November, 25 senior scientists and research managers from the Central Asian Republics visited ICARDA to participate in the first ICARDA/Central Asia coordination meeting. ICARDA's collaborative activities in Central Asia are summarized later in this report.

Early in 1997, H.E. the Minister of Agriculture and Fisheries of the United Arab Emirates inaugurated ICARDA's new office in Dubai for its Arabian Peninsula Regional Program. In March, a number of distinguished scientists from the Arabian Peninsula came to Aleppo to hold their regional coordination meeting. The themes addressed at the meeting included rangeland and livestock, protected agriculture, abiotic stresses, on-farm water use, and irrigation management.

At country level, ICARDA continued to maintain close contacts. The Director General held discussions with a number of Ministers of Agriculture during the year which helped promote cooperation with partner-countries. These included China, with which ICARDA has a growing and fruitful collaboration. ICARDA was a part of the CGIAR mission which visited China in November to explore the potential for expanding collaborative work.

Drs Gus Gintzburger (second from left) and Euan Thomson (fourth from left) of ICARDA discuss small-ruminant and rangeland improvement collaborative research plans with Uzbek scientists at Karnap Research Station, near Samarkand.

Collaboration with the scientific community in general continued to grow. A number of workshops/symposia were held at headquarters and elsewhere. In the spring, more than 100 scientists from 33 countries arrived at Aleppo for the Third International Triticeae Symposium; and 60 archaeologists, ethnobotanists, and plant scientists from 23 countries came for the Harlan Symposium on the Origins of Agriculture and the Domestication of Crop Plants in the Near East. July saw a major meeting to discuss animal genetic resources. In the same month, ICARDA and the Jordanian national program organized a successful workshop on indigenous water-harvesting systems. In November, ICARDA hosted the largest-ever livestock meeting on setting livestock research priorities for the West Asia and North Africa (WANA) region. Later that month, participants from 22 countries (and 12 of the 16 CGIAR Centers) met at ICARDA to devise a conceptual framework for fitting property rights and collective action issues into agricultural research. December saw a major workshop on Long-Term Studies in Agronomic Research in Dry Areas. Throughout the year, regular contacts with national programs were maintained through visits, traveling workshops and coordination meetings, to ensure a research continuum between their and ICARDA's research programs.

Partnership with Farmers

Based on its success with including farmers in traveling workshops—an idea first tried in Jordan in 1996—ICARDA invited a number of farmers from the Matrouh Resource Management Project in Egypt to visit Syria and discuss some of the Center's technology with Syrian farmers who have adopted it. Two such workshops took place: in the first, farmers exchanged experience on ICARDA's legume-based technology for rotation with cereals and feed production, and the Egyptian group saw the efforts of Syrian farmers. In the second workshop, another group of farmers saw the water-harvesting technology developed by Syria, and discussed range-management issues.

At the same time, ICARDA's participatory breeding approach continued to involve farmers as partner-breeders in crop improvement. As part of this approach, first-year selections of barley lines were made by farmers in Syria. Farmer-managed on-farm experiments began in the olive groves in northwest Syria, with the aim of finding control strategies for soil exhaustion and erosion. The Mashreq & Maghreb Project continued to help national programs integrate farmers into the planning of natural-resource conservation work, and this gave encouraging results, with farmers taking increasing responsibility for environmental protection. The Latin America Regional Program continued to strengthen its work with the Ecuadorian national program on its farmer-participatory barley-production project.

The Weather in 1996/97

Exceptionally heavy rains fell in Somalia and parts of eastern Ethiopia during the autumn, a period normally considered a minor rainy season in the area. Widespread flooding severely damaged the crops in the field. In other parts of Ethiopia, and in Eritrea, Sudan and Yemen, the summer-season rainfall was not enough, causing below-average harvest. The unusual weather conditions in the Horn of Africa during the second half of 1997 are attributed to the El Niño phenomenon.

Around the southern shores of the Mediterranean, from Morocco to Jordan and Cyprus, fairly dry conditions prevailed during the growing season, causing yield levels to fall below average, but no major crop failures were reported. In May, Egypt was hit by abnormally high temperatures and violent dust storms, which negatively affected the irrigated crops.

In Syria, Lebanon, Iraq, and Turkey, weather conditions were generally favorable and yield levels ranged from slightly below average in Turkey to well above average in Syria. In Syria, this was due to good rainfall in December/January and March/April.

Generally favorable conditions for crops also prevailed in the Caucasian and Central Asian Republics, and in Iran and Afghanistan. In Georgia, Armenia and Azerbaijan, heavy rains and snowfall during winter laid the ground for a good harvest, although excessive rains in June caused damage and flooding, which was especially widespread in Azerbaijan. Heavy winter snow, creating a good stock of moisture for spring, also benefited yields in Afghanistan, Kyrgyzstan, Tajikistan and western Kazakhstan, while the moisture supply was less favorable in other parts of Kazakhstan, and in Turkmenistan and Uzbekistan.

Agroecological Characterization

A meta-database (DOCUMENT) for storing natural-resource information was developed. This system allows retrieval of information from any document (paper, book, thesis, map, image, etc.) relevant to agroecological characterization, or of the scanned document itself in an Internet-compatible format.

In collaboration with the Moroccan meteorological service, a state-of-the-art interpolation technique for precipitation mapping was developed. This technique allows better precision of rainfall mapping, particularly in areas with rugged topography and with a low density of rainfall gauges. In combination with crop-modeling approaches, the technique will be valuable for assessing site-specific conditions at the farmer and community level.

Collaboration in agroclimatic applications remote-sensing in Southwest Asia was initiated with the Center of Earth Observations, Yale University,

and a first regional Atlas of Climate and Vegetation in the Fertile Crescent was developed. The Atlas demonstrates the potential of AVHRR (Advanced Very High Resolution Radiometer) 1-km resolution satellite imagery for agroecological zoning, and monitoring of water-balance and vegetation response over large areas. The climate analysis part of the Atlas also shows the primary control of climate on land use and agriculture in the region.

Progress was made during 1997 in developing a network on agroecological characterization. Missions were organized in Central Asia and the Arabian Peninsula. Environmental degradation, particularly depletion of water resources and range degradation, and germplasm adaptation to specific ecological conditions, were identified as the major areas for collaborative research.

To acquaint potential collaborators with the approaches, principles and techniques of agroecological characterization, workshops were organized in Turkey and Jordan, and a draft guide was prepared.

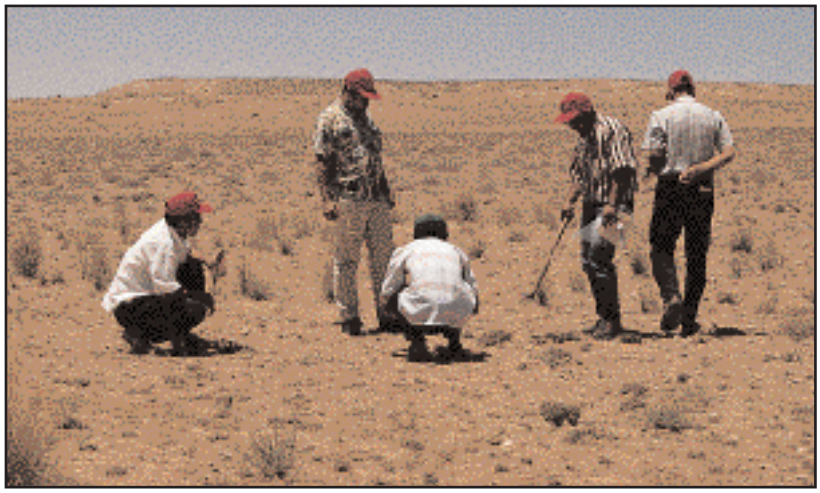
Germplasm Conservation

Collection of Wild Wheats in Syria

A joint collection mission with the Syrian national program on wild wheats explored the Homs, Hama and Idleb Provinces of Syria. Although only two sites with *Triticum turgidum* subsp. *dicoccoides* had been reported earlier for wild wheats in the target area, the mission unexpectedly found all four wild *Triticum* spp. The most frequent was *T. dicoccoides*, followed by *T. urartu*. Two close relatives of wheat, *Aegilops speltoides* and *Ae. searsii*, were found in the same dry area, about 1 km from the *T. urartu* site. This represents an ecological margin for *Ae. speltoides*, which usually occurs in higher-rainfall zones. For *Ae. searsii*, this was the northernmost limit of geographical distribution, as the nearest site reported for the species is located more than 200 km south, near Ba'albek in the Beka'a valley in Lebanon. *Triticum monococcum* subsp. *aegilopoides* (= *T. baeoticum*) and *T. timopheevii* subsp. *armeniacum* (= *T. araraticum*) were found in one site each. The *armeniacum* new site extends the geographical distribution of this taxon in the western part of the Near East arc some 100 km to the south. The findings of this mission indicate that wild wheats distribution in the western Fertile Crescent region is more continuous than previously thought, and the existing gaps between nearest sites usually do not exceed 100 km.

Collection of Rangeland Species in the Oujda Region of Morocco

This collection covered 43 sites over an area of 2200 km and rainfall zones of 180 to 500 mm. Samples were collected at intervals of 10–15 km along the collection route. Over 385 accessions of at least 60 species were collected. *Stipa* spp. was most frequent (51 accessions of four species); other species collected were *Heliantheum* spp., *Herniaria* spp., *Paronychia argentea*, *Schismus barbatus*, and *Thymus* spp. Another important rangeland plant, *Artemisia* spp., was found frequently but was not collected as it sets seed in the autumn. In areas where there was protection from grazing, vetch and medic species were collected. In addition, the relative frequency of each range species was measured at each collection site at 100-meter transects.



Moroccan and ICARDA researchers collecting rangeland species at a site in Morocco.

Collection of Pasture and Forage Germplasm in Spain

A collection mission was organized in Spain with INIA (Instituto Nacional de Investigacion y Technologia Agraria y Alimentaria), Madrid. Over 363 accessions of *Vicia, Lupinus, Trifolium* and *Biserula* species were collected from the provinces of Andalucia, Valladolid and Salamanca, and the administrative region of Extramadura. Soil samples and climatological data from collection sites were taken for ecogeographic analysis of the distribution of rangeland species, and to determine the factors that influence the distribution of the target species in Spain. Samples were collected at intervals of 10–15 km along the collection route.

Germplasm Enhancement

Participatory Barley Breeding

Decentralized selection is a powerful methodology for developing new cultivars of crops suited to specific environments. At ICARDA, the concept of farmers' participation in breeding for specific adaptation emerged from a close study of genotype × environment interactions. The concept was implemented in 1996/97 through a participatory breeding project supported by BMZ. The project began by planting 208 different barley populations in nine villages, stretching from Hama Province in central Syria to Hassakeh Province in the northeast of the country. These areas represent the various agroecological zones where barley is grown.

Barley grain yields ranged from as little as 0.28 t/ha to as much as 3.7 t/ha. The same populations were also planted at two of ICARDA's research stations in Syria, namely, Tel Hadya (favorable environment) and Breda (low-rainfall environment), where grain yields were 4.4 t/ha and 0.8 t/ha respectively.

Participatory selection was carried out in 1997 as follows: (i) individual selection by each participating (host) farmer in his/her own field; (ii) individual selection by each participating farmer at Breda and Tel Hadya–each farmer was assisted by a researcher in recording both quantitative and qualitative data; (iii) individual selection by a barley breeder of the Directorate of Agricultural and Scientific Research, Ministry of Agriculture and Agrarian Reform, Syria, in each of the nine farmers' fields as well as at Breda and Tel Hadya; (iv) group selection by neighboring farmers in five of the nine villages. At the end of this exercise, each farmer was asked to identify the best 15 entries and rank them.

The data indicated that, in a high-yielding environment, both farmers and the breeder selected mostly improved barley cultivars; in low-yielding stressed environments, they selected mostly landraces. This suggested that, at least for broad categories, selection was driven by the environment. In such situations, decentralization should help improve breeding efficiency even without farmer participation.

When a comparison was made of individual lines selected by each of the participating farmers and by the breeder in the two research stations and in the farmers' fields, it was evident that, although the environment had a strong influence on selection, the individual-farmer preferences played a determinant role in selecting a specific line. This experiment also demonstrated that farmers were happy to participate in the selection process, and they were able to record and interpret their observations working with the breeders.

Farmers selecting barley lines according to their own criteria in an ICARDA/BMZ participatory barley breeding experiment in Syria.

Genetic-Linkage Maps of ICARDA Crops

Molecular-marker techniques are used to identify genes for specific traits in all of ICARDA's mandate crops. Here, PhD student Ismahane El-Ouafi uses molecular markers to screen advanced durum wheat lines for grain quality.

Genetic-linkage maps are useful in identifying specific traits in crops. A genetic linkage map in barley was developed using the cross Tadmor × WI2291 in collaboration with the University of Munich, Germany, and molecular markers for powdery mildew and scald were identified. The conversion of these markers into easy-to-use PCR (Polymerase Chain Reaction) markers will allow marker-assisted selection for these two traits in the barley program.

A core set of mapped barley microsatellite markers (170) has been generated in collaboration with scientists from the Scottish Crop Research Institute (SCRI).

Twenty-four mapped microsatellites are being used to study the extent and distribution of genetic diversity in 125 barley landraces from Syria and Jordan (25 lines from five collection sites ranging from southern Jordan to northeast Syria). Preliminary results indicate high levels of diversity both within each collection site and significant differentiation between sites. Furthermore, the total number of alleles (n=26) revealed in these landraces is greater than in European cultivated and landrace material (n=10).

The application of gliadin and glutenin components and molecular-marker techniques to screen for grain quality was incorporated in durum wheat breeding. Mapping of the populations of the crosses Jennah Khetifa/Cham1, Korifla/*Triticum dicoccoides*//Korifla, and Omrabi 5/*T. dicoccoides*//Omrabi 5, was carried out in collaboration with Cornell University, USA and the University of Cordoba, Spain.

A set of 150 microsatellite markers in chickpea was generated in collaboration with the University of Frankfurt, Germany. This kind of molecular marker is a valuable asset for future mapping projects for a less-researched crop such as chickpea.

A genetic-linkage map in lentil was generated in collaboration with SCRI. This map includes RAPD, RFLP and AFLP markers. This is the first extensive linkage map in lentil and it will allow the addition of more markers which are closely linked to fusarium wilt and reaction to cold.

Durum Wheat Research Networks

To complement and integrate research on the improvement of durum at ICARDA, CIMMYT, NARS and advanced research institutes, a SEWANA (South Europe, West Asia, and North Africa) network was established for the Mediterranean region. For the dry areas in WANA, another network, WANADDIN (WANA Dryland Durum Improvement Network), supported by IFAD, was also established with the aim of setting up national durum-research teams. These teams will benefit from the comparative advantage of each durum-producing country. In Morocco, WANADDIN activities focus on temperate drylands, with emphasis on drought and associated constraints (Hessian fly, root rot, leaf rust, *Septoria tritici*, *Fusarium* spp., and Russian wheat aphid); in Tunisia, on moderate continental dryland, with emphasis on drought and associated constraints (*Septoria tritici* and *Fusarium* spp.); and in Syria, on cool, continental dryland, with focus on yellow rust, common bunt, and stem sawfly. In the mild high-altitude areas, Algeria focuses on adaptation to environments of the Atlas high plateau and on grain quality, whereas Turkey focuses on adaptation in the severe cold areas of the Anatolian plateau and on boron toxicity, zinc deficiency, and grain quality. The WANADDIN network is also used as a means for decentralizing durum research to national programs on breeding, stress physiology, biotic stresses, and grain quality.

Winter Bread Wheat Improvement

Wheat covers large areas of highlands in Iran.

In 1997, ICARDA, in partnership with CIMMYT and Turkey, decentralized its highland winter wheat improvement activities. A senior wheat breeder was transferred from ICARDA's base program in Aleppo to its Highland Regional Program in Turkey.

During the year, about 1800 wheat crosses were jointly made to improve tolerance to yellow rust, common bunt, Russian wheat aphid, zinc deficiency, boron toxicity, drought and cold, and to enhance the nutritional quality of wheat germplasm. Emphasis is also being placed on developing an integrated program to control suni bug, a major insect pest in Turkey and Iran.

Three major winter wheat nurseries were jointly assembled and distributed to researchers in the region for testing and selecting under local conditions. Promising materials were selected by NARS, some of which were proposed or accepted for release in Iran, Pakistan, and Turkey. However, because landraces still cover a major portion of the cereal areas in the highlands, an in-depth study is being conducted to assess the advantages and limitations of landraces, and adapt the breeding methodology to farmers' needs and preferences.

New Faba Bean Lines

New breeding lines were identified which have good resistance to Faba Bean Yellows Necrotic and Bean Leaf Roll viruses. Under frost damage conditions, eight entries yielded an average of 2.2 t/ha. Nine germplasm accessions and 60 breeding lines were found to be highly resistant to chocolate spot and *Orobanche*, respectively. These will be useful in breeding improved cultivars.

Cold Tolerance in Chickpea Lines Derived from Interspecific Hybridization

Research over the years at ICARDA has established that cold tolerance in the wild *Cicer* species is higher than in cultivated chickpea (*C. arietinum*). Eight wild species have been under evaluation. From these, some of the accessions of *C. bijugum*, *C. reticulatum*, and *C. echinospermum* have exhibited higher levels of tolerance to cold, but only the latter two are cross-compatible with *C. arietinum.*

Seventy-eight crosses and three checks were evaluated for seed yield and cold tolerance during autumn (early October sowing) and winter (December sowing) at Tel Hadya (Syria) in 1996/97. Results showed that higher seed yields could be obtained if cold tolerance levels were higher. The following entries were the top 10 in autumn sowing (seed yields between 4467 and 5711 kg/ha): Sel-96TH 11485, -11490, -11484, -11439, -11518, -1716, -11516, -11448, -11409, and -11442. These derived lines also possess good agronomic and quality traits. These findings demonstrate the complementarity of the seed-yield genes between the cultigen and wild species.

Integrated Disease Management in Food Legumes

An integrated disease management project was initiated during the 1995/96 cropping season with the national programs of Ethiopia, Morocco, and Syria. The target diseases were: ascochyta blight (*Ascochyta rabiei*) of chickpea in Syria and Morocco; vascular wilt (*Fusarium oxysporum* f.sp. *lentis*) of lentil in Syria and Morocco; and chocolate spot (*Botrytis fabae*) of faba bean in Ethiopia.

Studies on the integrated management of ascochyta blight of chickpea at different locations in Syria showed that control components such as seed treatment with thiabendazole (Tecto), combined with one application of chlorothalonil (Bravo 500) at seedling stage, reduced disease severity and increased grain yields of winter chickpea cultivars with different levels of blight resistance. The work on integrated management of lentil vascular wilt in Syria showed that partially-resistant and susceptible lentil genotypes, on seed treatment with fungicide benomyl (Benlate), yielded higher when planted early in November, compared with late planting in December and January. Early planting reduced both percent terminal wilt and area under the disease progress curve (AUDPC). The fungicide seed treatment efficacy differed with planting date. In Ethiopia, two foliar sprays of faba-bean cultivars with the fungicide chlorothalonil, combined with early planting, decreased the severity of chocolate spot by 60% and resulted in a yield increase of 35%. These results will facilitate the formulation of appropriate recommendations for farmers.

Biological Control of Aphids in WANA Using Coccinellids

Aphids are a devastating pest of several ICARDA crops. In 1996/97, the role of a new coccinellid (*Harmonia axyridis*) in controlling aphids was studied in Syria. A study was conducted on the performance of this new predator, in comparison with the already established predator *Coccinella septempunctata*, in the laboratory on two aphid species, Russian wheat aphid (RWA, *Diuraphis noxia*) and black bean aphid (BBA, *Aphis fabae*).

Results showed that *H. axyridis* had significantly higher fecundity than *C. septempunctata*. When reared on BBA and RWA, *H. axyridis* laid a total of 1536 and 843 eggs/female, respectively. *Coccinella septempunctata*, on the other hand, laid only 1164 and 218 eggs/female, respectively. The other biological parameters (oviposition period, adult longevity, percent eggs hatched) were similar for the two predators. These data indicate that *H. axyridis* could be a potential predator of aphids in WANA. This predator has been sent to Egypt to be tested on faba bean aphid (cowpea aphid) and wheat aphids (greenbug and bird cherry-oat aphid).

Harmonia axyridis adults feeding on faba-bean aphids.

Grass Pea Nutritional Quality Improvement

Lathyrus sativus (grass pea or chickling) is a popular food and feed crop in many Asian and African countries. ICARDA's objectives in grass pea improvement are to increase the yield potential of this crop, its tolerance to different biotic and abiotic stresses, and its nutritional quality through reduction in the neurotoxin β-N-Oxalyl-L-α-β diaminopropionic acid (β-ODAP) which is implicated in causing paralysis in humans.

A breeding program was initiated in 1991/92 in which 21 high-yielding *L. sativus* lines with their β-ODAP content ranging from 0.27 to 0.75% were

Improved *Lathyrus sativus* lines, with low β-ODAP content, developed at ICARDA.

crossed with low β-ODAP lines. Due to transgressive segregation towards earliness and high β-ODAP content, a large proportion of the F_2 population matured earlier than the parents. Selection was done in F_3, F_4, and F_5 generations for early maturity, small and large seed sizes, white or light-cream seeds, and a β-ODAP content less than 0.1%. A total of 85 families with their parents were grown under rainfed conditions at Tel Hadya and Breda, to assess their yield potential and β-ODAP content during the 1996/97 season. Three families (nos. 19, 80 and 85) showed low β-ODAP content (0.02, 0.07 and 0.06, respectively) and had large white or cream-colored seed. The yield ranged from 0.9 to 1.5 t/ha. Location had no effect on β-ODAP content.

These findings indicate that it is possible to reduce the β-ODAP content in grass pea, but β-ODAP may be associated with the ability of the species to resist biotic and abiotic stresses. This aspect is being investigated.

New Horizons for Seeds

ICARDA expanded the scope of its seed production activities in 1996/97 to include policy issues and economics. This move is consistent with the general climate of development toward privatization. However, national governments face the challenge of providing seeds of the less-profitable crops and in the less-favored areas, which do not interest the private sector. During 1997, the Center organized national training courses on the economics of seed production in Egypt and Ethiopia. Also, a major study on seed production by small-scale farmers was completed in Ethiopia. These steps may help enhance the contribution of the informal seed sector.

In collaboration with the International Livestock Research Institute (ILRI), ICARDA organized a seminar in Addis Ababa in October 1997 in which scientists from 20 countries in WANA and Sub-Saharan Africa participated. The seminar emphasized the need for direct farmer participation in the development of sustainable systems for producing the seeds of pasture and forage crops. An understanding of seed economics at the local level was identified as a key factor in deciding how to organize a reliable supply system which will meet farmers' needs.

Participants in the Forage and Pasture Seed Workshop, held in Addis Ababa, Ethiopia, inspect field plots of grass/legume mixtures.

ICARDA increased its involvement in the seed activities of the Central Asian Republics (CARs). The Center hosted the first training course for 12 seed-production personnel from Kyrgyzstan in May at its headquarters. Later in the year, ICARDA seed scientists visited Tajikistan and Kyrgyzstan to participate in studies of the seed sector. There are special problems common to Central Asian countries, where the transition from centrally-planned agriculture to more diversified ownership and management is demanding new production and supply arrangements. ICARDA is sharing with CARs its experience in WANA on policy issues, regulatory reform, and institutional development to help them restructure their seed sector.

Seed Health Laboratory

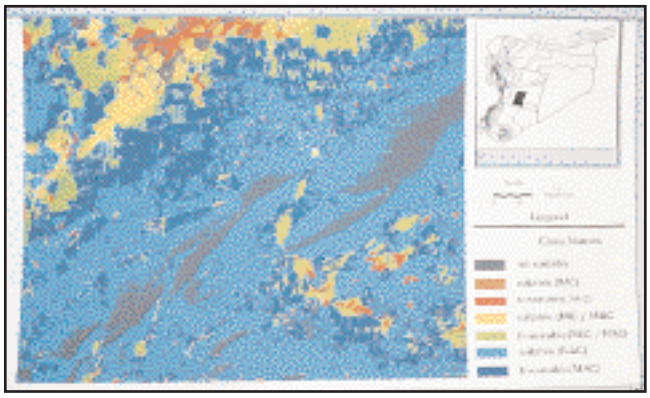
The Seed Health Laboratory, in cooperation with the Virology Laboratory, produced a polyclonal antiserum for virulent Syrian isolates of *Pseudomonas syringae* pv *pisi*, the causal agent of bacterial blight of pea. The antiserum is available for national seed health laboratories.

About 200 accessions of pea, collected from 17 countries and preserved in ICARDA's genebank, were evaluated under artificial inoculation for reaction to *Ps. syringae* pv *pisi.* Thirty accessions of *Pisum sativum* and *Pisum fulvum* were found resistant. The majority of these were collected from Syria and southern areas of Turkey, and are small-leaf types.

Resource Management and Conservation

Use of Remote Sensing and GIS for Water Harvesting

A three-year research project to develop a methodology for using remotely-sensed data and a Geographical Information System (GIS) in the selection of appropriate sites and suitable methods for water-harvesting concluded in 1997. The BMZ-supported project used a pilot area of about 32,000 km^2 in a typical dry land in central Syria to conduct the research. Several landsat TM scenes from different years and seasons were processed and used together with layers of information on topography, soils, and rainfall in a GIS setup to produce a classification of the various conditions associated with water-harvesting. A set of expert criteria was developed and applied to the various conditions required for any method of water-harvesting, resulting in a classification according to the suitability of each method. The methodology developed was verified through field checks. It shows that the methodology can be used in vast dry areas of WANA as it saves the substantial amount of effort that would otherwise be needed for planning large-scale water-harvesting projects. A second phase of the project will start in 1998 with the aim of linking it to the GIS setup of hydrologic models and socioeconomic parameters.



Classification of a dry area in Syria using Landsat images and GIS technology for determining its water-harvesting potential.

Indigenous Water-Harvesting Systems in WANA

The first-year activities of the Inter-Center Initiative on "On-Farm Water Husbandry in WANA" focused on documenting and analyzing the indigenous water-harvesting systems in nine countries of the region. Documents from Syria, Jordan, Oman, Iraq,

Indigenous *Jessour* system of water-harvesting in Tunisia.

Egypt, Libya, Tunisia, Pakistan, and Morocco were presented and discussed in a workshop held in Amman, Jordan in the summer of 1997. The lessons learned from these systems are being used to improve existing water-harvesting systems and to develop suitable systems for various conditions. A comprehensive document on indigenous water-harvesting systems in WANA is under preparation and will be available in 1998.

Tillage Systems and Stubble Management in a Mediterranean-Type Environment

Two long-term trials were established in the 1978/79 and 1985/86 seasons at ICARDA's main research station at Tel Hadya to evaluate the time of tillage in durum wheat (*Triticum turgidum* subsp. *durum*) - lentil (*Lens culinaris*) rotation and tillage systems in bread wheat (*T. aestivum* subsp. *aestivum*) -

chickpea (*Cicer arietinum*) - watermelon (*Citrullus vulgaris*) and durum wheat-lentil-watermelon crop rotation systems, respectively.

In the first trial, two alternative tillage systems were (i) 'conventional tillage' which involves deep discing (25 cm) followed by appropriate secondary tillage to prepare the seedbed, and (ii) zero-till. Conventional tillage represents practices widely used by farmers on similar soils in the wetter zones (>300 mm annual rainfall) of most of the WANA region. It is imposed at three times in the experiment: (i) early (CTE): all operations and sowing before the first rain; (ii) middle (CTM): discing before rain, secondary tillage and sowing after the first rain; and (iii) late (CTL): all operations and sowing after the first rains. Direct drilling of seed is done in zero-till early (ZTE) and middle (ZTM) at the same time as the seeding in the corresponding conventional tillage treatments. The first phase of this trial was designed for studying weed control in a single-crop phase entry and the second phase of the trial started on the same plot in the 1986/87 season to concentrate on time of tillage only in two-crop phase entry.

The second trial was established in a three-course rotation to test the hypothesis that on swelling clay soils, tillage, production costs and energy use can be reduced without causing a reduction in crop yields. Tillage systems compared are two alternative methods of deep tillage (disc and chisel at 25 cm) applied in dry soil, with a shallow and minimum tillage (tyned cultivator; sweep at 10–12 cm) applied after rain and zero-till. All deep- and shallow-tillage systems are followed by an application of appropriate secondary tillage implement after the rain for getting a proper seedbed. Zero-till plots are sprayed by a systemic herbicide for pre-sowing weed control. An auxiliary treatment of stubble burning was imposed on one-fourth of the plots in the wheat phase to test the effect of the practice adopted by farmers for easy seedbed preparation, on soil properties in the long term. Both the wheat and the alternate phases were included each year.

Results of the first study showed that wheat and lentil yields were better under normal planting conditions, as the probability of obtaining rain is higher in November, for both conventional tillage and zero-till. Water use was higher under wheat crop compared with lentil, partly because more water was available for wheat following lentil. However, total water use across the time of tillage practices was similar, providing water-use efficiency values parallel to crop yield levels.

Results of the second study indicated that deep tillage did not result in any advantage over minimum or zero-till systems for moisture storage in soils and increasing yield of any crop grown in the three-course rotations. Zero-till system was good for legume crops, but resulted in lower productivity in wheat and was not suitable at all for watermelon. Minimum tillage, with its highest energy-use efficiency and slightly higher crop yield levels compared with deep-tillage practices, appeared most promising.

Optimizing Soil Water Use in the Dry Areas of Sub-Saharan Africa and West Asia and North Africa

Across wide tracts of Sub-Saharan Africa (SSA) and West Asia and North Africa (WANA), water scarcity is a major factor limiting agricultural production. The concept of a project to stimulate and support research to improve the efficiency of soil water use in the dry areas of SSA and WANA is not new. It arose as part of the CGIAR Systemwide "Soil Water and Nutrient Management Initiative (SWNMI)," begun in 1995. Convened by ICARDA and ICRISAT, "Optimizing Soil Water Use" or OSWU is one of the four consortia within SWNMI. Its first activity was a planning workshop at ICARDA headquarters in Syria in February 1996. Eleven countries from WANA and SSA, as well as ICRISAT Sahelian Center and ICARDA, were represented. The research proposal developed at this meeting was reviewed by the steering committee of SWNMI and incorporated in the full SWNMI proposal submitted in March 1996 to the CGIAR Technical Advisory Committee (TAC) and subsequently approved. However, funding for this proposal could not be found. To respond to the funding uncertainties, the OSWU steering committee met in Morocco in May 1997 and made two decisions:

1. To utilize existing consortium funds (obtained through SWNMI) to (i) commission at the national

level, full-scale review reports of past research on soil water and related issues and also the impact of that research on farm-level practices; and (ii) hold a workshop early in 1998 entitled "Targetting water-use-efficiency technologies to WANA and SSA environments." The general aim is to better define the state-of-the-art in soil water studies in dry areas of the developing world, before initiating new field studies.

2. To seek substantial additional funding to start new field studies, and associated support activities, to be conducted at national level among consortium members. A project proposal for funding has been prepared as a joint venture between ICARDA, ICRISAT, and relevant NARS.

Farmer-Participatory Research to Control Land Degradation in Olive Steep Lands in Northwestern Syria

Large parts of northwestern Syria are characterized by steep, hilly terrain with shallow calcareous soils. The major crop in this area is olive. Olive trees are usually grown as monocrop and planted along the slope. Clean weeding is practised and, where the slopes are not too steep, tractors are used to till the soil up to five times during the rainy season to prevent weed growth and encourage rain infiltration. However, this practice also leads to enormous soil erosion. During the few short but intensive rainstorms, large quantities of the shallow soil are washed away. The signs of degradation are clearly visible and farmers in the area notice a decline in yields.

After an initial participatory appraisal of the land-use practices and problems faced by the farmers in two olive-growing villages, collaboration was sought from the Olive Bureau and the Agricultural Extension Office to assist in the development of alternative land-husbandry practices which would protect the soil and at the same time stabilize the yield.

Over a period of one year, several farmers' days and mutual farmers' visits between the two villages were arranged.

At the end of this awareness-creation and confidence-building effort, the farmers in the two villages agreed to participate in an adaptive research project to test alternative options of olive-grove management and land-husbandry practices. In each village, planning workshops were organized in which experimental treatments were jointly developed and the management arrangements for the experiments agreed.

The trials started with two farmers in each village who provided land with a total stand of about 300 olive trees. The trials will be managed by the farmers themselves. The collection and evaluation of the data will be carried out by the ICARDA team.

Olive trees are a common sight in the steep, hilly terrain in northwest Syria. But olive yields are falling as the soil continues to be washed away by rain. ICARDA is working with farmers in the area to develop suitable technologies that would protect the precious soil and improve olive yields.

