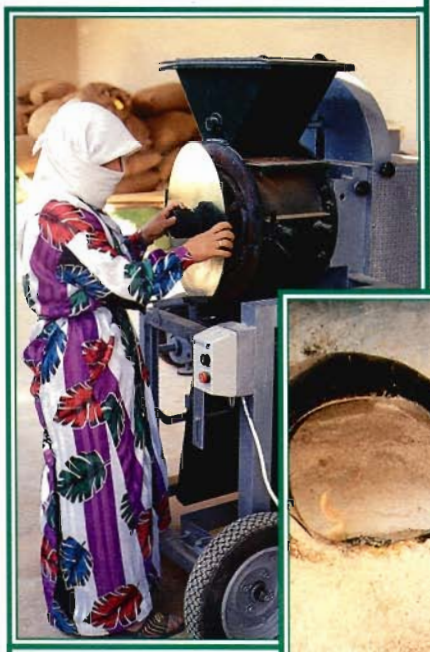
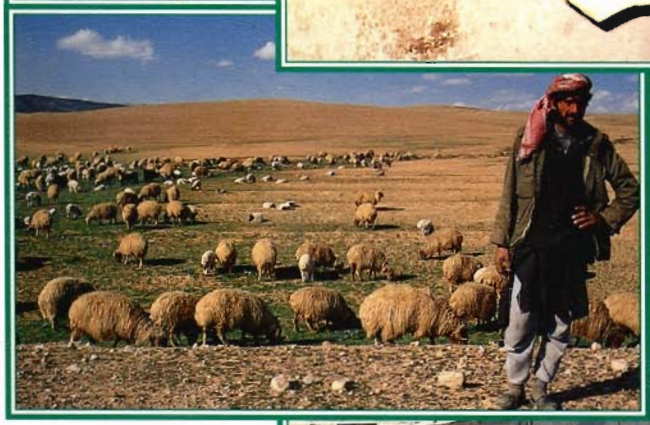
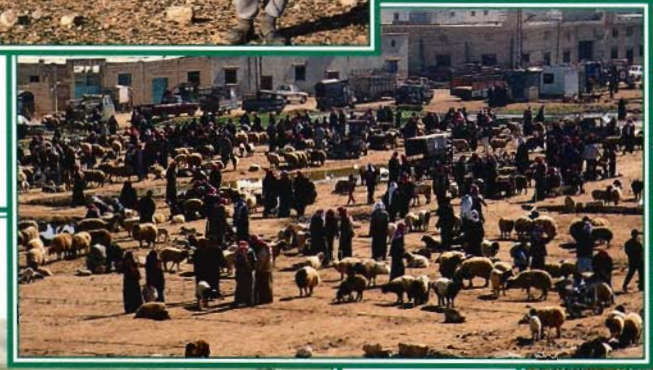
ICARDA Annual Report 1995







International Center for Agricultural Research in the Dry Areas

About ICARDA

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), which 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 seeks to enhance and sustain food production and, at the same time, improve socioeconomic conditions of people, through strengthening national research systems in developing countries.

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

The Center has a world responsibility for the improvement of barley, lentil, and faba bean, and a regional responsibility in West Asia and North Africa for the improvement of wheat, chickpea, forage and pasture—with emphasis on rangeland improvement and small ruminant management and nutrition—and of the farming systems associated with these crops.

Much of ICARDA's research is carried out on a 948-hectare farm at its headquarters at Tel Hadya, about 35 km southwest of Aleppo. ICARDA also manages other sites where it tests material under a variety of agroecological conditions in Syria and Lebanon. However, the full scope of ICARDA's activities can be appreciated only when account is taken of the cooperative research carried out with many countries in West Asia and North Africa.

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.

Front cover:

Sustainable agricultural development in water-scarce dry areas involves complex issues on natural resource management and protection of the environment. ICARDA's research program—in close partnership with national agricultural research systems, sister centers and advanced research institutes—weaves a wide range of disciplines into an integrated approach to fulfil the Center's mandate of achieving sustainable increases in food production and alleviating poverty and malnutrition.