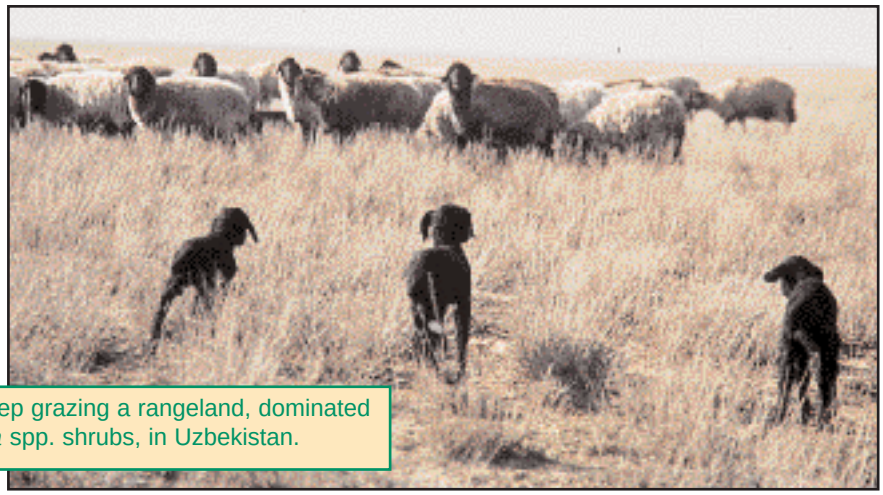
Range Management in Central Asia

ICARDA's first activity on sheep production and range management in Central Asia is a collaborative project with the Uzbek Karakul Sheep Research Institute in Samarkand and the ARS/USDA Sheep Experiment Station at Dubois in Idaho, USA. The project, which is funded by USDA and will continue until September 1999, aims to identify options for the management of the Karakul sheep industry and the rangelands in the Karnap district. The project is also linked with USAID-funded Small Ruminant Collaborative Research Support Project.

A rapid rural appraisal was conducted among flock-owners and a preliminary assessment of the condition of the rangelands was completed. It showed that shepherds employed by the collectives continue to face difficulties following the removal of government support when Uzbekistan became independent in 1991. As a result, size of flocks has become smaller, although the proportion of privately owned animals in them has increased. The size of fully private flocks has also fallen. Owners would like to increase sheep numbers, but seasonal variations in the quality and carrying capacity of the rangelands prevent them from doing so. Thus, as in so many extensive production systems and in the absence of subsidized feed, sheep numbers fluctuate from year to year as a result of variation in rainfall. These fluctuations, however, help control grazing pressure on the ranges, which are generally still in good condition on the collective farms. But the risk of damage to rangelands by cereal cultivation exists, because Uzbekistan is giving particular attention to increasing wheat production.

The main production objective of private flock owners is the sale of fattened lambs and goats or culled adult animals, with less emphasis on Karakul pelts. This is related to the domestic demand for meat. Furthermore, animals can be sold at any time to raise money for family use or to buy animal feed. On the other hand, pelts can only be sold during the short lambing season in spring, and making a profit is difficult since pelt prices have fallen in the face of international competition.

The project is establishing baseline levels of range biomass and species composition by using monthly monitoring at several sites. In March 1998, Bowen-ratio equipment will be assembled at one site to enable continuous measurement of the carbon-dioxide flux above the range vegetation. The CO_2 measurements aim to estimate the potential primary production and the contribution of a representative rangeland type to the global carbon balance, and thus quantify the role of rangeland as a carbon sink.



Karakul sheep grazing a rangeland, dominated by *Artemisia* spp. shrubs, in Uzbekistan.

User-Driven Rangeland Rehabilitation in Turkey

In 1995, the Central Research Institute for Field Crops (CRIFC) and ICARDA initiated a project to rehabilitate degraded rangeland in three districts in Ankara Province. This project involves full participation of the pastoral community, extension personnel and researchers.

As a first step, a Project Steering Committee was established, with representatives from CRIFC, Ankara University, Gazi University, Ankara Agricultural Extension Directorate, and the General Directorate of Agricultural Production and Development. The research team included socio-economists, range and livestock scientists, and extension specialists.

Farmers, extension agents and researchers assess rangeland rehabilitation and management in Kargali village in Ankara, Turkey.

Three surveys were undertaken. A *Mukhtar* (village chief) survey at the village level assessed farming systems and village structure. Information on feeding calendars, size and distribution of land, and flocks was gathered by conducting a general survey at the household level. A botanical survey in rangeland areas in villages aimed at determining sites with potential for rehabilitation.

To implement project activities, two villages were selected: Kargali in Polatli County and Golköy in Kalecik County. They represent the range conditions in the study area. A steering committee at the village level was established to discuss issues related to the project with the rest of the village community.

As a result of the increased awareness of the necessity for adequate rangeland management, the pastoral community deliberately prevented grazing on the commonly used rangeland in Kargali to stop its degradation and allow maintenance of species diversity and a high turnover of biomass. This protected rangeland was overplanted with crested wheatgrass (*Agropyron cristatum*), blue wheatgrass (*A. intermedum*), tall wheatgrass (*A. elongatum*), smooth bromegrass (*Bromus inermis*), and sainfoin (*Onobrychis sativa*).

Another important finding was the potential shown by Hungarian vetch (*Vicia pannonica*) for forage production. This species was introduced to meet farmers' needs for increased feed resources from cultivated land. The species proved adapted and the area planted increased from 6.5 ha in 1996 to 35 ha in 1997.

Impact Assessment and Enhancement

Adoption of Harvest Mechanization of Lentil

During the first decade of ICARDA, a major effort was made to develop economic machine-harvest systems for lentil production, because a rapid rise in the cost of hand-harvesting was discouraging farmers from cultivating lentil. Following the introduction and use of such systems by farmers in Syria and Turkey, a collaborative adoption survey was conducted in these countries.

In Syria, the use of hand labor for harvest was widespread (94% of farmers) in Aleppo, Idlib, Hama, and Dara'a Provinces; however, in Hassakeh Province 57% of farmers harvested by machine. Two years ago, only 19% of farmers practised mechanized harvesting in Hassakeh. Over 80% of the machine-harvesting was done with a combine and the remainder by self-propelled mower-swathers.

In the Urfa Province of Turkey, the survey revealed that over 70% of lentil is harvested by machine.

Demonstration of Rust-resistant Lentil in Ethiopia

Lentil is the highest valued pulse in Ethiopia, and is grown by small-holder farmers on approximately

60,000 ha on vertisols at elevations ranging from 2300 to 2600 meters above sea level. In the 1996/97 season, unusually heavy rainfall in October and November triggered a major lentil rust epidemic in northern Shewa. Thousands of hectares were severely damaged.

However, in the middle of a sea of burned, rusted lentils there was an island of green resistant 'Ada'a' in some of the farmers' fields. These were six half-hectare demonstration plots in the area of this newly-registered, rust-resistant cultivar (ILL 6027). The Ethiopian researchers and staff of the Ministry of Agriculture organized farmers' days at the demonstration sites. Farmers showed a strong interest in the new cultivar, but the challenge now is to provide them with seed. There is already a seed project at Debre Zeit to produce large quantities of lentil seed in the off-season in 1998.

The rust resistance of the new Ethiopian lentil cultivar comes from joint research with the Debre Zeit Research Station and is part of a larger network to produce rust-resistant lentils involving screening for resistance with national programs in India and Morocco, in addition to Ethiopia. Other rust-resistant cultivars have been released by national programs in Bangladesh, Chile, Ecuador, Morocco, and Pakistan. Collaboration among researchers from these countries, with input from USDA/ARS, Pullman, Washington, USA, is also focusing on mapping the lentil rust-resistance genes, and several populations of recombinant inbred lines have been produced.

Rust-devastated lentil in farmers' fields in Ethiopia in 1996/97–but the improved, rust-resistant lentil cultivar 'Ada'a' (left) stayed green and healthy.

On-farm Chickpea Trials in Syria

Three newly-developed chickpea lines, FLIP 88-85C, FLIP 89-29C, and FLIP 90-96C, were identified by the Directorate of Agricultural and Scientific Research (DASR), Ministry of Agriculture and Agrarian Reform, Syria, from ICARDA's Legume International Nurseries. These lines, along with the improved check, Ghab 3, were evaluated in on-farm trials by DASR in chickpea-growing areas in Syria during 1994/95 to 1996/97. FLIP 88-85C ranked number 1 with an overall seed yield of 2164 kg/ha, followed by Ghab 3 (improved check), FLIP 90-96C, and FLIP 89-29C. FLIP 88-85C also possesses larger seed size (33 g/100 seeds), higher level of cold tolerance, and higher level of ascochyta-blight resistance as compared to Ghab 3. The quality traits–including protein content, cooking time, and *Homus Bitehineh* quality–in this new cultivar are comparable with earlier-released cultivars. As ascochyta blight and cold tolerance are the most important traits for winter-sown chickpea, the new line FLIP 88-85C with a larger seed size and improved tolerance to these stressses is a good candidate for release for general cultivation in Syria.

Rural Poverty Indicator

To make general comparisons across countries in the dry areas, a rural poverty indicator (RPI) was developed in 1997. The indicator incorporates per-capita GDP as measure of income, adjusted for differences in purchasing power, differences in income distribution, and the proportion of rural poor in a particular country. The indicator has a value between 0 and 1. The larger the value, the larger the gap between the cross-country welfare poverty line and the per-capita GDP adjusted for purchasing power parity and income distribution of a particular country and, thus, the greater the severity of poverty.

The RPI allows the establishment of differences among and within groups. Even though this indicator

is 'narrow' in the sense that it is based on mean income, it is highly correlated with malnutrition of children below 5 years. Within the WANA low-income group, there are large country-to-country differences; for example, Lebanon with an RPI of 0.04 to Ethiopia and Eritrea with RPIs of 0.83.

Child Malnutrition

Low incomes, low levels of female education, and low public-expenditure for social support have a negative effect on people's diets. Malnutrition of children up to 5-years old is highest in the non-WANA low-income countries followed by WANA medium- and low-income countries. Ethiopia, Eritrea, Somalia, Afghanistan, Sudan, and Iran in WANA have no less than 30% of their children malnourished. Malnutrition is not only a symptom of poverty but it also limits the options of the poor. Malnourished children are unlikely to develop marketable skills and thus will not substantially increase household income.

The impact of agricultural research is greater where there is severe poverty and a large number of poor. If rural poverty is considered as a criterion for ranking the impact of agricultural research, then Ethiopia, Pakistan, Afghanistan and Somalia deserve special attention. Of course, other dimensions such as land and water constraints, value of agricultural and livestock production, biodiversity, or gender issues must also be considered in a balanced approach to assess the impact of agricultural research.

Human Resources Development Unit

The Training Coordination Unit was reorganized and named as Human Resources Development Unit (HRDU).

During 1997, ICARDA offered training to 813 national scientists from countries in the WANA region, other parts of Africa and Asia, the Pacific region, and Europe. Of these training participants, about 38% were trained in courses at ICARDA headquarters, while the remainder were trained in in-country, subregional and regional training courses. About 12% of the participants were women.

Prof. Dr Youssef Wally (left), Deputy Prime Minister and Minister of Agriculture and Land Reclamation, Egypt, awarded certificates to the trainees who participated in the First Regional Course on Expert Systems in Agriculture, held in Cairo. Also seen here are Prof. Ahmed Rafae (second from right), Director of the Central Laboratory for Agricultural Expert Systems (CLAES), Egypt, and Dr Samir Ahmed (second from left), Head of ICARDA's Human Resources Development Unit.

Sixty-four scientists from both developing and developed countries are conducting their thesis research for MSc and PhD degrees at ICARDA. ICARDA continued its strategy of gradually decentralizing its training activities by offering more non-headquarters training courses: in 1997, ICARDA offered 14 headquarters training courses and 30 in-country, regional and subregional courses.

With the recent involvement of ICARDA in the Central Asian Republics, three specialized training courses on seed production and technology, cereal improvement, and genetic resources were organized at ICARDA headquarters and in Uzbekistan.

In addition, ICARDA coordinated and managed training for several external projects. For example, 81 senior officials from the Southern Regional Agricultural Development Project (SRADP) in Syria participated in seven courses organized in Egypt, Cyprus, Kuwait, Morocco, and Spain, and 36 senior scientists and progressive farmers from Matrouh Resources Management Project (MRMP) in north Egypt were trained in 13 courses run by advanced research and training institutions in Germany, Morocco, Syria, and Tunisia.

Collaboration in human-resources development was expanded with regional centers including

ACSAD, AOAD, CIHEAM, and CLAES (Central Laboratory for Agricultural Expert Systems, Egypt).

The Center also collaborated with CIMMYT, IFPRI, ILRI, and IPGRI in conducting training. Inter-center collaboration was strengthened through participation in the IARCs Inter-Center Training Group (ICTG) and exchange of the ICARDA training database with other CG centers.

Information Dissemination

ICARDA's web site received nearly 90,000 hits in over 1700 user sessions, the highest number being in the USA. The job-announcement pages were particularly popular.

Publication of *Caravan*, a public-awareness magazine, continued. The 1997 issues focused on ICARDA's increasing emphasis on natural-resource management in line with its Medium-Term Plan, with coverage of biodiversity and soil conservation being particularly prominent.

Over 78 publications were produced during the year, in addition to color leaflets on rangeland conservation, soils, crop development including lentil and wheat, biotechnology, and training. The *Ties that Bind* donor series was augmented with new or revised titles on Central Asia, China, Japan, Jordan, Italy, the Netherlands, the USA, and Australia. An exciting new venture was the production of a four-page pull-out supplement for *Cairo Times*, timed to coincide with the the Mid-Term Meeting of the CGIAR in Cairo in May.

Ties were strengthened with the Arabic media. This led to the publication of special features on ICARDA in magazines in the Arab world.

An important step forward was the digitalization of 12,000 of the 15,000 slides held in ICARDA's slide library, and the organization and classification of these into an electronic library. Four videos were produced during 1997. A slide/sound video presentation on ICARDA's work was nearing completion at the end of the year.

Thirty-five journal articles and 103 conference papers and poster presentations were processed, and 53 papers from the national programs in WANA were published in ICARDA's *FABIS*, *Rachis* and *LENS Newsletters*. Six Proceedings and two brochures were also produced.

A joint publication on wheat, barley and triticale continued to be produced jointly with CIMMYT. Database updates and bibliography production involved collaboration with a wide range of international institutions and national programs, including CLIMA, ICRISAT, FAO, SR-CRSP and the Syrian national program.

To further strengthen national capacity in publishing, training courses in scientific writing were offered in Eritrea, Iran, and at headquarters. There were 55 participants in these courses. A headquarters training course in information management involved eight participants from seven WANA countries, and four individual courses in information management were provided for eight participants from four countries.

Internally, availability of information to scientists was improved by the computerization of all library holdings. Twenty-one CD-ROMs were mounted on three towers in the library, so scientists can now search a wide range of databases from their desktops. The library has also established a database to keep a record of all the services provided to ICARDA and national researchers. The database will allow the

A view of the CGIAR System-wide display, coordinated by ICARDA, on the occasion of the Mid-Term Meeting, held in Cairo, Egypt in May 1997.

Center to assess the impact both of research publications, and of the information services provided. Preliminary analysis suggests that ICARDA's information services reached over 80 countries in 1997.

Computer and Biometric Services

Major upgrading of computer resources was undertaken, with over 100 desktop and notebook computers, as well as peripherals, acquired to replace old PCs and to meet new requirements. A new computer server running Windows NT was installed for scientific applications. Upgrading of the Center's PCs from Windows 3.1 to Windows 95 operating system was almost completed. A migration to Pathworks (version 5) network operating system enabled the linking of PCs running with Windows 95 to the network. An ICARDA Intranet was established and loading of data initiated.

The data for legume international nursery trials for the year 1994/95 was loaded and analyzed using Trials Management System (TMS). A methodology to differentiate the images of virus-infected plant organs using the calibration and the intensity measures of SIGMASCAN software was established. The FAOSTAT data related to crop and livestock production was converted to ACCESS DBMS for easy retrieval, query, and graph-generation. A joint project for further development of a Wheat Expert System with the Central Laboratory for Agricultural Expert Systems, Egypt and Michigan State University, USA was initiated.

A model for estimation of time-trends in yield from a two-course crop rotation trial was formulated. Applications were made on barley/vetch rotations under two fertilizer regimes at Breda in northern Syria.

A model of yield and water-use efficiency was developed for determining optimum rates of nitrogen and supplemental irrigation. A procedure was developed for detecting the presence of crossover type interaction using the response-environment relationship and assessment of the frequency of crossovers for multi-environment yield data on barley.

An effort has been launched to describe ICARDA data that can be spatially referenced in order to create a meta-database in a UNEP/CGIAR standard format. Setting up a new central GIS laboratory commenced and existing GIS hardware in the Center is being reorganized.

A new database application was developed and implemented for recording and chargeback of photographic services. An application for data management and reporting system for staff travel was developed using ACCESS DBMS. The Medical Bills Processing System was modified to interface with the Oracle General Ledger System. A Personal Account inquiry and reporting subsystem was developed within the Oracle Financials to enable users to query their personal accounts. A Budgeting subsystem was developed within Oracle General Ledger for creating, updating, and inquiring the program budgets directly by the users.

A total of 97 staff from NARS were trained in biometrics, data management, and data presentation in five in-country, regional, and individual training courses. Some 107 ICARDA staff were trained in 11 internal courses covering various software packages.

Outreach Programs

While ICARDA has collaborative research projects with its cooperators throughout the world, its six Regional Programs specifically serve the subregions of North Africa, the Nile Valley and Red Sea, West Asia, the Arabian Peninsula, Highlands in the region, and Latin America. The Center established an office in Tashkent to facilitate smooth implementation of its increased activities in Central Asia. This office is a part of the Highland Regional Program, based in Ankara, Turkey.

North Africa Regional Program

The North Africa Regional Program focuses on research, training, and farmer participation in technology development and transfer in Algeria, Libya, Morocco, and Tunisia (collectively referred to as the Maghreb).

Besides the field research work and training activities, important meetings and workshops were held in North African countries to evaluate and monitor the progress made in research and transfer of technology. The Crop/Livestock Integration Project (Mashreq/Maghreb) held two major activities in North Africa: the Regional Traveling Workshop in Morocco and the Steering Committee meeting in Libya. Participants involved in both activities included scientists and administrators from Algeria, Iraq, Jordan, Lebanon, Libya, Morocco, Syria, Tunisia, ICARDA and IFPRI, and from AFESD and IFAD as donors. Close interaction with farmers was a major feature of the Traveling Workshop. Annual National Coordination Meetings involving Algeria, Libya, Morocco, Tunisia, and ICARDA were held in September and October 1997 to review the research and transfer of technology activities and develop collaborative research and training programs for the coming season.

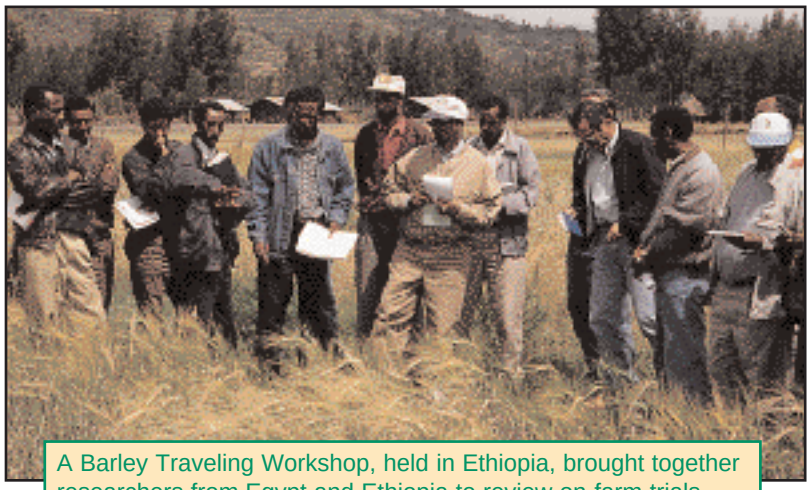
A New Network in the Maghreb

A workshop was held in May at the National Institute for Agricultural Research (INRA), Morocco to establish an Oat and Vetch Network in the Maghreb. This was done in response to a recommendation of the Regional Coordination Meeting between ICARDA and the Maghreb countries held in Rabat in October 1996. ICARDA has undertaken to implement this recommendation in coordination with the Maghreb countries, with assistance from FAO.

The objectives of this network are to strengthen cooperation among Maghreb countries in promoting research on oat and vetch, technology transfer, and the development of the seed-production sector.

Nile Valley and Red Sea Regional Program

The Nile Valley and Red Sea Regional Program (NVRSRP) is based on tripartite collaboration among the NARS of the Nile Valley countries—Egypt, Ethiopia and Sudan—and Eritrea and Yemen; donors (European Union, The Netherlands, The World Bank); and ICARDA. It covers a wide range of major food crops, including cool-season food legumes and cereals. Natural-resource management is an important component of the work in Egypt. NVRSRP is also involved in adaptive research and provides technical assistance to the Matrouh Resource Management Project in Egypt, and to the Agricultural Sector Management Support Project (ASMSP) in Yemen.



A Barley Traveling Workshop, held in Ethiopia, brought together researchers from Egypt and Ethiopia to review on-farm trials.

Regional Networks

The Regional Networks Project, financially supported by The Netherlands, seeks to strengthen basic and applied research on problems common to the countries of the region. There are six networks in operation under this project in the following areas: wheat rusts, wilt and root-rots of food legumes, aphids and viruses, thermotolerance in wheat, drought in barley and water-use efficiency in wheat, and socioeconomics. National researchers leading these networks continued to cooperate and complement each other's research efforts.

Within the framework of this project, training on integrated pest management and insect-rearing techniques was conducted at the Agricultural Research Center in Egypt. Participants from Egypt, Ethiopia, and Yemen attended. Twenty-four technicians participated in three short courses organized in Egypt and at ICARDA. A joint legume virus survey was conducted in Ethiopia.

Intra- and Inter-Regional Collaboration

A Regional Traveling Workshop on Cereals and a National Traveling Workshop on Cool-Season Food Legumes, both held in Egypt in March, were combined for the first time to enhance interaction between the two groups. A Regional Traveling Workshop on Food Legumes was held in Yemen in which scientists from Egypt, Ethiopia, and Yemen participated. A Regional Traveling Workshop on Resource Management was held in Egypt in April in which scientists from Egypt, Iran, Iraq, and Yemen participated. The objective of the workshop was to introduce to the participants the resource-management model being tested in Egypt since 1994. A Barley Traveling Workshop was held in Ethiopia in October which brought together scientists from Egypt and Ethiopia to review the on-farm trials in northern and central Ethiopia. A National Research Review Workshop was held in Egypt to review the work of NVRSP on cool-season food legumes since 1988, and to develop a strategy for the future.

The Seventh Regional Coordination Meeting of NVRSRP was held from 3 to 4 September, and the Steering Committee Meeting on 4 and 5 October, in Cairo, Egypt. Scientists from Egypt, Ethiopia, Sudan, Yemen, and ICARDA participated.

Human Resources Development

Eighteen scientists from Egypt participated in international conferences, 90 in individual non-degree training, 80 in in-country training, 136 in a Research Review Workshop in Egypt, 139 in national and regional traveling workshops, and 240 in national and regional coordination meetings. The number of Ethiopians was: in-country short courses, 53; national and regional coordination meetings and traveling workshops, 75.

Within the networks project, 22 scientists/technicians from Egypt, Ethiopia, Sudan, and Yemen attended short courses, 12 made scientific visits, 6 attended traveling workshops, and 47 participated in the regional coordination meeting in Egypt. Within the Agricultural Sector Management Support Project (ASMSP), 12 Yemeni scientists received degree training (MSc or PhD) and 6 attended a traveling workshop in Yemen.

ICARDA-Yemen

In collaboration with the Agricultural Research and Extension Authority (AREA), Yemen, ICARDA continued to support the implementation of the ASMSP, funded by The World Bank, in the Republic of Yemen.

Research for Rapid Impact (RIP). The work aimed at demonstrating the potential of technologies developed by AREA to the farmers for increased adoption. A total of 58 technologies were tested or demonstrated throughout the country. Participatory farming systems research approach was introduced in planning, implementation, and evaluation of RIP activities. Field days were also organized for policy-makers, donors, researchers, extensionists, and neighboring farmers.

A saltbush plantation in Yemen.

Research Strategy. A draft research strategy for AREA was developed which was approved by the Governing Board of AREA.

Strengthening Research Management and Coordination. A national research coordination and planning meeting was organized in September to review AREA research activities and to identify collaborative research areas with focus on rainfed agriculture.

West Asia Regional Program

The West Asia Regional Program (WARP) provides mechanisms for implementing collaborative research and training activities with Jordan, Syria, Iraq, Lebanon, Cyprus, and the lowlands of Turkey. The program continued its activities on technology development and transfer in both crop and animal production through the Mashreq and Maghreb (M&M) Project, which is funded by AFESD and IFAD. Policy and property rights components have become an integral part of the activities on transfer of technology. Moreover, water issues are gaining more focus through the water-harvesting in WANA project.

Intra- and Inter-Regional Collaboration

To promote cooperation among the Mashreq and Maghreb farmers, a traveling workshop was organized in Morocco in May 1997. Farmers from Algeria, Libya, Morocco and Tunisia, and technical staff from the eight countries of the project participated. An expert from Iraq visited North Africa to demonstrate the production of feedblocks from agro-industrial by-products as a feed supplement for small ruminants. And a group of scientists from the Mashreq countries visited Tunisia to gain experience in spineless cactus production and its utilization as feed. The cactus technology is now being transferred to Jordan.

The Third Regional Technical Planning and Coordination Meeting, and a Steering Committee Meeting, of the M&M Project were held in Amman and Aleppo, respectively. These meetings were particularly important as they marked the end of Phase I of the Project and the preparation for the implementation of Phase II.

Algerian, Libyan, and Tunisian farmers participated in a regional traveling workshop organized in Morocco.

A coordination meeting with the Economic and Social Commission for Western Asia (ESCWA) was also held in Amman to identify activities for joint implementation.

An international conference "Agricultural growth, sustainable resource management, and poverty alleviation in the low-rainfall areas of WANA," was held in Amman in September. Public and private investment in low-rainfall areas, crop/livestock integration, technology generation and transfer, and rangeland rehabilitation were discussed. The conference was organized by ICARDA, IFPRI, DSE, and NCARTT.

Human Resources Development

A regional training course on agroecological characterization was organized in Amman, from 13 to 23 October. Thirteen participants from Iraq, Jordan, Lebanon, Syria, and Yemen attended the course.

Arabian Peninsula Regional Program

The ICARDA Office for the Arabian Penin-sula Regional Program (APRP), established in Dubai in the United Arab Emirates in 1996, was formally opened in January 1997 by H.E. Saeed Al-Raqabani, Minister of Agriculture and Fisheries, UAE, and

Prof. Dr Adel El-Beltagy, Director General of ICARDA. In addition, the UAE kindly agreed to provide experimental areas for research, as well as offices, at the Agricultural Research Station in the Central Region at Al-Dhaid.

In March, the first Regional Steering Committee Meeting for Phase II of APRP was held in Aleppo. Four main research themes were identified: (i) rangeland, shrubs, irrigated forages and livestock; (ii) protected agriculture; (iii) abiotic stresses; and (iv) on-farm water use and irrigation management.

Collection of forage plants and shrubs brought to Al-Dhaid research station by farmers.

Farmers from the Al-Dhaid region were invited to bring to the research station the desert and mountain forages and shrubs that their goats, sheep and camels grazed, and that they knew to be important. They brought 85 different plant species (21 from the desert and 64 from the mountainous regions), of which 74 were fully identified. They then selected *Pennisetum divisum*, *Panicum turgidum*, *Cenchrus ciliaris*, *Dipterigium glaucum*, *Coelachrum piercei*, and *Stipagrostis plumosa* as the most important forage grasses, legumes, and shrubs. Steps to produce seed of these species were initiated.

Following the Second Regional Steering Committee Meeting, held in Dubai in June, the budget and workplan for the 1997/98 season were finalized.

The UAE, Kuwait, the Sultanate of Oman, Saudi Arabia, and the Republic of Yemen elected to participate in research on rangeland and livestock. Kuwait also volunteered to be the coordinating country.

A questionnaire survey of protected agriculture was conducted, and an ICARDA consultant visited the Arabian Peninsula countries to develop a report on the state-of-the-art in protected agriculture.

At the University of UAE in Al-Ain, forage barley lines were screened for salt tolerance. In addition, work started at Nashshallah, in Abu Dhabi Emirate, to evaluate the potential of *Sporobulus virginicus* as a salt-tolerant forage for camels.

A scientist from ICARDA's base program in Aleppo visited the Arabian Peninsula countries to review the status of research in agroecological characterization, and identify the areas for collaboration.

Highland and Central Asia Regional Program

The Highland Regional Program (HRP), with its regional office in Ankara, Turkey, coordinates and promotes research, training, and information dissemination activities in the highland areas (> 700 meters above sea level) of West Asia (Turkey, Iran, Afghanistan, Pakistan, Azerbaijan, Armenia, and Georgia), North Africa (Morocco, Algeria, and Tunisia), and Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan).

Turkey

Fifteen research projects were implemented by Turkish scientists in collaboration with ICARDA. These included two new activities: development of red lentils for southeastern Anatolia, and Awassi sheep improvement. Work was concluded on socio-economic studies, boron toxicity in barley, and winter/early spring chickpea technology transfer.

Mediterranean Highlands Project. This EC-funded project made good progress by establishing formal linkages among the participating countries–Algeria, Morocco, Tunisia, and Turkey–for the exchange of improved germplasm of wheat, barley, chickpea, lentil and vetches, and scientific visits and information. Several training courses were organized.

Turkey/CIMMYT/ICARDA Winter Wheat Improvement Project: A review of the project activities was carried out in September in Aleppo during the coordination meeting of the joint CIMMYT/ICARDA collaborative wheat improvement program in WANA. As a result, CIMMYT and ICARDA extended their collaborative activities on winter and facultative wheat to Central Asia.

Iran

ICARDA is assisting in the development of the recently established Dryland Agricultural Research Institute (DARI) in Marageh, Iran. An important step has been the inclusion of a 'farming systems' dimension in DARI's research program. This was initiated with a training course "Farm Survey Methodology," conducted at DARI to familiarize researchers with the farmer-orientated research approaches. The ICARDA/Iran project is financially supported by the Islamic Republic of Iran.

The joint farm surveys carried out in Iran helped in identifying constraints to production, developing research plans, and prioritizing research activities. The major food crop, wheat, has been at risk due to a number of biotic and abiotic stresses. Wheat yellow rust has become the most devastating disease in recent years. To overcome this, research activities were expanded for the identification and release of genetically diverse cultivars.

Agricultural policy-makers from Iran get into the field with ICARDA scientists.

The following bread wheat cultivars were released for general cultivation: Gaher, Zagross, and Niknegad. The first improved durum wheat cultivar, Seimareh, was released for general cultivation and seed multiplication program has started. Three cultivars of barley, Ganub, Izch (spring type) and Sahand (winter type), were also released for general cultivation.

ICARDA Board Chairperson, Dr Alfred Bronnimann, and Director General, Prof. Dr Adel El-Beltagy, visited the ICARDA/Iran project to discuss the ways and means to strengthen collaboration in areas of mutual interest.

Central Asia

ICARDA's collaboration with Central Asia was further strengthened. A Liaison Officer was appointed and based in Tashkent, Uzbekistan to promote collaboration with Central Asia. The First Central Asia/ICARDA Regional Coordination Meeting was organized in Aleppo in September, which was attended by 24 senior scientists/research managers from the region. The Meeting identified areas for collaborative research in Central Asia, and initiated action on developing project proposals for funding.

A luncheon meeting on Central Asia, sponsored by USAID and IFAD, was organized by ICARDA during the CGIAR Centers Week in Washington, DC in October 1997. To ensure a coordinated approach in addressing the needs of agricultural research in Central Asia, a Consortium—open to all CGIAR Centers—was formed. Eight Centers with mutual and complementary interest to contribute to agricultural research and development in Central Asia and the trans-Caucasian region joined the Consortium and signed a Memorandum of Understanding. ICARDA was designated as the focal point to support the activities of the Consortium.

CIMMYT and ICARDA signed an addendum to their September 1996 agreement to extend their collaborative research on wheat improvement to Central Asia. However, in Kazakhstan, which is the highest producer of wheat in Central Asia, the wheat research will be led by CIMMYT.

In addition to the supply of improved germplasm of ICARDA-mandated crops, ICARDA's first collab-

Participants in the First Central Asia/ICARDA Coordination Meeting, held in Aleppo. The heads of the delegations from the Central Asian Republics are (front row): Acad. J. Akimaliev of Kyrgyzstan (third from right); H.E. D. Karadurdiev of Turkmenistan (fourth from right); Acad. S. Usmanov of Uzbekistan (sixth from right); Acad B.S. Sanginov of Tajikistan (seventh from right) and Acad. A. Satybaldin of Kazakhstan (third from left).

orative research activity was initiated in Central Asia in June 1997. It was on rangeland and livestock management in Uzbekistan in collaboration with USDA-ARS/Utah State University, Logan. Also, ICARDA and IPGRI/WANA initiated joint activities on genetic resources in the region through a regional network. ICARDA also participated in a SR-CRSP/ University of California, Davis regional project on rangeland management in Central Asia.

Latin America Regional Program

The Latin America Regional Program (LARP), based at CIMMYT in Mexico, cooperates with the national programs in developing improved barley germplasm for the region. Much of the this work focuses on incorporating disease resistance into barley.

A farmer-couple in their barley field . They were among 240 farmers who grew two improved varieties of barley in Ecuador in 1997. The new varieties gave a six-fold increase over the national average.

A workshop was organized with the help of the Netherlands Government in Quito, Ecuador, on the utilization of partial resistance (PR) in various crops, including barley and faba bean. Three researchers from the National Research Institute of Ecuador presented their work with PR in barley.

Faba bean is a new export crop in Bolivia. ICARDA's work in collecting and screening new accessions for chocolate spot resistance is of great importance for the breeding activities in the region.

A new chocolate-spot resistant faba-bean cultivar was identified by scientists in Mexico from ICARDA's international nurseries. In addition to chocolate-spot resistance, Mexican researchers were interested in faba bean plants with short stature. Two dwarf introductions will be used in crosses with tall Mexican cultivars with the aim of improving lodging resistance.

In collaboration with Oregon State University, LARP implemented a Quantitative Trait Loci (QTL) strategy to map the loci responsible for resistance in barley to four diseases caused by fungi and one by a virus, in the Ecuadorian cultivar Shyri. QTLs were located for stripe rust on the short arm of chromosome 5, leaf rust on chromosome 1, scald on chromosome 5, and net blotch on chromosome 3. The location for barley yellow dwarf is different from the *Yd2*.

PART TWO

Research and Training Overview

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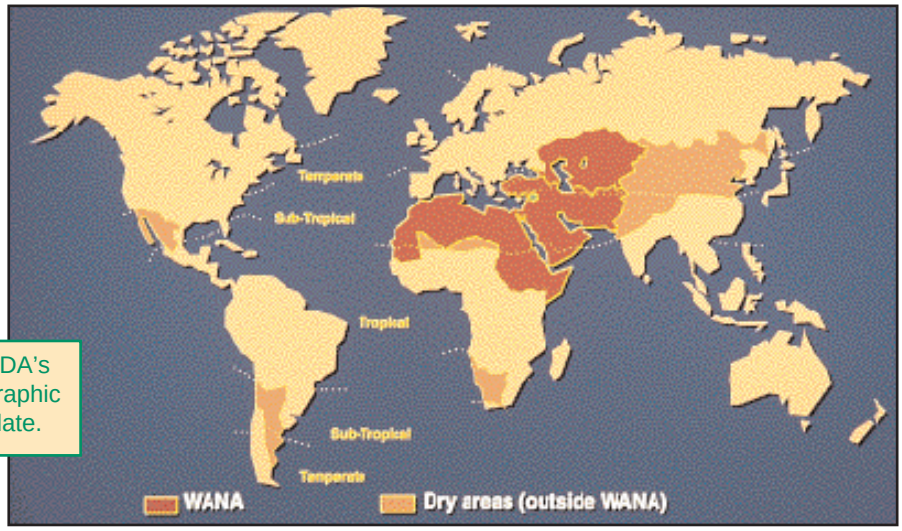
Research and Training Overview

ICARDA serves the entire developing world for the improvement of barley, lentil and faba bean; and dry-area developing countries for the on-farm management of water, improvement of nutrition and productivity of small ruminants (sheep and goats), and rehabilitation and management of rangelands. In the Central and West Asia and North Africa (WANA) region, ICARDA is responsible for the improvement of durum and bread wheats, chickpea, pasture and forage legumes, and farming systems; and for the protection and enhancement of the natural resource base of water, land, and biodiversity. Much of ICARDA's research and training activities are carried out in collaboration with National Agricultural Research Systems (NARS). For certain specialized areas of research, the Center has established linkages with several advanced institutions in industrialized countries (see Appendix 7). The Center has identified seven integrative activities central to its current research program. These are: agroecological characterization, germplasm conservation, germplasm enhancement, resource management and conservation, training and networking, information dissemination, and impact assessment and enhancement. Each activity is a multidisciplinary effort with well-defined objectives and program of work, designed to contribute to the Center's overall goal of achieving sustainable increases in crop and livestock productivity, while protecting the environment.



ICARDA's geographic mandate.

At its headquarters at Tel Hadya, about 35 km southwest of Aleppo, Syria, ICARDA conducts research on a 948-ha farm. The Center operates four additional sites in Syria and two in Lebanon (see Table 6, p. 61). The report that follows represents only a selection of important results achieved in collaboration with NARS during the 1996/97 cropping season. Progress in transfer of technology and strengthening partnerships with NARS is summarized under "Outreach Programs." A full report of each major Program/Unit is available from the Information Unit on request.

The Weather in 1996/97

Global weather during 1997 was marked by one of the strongest outbreaks of "*El Niño*" during this century. *El Niño* is a circulation irregularity of the tropical Pacific Ocean which is observed at irregular intervals every few years, with written records going back to the fist half of the 16th century. It is characterized by an increase of the sea surface temperature spreading eastward across the Pacific Ocean and by concurrent changes of weather patterns which propagate all through the tropical region and beyond. In WANA, the 1997 *El Niño* affected primarily the countries of the Horn of Africa during the last quarter of the year, while its influence in the Mediterranean Region and in Central Asia could not be distinguished from the random season-to-season weather fluctuations typical of semi-arid climates.

In Somalia, southeastern Ethiopia and Kenya, persistently heavy rains from mid-October onward caused serious floods and extensive damage to infrastructure. The period is normally considered the minor rainy season of the year in Somalia, but in 1997, the freshly planted crop was largely destroyed by floods. The heavy rains even reached central Ethiopia, usually rainless during this part of the year, interfered with the harvest, and damaged much of the main-season crop.

Sudan was similarly affected by unreliable precipitation during the rainy season. September was particularly dry. Eritrea fared better, but, here too, the drought during September crushed hopes for a good harvest. Rainfall in Yemen was not enough to produce a good crop. In other parts of the Arabian Peninsula, growing conditions for irrigated crops were generally favorable.

In the Maghreb countries, dry conditions prevailed during the 1996/97 season. In Morocco, November was much wetter than average, but precipitation quickly declined and February and March were particularly dry. In Algeria, the season started with unusually low precipitation during October and November. The following months brought more, but not enough, precipitation; and February and March were again very dry. Tunisia, too, experienced low precipitation at the beginning of the season. January then brought unusually heavy precipitation, but February was very dry. In the three countries, it is estimated that cereal production was lower than previous year's by 20 to 40%, Morocco being the least affected.

The other Maghreb countries were also affected by drought. Mauritania suffered from very erratic rainfall during July and August leading to widespread crop failure in spite of a good early start of the rains in June. In Libya, precipitation was below normal, and irrigated crops suffered from unusually high temperatures late in spring. In Egypt, high-speed winds combined with high temperatures during flowering and grain-filling periods, adversely affected yields of irrigated cereal crops.

In Jordan, Palestine and Cyprus, crops suffered from below-normal precipitation. In early December, heavy rain in Jordan, however, caused some flooding.

In Lebanon, Syria, Turkey and Iraq, precipitation during the 1996/97 growing season was generally adequate and, except for Iraq, crop yields varied from just below average to above average. In Iraq, the lack of inputs kept agricultural production low in spite of favorable weather. In Syria and Lebanon, the moisture distribution within the season was particularly favorable with abundant precipitation in December/January and March/April, but low temperatures late in the season (the last ground frost at Tel Hadya occurred on 16 April) prevented higher yields. The weather conditions at Tel Hadya in 1996/97 are shown in Figure 1. Turkey experienced quite contrasting weather conditions in its western and eastern parts. While in the east the season started with above-average rain and snowfall from October to December, the western part was fairly dry until February.

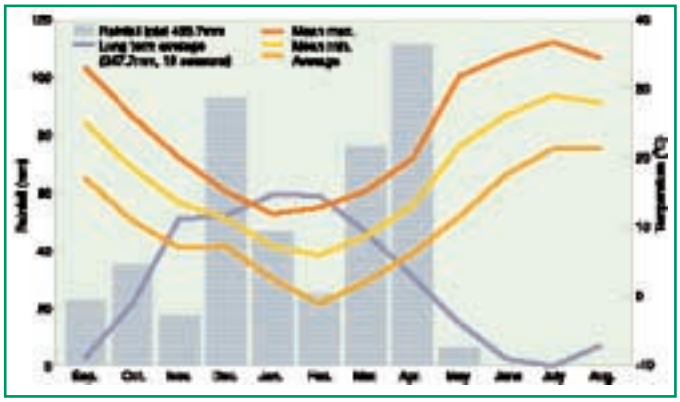


Fig. 1. The weather conditions at Tel Hadya, ICARDA's main research station, during the 1996/97 season.

Generally favorable conditions prevailed in Iran, Afghanistan, and Pakistan. In central Iran, the mid-winter period was drier than normal, but this was compensated by ample precipitation later in the season. Good conditions were also reported from the Caucasian republics. In Azerbaijan, Armenia and Georgia, above-average rainfall and snow during the autumn and early winter laid the ground for a good harvest. Yields could have been even higher, had there not been damage due to late frost and hail in spring and excessive rain and flooding during June and July.

In Turkmenistan, as well as in parts of eastern Kazakhstan and Uzbekistan, precipitation was below average and crop yields suffered, while the western half of Kazakhstan, Kyrgyzstan and Tajikistan had ample winter snow, more than the average amount of rainfall during spring, and generally favorable growing conditions leading to good crop yields.

Agroecological Characterization

Mapping Precipitation in Morocco

Collaboration between ICARDA and Morocco in agroecological characterization led to a novel method

for mapping precipitation. Building on the "Aurelhy method," devised by Météo France, the new method combines a number of statistical techniques—stepwise regression, kriging, principal components analysis, conversions between different types of distribution—and geographic information system (GIS) technology to interpolate precipitation data guided by topography.

Central to the method is the notion of expressing topography not only by altitude, but also by the increase or decrease of altitude in different directions and at different distances away from each point. This set of variables, derived from a digital elevation model (DEM), captures the variation of the local topography around each point. By relating it to precipitation data from meteorological stations it is possible to capture the effects of topography on precipitation: increases on the windward side of obstacles, where the air is forced to move upwards reducing its capacity to hold moisture, and decreases on the leeward side of hills and mountains, where the descending air warms and dissolves the clouds. These effects, once quantified, can be modeled in a GIS with great precision and detail, resulting in more detailed and accurate maps than would be possible by direct interpolation of the data or by purely altitude-guided interpolation.

Figure 2 shows a mean annual precipitation map of central Morocco draped over a three-dimensional representation of the relief as seen from the northwest. It was prepared jointly by scientists from Maroc Météo and ICARDA using the new method of precipitation mapping. Even at this small scale, the great detail with which the spatial distribution of precipitation is reproduced is apparent. With the help of such detailed climatic representations, scientists from INRA will be able to provide truly site-specific information to the farming community.

Another strong point of the new approach is the robustness of its estimates. Evidence for this can be seen in the southeastern part of the map. No precipitation data from this area have been used in the construction of the map, yet, a comparison with published maps in the Atlas du Maroc and elsewhere reveals that the representation of this area is fairly correct, despite the gross extrapolation from one side of the Atlas mountain chain to the other.

While the precision of interpolation achieved with this map is adequate for flat and hilly areas, it could still be improved for the high-mountain areas of the Atlas range. Here the spatial resolution of the digital elevation model used was incapable of representing all complexities of the relief in sufficient detail. Maroc Météo and ICARDA will follow up this work by preparing a set of precipitation maps of Morocco, using a more detailed digital elevation model.

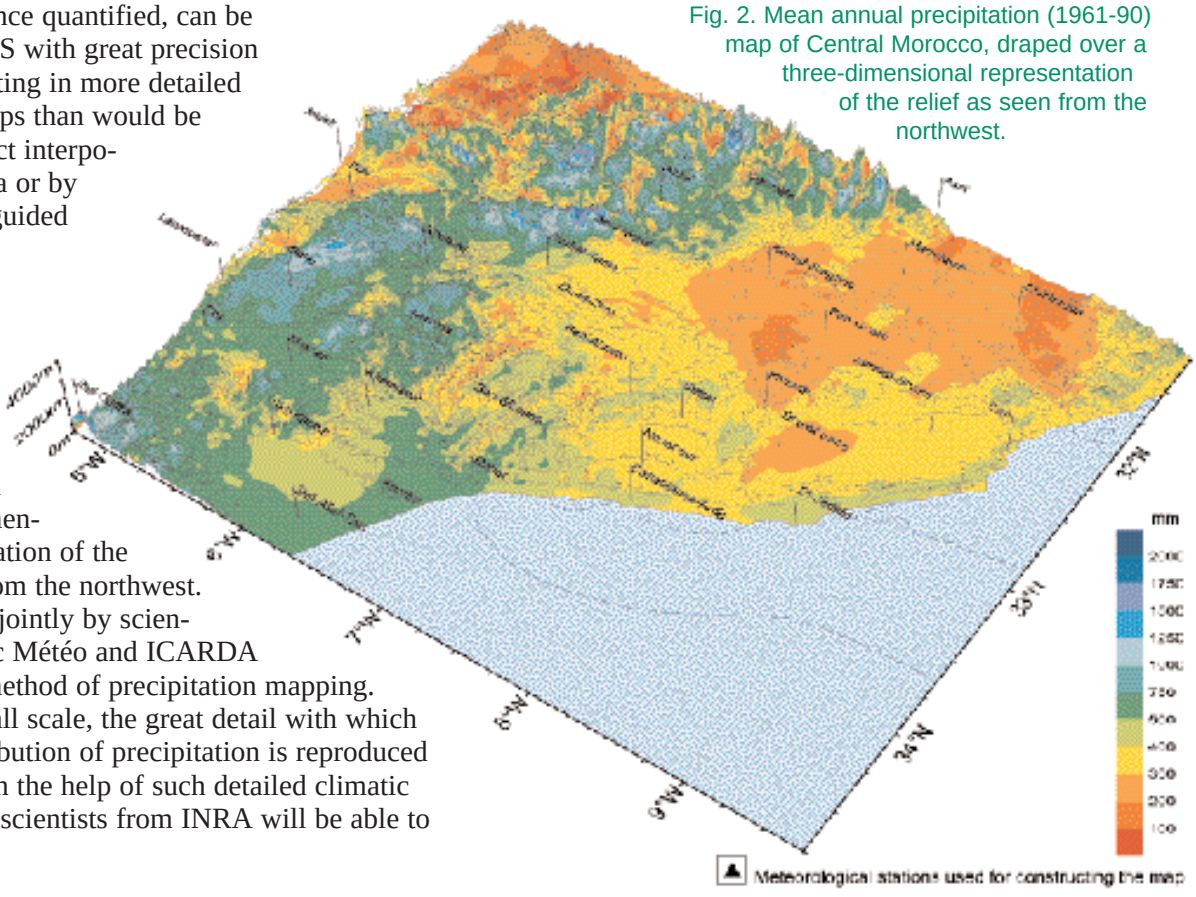


Fig. 2. Mean annual precipitation (1961-90) map of Central Morocco, draped over a three-dimensional representation of the relief as seen from the northwest.

Germplasm Conservation

Germplasm Evaluation

Faba bean germplasm collected from China and Ecuador in 1996 was evaluated for resistance to chocolate spot at Lattakia, Syria. This research was supported by grants from GRDC and ACIAR and was conducted in collaboration with CLIMA, New South Wales Agriculture, and the University of Adelaide. The germplasm from Ecuador had a much larger number of accessions with resistance to chocolate spot than those in the germplasm collected from China (Fig. 3). Compared with other known sources of resistance to chocolate spot, there was a much larger range in flowering dates in the germplasm from Ecuador, and some lines were earlier than 90 days as compared with the improved check variety (Fig. 4).

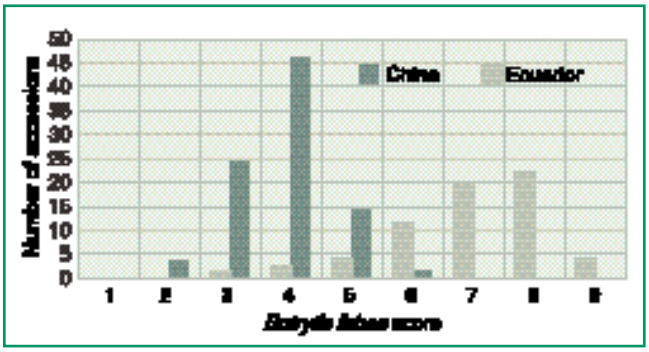


Fig. 3. Distribution of chocolate spot resistance in germplasm collected from Ecuador and China in 1996.

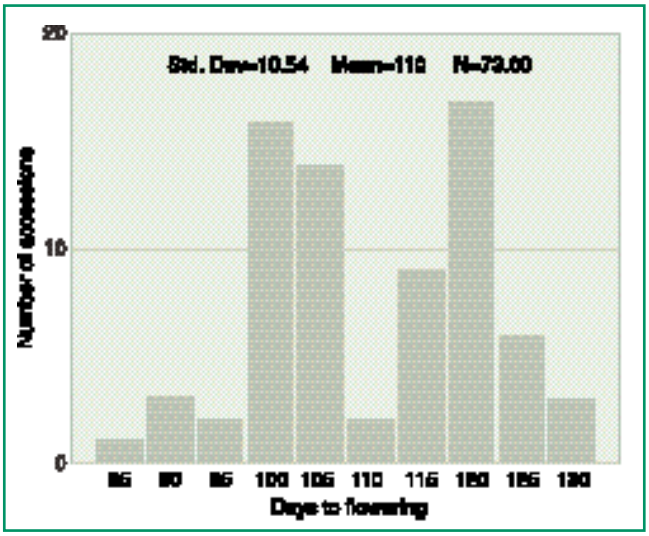


Fig. 4. Distribution of days to flowering for germplasm accessions from Ecuador with chocolate spot resistance score of 4 or less.

Simulated *in-situ* Conservation of Wheat Wild Progenitors in Syria

In collaboration with the Agricultural Research Center (ARC) Douma, Syria, experiments with self-regenerating populations of wheat wild progenitors were started in 1994 at Yahmoul ARC Research Station in Aleppo Province, northern Syria, and in 1995 at two other research stations in the south of the country. The main objectives of these experiments

Self-regenerating populations of cereal and legume wild progenitors in a simulated *in-situ* conservation experiment at Yahmoul research station in northern Syria.

are to: (i) explore the possibility of restoring lost natural populations of wheat wild progenitors using seed of gene bank accessions, (ii) establish self-regenerating local populations of wild *Triticum* spp. and their mixtures with other cereal wild relatives and wild legume species in order to study population dynamics in conditions similar to *in-situ* conservation; (iii) have reference populations for *in-situ* management studies to develop appropriate *in-situ* conservation methodology for cereal wild relatives; and

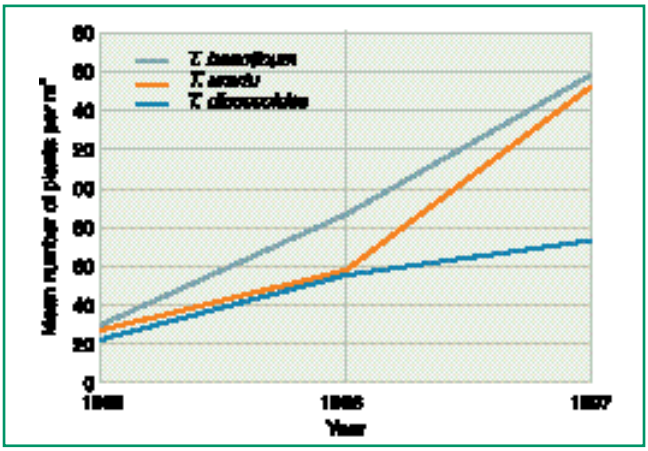


Fig. 5. Increase in plant density of *Triticum* species in an *in-situ* conservation experiment at Yahmoul research station in northern Syria.

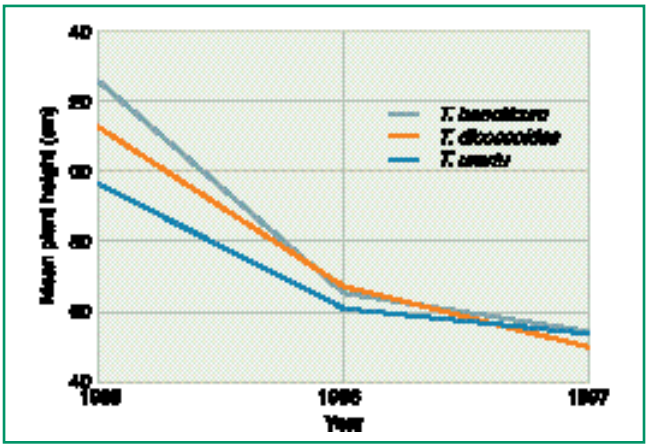


Fig. 6. Plant height of *Triticum* species in an *in-situ* conservation experiment at Yahmoul research station in northern, Syria.

(iv) restore semi-natural plant ecosystems similar to those which had existed in the region before the land was cultivated. The experiments at each station consist of 16 plots of 100 m^2 (10 × 10 m). Population dynamics is monitored in five 1 m^2 quadrates in each plot. There are eight treatments, which include genotype and species mixtures of different complexity, with two replications. The initial planting density was 30-50 spikelets/m^2 in single-species treatments. Results from Yahmoul station show that during the first three seasons the wild *Triticum* spp. competed very successfully with the autochotonous vegetation (mostly weed species) and the number of plants per m^2 increased in diploid species, *T. baeoticum* and *T. urartu*, from approximately 25 in the first season to 150 in the third, and to 70 in tetraploid *T. dicoccoides* (Fig. 5). This plant density and plant height (Fig. 6) of the target species is similar to that in natural populations. Thus, a plot of 100 m^2 should be sufficient for conserving populations of 6,000 to 15,000 plants.

Germplasm Enhancement

New Varieties Released by National Programs

A number of collaborating countries released new varieties of ICARDA-mandated crops during 1997 (see also Appendix 2).

Barley

Iran: Spring-type: 'Ganub' and 'Izeh'; winter-type: 'Sahand'. **Lebanon: '**Assi' (Mari/Aths*2) and 'Faiz' (Er/Apm)—both adapted to the northern Beka'a valley. **Libya:** 'Borjouj' (CI 08887/CI 5761), 'Maknesa' (Deir Alla 106/DL71//Strain 205), 'Ariel' (WI 2291/WI 2269), and 'Irawen' (ER/Apm). **Morocco:** 'Safia' and 'Aguilal'. **Pakistan:** 'Sanober-96'; **Tunisia:** 'Manel', derived from a single-plant selection within an F_2 provided by ICARDA.

Bread Wheat

Iran: (a) Rainfed areas: 'Gaher', 'Zagross', and 'Niknejad'; (b) Irrigated areas: 'Zareen', 'Alvand', 'Darab-2', 'Tajan', 'Mahdavi', 'Atark', 'Almut', and 'Chamran'.

Durum Wheat

Iran: 'Seimareh', 'Korifla', 'Heider'. **Iraq:** 'Omrabi 5', 'Korifla'. **Morocco:** 'Telset'. **Sudan:** 'Waha'. **Turkey:** 'Haran = Omrabi 5'.

Chickpea

Iran: 'Hashem', **Turkey:** 'Gökcee' (FLIP87-8C).

Vetch/Lathyrus

Lebanon: 'Baraka' (*Vicia sativa* 715/2556), 'Ammara' (*Vicia ervilia* 3030/2520), and 'Jaboula' (*Lathyrus cicera* 127/492).

Barley Improvement in Ethiopia

Performance of the recently released cultivar 'Shege' (3336-20) was demonstrated in west Shewa and northwest Ethiopia using an optimum package of seed and fertilizer rates and one hand-weeding, in comparison with the cultivar 'HB 120'. The improved practice resulted in a 53 to 75% higher yield (Fig. 7) and gave a marginal rate of return of 84%, indicating a high probability of acceptance by farmers. An improved production package for barley (cultivar 'HB 42', fertilizer and seed rate and one hand-weeding) was promoted to 52 farmers in west Shewa. These farmers realized a yield advantage of 72%.

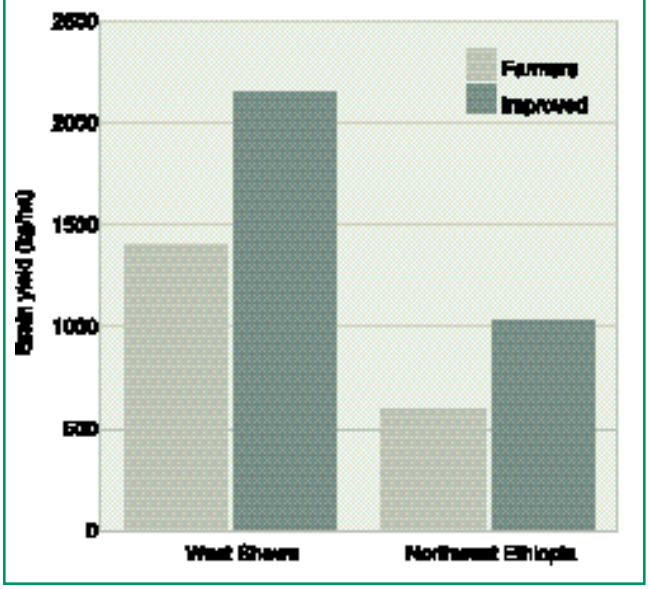


Fig. 7. Grain yield of cultivar 'Shege' using the improved production package in Ethiopia.

Performance of 'HB 42' and 'Shege' was verified in farmers' fields along with a local check at a number of sites in west and northwest Shewa, where the two cultivars had not been tested before. Results are shown in Table 1.

Table 1. Grain yield (kg/ha) of two improved barley cultivars in a verification trial in Jeldu (west Shewa) and Degem (northwest Shewa), Ethiopia, 1996/97.

Cultivar	Degem			Jeldu		
	LM	HM	% increase	LM	HM	% increase
'HB 42'	1717	2502	45.7	2363	3421	44.8
'Shege'	1618	2306	42.5	2758	3419	24.0
Local	1268	1747	37.8	2391	2799	17.1

LM = Low-level Management; HM = High-level Management.

Cold Tolerance in Barley

The 1996/97 season was quite suitable for evaluating cold tolerance in winter/facultative barley germplasm in Turkey, Iran, and Lebanon. In the Central Anatolian plateaux, temperature dropped to –20°C without snow cover. The advanced ICARDA barley lines displayed very good performance. In the observation nurseries and preliminary yield trials, 50-60% of lines showed better cold tolerance than national checks. Some of them combine cold tolerance with high resistance to scald and good yield. As a result of the ICARDA-Krasnodar collaboration, a new cold-tolerant winter barley variety, 'Dobrinya', and spring barley, 'Rubicon', will be promoted to official state trials in Russia.

First Source of Resistance to Barley Stem Gall Midge

The barley stem gall midge (BSGM), *Mayetiola hordei*, is a destructive pest across the Mediterranean region. In Morocco, it causes up to 36% grain-yield losses every year.

A total of 3270 barley lines from ICARDA have been screened in the greenhouse at INRA, Settat, Morocco, for resistance to BSGM. Some 30 lines have shown varying level of tolerance, and one line was heterogeneous for antibiosis.

This is the first source of resistance, with antibiosis as a mechanism of resistance, identified for this pest.

Wheat Improvement in Egypt

Improved practices, including sowing date, seed rate, fertilizer, and herbicide were demonstrated to farmers in different zones. Substantial yield increases (Table 2) were obtained in the demonstration plots. Average grain yield increased from 4.7 t/ha in non-participant farmers' fields to 6.1 t/ha in participant farmers' fields, with an average net benefit of 21%. Several newly recommended cultivars gave 8-14% higher yield compared to the local checks.

Table 2. Pilot production/demonstration plots in different regions in Egypt.

Governorate	No. of fields	Yield (t/ha) Out-of-demo	In-demo	% increase
Sohag	74	5.0	6.6	32
Qena		5.2	6.6	27
Aswan		6.4	6.8	6
New Valley, Qena	42	4.3	5.3	23
New Valley	11	3.4	5.0	47
Fayoum	15	4.8	6.5	34
Minia	25	5.7	6.3	10
El-Bustan	5	2.2	4.1	88

Yield Stability and Adaptation of Spring Bread Wheat in the Mediterranean Drylands

Nearly one-third of the area planted to bread wheat in developing countries is located in marginal environments characterized by frequent drought stress during the growing season. Most of these areas are concentrated in the WANA region where bread wheat is the principal food, with average consumption being 145 kg/capita/year, the highest in the world.

The CIMMYT/ICARDA Wheat Program for the WANA Region seeks to enhance the adaptation and productivity of the crop in marginal environments. NARS in WANA are provided with germplasm sets that combine high yield potential with resistance to biotic and abiotic stresses common in the Mediterranean (continental and temperate) drylands.

The mean yield of the top three cultivars, expressed as percentage of the yield of the local check, at each test site of the Regional Bread Wheat Yield Trial for semi-arid areas is shown in Figure 8. The performance of the local check is indicative of site-specific adaptation. The three best cultivars derived from CIMMYT/ICARDA germplasm yielded more than the locally adapted checks across test sites,

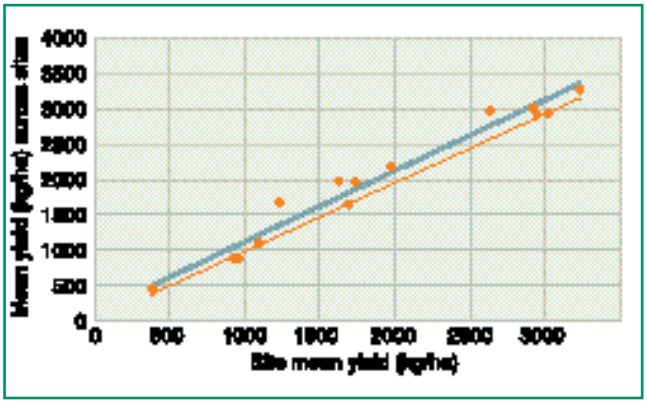


Fig. 9. Performance of 'Tracha-1' across dryland areas of WANA.

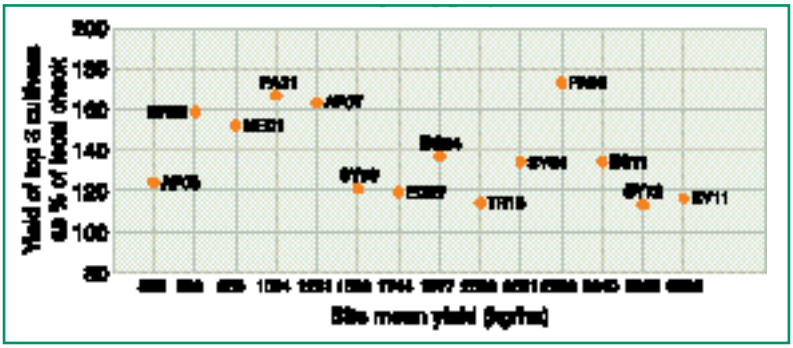


Fig. 8. Performance of some bread wheat lines in the semi-arid areas of WANA.

from 385 kg/ha (Jalalabad, Afghanistan) to 3228 kg/ha (Tel Hadya, Syria). These results indicate that the spring bread wheat improvement program has been successful in providing NARS in WANA with adapted high-yielding germplasm with potential for release as new varieties to enhance wheat production.

In Figure 9, the yield response of 'Tracha-1' is regressed over site mean yields across the 15 test sites of the Regional Bread Wheat Yield Trial for semi-arid areas.

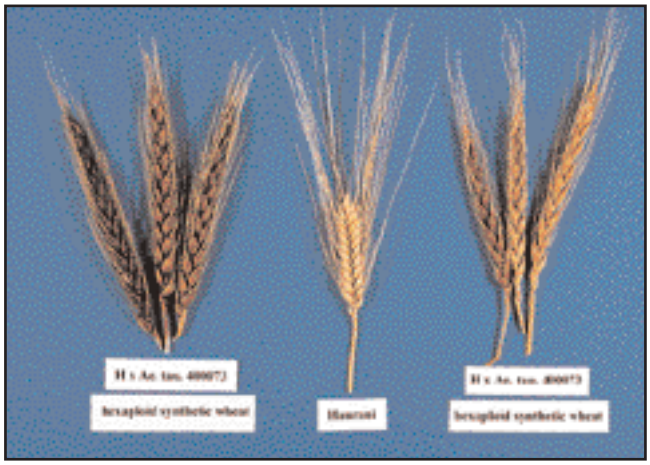
At some sites, the yield of 'Tracha-1' was higher than the site mean yield. This shows that 'Tracha-1' combines high yield potential and stability due to its wide adaptation, a feature commonly found in cultivars derived from the CIMMYT/ICARDA germplasm.

Gene Introgression from Wheat Diploid Wild Relatives

BC_1 plants derived from crosses of durum wheat cultivars 'Haurani' and 'Cham 5' with wheat diploid wild progenitors, *Triticum urartu*, *Triticum baeoticum* and *Aegilops speltoides*, were grown in the plastic house for further backcrossing with the respective durum wheat parent and for seed production after selfing. The plants showed a wide range of variation in morphological traits and fertility. Some BC_1 plants from crosses with *T. urartu* and *T. baeoticum* had more robust stature and spikes than the durum wheat parent, and several of them were resistant to powdery mildew in the plastic house. The number of spikelets in some plants reached as high as 28 spikelets/spike. In total, 138, 90 and 21 BC_2 seeds and 842, 433 and 0 selfed BC_1 seeds were obtained for *T. urartu*, *T. baeoticum*, and *Ae. speltoides* crosses, respectively.