ICARDA

Annual Report

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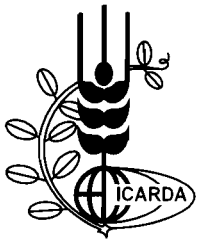

International Center for Agricultural Research in the Dry Areas

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AGROVOC descriptors: *Cicer arietinum*; *Lens culinaris*; *Vicia faba*; *Hordeum vulgare*; *Triticum aestivum*; *Triticum durum*; *Aegilops*; *Lathyrus sativus*; *Medicago sativa*; *Pisum sativum*; *Vicia narbonensis*; *Trifolium*; *Trigonella*; chickpeas; faba beans; lentils; feed legumes; soft wheat; hard wheat; barley; clover; dry farming; farming systems; pastures; steppes; rangelands; sheep; goats; international cooperation; research; training; germplasm conservation; resource management; resource conservation; diffusion of information; plant collections; biodiversity; sustainability; agricultural development; Middle East; North Africa; Pakistan; Ethiopia; Sudan

AGRIS category codes: A 50, A 01, E 10, F 01, F 30, H 60, L 01, U 30.

Front cover:

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Foreword

Achieving sustainable increases in agricultural productivity in the dry areas is a real challenge. Rainfall in these areas is, by definition, low and variable. Conventional water resources are limited, and the share available for agriculture is continually decreasing. Most of the dry areas are located in the South, where the population growth rate is high and the gap between food demand and supply is ever increasing. Increasing pressure of population is threatening the fragile resource base. There is little scope for increasing the arable land area, so the growing demand for food and feed has to be met from yield increases through the application of biotechnological tools to crop genetic improvement and the development of improved production practices based on sustainable use of the natural resource base. Thus, ICARDA has a crucial role in the development and transfer of improved technology to contribute to the alleviation of poverty and hunger while protecting the environment in these areas. Unless the challenges of agricultural production in the dry areas are wisely addressed, poverty and hunger may lead to socio-political disruption and environmental destruction of the fragile ecosystems with serious national, regional, and international consequences.

ICARDA is not alone in addressing these challenges. It continues to develop strong partnerships with national agricultural systems (NARS) in the West Asia and North Africa (WANA) region to achieve its objectives, as well as working jointly with sister centers of the CGIAR, other national organizations and advanced institutions in the North. These partnerships reached a new milestone in 1995, when the first regional forum of WANA-NARS was hosted by ICARDA to enhance NARS/CGIAR partnership and interaction as part of the revitalization process of the CG system and a followup of the Lucerne Declaration. Leaders of WANA-NARS identified subregional and regional research priorities and reaffirmed their keen interest in developing a continuing partnership with the CGIAR in setting priorities and in strengthening research directed towards achieving sustainable increases in agricultural production. As a cosponsor, ICARDA confirmed its commitment to support the focal point of WANA-NARS forum — a revitalized AARINENA (Association of Agricultural Research Institutes of the Near East and North Africa).

During the year, ICARDA also established new partnerships within the system-wide research programs and initiatives. It was identified as the lead Center in the CGIAR initiatives on: soil water-use efficiency; on-farm water husbandry; and the use of shrubs for animal feed. It also became a partner in other initiatives such as the network of genetic resources databases (SINGER); research on crop residues; integrated management of legume insect pests and parasitic weeds; and impact assessment and evaluation. An ecoregional research initiative, "Water in WANA," was launched in collaboration with nine NARS.

Improving water-use efficiency is seen by ICARDA as the key to increasing agricultural productivity in the dry areas. To achieve that goal, ICARDA is paying special attention to on-farm water management through increased support to research on water harvesting and supplemental irrigation. Use of GIS and remote sensing is being made to develop models applicable to other areas.

Biodiversity conservation continued to be high on ICARDA's agenda. Two workshops on biodiversity were held, one in Amman, Jordan and the other in Izmir, Turkey. Progress was made in developing a regional dryland biodiversity project which involves *in-situ* conservation as an integral part.

Consistent with the CGIAR policy of forging research linkages with the Newly Independent Republics (NIRs) of the former Soviet Union, ICARDA took a major first step in organizing a workshop in Tashkent, in collaboration with other CGIAR sister centers, to identify the research and seed production needs of the NIRs of Central and West Asia. The workshop was financially supported by the German Ministry of Cooperation (BMZ) through the German Agency for Technical Collaboration (GTZ). This has opened avenues for ICARDA, other CG centers, and donor agencies to work collectively to address the problems of food and feed production in the Republics as they make the transition from a centralized to free economy. An agreement was signed between ICARDA and the agricultural academies of the five Central Asian countries (Kazakhstan, Kyrgyzstan, Tadjikistan, Turkmenistan and Uzbekistan) to establish collaboration in agricultural research and the conservation of genetic resources.