Drought-Tolerant Hexaploid Synthetic Wheat

Two hexaploid synthetic wheat lines, developed in 1996 from crosses of durum wheat 'Haurani' with accessions ICAG 400709 and ICAG 400073 of *Aegilops tauschii*, donor of the bread wheat genome D, were multiplied in the field in the 1996/97 season. They encountered terminal drought and heat stress, as the last effective rainfall was recorded on 14 April, and there was a spell of high temperatures during the second week of May, shortly after anthesis, with daily maximum ranging from 35 to 38°C. The seed harvested was relatively well developed in 'Haurani'/ICAG 400709 synthetic wheat (1000-kernel weight, 34.1 g), while that of 'Haurani'/ICAG 400073 was more shriveled and its 1000-kernel weight was only 27.7 g, equal to that of the bread wheat check Cham 6. Better seed development and 23.1% higher seedweight in 'Haurani'/ICAG 400709 might have resulted from its higher terminal drought and heat tolerance, as the *Ae. tauschii* parent, ICAG 400709, was collected from a 150-mm rainfall site at the margin of the Syrian desert in Raqqa Province.



Two newly synthesized hexaploid wheat lines, using durum wheat landrace 'Haurani' and two *Aegilops tauschii* accessions collected from 150-mm rainfall environments in the Near East.

Vernalization Studies in Wheat for Highlands

Forty-eight wheat cultivars and breeding lines from different parts of the world were vernalized for 6 weeks at 2°C and grown at Tel Hadya in two greenhouses that differed in photoperiod (regular daylight in one, *versus* supplemental light, with 15-hr total photoperiod in the other). Regular daylight varied between 9 and 13 hours during the vegetative phase. Daily air-temperature was kept at the same level (±2°C) in both greenhouses, varying in a sinusoidal manner between 7 and 14°C from planting (end of November) through February, 12-18°C during March through April, and 14-24°C through mid-May. The phenology of the wheat entries was observed throughout the season. The number of days from planting to heading (DH) was significantly reduced by both vernalization and longer photoperiod. In general, the reduction was of 40 days by vernalization and 29 days by longer photoperiod. Although the genotypes responded differently to the two treat-

ments, the trend was qualitatively the same, with a more pronounced effect of vernalization across cultivars, as compared to photoperiod. Three major wheat groups were distinguished (Fig. 10):

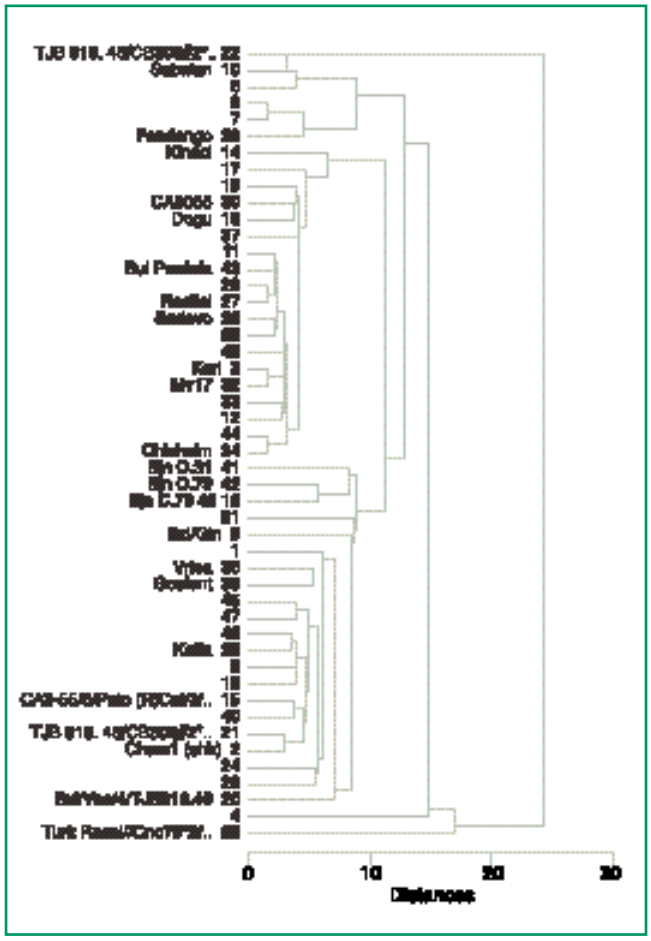


Fig. 10. Dendogram of wheat cultivars based on response to vernalization and photoperiod.

1. **Entries with high response to vernalization and low daylength effect:** The average DH in the case of unvernalized, short daylength treatment was 168 days, which was reduced by 59 days by vernalization and 26 days by longer photoperiod. All entries remained in rosette and did not head when grown in the field in summer at Tel Hadya. This group represents pure winter-types, which most likely possess the *vrn1* gene. It includes the cultivars 'Karl', 'Dogu 88', 'Sadovo 1', 'MV 17', 'CA 8055', and a number of breeding lines.

2. **Entries with moderate response to vernalization and daylength effect:** DH under unvernalized and short-day conditions was 151 days, reduced by 41 and 36 days through vernalization and increased daylength, respectively. Heading did not take place in summer planting, but certain entries entered the reproductive phase in spring (April) planting. Included in this group are 'Vratsa', 'Bjn C.31', 'Fandango', 'Bjhn C.79', 'CHN4184', 'Sxl/Glennson', 'Sabalan', and Sabalan-cross lines.

3. **Entries with low response to vernalization and moderate light effect:** When plants were unvernalized and grown in the greenhouse under regular daylength, they headed, on average, in 125 days. They headed 24 days earlier if vernalized or 34 days earlier if grown under 15-hr daylength. These entries either headed or approached heading in summer planting; they are, therefore, either pure spring-types with dominant *vrn* genes, or semi-winter (or facultative) types lacking *vrn1*. The advantageous earliness of this group, however, is offset by its higher susceptibility to cold, as compared to the other two groups.

Most of the entries in the second group have attributes similar to those of landraces, and should be more useful in most of the highland and continental areas of Central and West Asia and North Africa. Wheat types of the first group are targeted to the more confined severe-winter areas, whereas those of the third group provide sources of intrinsic earliness, and resistance to biotic stresses.

Cereal Pathology

Common bunt of wheat. The use of wheat flour and local skimmed milk as organic seed-treatment to substitute chemical seed-treatment for common bunt (*Tilletia laevis* and *T. tritici*) of wheat gave encouraging results again in the 1996/97 season. Common bunt head infection was reduced by 96% and 74% when seeds were treated with skimmed milk and wheat flour, respectively, compared to the inoculated, untreated control. Moreover, the reduction achieved with the use of these biological products was not significantly different from chemical treatment of seed.

Root diseases in cereals. Root rots and cereal cyst nematodes are becoming important in most WANA countries. Agronomic practices can play a major role in managing soil-borne diseases.

Evaluation of barley production systems in different agroecological zones of Syria was undertaken to identify the factors involved in the development of common root rot (*Cochliobolus sativus, Fusarium* spp.) and the cereal cyst nematode (*Heterodera latipons*) infections. In the dry areas, increase in nitrogen level, plowing, and crop rotation increased the incidence of common root rot. In the wet areas, high infection was found in monoculture and under no tillage. The infection level of the cereal cyst nematode was higher in drier than wetter areas. However, for both areas, barley monoculture, plowing and no fertilizer application led to a high infection level. Therefore, different control strategies should be applied depending on the agroecological zones targeted.

Faba Bean Improvement in Sudan and Yemen

Sudan. Sixty faba-bean genotypes were tested in preliminary, advanced, and verification yield trials. Three of them, namely, 'Wad El-Habashi', 'Mass 55' and 'Berber 1', proved superior. The large-seeded genotypes C42, SML85/2/W, BB25, and C34/1/2/1 outyielded the standard check 'SML'. In addition, many promising selections and crosses were identified. Nine faba-bean entries were found promising against wilt and root-rot diseases, and 13 immune against bean yellow mosaic virus (BYMV).

In a study of population dynamics of aphids and their natural enemies, it was found that aphid infestation increased towards the end of the growing season and then declined as the plants approached maturity. *Chrysoperlla carnia* was the most predominant entomophagous insect and could be used for biological control of insect pests.

Aqueous *neem* seed extract significantly reduced leaf-miner (*Liviomyza* spp.) infestation.

Frequent irrigation (every 10 days) gave the highest grain yield at Hudeiba. At Shambat, irrigation every 7 days increased seed yield by 36% when compared with 14-day irrigation intervals.

Yemen. In a verification trial in farmers' fields in northern highlands of Yemen, the small-seeded cultivar 'Giza 3' proved superior and gave excellent seed yield (5.2 t/ha), which was 113% higher than that of the local variety. Other superior traits included early flowering (56 days) and maturity (126 days), plant height (77 cm), and 100-seed weight (87 g). On the other hand, the large-seeded FLIP 84-14FB gave a yield of 5.6 t/ha, an increase of 100% over the local variety. This cultivar also exhibited early flowering (57 days) and maturity (130 days), and good plant height (104 cm) and 100-seed weight (125 g). Both cultivars have been recommended for release for the highlands region of Yemen.

Diagnostic Reagents for Virus Diseases

Over the last eight years, the Virology Laboratory at ICARDA has focused on the development of diagnostic kits for the detection of viruses affecting cereal and legume crops in WANA. So far, 18 kits for the detection of 4 cereal viruses and 14 legume viruses are available for use by NARS scientists. Each kit has enough reagents to test 2000 plant samples.

The detection kits employ two different techniques; the first is based on the double antibody sandwich ELISA (DAS-ELISA) and the other is based on tissue-blot immunoassay (TBIA). In the

A TBIA kit for the detection of faba-bean necrotic yellows virus (FBNYV) which includes all needed reagents (buffers, sero-diagnostic reagents) as well as nitrocellulose membrane.

development of these kits two types of antibodies, monoclonal and polyclonal, are used. The polyclonal antibodies are produced at ICARDA and the monoclonal antibodies in Germany in collaboration with the Institute of Biochemistry and Plant Virology, Braunschweig.

The TBIA kit includes all reagents needed for the test. The simplicity of the test and its use without the need for sophisticated and expensive equipment (e.g. ELISA reader) is making it very popular in WANA and beyond. During 1997, TBIA kits were used extensively for surveys of virus diseases affecting cool-season legume crops in Egypt, Ethiopia, Pakistan, Sudan, Syria, and Yemen.

Seed Unit

The WANA Seed Network is the main vehicle for coordination and information exchange between national seed programs within the region. It is guided by a Steering Committee—composed of five country representatives (currently Cyprus, Egypt, Lebanon, Morocco and Syria)—which monitors the progress of activities, while ICARDA's Seed Unit acts as the Secretariat in maintaining communication and assisting in implementing recommendations.

The Fifth Network Steering Committee meeting was held in Nicosia, Cyprus in July 1997. All country representatives attended, together with two Secretariat staff and a number of observers from associated seed projects. The Committee undertook a critical review of all Network activities and recommended future actions to improve implementation, participation by members, and communication with the Secretariat. The Committee also agreed to finalize three draft Network publications and to revise two existing documents. More attention will be given to issues of seed policy, variety release, seed certification procedures and private-sector involvement, which are the key to harmonizing seed systems and stimulating regional trade.

The Network Newsletter "SeedInfo" continued to be published. Three country reports were published in the "Focus on Seed Programs" series, covering Cyprus, Lebanon, and Tunisia.

One notable area of expansion has been work on the economics and policy aspects of national seed programs. This is important because many Government and parastatal seed organizations have been given new financial objectives in recent years as a result of budget cuts and expectations of cost recovery arising from the implementation of structural adjustment programs. As a result of this changing financial climate, many countries are seeking new approaches which are more cost effective and sustainable. This often involves the reorganization of existing institutions. In March 1997 ICARDA joined GTZ and USAID in a wide-ranging review of the seed sector in Egypt aimed at privatizing the seed production and marketing currently undertaken by government agencies.

In Ethiopia, two major research studies were carried out, one on the economics of seed production and distribution by smallholders, and the other on the mechanisms of the informal seed sector. Both were intended to assist the national seed institutions in devising new systems of seed supply appropriate to the circumstances and needs of small farmers.

Seed security is an important issue in some countries of WANA where there is risk of drought or crop failure. A study was carried out with funding from USDA to review policy and regulatory constraints that may hinder effective responses to emergency

Training course in seed production for participants from Kyrgyzstan, organized at Tel Hadya.

seed supply at national and regional levels, drawing on the experiences of selected countries in the WANA region. The main objective was to harmonize variety, seed, import-export and quarantine regulations and to link them with information about varieties, seed producers and regulatory services to enable a quick response to emergency situations.

With financial support from GTZ, the first inter-Center conference on seed supply systems was organized by ICRISAT, ICARDA and IITA, in cooperation with the South African Development Community (SADC), in Harare, Zimbabwe in March 1997, under the title "Enhancing Research Impact through Improved Seed Supply: Options for Strengthening National and Regional Seed Supply Systems." The main objective of this workshop was to devise national and regional action plans for improving seed supply systems, with particular reference to the countries of West Asia and North Africa (WANA) and Sub-Saharan Africa. The conference attracted 67 participants including senior policy makers from the public and private seed sectors, NGOs and farmer groups, as well as seed policy analysts and staff from IARCs.

In 1997, five training courses were organized for a total of 79 participants, mostly from the WANA region. Three of these were held at headquarters (variety description, general seed production and a 'Train-the-Trainers' course in seed processing), one on seed testing in Iran, and one on quality control in Egypt. The course in general seed production was specially arranged for a group from Kyrgyzstan. "Train-the-Trainers" courses were also held on the economics of seed production in Egypt and Ethiopia. These courses were attended by 43 participants.

A workshop on Forage and Pasture Seed Production was held jointly with ILRI in Addis Ababa. It brought together 30 participants from 19 countries within WANA and Sub-Saharan Africa. The participants discussed current status of national seed programs, constraints to forage and pasture seed production, and identified areas for future collaborative work.

In line with ICARDA's increasing attention to Central Asia, consultancy visits were made to Kazakhstan and Kyrgyzstan to understand the problems and develop collaborative activities in seed production. The newly independent republics of Central Asia face common problems in restructuring their agricultural research agenda, and this has a direct impact on seed supply systems. ICARDA's experience in policy and economic issues in the WANA region can be of direct relevance to the seed industries in Central Asia.

Resource Management and Conservation

Time Trends of Yields in Barley-Based Long-Term Trials

Trials involving barley in two-course rotations with several forage legumes and fallow, as well as barley monocropping, have been running at two sites: Tel Hadya (wetter) and Breda (drier) for about 15 years. Two other trials to test the effects of different fertilizer regimes on the maintenance of yields of annually monocropped barley have been running for 10 years at the same two sites. Originally, the main purpose of the trials was to compare rotations and fertilizer regimes in respect of annual and rotational productivity. Now the data-sets are also proving useful in the development of statistical methods to identify trends in long-term yields in the context of production sustainability.

Twelve years of data for barley grown in rotation with annual forage legumes, clean fallow or barley (monocropping), with and without biennial nitrogen and phosphate fertilization, show some positive and some negative time trends.

At the wetter site, trend values for grain and straw were all negative in the absence of fertilizer and were mostly positive in its presence; but many values were not statistically significant, and the analysis indicates that for many treatments more cycles of the rotation are required for the detection of significant time trends. The second trial, comparing the effects over nine years of different annual nitrogen and phosphate applications, factorially combined, on monocropped barley, also gave a mix of positive and negative trends; and here also many treatments require more time to establish a significant trend.

Altogether, the clearest result, supported by both trials, was at the drier site, where the grain yield of monocropped barley declined over time irrespective of the use of fertilizer.

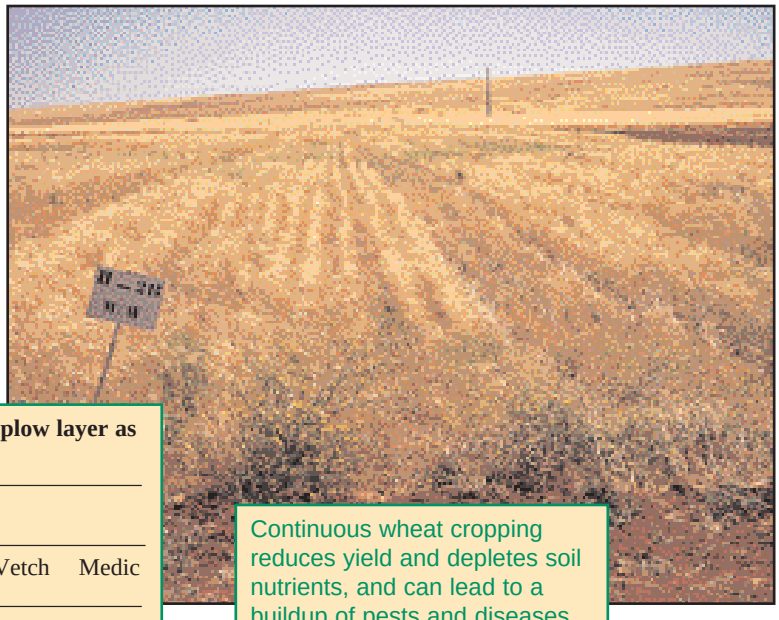
The models used in this analysis were linear with respect to time (years) and allowed for seasonal effects by means of a relationship quadratic on total rainfall and linear on planting date. A more complex model might account for more of the variance and allow significant trends to be identified earlier, but restrictions are imposed by the limited number of years and the choice of meaningful single-valued parameters of growth-season conditions. It was noticed that for many experimental treatments the model accounted for less of the total variance at the wetter site. This may be due to seasonal buffering by soil moisture stored at depth from one year to the next, and future iterations of the analysis will try to allow for this. The appropriateness of the linear time function will be compared with alternative functions.

Indices of Sustainability in a Long-Term Rainfed Wheat/ Legume Rotation

Farming systems in WANA involve rotations of cereals with fallow or food/forage legume crops depending on location and rainfall. Barley (*Hordeum vulgare*) dominates in the drier zones, and bread wheat (*Triticum aestivum*) and durum wheat (*T. turgidum* var. *durum*) in the more favorable areas. Sheep and goats are an integral part of the systems, particularly those dominated by barley.

A long-term trial was established in 1983/84 at ICARDA's main research station at Tel Hadya to evaluate the productivity of systems in which durum wheat is rotated with vetch (*Vicia sativa*), lentil (*Lens culinaris*), chickpea (*Cicer arietinum*), medic pasture (*Medicago* spp.), water-melon (*Citrullus vulgaris*), wheat, and fallow. Varying nitrogen levels (0, 30, 60, 90 kg N/ha) and intensities of grazing stubble (heavy, moderate, none) were imposed on the wheat phase. Both the wheat and the alternative phase were included each year.

The effects of rotation and N were readily apparent, but the effect of grazing stubble was slower in manifesting itself. While seasonal rainfall, which ranged from 210 to 486 mm, and residual soil moisture after the alternate phase dictated the magnitude of wheat yields, N application increased water-use efficiency. Relative wheat grain yields, as compared to yield in the wheat-fallow rotation, were about 95, 85, 85, 70, 70, and 45% following watermelon, vetch, lentil, medic, chickpea and wheat, respectively. One has to remember that wheat yields in 'fallow/wheat' rotation are obtained only once in two years.



Continuous wheat cropping reduces yield and depletes soil nutrients, and can lead to a buildup of pests and diseases.

Table 3. Soil organic matter concentration (%) in the plow layer as affected by crop rotation.

	Wheat following						
Year	Wheat	Fallow	Melon	Lentil	Chickpea	Vetch	Medic
1989	1.06	1.03	1.02	1.12	1.09	1.13	1.26
1990	--	1.0	--	--	1.11	--	1.22
1991	1.05	1.03	1.02	1.09	1.07	1.14	1.21
1992	1.20	1.22	--	--	1.25	--	1.44
1993	1.01	0.98	0.97	1.05	1.12	1.12	1.23
1994	1.14	1.12	1.08	1.11	1.20	1.19	1.39
1995	1.17	1.14	1.11	1.13	1.23	1.32	1.46
Mean	1.11	1.07	1.04	1.10	1.15	1.18	1.32

As the trial progressed, soil indicators of sustainability were studied. With time there was a buildup of organic matter (Table 3) and total N, with values showing the same general variation as yield parameters. Similarly, measurements of aggregate stability (wet-sieved) were higher for the medic plots and least for continuous wheat. Values also increased with N fertilizer level. This index was reflected in infiltration and permeability measurements. Sharp differences occurred in labile and biomass forms of carbon and nitrogen; again values were highest with legumes (medic, vetch) and lowest with continuous wheat. Bacterial biomass, N, and carbon (C) were more sensitive to environmental changes. Measurements of N-mineralization, both in the laboratory and the field, followed the same trend as organic C and total N. Net mineral N showed a strong seasonal effect.

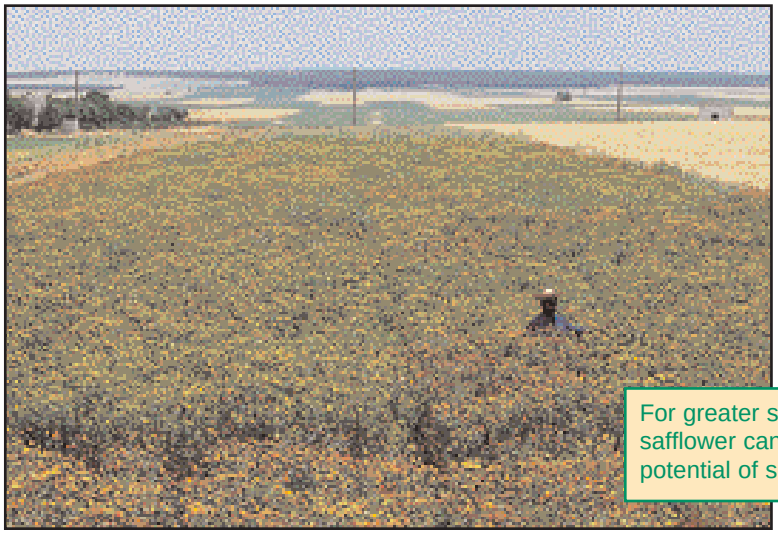
Agronomic Assessment of Safflower Germplasm

There is a critical shortage of edible oils in WANA. Safflower (*Carthamus tinctorius*)—an important oil crop specially adapted to dry areas—is grown in the region but only in a few countries. ICARDA is evaluating the potential of some safflower genotypes for their introduction into existing farming systems.

A world collection of 1700 safflower accessions was evaluated in the 1992/93 season at Tel Hadya. In the following two seasons, 87 entries were tested for grain yield and oil production as well as plant height, heads per plant, seeds per head, 1000-kernel weight, and days to emergence, flowering and maturity. In 1994/95, two safflower varieties, namely, 'Kino 76' (improved) and Syrian Local, were evaluated for their water-use efficiency under three water regimes: rainfed, 100% of full water needed to fill soil profile to field capacity when available water drops by 50% (W100), and 50% of full water needed (W50).

In 1993/94, grain yield ranged from 460 kg/ha (cultivar 'Lesof', USA) to 1735 kg/ha (cultivar '301055', Turkey); while in 1994/95, yield ranged from 325 kg/ha (cultivar '304462', Iran) to 1485 kg/ha (cultivar '250536', Egypt). 'Dinger 118' (Turkey), which had the best average yield over two seasons, was close to the highest yielder in each season. In 1993/94, oil yield ranged from 140 kg/ha ('Lesof', USA) to 530 kg/ha (cultivar '301055', Turkey); while in 1994/95, it ranged from 97 kg/ha (cultivar '304462', Iran) to 475 kg/ha (cultivar '250536', Egypt). 'Dinger 118' (Turkey) in both seasons, 'Kino 76' (USA) in 1993/94, and 'Gila' (USA) in 1994/95 were close to the maximum for oil yield. The water-use efficiency and grain yield for both varieties were closely correlated, with a coefficient of determination of 0.95 and 0.99 for Syrian Local and 'Kino 76', respectively. However, soil water was severely depleted through the whole profile under all water regimes. Seed yield water-use efficiencies (WUE) of both varieties were quite low. For 'Kino 76', WUEs of 2.0 kg/ha/mm in rainfed, 2.5 kg/ha/mm in W50 and 2.7 kg/ha/mm in W100 were obtained, while Syrian Local had a WUE of 2.6, 3.2, and 2.6 kg/ha/mm, respectively.

Safflower shows great potential in the farming systems of the region. Future work in the region should be built on the existing potential of safflower for achieving greater self-sufficiency in vegetable oil production in the context of both agroecology and national agricultural development policies.



For greater self-sufficiency in vegetable oil production in WANA, safflower can play an important role. ICARDA is testing the potential of several safflower germplasm accessions.

Resource Management in Egypt

Within the framework of the Nile Valley and Red Sea Regional Program, the resource management research component in Egypt consists of two activities: long-term trials (LTT), conducted at five locations; and long-term monitoring (LTM), done on farmers' fields at each location.

In the Sugar Beet area, which represents newly reclaimed calcareous soil, the prevailing farmers' crop rotation (berseem/corn-wheat/soybean-wheat/sunflower) was compared with the suggested rotation (berseem/tomato/corn-early wheat/soybean/sunflower-sugar beet/corn). There was no effect of water quality on the yield of any of the winter or summer crops. However, water consumptive use values for corn were 58 and 49 cm, and 51 and 45 cm for tomato, at the farmer and suggested levels, respectively. The LTM team collected information and samples from five farmers' fields each in four villages. Analysis showed that soil was poor in available NPK as well as micronutrients. Analysis of water quality showed that the nitrate content was high (28.3 mg/l) in the field drain of one farmer. A considerable amount of boron was also found.

At El-Bustan**,** which represents newly reclaimed sandy soil, the prevailing crop rotation (berseem/groundnut-berseem/groundnut-wheat/groundnut) was compared with the suggested rotation (berseem/groundnut-pea/sunflower/corn-wheat/sesame). As the soil is sandy (90% sand), sprinkler irrigation is used. An evaporation pan was used to determine the amount of water applied. The LTM team collected information and samples from five farmers each in four villages. Potato and green pea compete with the winter crops. Soil was found to be poor in organic matter content (average 0.24%) and available P (about 60% of the samples contained less than 4 ppm). Available N ranged between 10 and 91 ppm. Low values of nitrate and boron were recorded in the irrigation water. The water table was at a depth of more than 220 cm for all fields.

At El-Serw, which represents the saline-alkaline soils of the North Delta, a 'dry' rotation (wheat/rice-sugar beet/sunflower-berseem/cotton) was compared with a 'wet' rotation (berseem/rice-wheat/sunflower-berseem/rice) and a 'wet'/'wet' rotation (berseem/rice-berseem/rice-berseem/rice). The LTT has now been successfully established after rebuilding the water distribution system and improved drainage. Drainage water applied to LTT had a salt content about four times higher than that of the fresh water supply; and cadmium content was about 20 times higher. The LTM team collected baseline data from five farmers each in three villages. Available N and P on farmers' fields ranged from 5 to 88 ppm and 6 to 54 ppm, respectively. Trace elements were low in the soil, while nitrate levels were almost the same in both the inlet and outlet of irrigation. The water table was high in almost all fields. Values ranged between 35 and 92 cm, with about 50% of the samples showing a water table less than 60 cm deep.

At Sids, which represents old irrigated lands, the prevailing rotation (berseem/cotton-wheat/corn-faba bean/tomato) was compared with the suggested rotation (onion/cotton-early wheat/soybean/sunflower-faba bean/tomato). The fresh and drainage water applied to the trials produced only small differences in crop yield. The LTM team collected baseline data from five farmers each in three villages. In addition to the socioecomonic data, soil and water samples were collected from the farmers' fields. Available N values ranged from 19 to 65 ppm, according to management, while available P ranged from 6 to 29 ppm. Samples were also analyzed for K, Fe, Mn, and Zn and for trace elements (Cd, Pb, Cu, and B). The nitrate level at the outlet was 10 times more than at the inlet. The water table varied between 78 and 140 cm in depth.

Table 4. Wheat yield, water-use efficiency, and nitrogen-use efficiency in farmers' fields, in irrigated areas in different agroecological zones of Egypt, 1996/97.

Site	Sugar Beet	El-Bustan	El-Serw	Sids
Farmers surveyed	20	22	15	16
Yield (t/ha)	3.7	3.1	4.3	4.1
Water-use efficiency (kg grain/m^3)	0.70	0.60	0.53	1.47
N-use efficiency (kg grain/kg N)	11	6	8	14
95% CI*	(6,16)	(3,9)	(5,11)	(8,20)

* 95% CI = Confidence interval of the nitrogen-use efficiency at 0.05 significance level.

In Sinai (rainfed area), good rain in the 1996/97 season produced good crops at the two LTT sites (Rafah and El Barth). The LTM team collected information and samples from five farmers each at three LTM sites (Rafah, El Goura and El Barth). Farmers in Rafah use groundwater for supplemental irrigation of fruits and vegetables. Analysis of groundwater showed high nitrate concentration (up to 30 mg/l). Soils were sandy (more than 90 %) with low content of N, P, K, and micronutrients.

The average wheat yield and water- and nitrogen-use-efficiency, as affected by farmers' resource management in irrigated areas in different agroecological zones, are presented in Table 4.

Survey of Crop Production Practices in Kermanshah Province of Iran

A survey of the crop production practices in Kermanshah Province was jointly conducted. Cereal/livestock, wheat/chickpea and barley/chickpea are the main rainfed cropping systems. Leaving the land fallow has been abandoned by almost all the farmers surveyed.

Most farmers cultivate once before planting wheat and barley, some twice, and a few, three times. Lentil and chickpea are planted in spring. Introduction of improved, cold-tolerant lentil and chickpea varieties can appreciably increase production.

The most common sowing method for wheat and barley is broadcasting the seed by hand, followed by covering it mostly with a moldboard plow. The advantages of seed drills, which are not yet locally available, need to be demonstrated.

Local cereal and food legume varieties predominated in the survey area. A great scope exists to introduce improved varieties, as well as improved management practices, through on-farm verification and demonstration trials. The importance of fertilizer is well known to farmers, but 64% of them considered the amount currently used on wheat as insufficient. There is therefore a need to review the current fertilizer allocation policy.

Farmers rated the lack of machinery (69%) and fertilizer (70%) as the most important factors limiting crop production, followed by improper time of tillage (33%). Other factors named were insects and diseases, lack of credit, lack of tillage implements, inappropriate sowing date, weeds, and inadequate seed rate.

DARI (Dryland Agriculture Research Institute) researchers are designing new research strategies and programs to tackle some of these soil and crop management problems, with increased emphasis on on-farm research and demonstrations. A number of on-station results are ready to be tested in farmers' fields. Subsequently, farmers should be monitored for their perception and acceptance of the new technologies demonstrated on their farms. Active participation of the extension personnel is strongly recommended for the success of such efforts.

Prospects for Supplemental Irrigation in Central Anatolia

A two-year study of the prospects and limitations of improved and sustainable production with supplemental irrigation in Central Anatolia was conducted in collaboration with Rural Services Affairs Institute (RSAI) of Turkey in Ankara and with financial support from BMZ. The study included technical and socioeconomic aspects. Field surveys and water- and crop-modelling were used. The study showed that supplemental irrigation at critical periods of crop growth could substantially improve and stabilize wheat production in the area. It also showed that farmers generally overused water and substantial savings could be made with appropriate management. Several areas of research were identified and a field experiment was started at RSAI to address these issues.

Shrubs on Marginal Lands

Native pastures are an integral component of small-ruminant production systems in the dry areas. Previous ICARDA studies in northern Syria (Tel Hadya and El Bab) indicated great potential for improving productivity of marginal lands by application of phosphate fertilizers and/or seeding with small-seed legumes.

To carry this research further, 1000 seedlings of *Atriplex halimus* were established in the plastic house in the summer of 1997 and transplanted to 1-hectare

Shrubs (saltbush), established in rows within barley fields in marginal areas, can improve the quantity and quality of animal feed.

of marginal land at Tel Hadya in November. The main difficulty of planting shrubs on marginal lands is the preparation of suitable holes. Using a tractor-operated auger it was possible to dig such holes (1000 in a hectare), in place of *Asphodelus microcarpus*, a common weedy plant growing between rocks on such marginal lands in northern Syria. The holes were then manually shaped to act as water-catchments for the shrub seedlings. Periodic assessment in the coming season will include survival and productivity of the shrubs before exposing them to grazing.

Another type of marginal land is the one adjacent to the steppe, where cultivation is possible but rainfall is low (200 mm or less) and the soils are degraded. As a result, the barley crop on these lands is usually put to grazing. In the event of a good rainy season (one in 8 or 10 years), or when underground water is available for supplemental irrigation, the crop is harvested for grain and the stubble is left for grazing. Establishment of shrubs within barley fields can play an important role in improving the feed quality and quantity. The system could help stabilize the soils and reverse their degradation. It will also provide a balanced grazing resource, since barley stubble or residues will provide a source of energy while the shrubs are rich in protein. In 1997, research was started to test this hypothesis in collaboration with three farmers in Khanasser in Aleppo Province. In each farmer's location the experiment consists of four hectares: two hectares were sown with rows of shrubs and barley while the other two hectares were sown with only barley to follow the farmers' practice. The experiment will assess the productivity of feed and the effects of grazing in the coming years.

Performance of Some Forage Shrubs in Cold Environments

As part of its collaboration with INIA-Spain, ICARDA received the following shrub species in mid-September 1995: *Medicago arborea*, *M. citrina*, *M. suffruticosa*, and *Bituminaria bituminosa*. These shrubs were sown in nurseries in early October 1995 at Tel Hadya (Syria) and Terbol (Lebanon). The seedlings were then transplanted to the field in February 1996 (240 at Tel Hadya and 250 at Terbol). During the 1996 season, field observations were taken on survival and growth of all species, which showed good performance for *M. arborea* and *B. bituminosa* under low temperatures of –5°C. The other two species showed poor growth and were dead by early summer. The successful species started flowering in August 1996. Though no seed was set by *M. arborea*, about 1 kg seed was obtained from 26 shrubs of *B. bituminosa* by the end of the season.

The 1996/97 season was very cold. Starting from November 1996, the number of frost days was 66 at Terbol and 44 at Tel Hadya, the lowest temperature being –8°C in February 1997 at both locations. This proved detrimental for *B. bituminosa,* with all of its above-ground material killed, while *M. arborea* plants were still green. They began flowering in late

Transplanted seedlings of *Medicago arborea* survived the harsh environmental conditions in Terbol, Lebanon.

April and forming pods in May 1997. In mid-summer 1997, clones were taken from *M. arborea* at both locations and rooted in the greenhouse for further multiplication. A total of 900 seedlings were produced and transplanted to the field at the beginning of the 1997/98 season. In the coming seasons, propagation of *M. arborea* will continue using clones to allow for its field evaluation under actual grazing conditions.

Farmer Participation in Promoting New Pasture and Forage Species

In 1985, on-farm trials were established in the El Bab district in northwest Syria, where annual rainfall is about 270 mm and barley is the most common crop. The trials compared fallow or barley with common vetch (*Vicia sativa*) or chickling (*Lathyrus sativus*) in rotations with barley. After seven cropping seasons, yield of feed from both phases of the rotation was greatest from the barley/vetch and barley/chickling rotations; total outputs of crude protein were twice as high for the rotations including legumes compared with the average output of barley/fallow and barley/barley rotations. The barley/vetch rotation gave the highest output of metabolizable energy.

Farmers expressed great eagerness to try the barley/vetch rotation. A program was therefore implemented in 1991 to promote vetch in partnership with farmers and the extension service. The results have been impressive. Whereas in 1991 only three farmers in three villages were growing about seven hectares of vetch, the number had increased to 174 farmers in 15 villages by 1997, with an area of about 420 hectares. But even more significant were the benefits that farmers saw in their barley crop, because vetch interrupted the seed gall nematode (*Anguina tritici*) cycle (the syndrome is locally called *Abu Ulaiwi*), which has become widespread and has devastated barley grain yields in recent years. A survey conducted in 1997 on farmers' fields confirmed the beneficial effect of introducing vetch in the rotation. Cereal yields after vetch were significantly higher than those after barley (Table 5).

Table 5. Cereal yields on farmers' fields in different rotations at El Bab District, Aleppo Province, 1997.

Rotation	Cereal yield (kg/ha)
Deep Soil	
Barley after vetch	1574
Barley after barley	945
Wheat after vetch	897
Wheat after barley	648
Shallow Soil	
Barley after vetch	1068
Barley after barley	521

Rural Poverty Indicator

In order to make general comparisons across countries in the dry areas, a rural poverty indicator (RPI) was developed. The indicator incorporates per-capita GDP as a measure of income, adjusted for differences in purchasing power and in income distribution, and the proportion of rural poor in a particular country. The indicator has a value between 0 and 1; the larger the number, the larger the poverty gap between the cross-country welfare poverty line and the per-capita GDP adjusted for purchasing power parity and income distribution of a particular country and, thus, the greater the severity of poverty (Box 1).

The RPI allows to establish differences among and within groups. Even though this indicator is 'narrow' in the sense that it is based on mean income, it is highly correlated with the Human

Box 1. Assessment of poverty

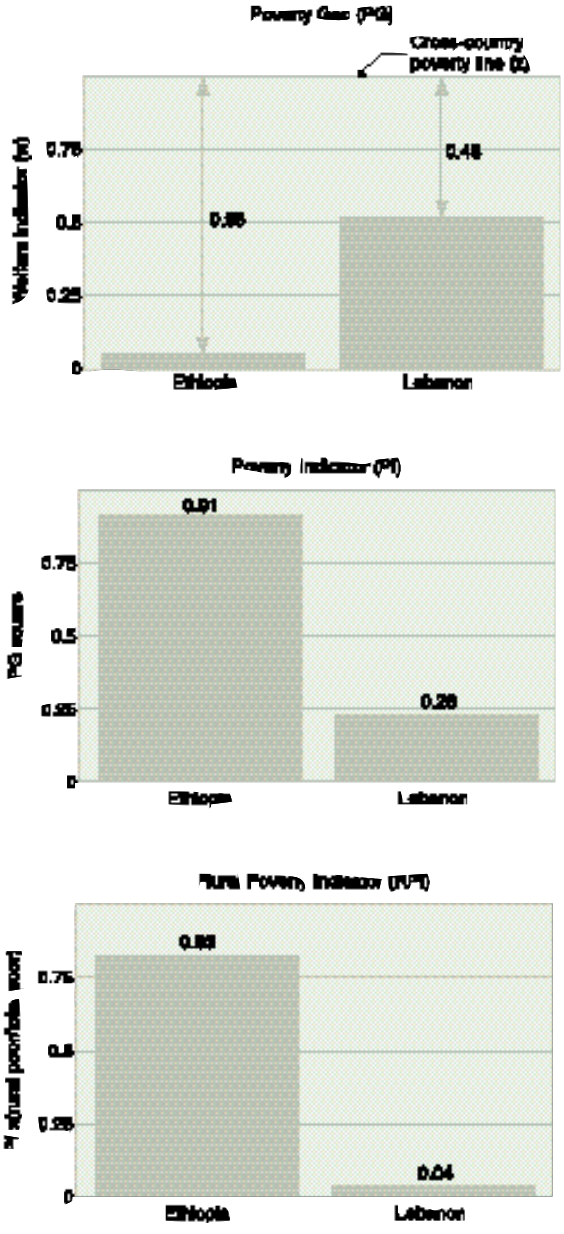
(i) A welfare indicator was used based on the per-capita GDP as an estimate of income. This indicator is given by w =(1–G) y, where 'G' is the Gini index of income or expenditure inequality (G=1 under total inequality and 0 under perfect equity) and 'y' is the per-capita GDP at purchasing power parity. Gini coefficients estimated by TAC were used.

(ii) The welfare indicator 'w' has the value zero whenever its value exceeds a critical value 'z' to discriminate higher-income countries ('z' was set at USD 6000); 'z' represents the poverty line when dealing with an individual country, in our case it is a *cross-country poverty line*.

(iii) Whenever w is at or below z, the Poverty Indicator is given by $(1–w/z)^{\beta}$, where β is set arbitrarily at a value of one or higher (when β is one, the expression denotes the poverty gap index; in this study, β was set at 2 to measure the 'severity' of poverty).

(iv) A Rural Poverty Indicator (RPI) was estimated by multiplying the Poverty Indicator by the fractional value of the number of rural poor with respect to the total number of poor.

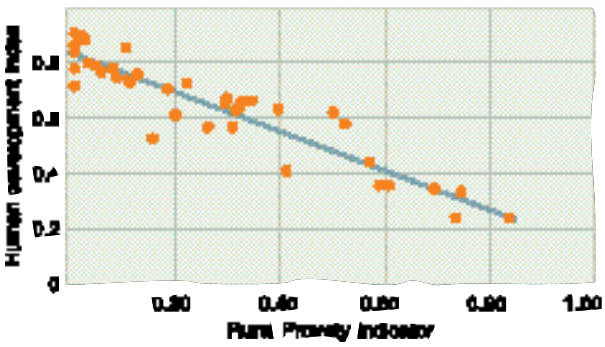
Construction of the RPI from the coefficient estimated in (iii) was considered appropriate because RPI had a higher correlation with the number of total poor, with the number of rural poor, and with the percentage of infant malnourishment than did the Poverty Indicator in (iii). Also, ICARDA's work is more focused on systems rather than commodities, and therefore concerned with rural poverty rather than poverty in general.

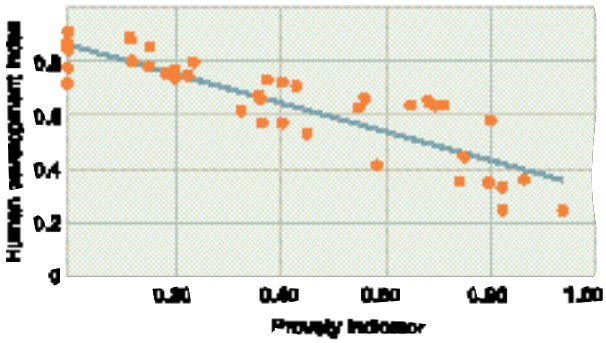


Development Index (HDI) which entails longevity, educational attainment and standard of living (Box 2). Within the WANA low-income group countries, there are large differences; for example, Lebanon with an RPI of 0.04 to Ethiopia and Eritrea with RPIs of 0.83. Several countries in the WANA high-income group have RPIs of 0 due to the USD6000 value for 'z' used as the threshold for multinational comparisons.

Poverty is a curse. Agricultural research can help alleviate it.

Box 2. Socioeconomic indicators in developing-country dry areas



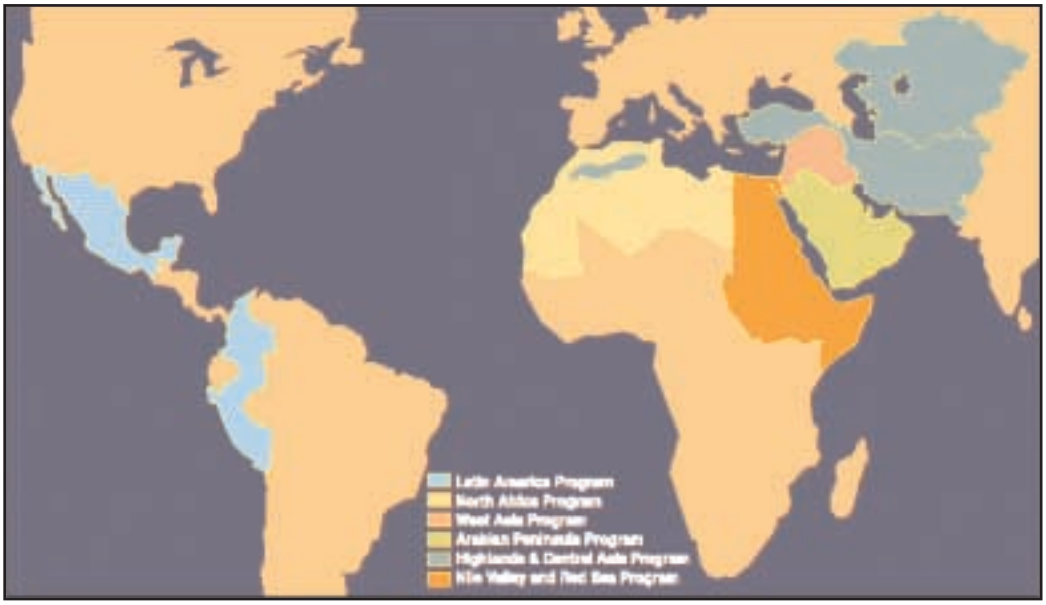


The Human Development Index (HDI) was plotted against the rural poverty indicator (RPI) and the poverty indicator (PI) in Box 1. The variance of HDI explained by RPI and PI was 86% and 77%, respectively. HDI was not available for Somalia, Afghanistan, and South Africa.

The impact of agricultural research, i.e. improved crop varieties or production systems, is greater where there is both severe poverty and a large number of poor. If the rural poverty dimension is considered as a criterion for ranking the expected impact of agricultural research among the WANA low-income countries, then Ethiopia, Sudan, Pakistan, Afghanistan and Somalia deserve special attention. Of course, other dimensions such as land and water constraints, the value of agricultural and livestock production, biodiversity, or gender issues need to be weighted for a more balanced approach to assess the impact of agricultural research.

Outreach Programs

The success of ICARDA's research and training activities largely depends on its active partnerships with national programs. Besides a large number of joint activities with other CGIAR centers and advanced research institutes throughout the world, the Center has consolidated its outreach activities into six regional programs, five in WANA and one in Latin America. These programs act as a mechanism for resource-use effectiveness, eliminating duplication of effort, balancing activities according to the identified needs of each country, exploiting spillover of research from one region to another, and, more importantly, for providing a research continuum and a long-term vision of the impact of ICARDA's work.



ICARDA's regional programs. The Central Asian Republics and the Caucasus are served by the Highland Regional Program.

These six regional programs link scientists both within countries and within the region, promote leadership at the national and regional levels, foster cooperation in solving problems common to a group of countries, capitalize on complementarity between countries, promote transfer of technology, and encourage self-reliance in research and development. They also help in identifying particular expertise in NARS to decentralize ICARDA's research and training activities. Where appropriate, they play a catalytic role in attracting donor funding for national programs and establishing linkages with advanced research institutes.

Results of collaborative research with NARS, conducted through the six regional programs, are reported under relevant sections of this Annual Report. What follows here is a brief overview of the activities of these programs in promoting cooperation in research and technology transfer.

North Africa Regional Program

The North Africa Regional Program (NARP) focuses on the dry areas of Algeria, Libya, Morocco, and Tunisia. ICARDA coordinates NARP activities from its regional office in Tunis in partnerships with NARS for the benefit of the whole region.

WANADDIN

Within the framework of the West Asia and North Africa Dryland Durum Improvement Network (WANADDIN)—an IFAD-funded project, executed jointly with CIMMYT by ICARDA—research on durum wheat improvement and technology adoption in the region is promoted by integrating the research capabilities of Algeria, Morocco, Syria, Tunisia, and Turkey. During 1997, on-farm yield trials were conducted to identify constraints to productivity in Algeria, Morocco, and Tunisia. Socioeconomic studies were also conducted in these countries, which included (i) a farm diagnostic survey to understand durum farmers' perceptions, and to document the current status of durum wheat production; and

(ii) an assessment of the economic impact of durum improvement research in the region. A meeting of the socioeconomic group was held in February in Settat, Morocco, and a workshop was held in Tunis in April 1997. The workshop identified tools to harmonize the analysis and interpretation of survey data collected in Algeria, Morocco, Syria, Tunisia, and Turkey. As part of the impact of WANADDIN, the interaction among researchers, extensionists, farmers, and policy makers for problem solving is increasing.

Mashreq/Maghreb Project

The 1996/97 cropping season marked the third and last year of the first phase of this project that covers all four NARS of North Africa (Maghreb), in addition to four countries in West Asia (Mashreq).

Transfer of technologies. The emphasis has been on improving feed resources and small ruminant productivity in the low-rainfall areas of the region. Technologies, particularly those dealing with the role of Vitamin A and the effect of nutrition on reproductive performance of small ruminants, were validated and impact studies were undertaken. Range and annual pasture legumes were collected, especially in Morocco in a transect from Khouribga to Safi. Throughout the region, farmers' participation in on-farm activities continued to increase. On-the-job training was organized for farmers in all four countries on the production of feedblocks and medic seed. As a result, some farmers have decided to establish small feedblock-manufacturing enterprises. The training sessions included the use of an ICARDA-developed medic pod sweeper.

Policy and Property Rights. Development of community and multi-market models constituted the main activity of this component. A sector modeling workshop was held in Tunis in January to discuss methodologies for the analysis of effects of market liberalization and other technological and institutional policies on agricultural production. A spreadsheet-based multi-market model, proposed by Tunisian scientists, was adopted. Based on this model, two studies on multi-market analysis of agricultural policies were undertaken in Morocco and Tunisia.

A community model was developed to test technology alternatives and simulate the effects of policy reforms on adoption of recommended technologies.

For the property rights component, survey data was collected from selected communities in Tunisia and Morocco between January and May 1997 to investigate existing links between prevailing land-tenure systems and investment and production strategies of households (110 in Tunisia and 75 in Morocco). Preliminary results were presented at the Amman workshop in September (see also p. 54, "Workshops and Coordination Meetings"). The analysis of data will be completed in 1998.

Farmer participation in collaborative activities in North Africa has been increasing at a fast pace. Here, scientists, extension workers, and farmers evaluate the performance of an ICARDA-developed medic pod sweeper.

On-Farm Water Husbandry in WANA

This project seeks to improve on-farm water-use efficiency through better water-harvesting systems in Libya and Tunisia as well as other WANA countries. Morocco is involved in the on-farm water husbandry initiative. Major activities in 1997 included (i) gathering information on available water resources; (ii) description of indigenous water-harvesting techniques; (iii) collection of information on rainfall and soil characteristics; and (iv) interviewing farmers from different regions. Reports on water resources and evaluation of indigenous water-harvesting techniques were developed, and recommendations were made for the improvement of such systems as *matfia* (cistern), *khettara* (underground channels), contours, terraces, and *rabta/tabia* (levees to collect runoff water).

Khettara (underground water channels) is an old, indigenous water-harvesting system in North Africa. ICARDA has conducted a comprehensive study of such systems and made recommendations on improving them to be useful for modern agriculture.

Mediterranean Highland Project

1997 was the third and last year of the first phase of this project, supported by the European Commission. The project aimed at improving the management and sustainable use of natural resources, as well as increasing the production of cereals and cool-season food legumes. A meeting of all national coordinators was held in Tunis in April to review the progress, discuss on-going activities, and develop a draft proposal for the second phase. A field tour enabled the participants to inspect the project field-trials in the highland region of Tunisia. Conclusions and recommendations from the work during the first phase were presented at a workshop in Ankara, Turkey in November (see also "Highland Regional Program," p. 56).

Human Resource Development

Two traveling workshops (barley and Mashreq/Maghreb) were organized, and a number of training courses were conducted in Morocco and Tunisia. The courses covered database and pedigree management for cereal breeders, cereal disease methodologies, water harvesting, use of chemical and biological methods of feed evaluation, statistical analysis of multilocation trials, agroecological characterization, advanced methods in land reclamation, and the role of extension in rural development. In addition, workshops on arresting soil degradation, rainfall management, and drought mitigation were held.

Nile Valley and Red Sea Regional Program

The Nile Valley and Red Sea Regional Program (NVRSRP) is based on tripartite collaboration among the NARS of the Nile Valley and Red Sea countries (Egypt, Ethiopia, Sudan, Eritrea, and Yemen); ICARDA; and donors. It covers a wide range of major food crops, including cool-season food legumes and cereals. Resource management is an important component of the activities in Egypt. A Regional Networks Project aims to strengthen basic and applied research to solve problems of common interest to the countries of the region. ICARDA/NVRSRP is also involved in adaptive research and in integrating research with development through the Matrouh Resource Management Project (MRMP) in Egypt, and the Agricultural Sector Management Support Project (ASMSP) in Yemen.

Regional Networks

Wheat Rusts Network. A regional wheat rust nursery was planted at 22 sites in Egypt, Ethiopia, Sudan, and Yemen to compare the commercial cultivars and advanced lines. From 1918 samples collected and analyzed, 29 stem-rust and 28 leaf-rust races were identified. Some of these were common to Egypt, Ethiopia, and Sudan. Genes imparting resistance to some of these races were identified.

Wilt and Root-Rots of Food Legumes Network. In a survey conducted in Egypt, Ethiopia and Sudan, *Fusarium solani* on faba bean and *F. oxysporum* on chickpea and lentil were the most important pathogens in all three countries. *Rhizoctonia batatícola* was also important on lentil and chickpea in Ethiopia and Sudan, and *Sclerotina sclerotiorum* on chickpea and *F. solani* on lentil in Egypt. Three races of *F. oxysporum* were identified in Sudan, and eight isolates are being studied in Ethiopia. Several resistant faba bean, lentil, and chickpea lines were identified, and will be included in regional nurseries.

Aphids and Viruses Network. Two wheat lines were found resistant to padi aphids in Middle and Upper Egypt; their seeds are being multiplied for release in Egypt, and for further testing in other countries. Three faba-bean landraces proved promising for resistance to aphids for three successive years in Egypt. A significant correlation was found between temperature and development time of the Hymenopterous parasite, *Aphilinus ascychis* in the studies on rearing this parasite. The best feeding materials were honey and sucrose. Twenty-two genotypes of wheat and 12 of barley were found tolerant to BYDV in Egypt. Of 1500 genotypes of faba bean tested against FBNYV during the past three years, none was found tolerant. Use of cultural practices such as rouging and sowing date decreased the incidence of the virus.

In Ethiopia, six barley landrace lines were found resistant to Russian wheat aphid (RWA), while 20 lines of dry pea were tolerant to pea aphid. Gaucho 70% WS and *neem* seed extract were effective in controlling the pea aphid. Surveys in four regions showed that FBNYV is widely spread in faba bean. The predominant serotype of BYDV was PAV followed by SGV. Four aphid vectors were also recorded.

In Sudan, faba bean cultivars 'SM-L' and 'Pakistani' proved resistant to aphids (*Aphis craccivora*). 'Pakistani' showed stable resistance for three years and can be used as a parent in crosses.

Surveys in Yemen showed that RWA was a serious pest on wheat and barley, whereas pea and cowpea aphids were dominant on faba bean and dry pea. Jojoba (*Simmondsia* spp.) oil and surfactant Sisi 6 were effective against cereal aphids. Common viruses detected on faba bean and lentil were AMV, FBNYV, BLRV, and CCDV. Germplasm found tolerant/resistant to aphids and viruses in one country is shared with all partners in the region.

Thermo-tolerance in Wheat Network. To broaden the genetic base for selection of heat-tolerant lines, about 200 crosses were made and 150 F_2 populations advanced in Egypt, Sudan, and Yemen. In the Advanced Yield Trial, 12 promising lines were identified in Egypt, five in Sudan, and seven in Yemen. Six lines ('Condor' x 'Baladi 18', 'Seri' x 'Bue', 'Pfau' x 'Vee # 5', 'Attila', 'Pfau', and 'Sids 3') gave high and stable yields in all three countries.

Drought in Barley and Water-Use Efficiency in Wheat Network. Six drought-tolerant barley cultivars, including 'Giza 126', were identified in North Sinai, Egypt, and seven in Dhamar, Yemen. In the Barley Drought Tolerance Screening Nursery, 20 genotypes proved drought-tolerant; these will be evaluated in the Regional Yield Trial next season.

Of 24 genotypes screened for tolerance to moisture stress in the Advanced Wheat Yield Trial in Egypt and Sudan, seven were drought tolerant and high yielding in both countries. In the wheat screening nursery, nine entries were selected in Egypt and 10 in Sudan. Four genotypes outyielded the local checks ('Asis' and 'Sonalika') in Yemen. Cultivar 'El-Neilein' gave high grain yield under water stress in both Egypt and Sudan.

Socioeconomics Network. Baseline studies in Ethiopia, Sudan and Yemen identified pests and diseases, poor management, and inadequate extension support as the main constraints to production of barley, wheat, and faba bean. Adoption rates of some

technologies were primarily influenced by availability and cost of inputs as well as by the attitude of farmers. Adoption was satisfactory in all four countries. Results of impact assessment studies conducted in Egypt, Ethiopia, and Sudan showed high returns at farmers' level and high production at the national level. Policy analysis in Sudan and Yemen indicated that farmers' decisions on area to plant and technology to use were affected by grain prices and import levels. It was recommended that policies should encourage the use of technology and avoid sharp price fluctuations.

In Sudan and Yemen, yield gap studies found specific relationship between yield levels and the technology use, soil type, and level of farmer participation. Results of gender analysis in Egypt, Ethiopia, and Sudan showed that women have a considerable role in crop production, but are less aware of existing technologies. Thus, more emphasis on women-targeted extension was recommended.

Workshops and Meetings

A Regional Traveling Workshop on Cereals and a National Traveling Workshop on Cool-Season Food Legumes, both held in Egypt in March, were combined for the first time to enhance interaction between the two groups.

A Regional Traveling Workshop on Food Legumes was held in Yemen in which scientists from Yemen, Egypt, and Ethiopia participated.

A Regional Traveling Workshop on Resource Management was held in Egypt in April and was attended by scientists from Egypt, Iran, Iraq, and Yemen. The objective of the workshop was to introduce the resource management model being tested in Egypt since 1994.

A Barley Traveling Workshop was held in Ethiopia in October which brought together scientists from Egypt and Ethiopia to review the on-farm trials in northern and central Ethiopia.

A National Review Workshop was held in Egypt to review the work of NVRSRP on cool-season food legumes and cereals, since 1988, and to develop a future strategy for the improvement of these crops.

The Seventh Regional Coordination Meeting of NVRSRP was held on 3-4 September, and the Steering Committee Meeting on 4-5 October in Cairo. Scientists from Egypt, Ethiopia, Sudan, Yemen, and ICARDA participated.

Within the Regional Networks Project, training on IPM and insect-rearing techniques was conducted at ARC, Egypt, in February. Participants from Egypt, Ethiopia, and Yemen attended. Nineteen senior scientists from ARC contributed to the sessions.

Barley Traveling Workshop in Ethiopia.

ICARDA-Yemen

ICARDA continued the implementation of the World Bank supported component of the Agricultural Sector Management Support Project (ASMSP) in the Republic of Yemen. During 1997, in close collaboration with the Agricultural Research and Extension Authority (AREA), ICARDA-Yemen focused on revitalization of agricultural research through initiation of research for rapid impact (RIP), development of a national research strategy, strengthening research management capacity of AREA, and human resource development.

Research for Rapid Impact (RIP). Technologies developed by AREA were demonstrated to the farmers for increased adoption. A total of 58 technologies were tested or demonstrated throughout the country. Participatory farming systems research approach was introduced in planning, implementing, and evaluating RIP activities. Field days were also organized for policy makers, donors, researchers, extensionists, and farmers.

Research Strategy. A draft research strategy for AREA was developed which was approved by the Governing Board of AREA.

Strengthening Research Management and Coordination. A National Research Coordination and Planning Meeting was organized in September to review on-going research and identify collaborative research areas in rainfed agriculture. Priority research activities identified include collection, evaluation and characterization of germplasm; inventory of use of genetic resources of sorghum, millet, barley, wheat, lentil and cowpea by breeders; evaluation of landraces by breeders both on farm and station; and introduction of a decentralized participatory breeding approach. Contacts were made with other international centers for obtaining relevant genetic materials of crops outside ICARDA mandate to include in the breeding programs.

ICARDA-team also utilized RIP as a model for instituting relevant research management processes and principles within AREA. A planning process, involving farmers and extensionists, was initiated at the station level. Other activities included project budgeting based on research proposals; allocation of budgets to project scientists; and monitoring, review, and evaluation of all research activities.

The national coordinators frequently visited RIP activities at the regional level to monitor the progress. A review workshop was organized for RIP activities implemented by highland research stations in the mountain region.

The IDRC-supported project on Dryland Resource Management in Mountain Terraces (soil and water management, socioeconomics, range management, and varietal evaluation), and the Arabian Peninsula Regional Program (forages, range management, and abiotic stresses) are important vehicles for on-station backup research, while on-farm technology testing is being conducted through RIP.

Human Resource Development

Eighteen scientists from Egypt participated in international conferences, 90 in individual non-degree training, 80 in in-country training, 136 in a Research Review Workshop in Egypt, 139 in national and regional traveling workshops, and 240 in national and regional coordination meetings. The number of Ethiopians was: in-country short courses, 53; national and regional coordination meetings and traveling workshops, 75.

Within the networks project, 22 scientists/technicians from Egypt, Ethiopia, Sudan, and Yemen attended short courses, 12 made scientific visits, and 47 participated in the Regional Coordination Meeting in Egypt.

The region around Mersa Matrouh in Northwest Egypt is typical dryland with low and unreliable rainfall. The key to agricultural development of this area lies in the effective conservation of rainfall and runoff. In the *wadi* (river beds), barley, and, where the soil

Farmers from Mersa Matrouh, Egypt visited ICARDA headquarters to be introduced to watershed planning and water-harvesting methods in dry areas.

is sufficiently deep, figs or olive trees are grown. But the potential for cultivation of these crops has not been fully realized.

In a series of short training courses, staff of the Matrouh Resource Management Project (MRMP) were introduced by ICARDA scientists to methods and procedures of watershed planning and water harvesting. Importance was placed on the practical and applied aspects and, therefore, a large part of the coursework was conducted in the field.

Beginning with the principles of appraisal of the available resources in a watershed, the courses covered such topics as resource mapping using field surveys, satellite images and other existing maps, identification and delineation of hydrologically distinct land units, preliminary land-use planning, the integration of secondary information into the planning process, and the selection, design and placement of appropriate water-conservation and water-harvesting structures.

The need for the involvement of local farmers in all stages of watershed planning was stressed throughout the training program.

Seventeen AREA researchers are presently undergoing long-term higher degree training in various universities. During 1997, study tour for three scientists on resource management (in Egypt and Syria), four senior research managers on research management (in ICAR, India and ICRISAT) and six scientists for short-term training in various disciplines were organized. ICARDA also facilitated the linkage between Yemen and the Asian Cereals and Legumes Network (sorghum, millet and groundnut), coordinated by ICRISAT.

A series of in-country training workshops on research strategy development, diagnosis and participatory research, on-farm research, economic analysis, soil fertility, livestock/range management, and research project development were organized. The ICARDA-team provided technical assistance to three regional research stations in conducting diagnostic exercises using participatory tools and methods. Information generated was used in developing the National Research Strategy and a Medium-Term Research Plan. In collaboration with other AREA projects, two traveling workshops and several field days were organized. A strategy for short-term training of AREA personnel was also developed. In collaboration with AREA researchers, the ICARDA-Yemen team prepared manuals for Planning Research Activities at the Regional Level, and Characterization of On-Farm Research Sites.

West Asia Regional Program

The West Asia Regional Program (WARP) provides mechanisms for implementing collaborative research and training activities in Jordan, Syria, Iraq, Lebanon, Cyprus, and low lands of Turkey. The program continued its activities on technology development and transfer in both crop and animal production through the Mashreq and Maghreb Project which is funded by the Arab Fund for Economic and Social Development (AFESD) and the International Fund for Agricultural Development (IFAD). The policy and property rights component is now fully integrated with the WARP activities, particularly where natural resources are a collective property. In addition, research on water conservation and improving on-farm water-use efficiency is receiving increased attention through ICARDA's "Water in WANA" project.

Demonstration of Technologies to Farmers

Several technologies for sustainable improvements in crop and animal production, and for increasing income, were demonstrated to farmers in the region.

Crop Production and Alternative Feed Sources.

Use of forage legume crops (e.g., *Vicia* spp. and *Lathyrus* spp.), in rotation with barley, and their alternative utilization (hay making, grazing, or harvesting at maturity for stored feed) proved quite promising.

In Lebanon, three forage legumes, namely, *V. sativa* 715, *V. ervilia* 3030, and *Lathyrus cicera* 491 were released for use in rotation with barley.

Lebanon released two barley cultivars, namely, 'Mary Athenaise' and 'Faiz'. These cultivars yielded 16% and 9%, respectively, more grain than the improved check 'Rihane', grown locally. In Iraq, a high-yielding barley variety, 'Tadmor', produced

Planting spineless cactus holds great promise in both Mashreq and Maghreb countries. The technology was developed and tested in the Mashreq, and is now being transferred to the Maghreb region.

21% more grain than the local 'Aswad' despite severe drought during the 1996/97 season. The seed of this variety is being multiplied. Fertilizer application in Syria and Lebanon increased barley grain yield by 37% and 41%, respectively. In Iraq, fertilizer application increased grain yield by 247%. Results from farmers' fields in Jordan indicated that a recommended barley production package resulted in 70-76% higher grain yield and 16-62% higher straw yield.

The feedblocks technology gained increased popularity among farmers in both Mashreq and Maghreb countries. The technology was originally developed in Iraq to produce multi-nutrient feedblocks from agroindustrial by-products. Feedblocks helped improve the body-condition score of the ewes and fertility and lambing rate by 22% primarily by increasing the twinning rate.

Spineless cactus holds a great potential as alternative feed. It is useful as livestock forage in times of drought. In addition, cactus plantation, combined with water-harvesting techniques, can play an important role in protecting the natural resource base by reducing soil erosion. Cactus production technologies were developed and demonstrated in the Maghreb countries.

Animal Production Improvement. Early weaning of lambs increased economic returns to sheep owners in Jordan and Syria. The milk production increased by 10 to 20 kg/ewe in Jordan, and 27 to 30 kg/ewe in Syria. The demonstration of sponge and PMSG hormone treatment in farmers' flocks in Iraq, Jordan, and Syria resulted in a substantial improvement in both fertility and twinning rates in all three countries. Ewe fertility increased on average by 32% in Iraq, 14% in Jordan and 37% in Syria, while twinning rates increased by 35%, 28%, and 40%, respectively.

A survey was conducted of 122, 110 and 100 sheep owners in Jordan, Syria and Iraq, respectively, to identify causes of low fertility of sheep in these countries. Farmers identified poor nutrition, high abortion, and low conception rates as main factors. Results from the survey will assist in developing plans for improving sheep fertility.

Interregional Collaboration

To foster collaboration between the Mashreq and Maghreb countries, an expert from Iraq visited North Africa to demonstrate the production of feedblocks from agroindustrial by-products as supplementary feed for small ruminants. On the other hand, a group of scientists from Mashreq countries visited Tunisia to gain experience in spineless cactus plantation and utilization. The utilization of olive by-products as animal feed was promoted by an expert from Tunisia in Jordan and Syria.