ICARDA has been responding to the emerging regional and global needs and concerns for agriculture in the dry areas by reorienting its research agenda and upgrading its approaches. Much that happened at ICARDA during 1995 reflects the Center's move in that direction. These concerns are represented by the Convention to Combat Desertification and the conventions on Biological Diversity, Climate Change, and Environmental Degradation, and the GATT, among others.

ICARDA's prompt response to urgent regional and global concerns in 1995 is in line with the Lucerne Declaration Action Plan on the Renewal of the CGIAR with respect to clarifying its vision, refocusing its research agenda, and improving its governance and operations. Securing stable financial support for ICARDA and other CGIAR centers remains a concern in spite of several positive gestures. The support of the World Bank and several other donors is greatly appreciated. From the WANA region, the contribution of Egypt and Iran, which became CGIAR donors, is also greatly appreciated. Several other countries in WANA are planning to become CGIAR donors.

The new spirit that prevailed at ICARDA in 1995 is a reflection of the beginning of a new era of the Center's greater effectiveness in the CGIAR. The efforts of ICARDA staff and our NARS partners were behind the considerable achievements documented in this Annual Report. We acknowledge, with great appreciation, the financial contribution of donors in making such achievements feasible. We would like to assure our stakeholders that ICARDA will continue to deliver by translating investment into research to achieve higher productivity in the dry areas through the sustained utilization of natural resources. The ultimate aim will be to continue to promote the social, economic and nutritional well-being of the present and future generations.

Prof. Dr Adel El-Beltagy
Director General

Dr Alfred Bronnimann
Chairman, Board of Trustees

Contents

PART ONE

Major Developments in 1995

Contents

Major Developments in 1995

A new sense of optimism emerged at ICARDA in 1995, thanks to the initiative of the CGIAR Chairman, Dr Ismail Serageldin, to revitalize the System, and his lead role in the Lucerne Meeting, which brought a renewed commitment from donors to support international agricultural research. Several donors—notably Australia, Denmark, France, Germany, India, Japan, the Netherlands, Norway and Sweden— increased their core contribution, while Egypt and Iran from the West Asia and North Africa (WANA) region became CGIAR donors for the first time.

The Lucerne Declaration called for the CGIAR to broaden its membership by encouraging more developing countries to join. It also called for more dialog with non-governmental organizations and the private sector, increased participation of NARS (National Agricultural Research Systems), and a move from a donor-client to a participatory approach.

Other recommendations of the Lucerne Declaration and Action Plan included more research on water and biodiversity conservation, increased collaboration with the Newly Independent Republics of the former Soviet Union, and greater efforts to seek funding from philanthropic institutions and the private sector.

The Year at ICARDA

The year started with the appointment of a new Director General, Prof. Dr Adel El-Beltagy. Much that happened under his leadership during 1995 reflected the Center's move in the direction set by the revitalization process of the CGIAR.

Participation with NARS has always been a key element in ICARDA's research strategy, through collaborative research and networking in which NARS scientists—both at national and regional levels—support each other in specific areas and exchange results and experience through national and regional coordination meetings, seminars, and traveling workshops. ICARDA reached a new milestone in its partnerships with NARS in 1995 as Yemen and Eritrea joined the Center's Nile Valley Regional Program (NVRP), based in Cairo. The expanded NVRP was renamed as the Nile Valley and Red Sea Regional Program (NVRSRP).

WANA earned the distinction of being the first region where NARS organized a regional forum as part of the System-wide efforts to increase NARS participation in the work of the CGIAR. The first meeting of the WANA-NARS Forum, co-sponsored by ICARDA, IFAD (International Fund for Agricultural Development), FAO (Food and Agriculture Organisation of the United Nations) and ISNAR (International Service for National Agricultural Research), took place at ICARDA in December. Representatives from the CG Secretariat and TAC also participated in the meeting. The meeting set priorities for agricultural research in partnership with ICARDA and sister centers at national and regional levels, and discussed mechanisms for increasing the role of NARS in the development of the CGIAR agenda. The recommendations of the meeting will help guide future TAC priority setting.