Workshops and Coordination Meetings

An international conference on "Agricultural Growth, Sustainable Resource Management, and Poverty Alleviation in Low-Rainfall Areas of WANA," held in Amman in September, brought together policy makers, researchers, and farmers. The workshop was inaugurated by H.E. the Crown Prince of Jordan. Public and private investment in low-rainfall areas, crop-livestock integration, technology generation and transfer, and rangeland rehabilitation were discussed. The conference also demonstrated the successful collaboration between international centers, donors, and national programs. It was organized by NCARTT, ICARDA, IFPRI, IFAD, AFESD, and DSE. It was apparent from the activities conducted in the Mashreq/Maghreb project that a combination of improved technology and appropriate policy and property rights was needed to halt the degradation of the natural resources.

A traveling workshop was organized in Morocco in May 1997. Farmers from Libya, Algeria, Tunisia and Morocco, and technical staff from the eight countries of the project, participated in this activity. The workshop provided an excellent opportunity for farmers to exchange experience and observe new activities conducted by Moroccan farmers. During Phase 1 of the Mashreq/Maghreb project (1995-1997), more than 13,500 farmers and technicians participated in different activities.

Scientists and technical staff from the eight countries served by the Mashreq/Maghreb project participated in a traveling workshop organized in Morocco.

The Third Regional Technical Planning and Coordination Meeting and a Steering Committee Meeting of the Mashreq/Maghreb project were held in Aleppo and Amman, respectively. These meetings were particularly important as they marked the end of Phase I of the project and preparations for the implementation of Phase II, which has two key components: policy and institutional research, and technology development and transfer. Phase II of the project envisages stronger regional cooperation and establishment of regional networks, to be led by national scientists, with support from ICARDA and IFPRI. These networks will cover: management of small ruminants and feed sources (including alternative sources), rangeland rehabilitation network, policy and property rights, and socio-economics (monitoring and evaluation of technology transfer, adoption and impact).

A Coordination Meeting with the Economic and Social Commission for Western Asia (ESCWA) was also held in Amman to explore areas of mutual interest and to identify relevant activities for joint implementation by the two organizations.

Human Resource Development

A regional training course on agroecological characterization was organized in Amman in October 1997. The course drew 13 participants from Iraq, Jordan, Lebanon, Syria, and Yemen. Participants were provided with an overview of the approaches, methodologies, and techniques of agroecological characterization.

Arabian Peninsula Regional Program

The ICARDA Office for the Arabian Peninsula Regional Program (APRP), established in Dubai in the United Arab Emirates late in 1996, was formally inaugurated in January 1997 by H.E. Saeed Al-Raqabani, Minister of Agriculture and Fisheries, UAE, and Prof. Dr Adel El-Beltagy, Director General of ICARDA. In addition, the UAE kindly agreed to provide experimental areas for research, as well as offices, at the Agricultural Research Station in the Central Region at Al-Dhaid.

In March, the first Regional Steering Committee Meeting for Phase II of APRP was held in Aleppo. Four main research themes were identified: (i) rangeland, shrubs, irrigated forages and livestock; (ii) protected agriculture; (iii) abiotic stresses; and (iv) on-farm water use and irrigation management.

Farmers from the Al-Dhaid region were invited to bring to the research station the desert and mountain forages and shrubs that their goats, sheep and camels grazed, and that they knew to be important. They brought 85 different plant species (21 from the desert and 64 from the mountainous regions), of which 74 were fully identified. They then selected *Pennisetum divisum*, *Panicum turgidum*, *Cenchrus ciliaris*, *Dipterigium glaucum*, *Coelachrum piercei*,

and *Stipagrostis plumosa* as the most important forage grasses, legumes, and shrubs. Steps to produce seed of these species were initiated.

Following the Second Regional Steering Committee Meeting, held in Dubai in June, the budget and workplan for the 1997/98 season were finalized.

The UAE, Kuwait, the Sultanate of Oman, Saudi Arabia, and the Republic of Yemen elected to participate in research on rangeland and livestock. Kuwait also volunteered to be the coordinating country.

A survey of protected agriculture was conducted, and an ICARDA consultant visited the Arabian Peninsula countries to develop a report on the state-of-the-art in protected agriculture.

At the University of UAE in Al-Ain, forage barley lines were screened for salt tolerance. In addition, work started at Nashshallah, in Abu Dhabi Emirate, to evaluate the potential of *Sporobulus virginicus* as a salt-tolerant forage for camels.

The status of research in agroecological characterization was reviewed by ICARDA to identify the areas for collaboration in the Arabian Peninsula.

Highland Regional Program

The Highland Regional Program (HRP), with its regional office in Ankara, Turkey, coordinates and promotes activities on research, training, and information dissemination in the highland areas (over 700 m asl) of West Asia (Turkey, Iran, Afghanistan, Pakistan, Azerbaijan, Armenia and Georgia), North Africa (Morocco, Algeria and Tunisia), and Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan).

The EC-funded Mediterranean Highland Project that operated in the highland areas of Morocco, Algeria, Tunisia, and Turkey in collaboration with ICARDA made significant progress in meeting its objective of sustainable use of natural resources, and improvement of cereals and cool-season food legumes. As a result, a regional network for highland research and a mechanism for its management were established involving the four countries of the Mediterranean highlands. The status of farming practices and of the natural resource base in the project's target areas was assessed. Through agroecological characterization of the target areas in each country and across countries, similarities between different locations in the four project countries were identified. Also, formal linkages were established among the four participating countries for exchange of improved germplasm of wheat, barley, chickpea, lentil, and vetches by developing regional highland nurseries and trials. The project helped increase the emphasis on crop diversification and farmer-participatory on-farm research, and on the exchange of visits and information.

Iran

Farm surveys were carried out jointly in Iran to identify constraints to production, develop research plans, and prioritize research activities. Collaborative research continued to improve the production of cereals and cool-season food legumes in rainfed areas.

An ICARDA delegation, consisting of the Chairman, Board of Trustees; the Director General; and the Director of International Cooperation, visited Iran to discuss and strengthen the ICARDA/Iran collaboration. The delegation met the Minister of Agriculture, H.E. Dr Issa Kalantari; Deputy Minister of Foreign Affairs; Deputy Minister of Agriculture; and other high-ranking officials, as well as visited key research sites in the country.

Three Members of Parliament, accompanied by high-ranking officials from Iran, visited ICARDA. Two Deputy Ministers from the Ministry of Agriculture, Tehran, accompanied by high-ranking officials also visited ICARDA in 1997. Twelve Provincial Directors of Agriculture also visited the Center to get acquainted with its work.

In May 1997, ICARDA's Tehran, Iran office, was formally inaugurated.

Human Resource Development. During the year, the following specialized in-country training courses were conducted to train 100 Iranian researchers: crop modeling and use of meteorological data in crop improvement; seed quality and production; improvement of food legumes; long-term data management and interpretation; and experimental data handling and scientific writing. In addition, a workshop on

Evaluation of promising barley lines at Sararood Station in Iran. Seen here are Prof. Dr Adel El-Beltagy (sixth from left), DG of ICARDA; Mr Hassan Barzegaran (fifth from right), DG of Agricultural Organization, Karmenshah Province; Mr Mohamed Kolivand (seventh from right), Director of Agric. Research Center, Karmenshah; Mr Ismail Sadeghi (left), Director of DARI; and other Iranian scientists.

"Regional Wheat Yellow Rust Research Network" was organized in Iran in which scientists from West and Central Asia participated. Eight Iranian researchers were sponsored for PhD studies. Furthermore, ICARDA scientists are supervising Iranian students for their thesis research for MSc (two students) and PhD degrees (two students).

Infrastructure/Research Facilities Development. The ICARDA/Iran Project is extending assistance to 12 Iranian research centers, located in different ecological regions, to upgrade their research capacity and facilities. The Project is also assisting them in the development and execution of research plans.

Afghanistan

In spite of the unstable political situation in the country, ICARDA continued to supply improved germplasm of its mandated crops to Afghanistan for evaluation and use, through the FAO Office in Peshawar, Pakistan. Cooperative work between FAO, ICARDA, and CIMMYT led to the identification of two bread wheat varieties in 1997 as candidates for release to farmers: 'Roshan-96' (yellow-rust-, leaf blotch-, bunt- and smut-resistant, facultative wheat), and 'Ghori-96' (yellow- and leaf-resistant facultative wheat for rainfed conditions).

Pakistan

Good progress was made during the third year of the collaborative project on range management and small ruminant improvement between the Arid Zone Research Institute (AZRI), Quetta, and ICARDA. The AZRI coordinator of the project presented a progress report at the First Regional Highland Coordination Meeting, held in Ankara in October 1997.

Discussions to further strengthen collaboration between the Pakistan Agricultural Research Council (PARC) and ICARDA were held in Islamabad and Ankara. It was agreed to initiate collaborative projects on the improvement of winter/facultative wheat for Balochistan (with AZRI) and the North-West Frontier (with the Wheat Project Directorate) provinces in the 1997/98 crop season.

Turkey

Turkey/ICARDA Collaborative Highland Project. Fifteen research activities were carried out by Turkish scientists in this project in close collaboration with ICARDA. These included two new activities: development of red lentils for southeastern Anatolia, and Awassi sheep improvement. Three research activities, namely, socioeconomic study, boron toxicity in barley, and winter/early spring chickpea technology transfer were concluded.

The project continued to lay increased emphasis on the development of improved technologies and their transfer through active participation of farmers. For example, farmers participated in the selection and evaluation of improved technologies in the winter lentil and Taurus Mountain subprojects. The community-based, farmer-participatory subproject on the management and rehabilitation of common village pastures in Central Anatolia made significant progress in creating awareness of the importance of sustainable management of rangeland and highlighting the key role of farmers in such an activity.

Turkey/CIMMYT/ICARDA Winter Wheat Improvement Project. Good progress was made by this tripartite project, which is based in Turkey and is a good example of a NARS/CG Centers collaboration. ICARDA's senior facultative wheat breeder, who contributed to the project in the past from Aleppo, was posted in Ankara in May 1997 to collaborate with CIMMYT scientists in the project. After a review of the project activities during the year, CIMMYT and ICARDA agreed to extend their joint collaborative arrangements on winter and facultative wheat in WANA to Central Asia (except Kazakhstan).

As a result of cooperative work between Afghanistan, FAO and the project scientists, four facultative bread wheat varieties were identified for release by Afghanistan: 'Gul-96', 'Takhar-96', 'Rana-96', and 'Dayma-96'.

The Caucasus

The research needs of the three Caucasian countries, Georgia, Armenia and Azerbaijan, were addressed along with those of Turkey, Iran, Afghanistan and the highlands of Pakistan at the First Highlands Regional Coordination Meeting. Further contacts were established with the NARS of these countries, and their representatives participated in the First Regional Coordination Meeting for the Highlands of West Asia and North Africa held in Ankara in October 1997. Efforts were initiated to develop subregional activities for these three countries.

Central Asia

ICARDA's efforts in Central Asia were intensified during the year. Dr. Mekhlis Suleimenov from Kazakhstan was appointed as ICARDA's Liaison Officer for Central Asia, and was based in Tashkent, Uzbekistan. The First Central Asia/ICARDA Regional Coordination Meeting was organized in Aleppo, Syria in September, which was attended by 24 senior scientists and agricultural research managers from the region. Participants identified priority areas for collaborative research and training between ICARDA and Central Asia, developed joint projects and requested ICARDA to seek financial resources to initiate the proposed activities.

A Luncheon Meeting on Central Asia, sponsored by USAID and IFAD, was organized by ICARDA on 27 October during the CGIAR Centers Week in Washington, D.C. As a result, eight CG Centers interested in collaborating with Central Asia formed a CGIAR Consortium on Central Asia and agreed to have ICARDA as the CGIAR's focal point for the work there.

Farmers in Kahraman Province of Turkey selecting lentil lines in varietal trials conducted in their fields.

In 1997, ICARDA initiated its first collaborative activity on rangeland and livestock management in Uzbekistan.

In June 1997, ICARDA's first collaborative research activity was initiated in Central Asia on rangeland and livestock management in Uzbekistan, in collaboration with USDA-ARS/Utah State University, Logan. Also, ICARDA joined hands with IPGRI/WANA in initiating activities on genetic resources in the region through a regional network. In addition, a joint project with CLIMA on collection, utilization, and preservation of cereal and legume genetic resources in Central Asia was approved by ACIAR. ICARDA also agreed to actively collaborate and participate in a SR-CRSP/ University of California, Davis regional project on rangeland management in Central Asia.

Human Resource Development

Several regional and in-country training courses and workshops were organized during 1997. These included: regional training courses on agroecological characterization, analysis of data of socioeconomic surveys, and agronomic practices for sustainable cropping systems in Ankara, Turkey; wheat rusts networking in Karaj, Iran; and an in-country training workshop for farmers and extension agents on management and rehabilitation of common village rangelands in Turkey. A two-week training course on seed production for the farmers and extension agents of Kyrgyzstan was organized on their request in Aleppo. In addition, study visits were organized to see the on-going activities in Turkey and Tunisia. Similar opportunities were provided to scientists from Central Asia through visits to the USA, and to ICARDA.

Latin America Regional Program

ICARDA's Latin America Regional Program (LARP), based at CIMMYT in Mexico, works on barley improvement for areas with higher precipitation than in the WANA region. LARP works closely with the national programs in the region and with advanced research institutes. The germplasm developed by LARP has proved useful not only in Latin America but also elsewhere, for example, in China and USA.

Four countries in the Americas (Brazil, Canada, Ecuador and Mexico), Morocco in Africa, and Vietnam in Asia identified new barley varieties originating from LARP-supplied material as candidates for release.

Barley bred for high yield in Mexico showed remarkable performance at experiment stations in some South American countries. A Chilean scientist reported a yield of 11.2 t/ha from 'Espanza//Gloria/ Come', a line resulting from a cross made to incorporate Russian wheat aphid resistance into a Mexican variety. Agrarian University La Molina in Peru released 'UNA-94', a variety reported to produce 11 t/ha.

Yield trials of hull-less cultivars reached record yields in two locations within Mexico. During the summer of 1997, two six-rowed hull-less lines yielded over 8 t/ha. In a five-year period there has been a 60% increase in yield of hull-less barley, equivalent to a gain of 660 kg per year.

A Canadian farmer in Alberta Province harvested a record yield of 7.7 t/ha of grain with the hull-less variety 'Falcon'. The variety was selected from an F_2 population supplied by the Latin America Regional Program.

Barley in Ecuador. In the Andes of South America, seed production and distribution of improved barley cultivars remains the major constraint to increase barley production. In collaboration with the National Research Institute of Ecuador (INIAP), LARP started a modest seed production project with farmers in a remote area of southern Ecuador. The project began with one farmer in 1995, but the number increased to 13 farmers in 1996 and 240 farmers in 1997. Two barley varieties, 'Shyri' (hulled) and 'Atahualpa' (hull-less), were promoted in the Loja Province. The unique feature of this seed production model is that credit is made available to farmers in the form of inputs distributed at the right time at the farm gate. During a three-year period, all farmers, except one, paid back in grain the equivalent to one-third of total grain harvested. In 1997, the project collected 25 tonnes of seed, enough for an additional 500 farmers to sow half-hectare plots. The grain, after fungicide treatment, will be distributed as seed to a large number of farmers in February 1998. Equipment for herbicide application and threshing will also be made available to farmers.

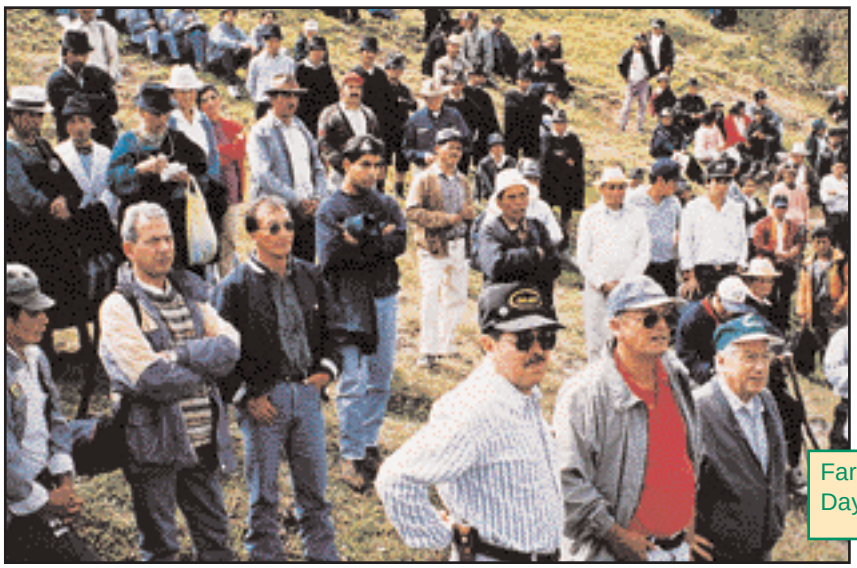
Yields harvested by farmers were lower than in previous years due to low rainfall during the 1997 growing season. However, average yields were 2.4 t/ha for 'Shyri' and 1.6 t/ha for 'Atahualpa', that is, a three- and two-fold increase over the national average, respectively.

In farmers' fields in Ecuador, the highest yield recorded with the hull-less variety 'Atahualpa' was 4.5 t/ha. This yield level is almost the same as recorded on experiment stations.

In Sarajuro, farmers asked INIAP for seed of peas. The project will start increasing seed of peas in the area during 1998 to implement a legume/barley rotation, for sustainable agriculture in the region.

Three young farmers received hands-on training in seed treatment with Vitavax, backpack calibration for herbicide application to control weeds, and handling stationary threshers. These farmers came for a one-week visit to Santa Catalina Experiment Station, the main station in the country, 700 kilometers from farmers' home. Young farmers not only gained new knowledge but also received seed of new varieties of different crops to grow in their fields.

In 1997, subsistence farmers in Sarajuro sold barley seed to neighbors at a higher price than the international barley price. 'Atahualpa' hull-less seed costs USD 356/t, while 'Shyri' (covered seed) has a lower price (USD 285t/ha). In Ecuadorian villages where barley is a staple food, hull-less barley has a higher price because it is relatively simple to prepare dishes with hull-less than with covered-grain barley, that requires extra handling such as the removal of husk by pearling.



Farmers' Field Day in Ecuador.

Resources for Research and Training

Finance

ICARDA's programs are funded by its generous donors (see Appendix 11). In 1997, the Center's grant funding was USD 22.877 million. Combined with other income of USD 0.474 million, the total revenue for the year was USD 23.351 million. The operating expenses for 1997 were USD 27.634 million, resulting in a deficit of USD 4.283 million. The Center implemented several measures to meet the shortfall, including cuts in spending and staff readjustments.

Staff

During 1997, the following internationally-hired, P-level staff members joined ICARDA: Dr John Dodds, Assistant Director General (Research); Dr Michael Turner, Head of Seed Unit; Dr Thomas Taylor, School Principal; Dr Victor Shevtsov, Barley Breeder; Dr Mustapha Bouhssini, Entomologist; Dr Abdurazzak Belaid, Socioeconomist.

Dr Mahmoud El Solh, was transferred from Cairo to Aleppo and appointed as Director of International Cooperation; Dr Scott Christiansen was transferred from Aleppo to Cairo as Grazing Management Specialist/International Facilitator. Dr Nasri Haddad was transferred from Amman to Cairo as Regional Coordinator of NVRSP; Dr Osman Abdalla was seconded by CIMMYT (Mexico) to replace Dr G. Ortiz Ferrara, Bread Wheat Breeder at ICARDA. Dr Habib Ketata was transferred from Aleppo to Ankara as Facultative and Winter Bread Wheat Breeder.

Five new internationally-hired, RA-level staff members also joined during the year: Dr Lahcen Grass as Training Officer; Mr Moyomola Bolarin, Multimedia Specialist; Ms Christine Kalume, Science Writer/Editor; Dr Mekhlis Suleimenov, Central Asia Liaison Officer; Mr Nicholas Thomas, GIS Analyst; and Mr Nihad Maliha, Library and Information Services Manager. Two new staff from Denmark joined as Junior Professional Officers: Mr Soren Jorgensen in Germplasm Program; and Dr Trine Nielsen in Natural Resource Management Program. Dr Abdul Bari Salkini was posted from Aleppo to the Matrouh Resource Management Project as Liaison Scientist in Cairo. Dr John Howeison and Dr Nassir el-Jabi joined as Visiting Scientists, and Dr Roberto Mancinelli and Mr Ra'ed Badwan as Research Fellows. Ten new Teachers joined the ICARDA International School of Aleppo.

The following staff members left during 1997: Mr Ramaswami Seshadri, Purchasing and Supplies Manager; Dr James Bonnell, School Principal; Dr Leonard Reynolds, Livestock Specialist; Dr Franz Weigand, Biotechnologist; Dr Omar F. Mamluk, Consultant; Dr Alfredo Impiglia, Research Associate; and Dr Philip Eberbach and Dr John Howeison, Visiting Scientists. Nine teachers left the ICARDA International School. Three Research Fellows also left: Dr Giuseppe Colla; Mr Ahmed Chibnou; and Mr Jens Berger.

The Farms

ICARDA operates five sites in Syria (including its main research station at Tel Hadya, near Aleppo) and two in Lebanon (Table 6). These sites represent a variety of agroclimatic conditions, typical of those prevailing in the WANA region.

At the Tel Hadya site, yields for the 1996/97 season were lower than expected with a 434 mm of precipitation. A remarkable event was frost occurring in April, which is rare. On April 11 and 12, the

Table 6. ICARDA sites in Syria and Lebanon.

Site	Location		Area (ha)	Approximate elevation (m)	Average precipitation (mm)
SYRIA					
Tel Hadya	36°01'N	36°56'E	948	284	348
Bouider	35°41'N	37°10'E	35	268	226
Ghrerife	35°50'N	37°15'E	2	320	267
Breda	35°56'N	37°10'E	76	300	266
Jindiress	30°24'N	36°44'E	10	210	476
LEBANON					
Terbol	33°49'N	35°59'E	39	890	565
Kfardane	34°01'N	36°03'E	50	1080	445*

* 1996/97 season.

ground temperature fell to -4.8°C which adversely affected many crops. While the last frost night was on April 12, the first day reaching over 30°C maximum was after 12 days on 24 April. This resulted in yields somewhat below the potential of the precipitation received.

Forage conservation is presently under review. Crops are generally ready to be cut in April, a month when precipitation can reach 60 mm in a wet season.

Lathyrus ochrus is suitable for hay production, particularly in *Orobanche*-infested areas. It is resistant to *Orobanche aegyptiaca* and *Orobanche crenata*.

This makes the process a bit risky, as proper hay requires 3-6 days of drying, depending on relative humidity and precipitation. On the other hand, *Vicia sativa* (common vetch), or *Lathyrus ochrus* (chickling) are prone to losing leaves, if properly dried. These two factors triggered interest in testing whether silage-making could be an alternative. Samples prepared indicated that pure stands of vetch may have too little sugar for easy fermentation. This is one reason to add cereals to the legume forage crop. Oat (*Avena sativa*) has been multiplied to be added at 20-25% to the forage legume in a mixture. Another reason for cereals in the legumes is to reduce the risk of lodging, which can make mechanized harvesting difficult.

The common vetch is not too susceptible to *Orobanch*e, but not totally resistant either. In the past *Vicia dasycarpa* (wooly-pod vetch) has been used in highly *Orobanche*-infested fields. The problem of wooly-pod vetch lies in its hard seededness. Therefore, another resistant species, *Lathyrus ochrus* was tested. It proved to be reasonably palatable, but is somewhat frost sensitive. In 1996/97, a selected line survived a minimum temperature of -9°C at ground level in February, and again -4.8°C in mid-April(one month later than normal. It is planned to replace *Vicia sativa* with *Lathyrus ochrus* in *Orobanche*-infested areas.

Appendixes

Contents

Appendix 1

Precipitation (mm) in 1996/97

	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	TOTAL
SYRIA													
Tel Hadya													
1996/97 season	22.9	35.3	17.4	92.5	46.8	24.8	76.3	111.7	6.0	0.0	0.0	0.0	433.7
Long-term average (19 seasons)	3.0	21.5	51.0	52.2	59.4	59.1	46.4	30.8	14.9	2.4	0.0	7.0	347.7
% of long-term average	763	164	34	177	79	42	164	363	40	0		0	125
Breda													
1996/97 season	5.4	29.8	8.8	57.8	25.6	11.2	35.6	54.4	2.2	0.0	0.0	0.0	230.8
Long-term average (40 seasons)	1.7	14.7	30.0	49.8	48.8	40.9	33.9	29.1	16.2	1.3	0.0	0.0	266.4
% of long-term average	318	203	29	116	52	27	105	187	14	0			87
Bouider													
1996/97 season	1.6	31.0	14.4	82.6	56.4	22.4	69.8	61.0	3.2	6.0	0.0	0.0	348.4
Long-term average (24 seasons)	0.5	17.9	27.3	37.0	44.2	38.5	30.2	18.9	9.9	1.3	0.1	0.0	225.8
% of long-term average	320	173	53	223	128	58	231	323	32	462	0		154
Ghrerife													
1996/97 season	1.2	36.2	29.2	68.4	38.4	17.8	65.4	72.4	2.0	0.0	0.0	0.0	331.0
Long-term average (11 seasons)	0.6	26.8	32.9	38.0	48.2	45.7	40.4	17.1	14.8	2.6	0.0	0.0	267.1
% of long-term average	200	135	89	180	80	39	162	423	14	0			124
Jindiress													
1996/97 season	7.1	85.3	27.4	116.2	31.6	48.0	89.3	115.3	11.6	0.0	0.0	0.0	531.8
Long-term average (37 seasons)	1.6	30.6	59.0	91.5	84.0	73.9	65.1	43.3	21.6	3.8	0.4	1.3	476.1
% of long-term average	444	279	46	127	38	65	137	266	54	0	0	0	112
LEBANON													
Terbol													
1996/97 season	1.6	57.8	21.2	103.2	49.9	92.4	104.9	52.5	12.4	0.0	0.0	0.0	495.9
Long-term average (17 seasons)	0.5	24.3	74.8	95.0	117.3	108.0	100.4	26.0	15.9	2.3	0.2	0.0	564.7
% of long-term average	320	238	28	109	43	86	104	202	78	0	0		88
Kfardan													
1996/97 season	0.0	28.8	20.4	106.2	52.7	102.2	75.2	50.8	9.0	0.0	0.0	0.0	445.3

Notes: For area and elevation of these sites, please see Table 6 on page 61.

Appendix 2

Cereal and Legume Varieties Released by National Programs

Barley

Country/year	Variety
Algeria	
1987	Harmal
1992	Badia
1993	Rihane-03
Australia	
1989	Yagan
1993	Kaputor, Namoi
Bolivia	
1991	Kantuta
1993	Kolla
1994	San Lorenzo
Brazil	
1989	Acumai
Canada	
1992	Seebe
1993	Falcon
1994	Tukwa
1995	Kasota
Chile	
1989	Leo/Inia/Ccu, Centauro
China	
1986	Gobernadora
1988	Zhenmai 1
1989	V-24
	Api/CM67//B1
	CT-16
Cyprus	
1980	Kantara
1989	(Mari/Aths*)
1994	Mia Milia, Achera
1995	Lefkonoiko,
	Sanokrithi-79,
	Lysi
Ecuador	
1989	Shyri
1992	Calicuchima-92,
	Atahualpa-92
Egypt	
1992	Giza 125
1993	Giza 126
1996	Giza 127
	Giza 128
Ethiopia	
1981	BSH 15

Barley (contd.)

Country/year	Variety
1984	BSH 42
1985	Ardu
1996	Shege
Iran	
1986	Aras
1990	Kavir, Star (Makui)
1997	Izeh
	Sahand (=Tokak)
	Ganub
Iraq	
1994	Rihane-03, IPA 7
	IPA 9, IPA 265
Italy	
1992	Salus, Digersano
	(naked)
Jordan	
1984	Rum (6-row)
Kenya	
1984	Bima
1993	Ngao
Lebanon	
1989	Rihane-03
1997	Assy
	ER/Apm
Libya	
1992	Wadi Kuf
	Wadi Gattara
1997	Borjouj
	Maknesa
	Ariel
	Irawen
Mexico	
1986	Mona/Mzq/DL71
Morocco	
1984	Asni, Tamellat, Tissa
1988	Tessaout, Aglou,
	Rihane, Tiddas
1997	Safia
	Aguilal
Nepal	
1987	Bonus
Pakistan	
1985	Jau-83
1987	Jau-87, Frontier 87

Barley (contd.)

Country/year	Variety
1993	Jau-93
1996	Sariab
1997	Sanober-96
Peru	
1987	Una 87, Nana 87
1989	Bellavista
1994	Una 94
Portugal	
1982	Sereia
1983	CE 8302
1991	Ancora
Qatar	
1982	Gulf
1983	Harma
Saudi Arabia	
1985	Gusto
Spain	
1987	Resana (Rihane-03)
Syria	
1987	Furat 1113
1991	Furat 2
1994	Improved Arabi Abiad
	(Arta)
Tanzania	
1991	Kibo
Thailand	
1987	Semang 1 IBON 48
	Semang 2 IBON 42
	BRB-8
Tunisia	
1985	Taj, Faiz, Roho
1987	Rihane"S"
1997	Manel
Turkey	
1993	Tarm-92, Yesevi 93
1995	Orza
USA	Poco
	Micah
Vietnam	
1989	Api/CM67//B1
Yemen	
1986	Arafat, Beecher

Country/year	Variety

Durum Wheat

Algeria	
1982	ZB S FG'S'/LUKS GO
1984	Timgad
1986	Sahl, Waha
1991	Korifla
1992	Om Rabi 6
1993	Haidar, Belikh 2, Om Rabi 9, Kabir 1
Cyprus	
1982	Mesoaria
1984	Karpasia
1994	Macedonia
Egypt	
1979	Sohag I
1988	Sohag II, Beni Suef
1990	Sohag III, Beni Suef I
Greece	
1982	Selas
1983	Sapfo
1984	Skiti
1985	Samos, Syros
Iran	
1997	Om Rabi 5 = Seimareh Korifla, Heider
Iraq	
1996	Waha Iraq
1997	Omrabi 5 Korifla
Jordan	
1988	Korifla = Petra Cham 1 = Maru N-432 = Amra Stork = ACSAD 75
Lebanon	
1987	Belikh 2
1989	Sebou
1994	Waha = Cham 1
Libya	
1985	Marjawi, Ghuodwa, Zorda, Baraka, Qara, Fazan
1991	Zahra 1
1992	Khiar 92
1993	Zahra 5 = Korifla Zahra 3
1995	Zahra 7, Zahra 9

Country/year	Variety

Durum Wheat (contd.)

Morocco	
1984	Marzak
1989	Sebou
1991	Tensif
1994	Anouar, Jawhar
1995	Om Rabi 6
1997	Telset
Pakistan	
1985	Wadhanak
Portugal	
1983	Celta, Timpanas
1984	Castico
1985	Heluio
Saudi Arabia	
1987	Cham 1
Spain	
1983	Mexa
1985	Nuna
1989	Jabato
1991	Anton, Roqueno
Sudan	
1997	Waha
Syria	
1984	Cham 1
1987	Cham 3, Bohouth 5
1993	Om Rabi 3
1994	Cham 5
Tunisia	
1987	Razzak
1993	Khiar, Om Rabi 3
Turkey	
1984	Susf bird
1985	Balcili
1988	EGE 88
1990	Cham 1 = Sam 1
1991	Kiziltan
1994	Korifla = Aydin Firat 93
1997	Haran = Om Rabi 5

Bread Wheat

Algeria	
1982	Setif 82, HD 1220
1989	Zidane 89
1992	Zidane, Nesser, ACSAD 59 = 40DNA,

Country/year	Variety

Bread Wheat (contd.)

	Cham 4 = Sidi Okba, Siete Cerros = Rhumel, Alondra = 21AD, DouggaXBJ = Soummam
1994	Mimouni, Ain Abid
China	
1995	Mayon-1 = (Dongfeng 1)
Egypt	
1982	Giza 160
1988	Sakha 92, Giza 162, Giza 163, Giza 164
1991	Gammeiza 1, Giza 165
1993	Sahel 1
1994	Giza 166, Giza 167, Sids 1, Sids 2, Sids 3, Benesuef-3
1995	Giza 167, Sids 4, Sids 5, Sids 6, Sids 7, Sids 8
Ethiopia	
1984	Dashen, Batu, Gara
Greece	
1983	Louros, Pinios, Arachthos
Iran	
1986	Golestan, Azadi
1988	Sabalan, Darab, Quds
1990	Falat
1995	Tajan, Nicknejad Mahdabi, Darab 2
1997	Gaher, Zagross, Nicknejad, Zareen, Alrand, Darab-2, Tajan, Mahdabi, Atrak, Alement, Chamran
Iraq	
1989	Es14
1994	Adnanya, Hamra, Abu Ghraib
Jordan	
1988	Nasma = Jubeiha, L88 = Rabba
1990	Nesser
Lebanon	
1990	Seri
1991	Nesser = Cham 6
1995	Roomy

Country/year	Variety

Bread Wheat (contd.)

Libya	
1985	Zellaf, Sheba, Germa
Morocco	
1984	Jouda, Merchouche
1986	Saada
1989	Saba, Kanz
Oman	
1987	Wadi Quriyat 151, Wadi Quriyat 160
Pakistan	
1986	Sutlej 86
Portugal	
1986	LIZ 1, LIZ 2
Qatar	
1988	Doha 88
Sudan	
1985	Debeira
1987	Wadi El Neel
1991	Neelain
1992	Sasarieb
Syria	
1984	Cham 2, Bohouth 2
1986	Cham 4
1987	Bohouth 4
1991	Cham 6, Bohouth 6
Tanzania	
1983	T-VIRI-Veery 'S' 69/BD
Tunisia	
1983	T-DUMA-D6811-Inrat 69/BD Tunisian release
1987	Byrsa, Salambo
1992	Vaga 92
Turkey	
1986	Dogankent-1 (Cham 4)
1988	Kaklic 88, Kop Dogu 88
1989	Es14
1990	Yuregir, Karasu 90 Katia 1
1994	Sultan 94
1995	F//68.44/NZT/3/ CUC'5', Kasifbey 95 Basribey 95

Country/year	Variety

Bread Wheat (contd.)

UAE	
1995	Cham 2, Seyhan 95, Kirgiz 95
Yemen	
1983	Marib 1, Ahgaf
1988	Mukhtar, Aziz, Dhumran, SW/83/2
1995	Radfan, SW/88/7, SW/88/6, SW/88/8, SW/89/3, SW/89/7
Algeria	
1988	ILC 482, ILC 3279
1991	FLIP 84-79C
	FLIP 84-92C
China	
1988	ILC 202, ILC 411
1993	FLIP 81-40W
	FLIP 81-71C
Cyprus	
1984	Yialousa (ILC 3279)
1987	Kyrenia (ILC 464)

Kabuli Chickpea

Egypt	
1993	ILC 195
France	
1988	TS 1009 (ILC 482)
	TS 1502 (FLIP 81-293C)
1992	Roye Rene (FLIP 84-188C)
India	
1996	Pant G 88-6
Iran	
1995	ILC 482, ILC 3279
	FLIP 84-48C
1997	Hashem
Iraq	
1991	Rafidain (ILC 482)
	Dijla (ILC 3279)
Italy	
1987	Califfo (ILC 72)
	Sultano (ILC 3279)
1995	Pascia (FLIP 86-5C)
	Otello (ICC 6306/ NEC 206)

Country/year	Variety

Kabuli Chickpea (contd.)

Jordan	
1990	Jubeiha-2 (ILC 482)
	Jubeiha-3 (ILC 3279)
Lebanon	
1989	Janta 2 (ILC 482)
1993	Baleela (FLIP 85-5C)
Libya	
1993	ILC 484
Morocco	
1987	ILC 195, ILC 482
1992	Rizki (FLIP 83-48C)
	Douyet (FLIP 84-92C)
1995	Farihane (FLIP 84 79C), Moubarak (FLIP 84-145C)
	Zahor (FLIP 84-182C)
Oman	
1988	ILC 237
1995	FLIP 87-45C
	FLIP 89-130C
Pakistan	
1992	Noor 91 (FLIP 81-293C)
Portugal	
1989	Elmo (ILC 5566)
	Elvar (FLIP 85-17C)
Spain	
1985	Fardan (ILC 72)
	Zegri (ILC 200)
	Almena (ILC 2548)
	Alcazaba (ILC 2555)
	Atalaya (ILC 200)
1995	Bagda (ILC 72 x CA2156)
	Kairo (ILC 72 x CA2156)
	Athenas (ILC 72 x CA2156)
Sudan	
1987	Shendi (ILC 1335)
1994	Jebel Mara 1 (ILC 915)
Syria	
1986	Ghab 1 (ILC 482)
1986	Ghab 2 (ILC 3279)
1991	Ghab 3 (FLIP82-150C)

Country/year	Variety

Kabuli Chickpea (contd.)

Tunisia	
1986	Chetoui (ILC 3279)
	Kassab (FLIP 83-46C)
	Amdoun 1 (Be-sel-81-48)
1991	FLIP 84-79C
	FLIP 84-92C
Turkey	
1986	ILC 195, Guney Sarisi
	482 (ILC 482)
1991	Akcin (87AK 11115)
1992	Aydin 92
	(FLIP 82-259C)
	Menemin 92
	(FLIP 85-14C)
	Izmir 92 (FLIP 85-60C)
1994	Aziziye (FLIP 84-15C)
	Damla (FLIP 85-7C)
1997	Gökce (FLIP 87-8C)
USA	
1994	Sanford (Surrotato x
	FLIP85-58C)
	Dwelley (Surrotato x
	FLIP85-58C)

Lentil

Algeria	
1987	Syrie 229
1988	Balkan 755, ILL 4400
Argentina	
1991	Arbolito
	(ILL 4650x-4349)
Australia	
1989	ILL 5750
	Aldinga (FLIP 84-80L)
1993	Digger (FLIP84-51L)
	Cobber (FLIP84-58L)
	Matilda (FLIP84-154L)
1995	Northfield (ILL 5588)
Bangladesh	
1993	Bari Masur-2 (Sel. from
	ILL 4353 x ILL 353)
1995	Bari Masur-4 (Sel. from
	L5 x FLIP84-112L)
Canada	
1989	Indian Head (ILL 481)
1994	CDC Redwing
	(Eston x ILL 5588)
	CDC Matador (Indian
	Head (ILL 481) x
	(Eston x PI179310)
Chile	
1989	Centinela (74TA 470)
China	
1988	FLIP87-53L
	(ILL 6242)
Ecuador	
1987	INIAP-406
	(FLIP 84-94L)
Egypt	
1990	Precoz (ILL 4605)
1996	Sinai 1 (sel ILL 4605)
	Giza 51 (FLIP84-51L)
Ethiopia	
1980	R 186
1984	Chalew ILL 358
1993	NEL 2705, FLIP84-7L
1994	NEL 2704
1995	Gudo (FLIP84-78L),
	Ada'a (FLIP86-41L)
Iraq	
1992	Baraka (ILL 5582)
Jordan	
1990	Jordan 3 (78S 26002)
Lebanon	
1988	Talya 2 (78S 26013)
1995	Toula (FLIP 86-2L)
Libya	
1993	El Safsaf 3 (78S 26002)
Morocco	
1990	Precoz (ILL 4605)
Nepal	
1989	Sikhar (ILL 4402)
N. Zealand	
1992	Rajah (ILL 6243)
Pakistan	
1990	Manserha 89 (ILL 4605)
1995	Masur-95 (18-12 x
	ILL 4400)
1996	Shiraz-96 (ILL 5865)
Sudan	
1993	Rubatab 1 (ILL 813)
	Aribo 1 (ILL 818)
Syria	
1987	Idleb 1 (78S 26002)
Tunisia	
1986	Neir (ILL 4400)
	Nefza (ILL 4606)
Turkey	
1987	Firat '87 (75kf 36062)
1990	Erzurum '89 (ILL 942)
	Malazgirt '89
	(ILL 1384)
1991	Sazak '91 (ILL 854)
1996	Sayran 96 (ILL 784)
USA	
1991	Crimson (ILL 784)

Faba Bean

Egypt	
1991	Giza Blanca
1995	Giza 461, Giza 714
	Giza 716, Giza 717
	Giza 429, Giza 643
	Giza 674
Iran	
1986	Barkat (ILB 1269)
Portugal	
1989	Favel (80S 43977)
Sudan	
1990	Sellaim-ML
1991	Shambat 75
	Shambat 104
1993	Shambat 616 (00616)
	Basabeer (BB 7)
	Hudeiba 93 (Bulk 1/3)
Syria	
1991	Hama 1 (Selection from
	Aquadulce)

Peas

Cyprus	
1994	Kontemenos
	(PS210713)

Country/year	Variety

Peas (contd.)

Ethiopia	
1994	061K-2P-2192
Oman	
1995	Collegian, MG102703, A0149, Syrian Local Dry Pea
Sudan	
1989	Karima-1
1994	Ballet

Forage Legumes

Jordan	
1994	*Vicia villosa* subsp. *dasycarpa* (IFLVD 683) *Vicia sativa* (IFLVS 715) *Lathyrus ochrus* (IFLLO 101/185)
Lebanon	
1997	Baraka (*Vicia sativa*) Ammara (*Vicia ervilia*) Jaboula (*Lathyrus cicera*)
Morocco	
1990	*Vicia sativa* (ILF-V-1812)
1992	*Vicia villosa* ssp *dasycarpa* (IFLVV 2053)
1994	*Vicia narbonensis* (IVLVN 2387) *Vicia narbonensis* (IVLVN 2391) *Vicia sativa* (IVLVS 709)
Pakistan	
1996	*V. Villosa* ssp. *dasycarpa* Kukak-96

Appendix 3

Publications

The following list covers, as of the time of going to press, journal articles published by ICARDA researchers — many of them in collaboration with colleagues from national programs. A complete list of publications, including book chapters and papers published in conference proceedings, is published separately and is available on request from ICARDA.

Journal Articles

Araus, J.L., J. Bort, S. Ceccarelli and S. Grando. 1997. Relationship between leaf structure and carbon isotope discrimination in field grown barley. Plant Physiology and Biochemistry 35(7): 533-541.

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Goodchild, A.V. 1997. Effects of rainfall and temperature on the feeding value of barley straw in a semi-arid mediterranean environment. Journal of Agricultural Science, Cambridge 129: 353-366.

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Appendix 4

Graduate Theses Produced with ICARDA's Assistance

Master's

1996

LB American University of Beirut

Khaled Y. Faour (LB). Small ruminant production and land use in the Beka'a valley, Lebanon: a bio-economic model. 196 pp.

1997

JO University of Jordan, Amman

Abdel Hassan Mahmoud Abdel-Ghani (JO). Assessment of variability among Baladi wheats grown in Jordan. 97 pp. (Arabic summary.)

Nour Eddin Al-Kokhon (JO). Assessment of wind erosion under different practices in a rainfed area in Jordan. 108 pp. (Arabic summary).

NL Wageningen Agricultural University

Bayeh Mulatu (ET). Localization of resistance factors in leaf tissue profile of selected barley lines against the Russian wheat aphid (*Diuraphis noxia* Mordwilko, Homoptera: Aphididae). 57 pp.

Doctoral

1996

AU La Trobe University

Layth Khalil Mahdi (IQ). Agronomic assessment of variable sowing date, depth and seeding rate of wheat in a mediterranean-type environment. 219 pp.

1997

IQ University of Baghdad

Turki Muftin Saad Al-Aridhi (IQ). [Response of chickpea and lentil to inoculation with different strains of root nodule bacteria (*Rhizobium*)]. 99 p. (In Arabic.)

* Country codes:
AU, Australia; ET, Ethiopia; IQ, Iraq; JO, Jordan; LB, Lebanon; NL, Netherlands

Appendix 5

Agreements

Agreements of Cooperation with Governments and Institutions in 1997

AUSTRIA

7 August 1997, Memorandum of Understanding with the International Atomic Energy Agency (IAEA), Vienna and ICARDA (En).

CENTRAL ASIA

31 October 1997. Memorandum of Understanding of the CGIAR Consortium for Collaboration on agricultural Research and Development in Central Asia (En).

FRANCE

23 April 1997. Agreement between Centre International de Hautes Etudes Agronomique Méditerranéennes (CIHEAM), Paris and ICARDA (En).

CIMMYT

Addendum to the September 1996 Agreement between ICARDA and CIMMYT on wheat improvement research in the West Asia and North Africa region.

MOROCCO

4 August 1997. Agreement between the World Phosphate Institute (IMPHOS), Casablanca and ICARDA (En).

PHILIPPINES

15 August 1997. Agreement between the International Center for Living Aquatic Resources Management (ICLARM) and ICARDA (En).

SRI LANKA

3 December 1997. Agreement between the International Irrigation Management Institute (IIMI), Colombo and ICARDA (En).

USA

31 January 1997. Memorandum of Understanding between Texas Tech University, USA and ICARDA (En).

25 June 1997. Memorandum of Understanding between Texas Agricultural Experiment Station, USA and ICARDA (En).

Appendix 6

Special Projects

During 1997, the following Special Projects were operational. Special Projects include all activities supported by funds provided separately from ICARDA's unrestricted core budget, i.e., supported by Restricted Core, Complementary and In-Trust funding. The financial contribution by the respective donors are reported in Appendix 11. The reports on the activities listed are encompassed in the appropriate sections of the body of this Annual Report.

AUSTRALIA

ACIAR (Australian Centre for International Agricultural Research)

Development and Conservation of Plant Genetic Resources from the Western Mediterranean Region

Improvement of Drought and Disease Resistance in Lentils in Nepal, Pakistan and Australia

Improvement of Faba Beans in China and Australia through Germplasm Evaluation, Exchange, and Utilization

Near-Isogenic Lines for the Assessment of Pathogenic Variation in the Wheat Stripe (yellow) Rust Pathogen

GRDC (Grains Research and Development Corporation)

Improved ICARDA Germplasm for Australia through Regional Adaptation Analysis

Coordinated Improvement Program for Australian Lentils

Faba Bean Germplasm Multiplication

International Durum Wheat Improvement Cooperation

Preservation and Utilization of the Unique Pulse and Cereal Genetic Resources of the Vavilov Institute

International Selection, Introduction and Fast Tracking of Kabuli Chickpea with Large Seed Size, High Biomass, Yield and *Ascochyta* Blight Resistance

AFESD (Arab Fund for Economic and Social Development)

Technical Assistance to ICARDA's Activities in Arab Countries (Postgraduate Research, Training, and Visiting-Scientist Program)

Regional Adaptive Research Program for the Development of Integrated Crop/Livestock Production in West Asia and North Africa

Arabian Peninsula Regional Program - Phase II

CANADA

IDRC (International Development Research Centre)

Scientific support to dryland resource management research in the highlands of Yemen

Water harvesting in Jordan

Integrated watershed development in Syria

Farmer participation in barley breeding in North Africa

Supplemental irrigation with brackish water in Syria

Dryland Pasture, Forage and Range Newsletter

EC (European Commission)

Nile Valley Regional Program - Egypt Phase II

Nile Valley Regional Program Wild Oats Project - Egypt. Wild oats control in cereals and other winter crops

Enhancing productivity and sustainability of crop production in the Mediterranean highlands

Analyzed climatology of rainfall obtained from satellite and surface data for the Mediterranean basin. A version for the Eastern Mediterranean region

FAO (Food and Agriculture Organization of the United Nations)

Analytical review of NARS in West Asia and North Africa

FAO/RNE (Regional Office for the Near East)

Upgrading laboratory analytical procedures

Second international conference on Soil Solarization and Integrated Management of Soil-Borne Pathogens and Pests

Workshop on Animal Genetic Resources

Dryland Pasture, Forage and Range Newsletter

FORD FOUNDATION

Dryland Resource Management and the Improvement of Rainfed Agriculture in Drier Areas of WANA

Support to Gender Analysis in the Agricultural Systems of WANA

GERMANY

BMZ (Federal Ministry for Economic Cooperation) / GTZ (German Agency for Technical Cooperation)

DNA Marker-Assisted Breeding and Genetic Engineering of ICARDA-Mandated Crops

Use of DNA-Markers in Selection for Disease Resistance Genes in Barley

QTL Analysis by Molecular Markers of Agronomically Important Characters of Barley for Dryland Conditions

Resource Management for Sustainable Agricultural Production in WANA

Integrated Disease Management in Cereal-and Legume-Based Cropping Systems of the West Asia and North Africa Region

Farmer Participation and Use of Local Knowledge in Breeding Barley for Specific Adaptation

GTZ (German Agency for Technical Cooperation)

Development of National Seed Production Organizations in WANA

Workshop on Local Seed Supply Systems: Status, Constraints, and Prospects

IDA (International Development Agency)/World Bank

Agriculture Sector Management Support Project (ASMSP), Yemen

Matrouh Resource Management Project

IFAD (International Fund for Agricultural Development)

Regional Adaptive Research Program for the Development of Integrated Crop/Livestock Production in West Asia and North Africa

West Asia and North Africa Dryland Durum Wheat Improvement Network

Arabian Peninsula Regional Program - Phase II

Technical Backstopping Support Program to On-going IFAD-financed Projects in the Near East and North Africa

IMPHOS (Institut Mondial du Phosphate)

Phosphorus Fertilizer Use Efficiency for Increased Crop Production in West Asia and North Africa

IRAN

ICARDA/Iran - Scientific and Technical Cooperation

NETHERLANDS

Strengthening Research and Transfer of Technology for Sustained Barley Production in Ethiopia

Problem-Solving Regional Networks Involving Cool-Season Food Legumes and Cereals in the Nile Valley Countries and Yemen

Training in Seed Technology

NORWAY (through United Nations Environment Programme)

Wind Erosion in Africa and Western Asia - Problems and Control Strategies

OPEC Fund for International Development

Devolution of Barley Breeding to Farmers in North Africa

SPAIN

Incorporating Resistance to Drought and Upgrading the Grain Quality in Durum Wheat for Ibero-Maghreb Region

Race Identification of *Fusarium oxysporum* f. sp. *ciceri* in Chickpea in the Mediterranean Region

Exchange of Fodder, Pasture and Range Plant Germplasm

Reclamation of Marginal Soils

UNDP (United Nations Development Programme)

Technical Assistance to Agricultural Investment in the Southern Region - Phase II

UNITED STATES OF AMERICA

USAID (United States Agency for International Development)

SR-CRSP (Small Ruminant Collaborative Research Support Program) Assessment Team: GIS Modelling Tools to Predict Regional Trends of Rangeland Production in Central Asia

USAID Agricultural Technology Utilization and Transfer Project (ATUT)

Leveraging an Integrated Expert System/Crop Modelling for Farm-Level Wheat Crop Management

Application of Molecular Genetics for Development of Durum Wheat Varieties Possessing High Yield Potential, Rust Resistance, Stress Tolerance, and Improved Grain Quality

Development of High-Yielding, Long-Spike Bread Wheat Cultivars Possessing High Tiller Number, Rust Resistance, and Heat Tolerance Facilitated by Microsatellite DNA-Markers

USDA/ARS (United States Department of Agriculture, Agricultural Research Service)

Central Asian Range and Sheep Evaluation

Appendix 7

Collaboration in Advanced Research

ICARDA's collaborative activities with advanced research institutions regardless of funding source:

International Centers and Agencies

ACSAD (The Arab Center for the Studies of Arid Zones and Dry Lands)
- Joint workshops, conferences and training.
- Exchange of germplasm.
- ICARDA provides ACSAD with plant pathology back-stopping.
- ACSAD is participating in the ICARDA/CIMMYT Durum Wheat Network for WANA, supported by IFAD.

CIAT (Centro Internacional de Agricultura Tropical)
- ICARDA is participating in the Systemwide Soil Water and Nutrient Management Initiative and in the Systemwide Initiative on Participatory Research and Gender Analysis for Technology Development, both coordinated by CIAT.
- Joint development of CGIAR Systemwide Microbial Genetic Resources Database.

CIHEAM (International Center for Advanced Mediterranean Agronomic Studies)
- Joint training courses and information exchange.
- Collaboration in an analytical review of NARS in WANA.

CIMMYT (International Center for the Improvement of Maize and Wheat)
- CIMMYT has seconded two wheat breeders to ICARDA, and ICARDA has seconded a barley breeder to CIMMYT.
- CIMMYT's outreach program in Turkey and ICARDA's Highland Regional Program share facilities in Ankara, Turkey and collaborate in a joint facultative wheat improvement program.
- ICARDA and CIMMYT jointly coordinate a durum wheat research network encompassing WANA and southern Europe.

FAO (Food and Agriculture Organization of the United Nations)
- ICARDA participates in the Inter-Agency Task Forces convened by the FAO-RNE (FAO Regional Office for the Near East).
- ICARDA and FAO are co-sponsors of AARINENA.
- ICARDA participates in FAO's AGLINET cooperative library network, AGRIS and CARIS.
- Collaboration in an analytical review of NARS in WANA.
- FAO and ICARDA co-sponsored a Workshop for the Initiating Group for Implementation of Animal Genetic Resources Management for the Near East.

EC (Commission of the European Community)
Joint Research Centre, Space Applications Institute, Italy
- Agrometeorological research on land use and crop monitoring and yield forecasting.

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics)
- ICARDA and ICRISAT maintain the Global Grain Legume Drought Research Network.
- ICARDA and ICRISAT are co-convenors of the theme Optimizing Soil Water Use within the Systemwide Soil Water and Nutrient Management Initiative.
- ICARDA is collaborating with ICRISAT on insect pests of grain legumes within the Systemwide Initiative on Integrated Pest Management.
- Joint Workshop on Wind Erosion in Africa and Western Asia - Problems and Control Strategies.

IFPRI (International Food Policy Research Institute)
- ICARDA collaborates with IFPRI in the Inter-Center Initiative on Property Rights and Collective Action.
- Collaboration in policy and property rights research in WANA: ICARDA hosts two joint ICARDA/IFPRI-appointed Post-doctoral Fellows.

IIMI (International Irrigation Management Institute)
- ICARDA and IIMI share offices in Cairo.
- ICARDA is the convening center for a project on Efficient Use of Water in Agriculture within the Systemwide Water Resources Management Program coordinated by IIMI.

IITA (International Institute of Tropical Agriculture)
- ICARDA is collaborating with IITA on parasitic weeds within the Systemwide Initiative on Integrated Pest Management.
- Joint development of CGIAR Systemwide Microbial Genetic Resources Database.

ILRI (International Livestock Research Institute)
- ICARDA is the convening center, in collaboration with ILRI and ICRISAT, for a program on Production and Utilization of Multi-purpose Fodder Shrubs and Trees in West Asia, North Africa and the Sahel as part of the Systemwide Livestock Initiative on Feed Resources Production and Utilization coordinated by ILRI.
- Joint development of CGIAR Systemwide Microbial Genetic Resources Database.
- ICARDA and ILRI co-sponsored a Consultation with NARS of WANA on priorities in livestock research.

IPGRI (International Plant Genetic Resources Institute)
- ICARDA hosts and services the IPGRI Office for West Asia and North Africa.
- ICARDA participates with other CG Centers in the Systemwide Genetic Resources Program, coordinated by IPGRI.

IRRI (International Rice Research Institute)
- Joint development of CGIAR Systemwide Microbial Genetic Resources Database.

Islamic Development Bank
- ICARDA provides support to the implementation of OICIS-NET (Information Systems Network for Member Countries of the Organization of Islamic Conference).

ISNAR (International Service for National Agricultural Research)
- ICARDA and ISNAR cooperate in research management for NARS in WANA.

UNEP (United Nations Environment Programme)
- Joint Workshop on Wind Erosion in Africa and Western Asia - Problems and Control Strategies.

AUSTRALIA

NSW Agriculture, Agricultural Research Centre
- Durum Wheat Improvement.
- Improvement of Faba Beans in China.

CLIMA (Centre for Legumes in Mediterranean Agriculture)
- Conservation of plant genetic resources from the western Mediterranean region.
- Lentil improvement.
- Faba bean germplasm multiplication.
- Germplasm testing and assessment of antinutritional factors: *Lathyrus* spp. and *Vicia* spp.
- International selection, introduction and fast tracking of kabuli chickpea.

Victorian Institute for Dryland Agriculture
- Lentil improvement.

University of Sydney, I.A. Watson Wheat Research Centre
- Wheat improvement through regional adaptation analysis.

University of Western Australia
- Whole-farm modelling of pasture, cereals and livestock (with CLIMA).
- Collection, evaluation and ecology of subterranean vetch (*Vicia amphicarpa*).

Plant Breeding Institute, Cobbity, NSW
- Yellow rust virulence and resistance.

AUSTRIA

Federal Institute for Agrobiology, Linz
- Safety duplication of ICARDA's legume germplasm collection.

CANADA

Agriculture Canada, Quebec
- Screening for barley yellow dwarf virus resistance in cereals.

Canadian Grain Commission, Winnipeg
- Development of techniques for evaluating the quality of barley, durum wheat, and food legumes.

Concordia University, Montreal and University of Moncton
- Development of an optimization model for water harvesting in Jordan.

Laval University, Quebec
- Screening for barley yellow dwarf virus resistance in cereals.

University of Guelph
- Agrometeorology and crop modelling.

University of Saskatchewan, Saskatoon
- Collection, evaluation and conservation of barley, durum wheat, and their wild relatives.
- Information services on lentil, including publication of the LENS Newsletter.
- Evaluation of chickpea germplasm and their wild relatives.

DENMARK

Danish Centre for Tropical Agriculture and Environment, Royal Veterinary and Agricultural University, Copenhagen
- Barley improvement.

FRANCE

Institut National de la Recherche Agronomique (INRA)
- Association of molecular markers with morphophysiological traits associated with constraints of Mediterranean dryland conditions in durum wheat with Ecole Nationale Supérieure d'Agronomie (ENSA), Montpellier and ENSA-INRA, Le Rheu.

- Monitoring and on-farm data analysis of parasitic diseases of small ruminants.
- Water balance studies in cereal-legume rotations in semi-arid mediterranean zone (with Bioclimatology Research Unit of INRA, Thiverval-Grigon).

Institut Français de Recherche Scientifique pour le Développement en Coopération (ORSTOM)
- Cooperation in the establishment of a network on water information.

Maison de l'Orient Méditerranéen, Université Lyon
- History of agricultural and pastoral production systems and the management of agricultural and pastoral resources in the Middle East and North Africa.

Réseau Céréales Mediterranean (RCM), Paris
- Collaboration on cereal improvement in the Mediterranean region.

Université Paris-Sud, Labo Morphogénese Végétale Experimentale
- Production of double haploids in durum wheat.

GERMANY

BBA (Institute for Biochemistry and Plant Virology), Braunshweig, Germany
- Control of Faba Bean Necrotic Yellow Virus.

University of Bonn
- Ecology and biology of cereal cyst nematodes.

University of Kiel
- Assessment of information needs for development of water management models.

University of Frankfurt am Main
- Development and use of DNA molecular markers for indirect selection in chickpea.
- Characterization of *Ascochyta rabiei* and mapping of geographical distribution in WANA.

University of Göttingen
- Development of wheat germplasm with multiple disease resistance.

University of Hannover
- Development of transformation protocols for chickpea.

University of Hohenheim
- Barley market studies and economic assessment of grain and straw quality and morphological traits.
- Effect of heterozygosity and heterogeneity on yield stability of barley.
- Straw quality: breeding and evaluation methods (near-infrared reflectance and histochemistry).
- Stability of crop/range/livestock systems in the Al Bab area in northern Syria.

University of Karlsruhe
- Use of remote sensing and GIS for identification of water harvesting sites.

Technical University, Munich
- Use of DNA markers in selection for disease resistance genes in barley.

ITALY

Applied Meteorology Foundation, Florence; Centre for Computer Application in Agriculture (CeSIA)
- Agroecological characterization: generation of weather data.

Institute of Nematology, Bari
- Studies of parasitic nematodes in food legumes.

University of Genova
- Analysis of the climatology of rainfall obtained from satellite and surface data for the Mediterranean basin.

University of Naples; ENEA, Rome; Stazione Sperimental di Granicoltura per la Sicilia, Caltagerone; Instituto Sperimentale per la Patalogia Vegetale, Rome.
- Development of chickpea germplasm with combined resistance to *Ascochyta* blight and *Fusarium* wilt using wild and cultivated species.

University of Tuscia, Viterbo.
- Enhancing wheat productivity in stress environments utilizing wild progenitors and primitive forms.
- Diversity of storage proteins in durum wheat

University of Tuscia, Viterbo; Germplasm Institute, Bari; ENEA, Rome.
- Evaluation and documentation of durum wheat genetic resources.

JAPAN

Japan International Cooperation Agency (JICA)
- Animal health: surveys and monitoring of parasitic and viral diseases.

Japan International Research Center for Agricultural Sciences (JIRCAS)
- Resource management: mapping of soil loss, feed resources, and vegetation loss in crop/range/livestock system of northeastern Syria.

Gifu University, Faculty of Agriculture
- Assessment of the adaptive role of plant color and chlorophyll a/b ration in barley.

NETHERLANDS

ISRIC (International Soil Reference Information Centre)
- Collaboration on modelling soils in GIS.

Royal Tropical Institute, Amsterdam
- Orobanche control.

PORTUGAL

Estacao National de Melhoramento de Plantas, Elvas
- Screening cereals for resistance to yellow rust, scald, *Septoria*, and powdery mildew.
- Developing lentil, faba bean, chickpea, and forage legumes adapted to Portugal's conditions.

RUSSIA

Krasnodar Agricultural Research Institute
- Wheat and barley breeding.

Scientific Research Institute for South East, Saratov
- Durum wheat quality.
- Cold and drought tolerance in durum and bread wheat.

SPAIN

INIA (Instituto Nacional de Investigacion y Tecnologia Agraria y Alimentaria)
- Barley stress physiology (with University of Cordoba).
- Improvement of drought tolerance and semolina and pasta quality of durum wheat (with University of Cordoba; Jerez de la Frontera; University of Barcelona; Centre Udl-IRTA, Lleida).
- Race identification of *Fusarium oxysporum* f. sp. *ciceri* in chickpea in the Mediterranean region (with University of Cordoba)
- Exchange of fodder, pasture and range plant germplasm.
- Reclamation of marginal soils.

SWITZERLAND

Institut Universitaire d'Études du Développement (IUED), Geneva
- History of agricultural and pastoral production systems and the management of agricultural and pastoral resources in the Middle East and North Africa.

Station Fédérale de Recherches Agronomiques de Changins (RAC)
- Duplication of *Lathyrus* genetic resources and data.

UNITED KINGDOM

University of Birmingham
- Botanical surveys and assessment of communal pastures in Turkey.

University of Reading
- Gender analysis in the agricultural systems of WANA.
- Adaptation of lentils.
- Utilization of cereal straws and stubble.

Scottish Agricultural College, Edinburgh
- Isozyme variability in barley landraces.

Silsoe College
- ICARDA is providing consultancies in support of the Jordan Arid Zone Productivity Project implemented by Silsoe College.

UNITED STATES OF AMERICA

University of California, Riverside
- Biodiversity of wheat wild relatives.

University of California, Davis
- SR-CRSP (Small Ruminant Collaborative Research Support Program: rangeland production and utilization in Central Asia.
- Developing chickpea cultivars with resistance to *Ascochyta* blight.

Cornell University, Ithaca.
- Use of molecular markers for genome mapping and marker-assisted selection for stress resistance in durum wheat.

University of Massachusetts, Amherst
- Child nutrition in rural areas of Syria.

Michigan State University, East Lansing, Michigan
- Simulation of phosphorus dynamics in the soil-plant system.
- Integrated expert systems/crop modelling of wheat crop management.

North Dakota University
- Grain quality and PCR-primers for durum wheat.

Oregon State University
- Molecular mapping of barley within the North America Barley Genome Mapping project.

- Identification of molecular markers associated with resistance to diseases of barley.

Oregon State University; Kansas State University; Texas A&M.
- Collaborative interdisciplinary research in winter and facultative wheat and barley.

Texas Tech University, Plant Molecular Genetics Laboratory, Lubbock, Texas
- Adaptation to drought and temperature stress in barley using molecular markers.

USDA/ARS (US Department of Agriculture, Agricultural Research Service), National Germplasm Resources Laboratory.
- Production of PCR primers for detection of viruses.

USDA/ARS Beltsville Agricultural Research Center, Beltsville, Maryland
- Development of bread wheat cultivars facilitated by microsatellite DNA markers.

USDA/ARS Range Sheep Production Efficiency Unit (RSPEU), Dubois, Idaho
- Central Asian rangeland and sheep evaluation.

USDA/ARS Forage and Range Research Laboratory (FRRL), Logan, Utah
- Central Asian rangeland and sheep evaluation.

USDA/ARS Grain Legume Genetics and Physiology Research, Washington State University
- Gene mapping of economic traits to allow marker-assisted selection in chickpea and lentil.
- Exploitation of existing genetic resources of food legumes.

USDA/ARS Western Regional Plant Introduction Station, Pullman, Washington
- Conservation of temperate food, pasture, and forage legume biodiversity.

Utah State University
- SR-CRSP (Small Ruminant Collaborative Research Support Program): rangeland production and utilization in Central Asia.

University of Vermont
- Use of entomopathogenic fungi for the control of Sunn pest in West Asia.

Washington State University, Pullman, Washington
- Mapping economic genes of lentil.
- Adaptation of peas for Mediterranean environments.
- *Ascochyta* blight resistance in chickpea.
- Genetics of winter hardiness and adaptation of lentil to cold highland areas.

University of Wisconsin, Land Tenure Center, Madison
- Livestock and rangeland policy and property rights in Central Asia.

Yale University, Center for Earth Observations
- Feasibility study of use of remote sensing and image analysis for land-use mapping and evaluation.