Opening session of the WANA-NARS Forum at ICARDA. Left to right: Prof. R. Musangi (TAC), Dr S. Mathur (IFAD), Prof. Dr Adel El-Beltagy (ICARDA), Dr A.S. Goma'a, Chairman (AARINENA-Association of Agricultural Research Institutions in the Near East and North Africa), Mr A. von der Osten (CG Secretariat), and Dr B. Müller-Haye (FAO).

As part of the ecoregional initiative, representatives of eight NARS met at ICARDA to discuss priorities and programs of research on water conservation and use in WANA, and to prepare a proposal with ICARDA for submission to the Technical Advisory Committee (TAC). The proposal was accepted and ICARDA was designated as the regional center for convening research on water conservation and use.

Additionally, ICARDA was identified to be the lead Center in the System-wide research initiatives on soil water-use efficiency; on-farm water husbandry; and the use of shrubs for animal feed. In cooperation with other centers, ICARDA also became an active player in other initiatives, such as SINGER (a computer network linking genetic resources databases); research in crop residues; integrated management of legume insect pests and parasitic weeds; and impact assessment and evaluation.

With the assistance of the German Agency for Technical Cooperation (GTZ) and the Ministry of Agriculture of Tunisia, ICARDA organized a workshop on privatization of seed industries in WANA countries. Two workshops on biodiversity were held during the year, the first in Amman, Jordan (supported by UNDP) and the second in Izmir, Turkey (UNEP); the latter concentrated on biodiversity preservation within the framework of farming systems. ICARDA's involvement with biodiversity conservation was further strengthened with the construction of new facilities for IPGRI (International Plant Genetic Resources Institute) regional office for WANA at ICARDA's Tel Hadya headquarters. The building was inaugurated in September by H.E. Mr Asa'ad Mustapha, Syrian Minister of Agriculture and Agrarian Reform. The Board of Trustees of IPGRI held its annual meeting at ICARDA to coincide with the formal opening of the Institute's regional office.

In September, ICARDA was host to H.E. Mr Carl-Dieter Spranger, German Minister of Development and Cooperation, who, impressed by ICARDA's work and the level of cooperation with German researchers and institutes, encouraged the Center to increase public knowledge about its work in Germany. ICARDA has already speeded up the output of its public relations material, including a new general-audience newsletter called *Caravan*, a CD-ROM, and a video film.

Consistent with the CGIAR policy of exploring collaboration with the Newly Independent Republics (NIRs) of the former Soviet Union, ICARDA, with support from GTZ/BMZ, took the lead in organizing a major seminar in Tashkent, Uzbekistan in December. On ICARDA's invitation, representatives of ISNAR and CIMMYT (Centro Internacional de Mejoramiento de Maiz y Trigo) also participated. Presidents of the Agricultural Academies of Sciences and researchers from seven NIRs in Central and West Asia (CWA) met to discuss research priorities and future collaboration. The agroecological conditions in these NIRs are similar to those in much of the WANA region, including steppe, large-scale durum wheat farming, and highland areas. Uzbekistan generously offered to host the NIRs-CWA regional office of ICARDA's highland program.

Board of Trustees

The Board of Trustees and its Program Committee met twice at ICARDA in 1995. The first extraordinary meeting was in January, when Prof. Dr El-Beltagy took over the responsibility of Director General from Dr Nasrat Fadda, who retired after having served for over seven years. The second was in April, when the Board heard presentations from the NARS leaders of Egypt, Morocco, Sudan and Turkey, and discussed major initiatives in the fields of water and biodiversity conservation.

The chairperson of the Board of Trustees is now Dr Alfred Bronnimann from Switzerland, succeeding Dr Enrico Porceddu from Italy, who completed his term last year. Two new members, Drs Raoul J.A. Dudal from Belgium and Luigi Monti from Italy, joined the Board in 1995.