Appendix 8

Research Networks Coordinated by ICARDA

Title	Objectives/Activities	Coordinator	Countries/ Institutions involved	Donor Support
International & Regional Networks				
Cereal International Nursery	Disseminates barley, durum wheat and bread wheat advanced lines, parental lines and segregating populations developed by ICARDA, CIMMYT and by national programs themselves. Feedback from NARS assists in developing adapted germplasm for national programs and provides a better understanding of genotype x environment interaction and of the agroecological characteristics of major cereal production areas.	Germplasm Program	50 countries worldwide; CIMMYT	ICARDA Core funds
International Legume Testing Network (ILTN)	Dissemination of genetic material to NARS for evaluation and use under their own conditions. Permits multilocation testing of material developed by NARS and ICARDA and helps in developing better understanding of genotype x environment interaction as well as agroecological characterization of legume production areas. Includes lentil, chickpea, dry pea, vetches and chickling.	Germplasm Program	52 countries worldwide; ICRISAT	ICARDA Core funds
SEWANA (Southern Europe and WANA) Durum Wheat Research Network WANADDIN (WANA Dryland Durum Improvement Network)	Durum breeder and crop improvement scientists from southern Europe, West Asia and North Africa (SEWANA) complement eachother's activities in developing techniques and breeding material of durum wheat adapted to the Mediterranean environment and with high grain quality.	Germplasm Program	Algeria, Jordan, Lebanon, Morocco, Tunisia, Turkey, Syria, France, Greece, Italy, Spain, Canada, USA	ICARDA Core funds; France Italy; IFAD
Soil Fertility Network	To standardize methods and exchange information and results from research on soil fertility, soil management, and fertilizer use.	Natural Resource Management Program	Algeria, Cyprus, Egypt, Iran, Iraq, Jordan, Lebanon, Libya, Morocco, Pakistan, Syria, Tunisia, Turkey, Yemen	ICARDA IMPHOS
Dryland Pasture and Forage Legume Network	Communication linkages among pasture forage and livestock scientists in WANA.	Natural Resource Management Program	WANA; Europe; USA; Australia	ICARDA, CIHEAM, CLIMA, FAO-RNE,

Research Networks Coordinated by ICARDA

Title	Objectives/Activities	Coordinator	Countries/ Institutions involved	Donor Support
				IDRC, USAID (CRSP)
WANA Plant Genetic Resources Network (WANANET)	Working groups will specify priorities in plant genetic resources; identify and implement collaborative projects; implement regional activities.	IPGRI Regional Office for WANA; ICARDA Genetic Resources Unit	WANA countries; IPGRI; FAO; ACSAD	IPGRI, ICARDA, FAO
Faba Bean Information Services (FABIS)	Collection and dissemination of worldwide information on faba bean, chickling and vetch to facilitate communication between research workers. FABIS newsletter; specialized bibliographic journals; research workers directory.	Germplasm Program; Communication, Documentation and Information Services	Worldwide	ICARDA Core funds
Lentil Experimental News Services (LENS)	Collection and dissemination of worldwide information on lentils to facilitate communication between research workers. LENS newsletter; specialized bibliographic journals; research workers directory.	Germplasm Program; Communication, Documentation and Information Services	Worldwide	ICARDA Core funds
RACHIS	Collection and dissemination of worldwide information on wheat and barley to facilitate communication between research workers. RACHIS newsletter; specialized bibliographic journals; research workers directory.	Germplasm Program; Communication, Documentation and Information Services	Worldwide	ICARDA Core funds
WANA Seed Network	Encourages (1) stronger regional seed sector cooperation, (2) exchange of information, (3) regional consultations, and (4) inter-country seed trade.	ICARDA Seed Unit	Algeria, Morocco, Iraq, Cyprus, Turkey, Jordan, Syria, Egypt, Sudan, Libya, Yemen	ICARDA Germany (GTZ) Netherlands
Agricultural Information Network for WANA (AIN-WANA)	Improve national and regional capacities in information management, preservation and dissemination.	Communication, Documentation and Information Services	WANA countries; CIHEAM; ISNAR	ICARDA
Dryland Resource Management Research Network	Promotes and supports interaction between countries conducting case studies of dryland resource management under the	Natural Resource Management	Egypt, Lebanon, Libya, Jordan, Pakistan, Syria,	Ford Foundation IDRC

Research Networks Coordinated by ICARDA

Title	Objectives/Activities	Coordinator	Countries/ Institutions involved	Donor Support
	auspices of the Dryland Resource Management Project.	Program, ICARDA	Tunisia, Yemen	ICARDA
Global Grain Legume Drought Research Network (GGL-DRN)	Establish integrated global efforts on enhancing and stabilizing grain legume production in drought-affected environments through provision of information. Characterize and map types of drought using GIS. Quantify yield losses using existing data or through experimentation. Identify priority areas for research. Extend available technologies to target regions.	ICRISAT/ ICARDA	Worldwide; ICRISAT FAO	ICARDA ICRISAT FAO
Sub-Regional Networks				
Networks operating under the North Africa Regional Program (NARP)				
North African Sub-Regional Collaborative Research Network	Multinational, multidisciplinary cooperation between national programs in North Africa. Lead countries are identified for specific activities to serve as the liaison country between specialists in the identified area.	NARP, ICARDA	Algeria, Libya, Morocco, Tunisia	AFESD; IFAD
North African Faba Bean Research Network	Network provides for continued availability of ICARDA enhanced faba bean germplasm and runs regional trials and nurseries including Orobanche resistance nursery, joint evaluation visits, regional training courses.	GTZ INRA, Morocco	Algeria, Libya, Morocco, Tunisia	GTZ
Networks operating under the West Asian Regional Program (WARP)				
West Asian Sub-Regional Collaborative Research Network	Multinational, multidisciplinary cooperation between national programs in West Asia. Lead countries are identified for specific activities to serve as the liaison country between specialists in the identified area.	WARP, ICARDA	Cyprus, Iraq, Jordan, Lebanon, Syria	AFESD; IFAD
Networks operating under the Highland Regional Program (HRP)				
Highland Sub-Regional Collaborative Research Network	Multinational, multidisciplinary cooperation between national programs in West Asia. Lead countries are identi-	HRP, ICARDA	Iran, Pakistan, Turkey; Central Asian	ICARDA & CIMMYT

Research Networks Coordinated by ICARDA

Title	Objectives/Activities	Coordinator	Countries/ Institutions involved	Donor Support
	fied for specific activities to serve as the liaison country between specialists in the identified area.		Republics; Trancaucasian Republics	
Enhancing Productivity and Sustainability of Crop Production in the Mediterranean Highlands	Improvement of crop production in the highland areas of the Mediterranean region through the use of improved, disease resistant and drought and cold tolerant varieties in appropriate crop sequences, through enhanced collaboration between countries of the Mediterranean region with large highland areas of similar ecological conditions.	HRP, ICARDA	Algeria, Morocco, Tunisia, Turkey	EEC
Networks operating under the Nile Valley and Red Sea Regional Program (NVRSRP)				
Sources of Primary Inoculum of Stem and Leaf Rusts of Wheat: Their Pathways and Sources of Resistance	Determine disease development of leaf and stem rusts in relation to weather data. Identify prevailing races and the pathways of pathogens. Identify wheat germplasm with effective resistance genes. Identify primary sources of inoculum. Contribute to overall breeding strategy.	ARC, Egypt	Egypt, Ethiopia, Sudan, Yemen, ICARDA	Netherlands (DGIS)
Management of Wilt and Root Rot Diseases of Cool Season Food Legumes	Identify sources of resistance to wilt and root-rots. Incorporate resistance into germplasm with suitable characteristics. Provide segregating populations to NARS to select under their own conditions. Develop strategy for multiple disease resistance. Identify races in Fusarium wilt pathogens. Studies on other components of integrated disease management.	AUA, Ethiopia	Egypt, Ethiopia, Sudan, ICARDA, ICRISAT	Netherlands (DGIS)
Integrated Control of Aphids and Major Virus Diseases in Cool Season Food Legumes and Cereals	Assess the potential for and implement biological control of aphids. Identify and incorporate sources of resistance to, and improve chemical control of, aphids. Develop improved diagnostic methods to identify virus diseases, and assess their spread and relative importance. Identify germplasm for virus resistance. Develop integrated pest management program.	ARC, Egypt ARC, Sudan	Egypt, Ethiopia, Sudan, Yemen, ICARDA	Netherlands (DGIS)
Thermotolerance in Wheat and Maintenance of Yield Stability in Hot Environments	Identify physiological and morphological traits for improving wheat adaptation to heat; verify these traits in collaboration with breeders. Identify improved manage-	ARC, Sudan	Egypt, Ethiopia, Sudan, Yemen, ICARDA, CIMMYT	Netherlands (DGIS)

Research Networks Coordinated by ICARDA

Title	Objectives/Activities	Coordinator	Countries/ Institutions involved	Donor Support
	ment strategies through a better understanding of development and growth. Describe the physical environment and characterize promising genotypes for development of computer simulations of crop growth. Characterize photothermal and vernalization responses of selected commercial lines.			
Water Use Efficiency in Wheat	Develop and identify wheat cultivars requiring less water and tolerant to moisture stress. Identify irrigation regimes that meet crop-water requirements. Improve soil management practices for soil moisture conservation. Develop improved production packages. Calibrate crop modelling systems.	ARC, Egypt	Egypt, Ethiopia, Sudan, Yemen, ICARDA	Netherlands (DGIS)
Socio-Economic Studies on Adoption and Impact of Improved Technologies	Monitoring and evaluation of technology transfer to farmers with respect to adoption levels and identification of factors influencing adoption; impact of improved technology on farm income levels and production; effect of policy and institutional factors on technology transfer and adoption.	ARC, Sudan	Egypt, Ethiopia, Sudan, Yemen, ICARDA	Netherlands (DGIS)

Barley Networks operating under the Latin America Regional Program (LARP)

Development of Stripe Rust Resistant Barley	To produce barley resistant to stripe rust using double haploid method (DH). DH lines produced by Oregon State University, field tested in Mexico, and superior cultivars distributed to NARS.	LARP Regional Coordinator	Oregon State Univ. Latin American NARS; CIMMYT	ICARDA & CIMMYT Core Funds
Development of Hull-less Barleys	Develop high yielding hull-less cultivars and improve their nutritional value, producing cultivars with high energy and low fibre.	LARP Regional Coordinator	CIMMYT; Canada; Australia; Colombia	ICARDA & CIMMYT Core Funds
Development of Barley Yellow Dwarf (BYD) Resistant Lines	ELISA testing of barley lines. Yield testing of identified resistant lines in Latin America. International testing in Chile, Ecuador and Kenya where disease has reached epidemic proportions.	LARP Regional Coordinator	CIMMYT; Chile; Ecuador; Kenya	ICARDA & CIMMYT Core Funds

Research Networks Coordinated by ICARDA

Title	Objectives/Activities	Coordinator	Countries/ Institutions involved	Donor Support
Development of Germplasm Resistant to Scab and Barley Yellow Mosaic Virus (BYM)	Development of scab resistant barley with tolerance to BYM for China.	LARP Regional Coordinator	CIMMYT; China	ICARDA & CIMMYT Core Funds
Development of Barley Lines Resistant to Spot Blotch Caused by *Helminthosporium sativum*	Crossing sources of resistance identified in Thailand and North America. International field testing in Thailand, Vietnam, Uganda.	LARP Regional Coordinator	CIMMYT; Vietnam; Uganda; Thailand	ICARDA & CIMMYT Core Funds
Development of Leaf Rust Resistant Barleys	Network of researchers investigating leaf rust resistance	LARP Regional Coordinator	Virginia Tech.; North Dakota State; CIMMYT; Latin American NARS	ICARDA & CIMMYT Core Funds

Appendix 9

ICARDA International School of Aleppo

The ICARDA International School of Aleppo (IISA) is a coeducational day-school primarily for the children of ICARDA staff members, but is also open to students from the larger Aleppo community. Two hundred and seventy-five students, ages four to eighteen, are served by the School, with approximately one-third being from ICARDA families. The majority of teachers are recruited internationally. Through the provision of a strong academic program, the School makes it possible for scientists to come Aleppo with their families, thus serving as an incentive to staff recruitment.

The School uses English as the language of instruction and operates on a modified British-American model. Students have the opportunity to earn the International General Certificate of Secondary Education (IGCSE), the International Baccalaureate (IB), or the IISA US-style high school diploma. Graduates qualify for entry to universities throughout the world.

The 1997 calendar year saw the School achieve full accreditation as an educational institution. This was granted by the Middle States Association of Colleges and Schools (MSA) of the United States. Accreditation followed an in-depth self-study by the School's teachers and a visiting inspection by a team of leading educators. From these studies the School has devised a series of plans for overall improvement.

The School also witnessed the expansion of its physical facilities with the start of work on a new classroom building. The addition of three larger classrooms, an auditorium, and a stage will provide needed relief for overcrowded classrooms at the secondary level.

In planning for the future the School will focus on the use of technology for the 1998-99 academic year. Plans are underway to provide about 50 computers in the library and to see that all students and teachers continue to update their computer skills.

A member of the European Council of International Schools and the Near East/South Asia Council of Overseas Schools, IISA is proud to provide excellent educational facilities to the children of ICARDA staff members as well as those from the Aleppo community.

Appendix 10

Visitors to ICARDA

The year 1997 witnessed a remarkable increase in the number of visitors to ICARDA. The Center received 2500 visitors in comparison with 1977 received last year. Of these, 58.5 came from WANA, 15.3% from Europe, 13.3% from Africa, 6.7% from Asia, and 6.2% from the USA and Australia. The visitors included ministers of agriculture, parliament members, senior government officials, representatives of donor organizations, media personnel, researchers, extension specialists, farmers, representatives of farmer unions, and students.

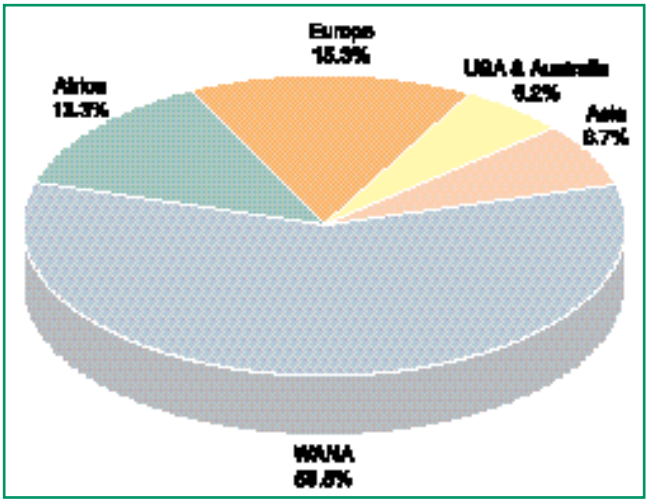

Fig. 11. Percentage distribution of visitors to ICARDA during 1997.

Appendix 11

Statement of Activity

For the Year Ended 31 December 1997 (x 1000 USD)

	1997	1996
REVENUE		
Grants	22,877	21,865
Exchange gains/(losses) - net	(220)	588
Interest income	327	718
Other income	367	249
	23,351	23,420
EXPENSES		
Research	19,859	17,927
Training	2,314	1,522
Information services	918	847
General administration	2,771	2,707
General operations	1,772	1,421
	27,634	24,424
(DEFICIT)/EXCESS OF REVENUE OVER EXPENSES	(4,283)	(1,004)
ALLOCATED AS FOLLOWS:		
Capital invested in property, plant and equipment	318	160
Capital fund	4	100
Operating fund	(4,605)	(1,264)
(Deficit)/Surplus	(4,283)	(1,004)

Statement of Grant Revenue

For the Year Ended 31 December 1997 (x 1000 USD)

Donors	Amount	Donors	Amount	Donors	Amount
Arab Fund	1,524	France	137	Norway	292
Australia	497	Germany	2,297	OPEC	15
Austria	60	IMPHOS	18	Spain	41
Canada	409	India	38	Sweden	452
China	20	IBRD (World Bank)	4,435	United Kingdom	713
CGIAR	296	IDRC	93	UNDP	306
Denmark	510	IFAD	911	UNEP	49
EEC	3,260	Iran	1,239	USAID	1,370
Egypt	150	Italy	1,100	USDA	89
FAO	86	Japan	716	Miscellaneous	6
Ford Foundation	106	The Netherlands	1,642	Total	22,877

Appendix 12

Board of Trustees

Dr Mervat Badawy completed her term of office in 1997. The Board, at its annual meeting held on 20-21 February 1997 in Rabat, Morocco, expressed its appreciation for Dr Badawi's valuable contributions to the progress of ICARDA and thanked her for her active participation in the Board business during her tenure as a Trustee. Dr Badawi had joined the Board in 1992.

Dr George Some, host-country representative, was re-elected for a third 3-year term starting immediately after the 1997 annual Board meeting.

Dr Michel de Nuce de Lamothe

Dr Michel de Nuce de Lamothe joined the ICARDA Board of Trustees for a 3-year term starting immediately after the February 1997 annual Board meeting. Dr de Lamothe is French, and is currently President of AGROPOLIS, an association of 17 research centers and higher-education institutes specializing in agriculture and development of Mediterranean and tropical countries. Prior to assuming this position in 1996, he was the Director General of the Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD) in Paris, with staff based in 60 countries.

Dr de Lamothe's specialization is in plant genetics. Awarded the Diploma of Ingénieur Agronome, from the Institut National Agronomique in Paris in 1959, he also holds the qualification of Research Director (Exceptional Class) from the Institut National de la Recherche Agronomique (INRA). He served for several years with INRA in the 1960s before joining as Head of the Coconut Breeding Research Station at Port-Bouat, Ivory Coast. He joined CIRAD in 1983, and became its Director General 10 years later.

Dr de Nuce de Lamothe has been a Board member of a number of institutions and currently serves on the boards of INIBAP, IPGRI, and NATURA (a network of European universities and advanced institutions working on tropical and subtropical agricultural development). His publications include 42 scientific and technical articles and 15 presentations at international congresses, and he has participated in a wide range of missions and networks in the Mediterranean and elsewhere.

Full Board, 1997

On 31 December 1997, the membership of ICARDA's Board of Trustees was as follows:

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Board Meetings, 1997

Rabat, Morocco

17-19 Feb	Program Committee Meeting
20 Feb	Nomination Committee Meeting
21-22 Feb	Board of Trustees Meeting

Aleppo, Syria

1-3 June	Audit Committee Meeting

Washington DC, USA

2 Nov	Nomination Committee Meeting
3-4 Nov	Executive Committee Meeting

Appendix 13

Senior Staff

(as of 31 December 1997)

SYRIA (Aleppo: Headquarters)

Director General's Office

Prof. Dr Adel El-Beltagy, Director General
Dr M.C. Saxena, Assistant Director General
Dr John Dodds, Assistant Director General (Research)
Dr Mahmoud El-Solh, Director of International Cooperation
Dr Elizabeth Bailey, Project Officer
Mr V.J. Sridharan, Internal Auditor
Ms Houda Nourallah, Administrative Officer to the Director General and Board of Trustees

Government Liaison and Public Relations

Dr Ahmed El-Ahmed, Acting Assistant Director General (Government Liaison)

Finance

Mr John E. Noisette, Director of Finance/Director of Administration
Mr Suresh Sitaraman, Associate Director of Finance
Mr Edwardo Estoque, Finance Officer, Financial Reporting
Mr Mohamed Samman, Treasury Supervisor
Mr Issam Abdalla Saleh A. El-Nagga, Accountant

Natural Resource Management Program

Farm Resource Management

Dr Michael Jones, Barley Agronomist and Leader
Dr Mustafa Pala, Wheat-based Systems Agronomist
Dr John Ryan, Soil Fertility Specialist
Dr Richard Tutwiler, Socioeconomist/Anthropologist
Dr Theib Oweis, Water Harvesting/Supplemental Irrigation Specialist
Dr Abelardo Rodriguez, Agricultural Economist
Dr Aden Aw-Hassan, Coordinator Dryland Resource Management Project
Dr Michael Zöbisch, Soil Conservation & Land Management Specialist
Dr Eddy De Pauw, Agroclimatologist
Mr Wolfgang Göbel, Agroclimatologist
Dr Ahmed Mazid, Agricultural Economist
Dr Abdul Bari Salkini, Agricultural Economist-MRMP, Egypt Liaison Scientist
Dr Heping Zhang, Post-Doctoral Fellow
Dr Trine Nielsen, Junior Professional Officer
Mr Sobhi Dozom, Research Associate

Pasture, Forage, and Livestock

Dr Gustave Gintzburger, Range Ecology & Management Scientist and Leader
Dr Ahmed El Tayeb Osman, Pasture Ecologist
Dr Thomas Nordblom, Agricultural Economist
Dr Anthony Goodchild, Ruminant Nutritionist
Dr Euan Thomson, Livestock Scientist
Mr Faik Bahhady, Assistant Livestock Scientist/Consultant
Dr Nabil Chaherli, Post-Doctoral Fellow
Dr Mustafa Bounejmate, Post-Doctoral Fellow/Consultant Pasture-Crop-Livestock Integration
Mr Nerses Nersoyan, Research Associate
Dr Tidiane Ngaido, Post-Doctoral Fellow
Dr Safouh Rihawi, Research Associate
Ms Monika Zaklouta, Research Associate
Mr Farouk Shomo, Research Associate

Germplasm Program

Dr Salvatore Ceccarelli, Acting Leader
Dr Victor Shevtsov, Barley Breeder
Dr Mustafa El Bouhssini, Entomologist
Dr Osman Abdulah, Spring Bread Wheat Breeder (seconded from CIMMYT)
Dr Miloudi Nachit, Durum Wheat Breeder (seconded from CIMMYT)
Dr Khaled Makkouk, Plant Virologist
Dr William Erskine, Lentil Breeder
Dr Ali M. Abd El Moneim, Forage Legume Breeder
Dr Michael Baum, Biotechnologist
Dr Chrysantus Akem, Legume Pathologist
Mr Issam Naji, Agronomist
Dr Stefania Grando, Research Scientist, Barley Breeding
Dr R.S. Malhotra, International Trials Scientist
Dr Mustafa Labhilili, Post-Doctoral Fellow
Dr S.M. Udupa, Post-Doctoral Fellow
Dr Hala Toubia Rahme, Acting Senior Cereal Pathologist
Dr Ashutosh Sarker, Post-Doctoral Fellow Lentil Breeding
Mr Seid Ahmed Kemal, Post-Doctoral Fellow
Dr Wafa Chouman, Post-Doctoral Fellow
Mr Soren Jorgensen, Junior Professional Officer
Mr Mohamed Asaad Mousa, Research Associate
Dr Bruno Ocampo, Research Associate
Mr Fadel Afandi, Research Associate
Ms Bianca van Dorrestein, Visiting Research Fellow

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Dr Larry Robertson, Legume Germplasm Curator
Mr Jan Konopka, Germplasm Documentation Officer
Dr Kamel Chabane, Post-Doctoral Fellow
Mr Bilal Humeid, Research Associate
Ms Siham Asaad, Research Associate

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Mr Guy Manners, Science Editor/Writer
Mr Mike Robbins, Science Writer/Editor
Ms Christine Kalume, Science Writer/Editor
Mr Moyomola Bolarin, Multimedia Specialist
Mr Nihad Maliha, Manager Library & Information Services

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Mr Mohamed A. Hamwieh, Administrative Officer (Visitors Services)

Computer and Biometrics Services

Dr Zaid Abdul-Hadi, Head
Dr Murari Singh, Senior Biometrician
Mr Bijan Chakraborty, Scientific Application Team Leader
Mr Gerard van Eeden, Scientific Data Base Senior Analyst/Programmer
Mr Michael Sarkissian, Systems Engineer
Mr Awad Awad, Data Base Administrator
Mr Alain Mayoux, System Programmer/Network Administrator
Mr C.K. Rao, Senior Analyst/Programmer
Mr Nicholas Thomas, GIS Analyst

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Dr Samuel Bockari-Kugbei, Seed Economist
Dr Lahcen Grass, Training Officer
Mr Zewdie Bishaw, Assistant Seed Production Specialist
Mr Abdoul Aziz Niane, Research Associate

Personnel

Mr David Martone, Personnel Officer

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Mr Peter Eichhorn, Vehicle/Farm Machinery Supervisor
Mr Ahmed Shahbandar, Assistant Farm Manager
Mr Bahij Kawas, Senior Horticultural Supervisor

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Facilities Management Unit

Mr Khaldoun Wafaii, Civil Engineer

Catering

Mr Farouk Jabri, Food and General Services Officer/ Consultant

Purchasing and Supplies

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Labor Office

Mr Marwan Mallah, Administrative Officer/Consultant

International School of Aleppo

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Mr Anthony Brown, Deputy Principal

Damascus Office, Syria

Mr Abdul Karim El Ali, Administrative Officer

Beirut Office, Lebanon

Mr Anwar Agha, Executive Manager/Consultant

Terbol Research Station, Lebanon

Mr Munir Sughayyar, Engineer, Station Operations

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North Africa Regional Program

Tunis, Tunisia

Dr Abdul Razzak Belaid, Socioeconomist, Acting Coordinator, North Africa Regional Program

Rabat, Morocco (Camp Office)

Nile Valley and Red Sea Regional Program

Cairo, Egypt

Dr Nasri Haddad, Coordinator, Nile Valley and Red Sea Regional Program
Dr Scott Christiansen, Grazing Management Specialist/ International Facilitator
Dr Hailu Gebre, Visiting Scientist, Coordinator of the Regional Networks Project
Dr Mohamed Abdul Moneim, Soil Scientist
Dr Hamdy Khalifa, Water Management Specialist
Dr Mustafa Bedeir, Socioeconomist

Dhamar, Yemen

Dr S.V.R. Shetty, Team Leader
Dr Mohamed Zainul Abedin, Farming Systems Specialist

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Mohamed Habib Halila, Coordinator, West Asia Regional Program

Arabian Peninsula Regional Program

Dubai, United Arab Emirates

Dr John Peacock, Coordinator, Arabian Peninsula Regional Program

Highland Regional Program

Ankara, Turkey

Dr S.P.S. Beniwal, Coordinator, Highland Regional Program
Dr Habib Ketata, Facultative and Winter Bread Wheat Breeder

Tehran, Iran

Dr Muhammed Tahir, Plant Breeder, and Coordinator, Iran/ICARDA Project

Tashkent, Uzbekistan

Dr Mekhlis Suleimenov, Central Asia Liaison Officer

Latin America Regional Program

Mexico

Dr Hugo Vivar, Barley Breeder and Coordinator, Latin America Regional Program

Research Fellows

Italy

Ms Elena Iacono, Durum Improvement
Dr Catia Stamigna, Chickpea Improvement
Dr Nicoletta Pucci, Chickpea Improvement
Dr Roberto Mancinelli, Chickpea Improvement
Mr Ra'ed Badwan, Economist

Consultants

Dr Hisham Talas, Medical Consultant (Aleppo)
Dr Edward Hanna, Legal Advisor (Beirut)
Mr Tarif Kayali, Legal Advisor (Aleppo)
Dr Ahmed El Ahmed, Seed Pathologist
Dr Bassam Bayaa, Lentil Pathologist
Dr Nour-Eddine Mona, Syrian National Coordinator

Appendix 14

Acronyms

ACIAR	Australian Centre for International Agricultural Research (Australia)
ACSAD	Arab Center for Studies of the Arid Zones and Dry Lands (Syria)
AFESD	Arab Fund for Economic and Social Development (Kuwait)
ARC	Agricultural Research Center (Egypt)
AREA	Agricultural Research and Extension Authority (Yemen)
ASMSP	Agricultual Sector Management Support Project (Yemen)
AZRI	Arid Zone Research Institute (Pakistan)
BMZ	Federal Ministry for Economic Cooperation (Germany)
CGIAR	Consultative Group on International Agricultural Research (USA)
CG	Consultative Group (USA)
CIHEAM	Centre International de Hautes Etudes Agronomiques Mediterraneennes (France)-International Center for Advanced Mediterranean Agronomic Studies
CLIMA	Center for Legumes in Mediterranean Agriculture (Australia)
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo (Mexico)
DSE	Deutsche Stiftung fur Internationale Entwicklung, Development and Cooperation (Germany)
EC	European Commission
ESCWA	Economic and Social Commission for Western Asia (Jordan)
FAO	Food and Agriculture Organization of the United Nations (Italy)
GIS	Geographical Information System
GRDC	Grains Research and Development Corporation (Australia)
GTZ	German Agency for Technical Cooperation (Germany)
IARCs	International Agricultural Research Centers
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics (India)
IBRD	International Bank for Reconstruction and Development (USA)
IDRC	International Development Research Centre (Canada)
IFAD	International Fund for Agricultural Development (Italy)
IFPRI	International Food Policy Research Institute (USA)
IITA	International Institute of Tropical Agriculture (Nigeria)
ILRI	International Livestock Research Institute (Kenya)
IMPHOS	Institut Mondial du Phosphate (Morocco)
INIBAP	International Network for the Improvement of Banana and Plantain (France)
INRA	Institut National de la Recherche Agronomique (Morocco)
IPGRI	International Plant Genetic Resources Institute (Italy)
ISNAR	International Service for National Agricultural Research (The Netherlands)
MRMP	Matrouh Resources Management Project (Egypt)
NARS	National Agricultural Research Systems
NCARTT	National Center for Agricultural Research and Technology Transfer (Jordan)
NGOs	Non-Governmental Organizations
OPEC	Organization of the Petroleum Exporting Countries (Austria)
PARC	Pakistan Agricultural Research Council (Pakistan)
SADC	South African Development Community (Zimbabwe)
SR-CRSP	Small-ruminant Collaborative Research Support Program (USA)
TAC	Technical Advisory Committee of the CGIAR
UNDP	United Nations Development Programme (USA)
UNEP	United Nations Environment Programme (USA)
USAID	United States Agency for International Development (USA)
USDA	United States Department of Agriculture (USA)
WANA	West Asia and North Africa

Appendix 15

ICARDA Addresses

Headquarters, Syria

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The CGIAR Centers

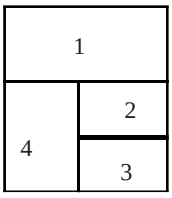
The Consultative Group on International Agricultural Research (CGIAR) is an informal association of public and private sector members that supports a network of 16 international agricultural research centers. The Group was established in 1971.

The World Bank, the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP), and the United Nations Environment Programme (UNEP) are cosponsors of the CGIAR. The Chairman of the Group is a senior official of the World Bank, which provides the CGIAR System with a Secretariat in Washington, D.C. The CGIAR is assisted by a Technical Advisory Committee, with a Secretariat at FAO in Rome.

The mission of the CGIAR is to contribute, through its research, to promoting sustainable agriculture for food security in developing countries. International centers supported by the CGIAR are part of a global agricultural research system. The CGIAR conducts strategic and applied research, with its products being international public goods, and focuses its research agenda on problem solving through interdisciplinary programs implemented by one or more of its international centers, in collaboration with a full range of partners. Such programs concentrate on increasing productivity, protecting the environment, saving biodiversity, improving policies, and contributing to strengthening agricultural research in developing countries.

Food productivity in developing countries has increased through the combined efforts of CGIAR centers and their partners in developing countries. The same efforts have helped to bring about a range of other benefits, such as reduced prices of food, better nutrition, more rational policies, and stronger institutions. CGIAR centers have trained more than 45,000 agricultural scientists from developing countries during the past 20 years. Many of them form the nucleus of, and provide leadership to, national agricultural research systems in their own countries.

Front cover



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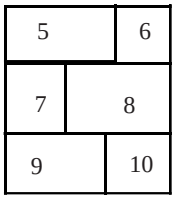

1. Spineless cactus plantations on degraded lands can provide feed for livestock and reduce soil erosion.
2. A training course in seed economics in Ethiopia.
3. Lentil intercropped with sugarcane in Bangladesh.
4. Three generations of a farming family with their unique juniper tree in Samarkand Province, Uzbekistan.
5. Adoption of ICARDA's livestock management practices has helped farmers in northwest Syria to increase sheep production, including these triplets.
6. An ICARDA socioeconomist (left) interviews an agricultural labor-contractor in Syria.
7. Firewood collection contributes to desertification, but ICARDA's work on rehabilitation of degraded land can offer a solution.
8. GIS and remote sensing for agroecological characterization.
9. The ancient *Jassour* system of water-harvesting in Tunisia.
10. Gene mapping at ICARDA for resistance of lentil to diseases and cold.

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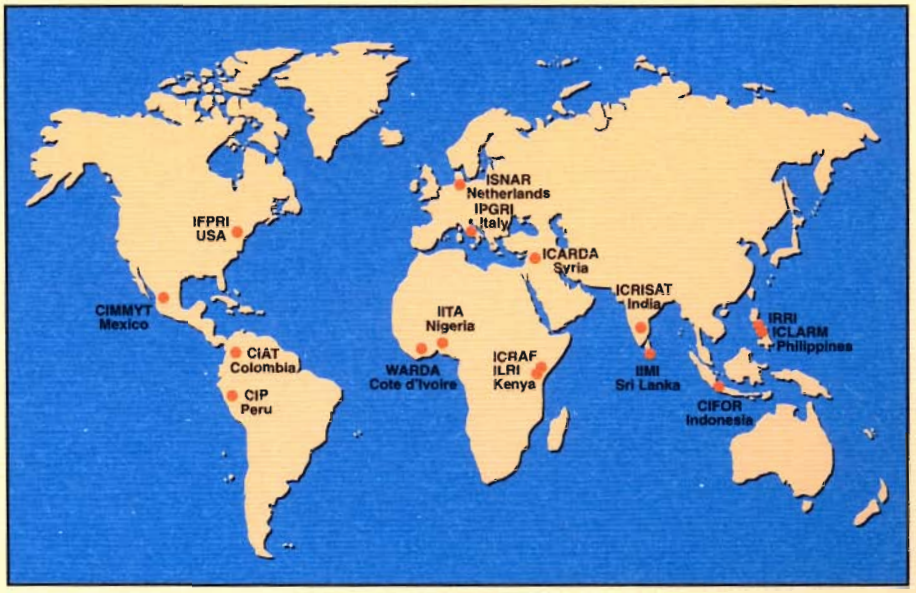
The CGIAR Centers



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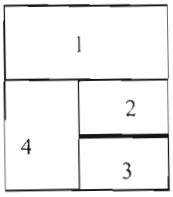

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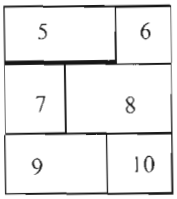

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