The Weather in WANA

Drought gripped Morocco again in 1994/95, with seasonal rainfall falling below 50% of the long-term average across most of the country, and below 25% in the north. As a result, cereal production dropped

to one-fifth of that of the previous year and was the lowest in 30 years. The rainfall totals for Tunisia, too, stayed below 50% of the long-term average. For Tunisia, thus, this was the second poor harvest in a row.

In West Asia, the season was fairly dry. In Jordan and across large parts of Syria and Lebanon, the seasonal rainfall stayed below the long-term average, but the distribution was such that crop yields did not suffer. In Turkey, seasonal rainfall was above average, but its distribution was poor, resulting in below-average crop yields—but slightly higher than last year's level. Seasonal precipitation in most of Iraq was above average.

In Yemen, Ethiopia, Eritrea and Sudan, the main rainy season started with lighter-than-average rainfall during May to July, but was generally favorable.

Germplasm Conservation

Collection of Legumes

Bangladesh: A total of 142 germplasm accessions of *Lathyrus* (62), lentil (39), faba bean (6), pea (21) and vetch (14) were collected from 17 districts. Pea accessions, with the exception of one collected in a faba bean field, were found as weeds in lentil fields. The six accessions of faba bean are the first to be collected in Bangladesh, outside the range of environments where this crop is normally grown, and may possess some unique characteristics.

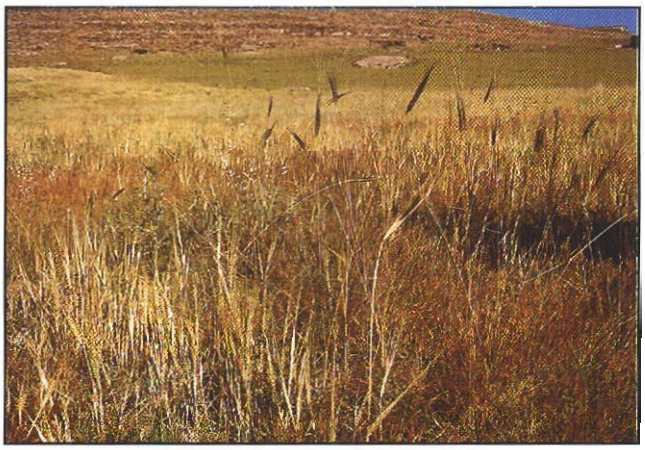
Nepal: In Nepal, 714 accessions of legumes were collected. Faba bean was found in the mid-hills (mostly large seeded); it was extensively distributed throughout the *terai* (mostly small seeded). The largest number of accessions collected were of lentil (140), followed by those of pea (116, including var. *arvense*), *Lathyrus* (90), and desi chickpea (70). Both lentil and *Lathyrus* were distributed throughout the *terai*. A large number of pasture and forage accessions of *Vicia* spp. and *Medicago* spp. (mostly *M. polymorpha*) were collected as weeds in the pulse crops.

Collection of Cereal Wild Progenitors

Turkey: Gaziantep Province in southeastern Anatolia is not adequately represented in the global and national *ex situ* collections of wheat wild progenitors. Therefore, collection missions were undertaken in cooperation with the Aegean Agricultural Research Institute, Menemen, Izmir and the Central Research Institute for Field Crops, Ankara. A mixed stand of all four wild *Triticum* species was found in two sites and sympatric populations of three species were fairly common (11 sites). The wild progenitor of barley, *Hordeum vulgare* ssp. *spontaneum*, was present in 36 sites out of 44 surveyed, and the species grew in a wide range of habitats. A total of 154 bulk samples of cereal wild progenitors and relatives, including 31 samples of *Triticum monococcum* ssp. *aegilopoides*, 17 *T. urartu*, 18 *T. turgidum* ssp. *dicoccoides*, and 7 *T. timopheevii* ssp. *armeniacum* were collected. The presence of *T. timopheevii* ssp. *armeniacum* wheat populations in southwest Gaziantep Province is a new finding which extends the known area of geographical distribution of this species.

Eleven sites were identified for *in situ* conservation.

Jordan: A joint collection mission was conducted in Jordan by the National Center for Agricultural Research and Technology Transfer, Jordan, in cooperation with ICARDA and the United Nations Environ-



***Triticum turgidum* ssp. *dicoccoides* at Qasidiye in Jordan.**

ment Program. A total of 63 bulk and 276 single-plant samples were collected. The most significant result of the survey was the discovery of relatively large *T. turgidum* ssp. *dicoccoides* populations at Qasidiye in southern Jordan, which moves the southern limit of the geographical distribution of the subspecies by 200 km. Moreover, these populations grew in mixed stands with *T. urartu* in its southernmost area of distribution. In a visit to the experimental fields of the University of Jordan, Amman, 12 *T. urartu* plants were identified among a wild wheat accession, which had been collected as *T. turgidum* ssp. *dicoccoides* at Ibeen, in Irbid Province. This is the first finding of *urartu* wheat from northern Jordan and the accession may be the missing link between the population in the Hauran and Jebel Al Arab in southern Syria and Qasidiye in southern Jordan.

Disease Resistance in Wild Wheats

Evaluation of 214 single-plant progenies, derived from natural populations of wild einkorn, *Triticum monococcum* ssp. *aegilopoides* and *Triticum urartu*, and wild emmer wheat, *T. turgidum* ssp. *dicoccoides*, revealed high or moderate yellow rust resistance in most wild wheat accessions. In addition, all 95 wild einkorn single-plant progenies were highly or moderately resistant to leaf rust. Although none of the wild wheat accessions was highly resistant to stem rust, medium-infection types and low pustule number indicated horizontal resistance in some progenies. Resistance to common bunt was found in all three *Triticum* spp. Accessions with multiple resistance against two or even three pathogens were identified as valuable donors for hybridization programs.

Seed Health Laboratory

The Seed Health Laboratory developed an improved technique for detecting *Pyrenophora graminea* in barley seeds. The technique is simple, repeatable, and gives reliable results within three days, compared with nine days needed for the freezing-blotter test recommended by the International Seed Testing Association.

Germplasm Enhancement

Cereal Crops

Release of New Cultivars

During the year, one barley variety was released in Canada, two in Cyprus, one in Egypt, five in Morocco, and one in Tunisia. Durum wheat cultivars were released in Egypt (2), Iran (2), Morocco (3), Tunisia (1), and Turkey (2); and bread wheat cultivars in Egypt (6), Lebanon (1), Morocco (3), Turkey (3), UAE (1), and Yemen (6).

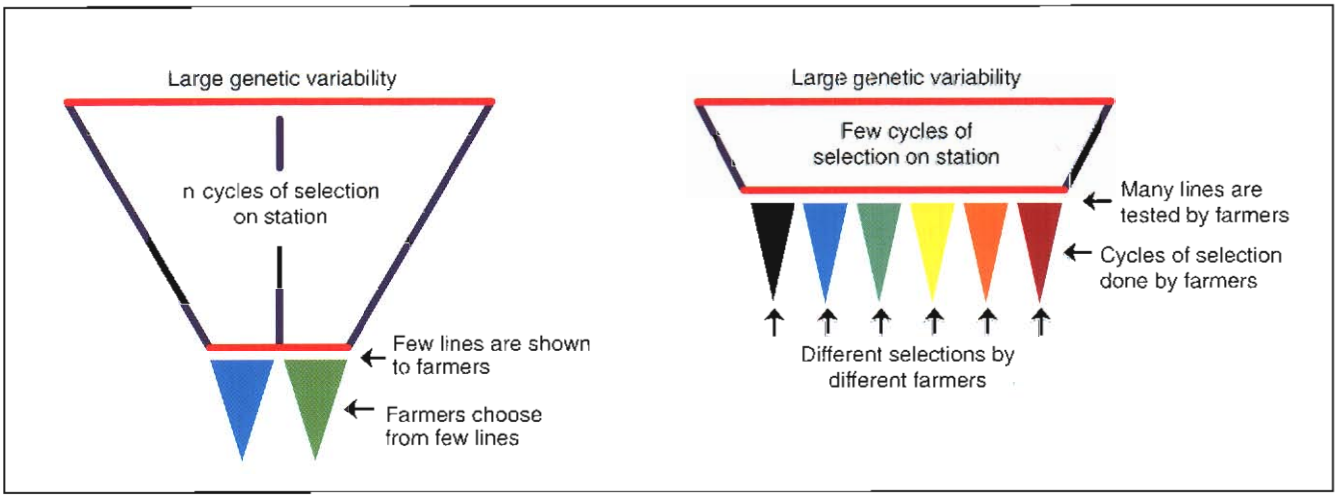
New Barley Germplasm for Dry Areas

ICARDA has used *Hordeum vulgare* ssp. *spontaneum*, the tall, wild progenitor of barley, still abundant in the Fertile Crescent, to increase plant height of cultivated barley under drought.

At one of ICARDA's driest experiment sites, Breda in Syria, the rainfall in 1995 was less than 200 mm. Several barley lines were grown there without fertilizer. The local landraces, Arabi Abiad and Arabi Aswad, had a poor grain yield (0.9 and 0.6 t/ha); their straw yield was less than 2 t/ha; and their plants were short (24 cm). On the other hand, a number of breeding lines yielded more than 1 t/ha of grain, between 1.9 and 3.3 t/ha of straw, and their plant height ranged from 27 to 35 cm. Line 4375 (a cross between *H. spontaneum* and Tadmor) was 11 cm taller than the landraces and yielded 22% more grain and 50% more straw. This line is now being multiplied for testing on farmers' fields.

Barley Breeding: From Decentralization to Farmer Participation

Research conducted at ICARDA and elsewhere has led to a new approach to crop breeding for low-input and stressful environments which combines two philosophies. One, that varieties which perform well in optimum growing conditions, commonly perform



Decentralization of barley breeding to include farmers as active partners in selecting for specific adaptation.

poorly in stressful and low-input conditions. Two, the "farmer-back-to-farmer" philosophy which recognizes the importance of the use of indigenous knowledge through farmer participation, and the fact that decentralization from an "international" to a "national" research station may not meet the needs of resource-poor farmers.

Thus, to exploit the potential gains from specific adaptation, selection must not only be decentralized but must be carried out with the farmers under their own conditions. The outcome of this approach is that farmers are becoming essential partners with national and international researchers in breeding for specific adaptation.

Understanding the *Abu Ulaiwi* Phenomenon in Barley

To reap the short-term economic benefits from growing barley, farmers in northeastern Syria started planting barley every year instead of their traditional practice of leaving the land fallow every alternate year. In 1986, farmers complained that a disease, which they called *Abu Ulaiwi*, caused progressive yield decline year after year, reaching as high as 88%. Losses are due to spike sterility, which can be total or partial. The area affected most is Bab-Sjerablous-Menbij, a major rainfed barley cultivation zone in Syria. In May 1995 ICARDA pathologists found that the sterile spikes were infected with seed-gall nematode (*Anguina* spp.). This is believed to be the first report of incidence of this nematode on barley in Syria. The seed-gall nematode is a seed-borne pest. Seed-galls fall to the soil during harvest or become mixed with healthy seed. Preliminary studies indicate that using clean seed and growing barley in rotation with legumes can control the disease, but spike sterility is a complex disease and nematodes may not be the only cause.

National Programs Assume Responsibility for Research on Wheat Rusts

Until recent years, most of the virulence analysis of the rust pathogens, especially for yellow rust, was done at advanced institutions in Europe. In helping to upgrade research capabilities of WANA NARS, ICARDA has identified institutions with excellent expertise to carry out national as well as regional responsibilities. One of these institutions is the Cereal Disease Division of the Agricultural Research Center, Egypt, which has taken the responsibility for race identification and virulence analysis of stem rust (*Puccinia graminis*) and leaf rust (*P. recondita*) for countries of the Nile Valley and Red Sea region. The Institut Agronomique et Veterinaire Hassan II, Rabat, Morocco, has similarly accepted responsibility for the analysis of leaf rust for Maghreb countries. For yellow rust (*P. striiformis*),

the University of Aleppo has taken the responsibility for race identification and virulence analysis for Syria and Lebanon. Efforts continue to strengthen capabilities for yellow rust research at Kolumsa Agricultural Research Station of the Ethiopian Institute for Agricultural Research, for both Ethiopia and Yemen; and at the Seed and Plant Improvement Institute, Karaj, Iran for other West and Central Asian countries.

Introgressing Hessian Fly Resistance in Durum Wheat

Durum wheat in the Mediterranean region accounts for more than 85% of the total area under this crop in the developing world. The joint ICARDA/CIMMYT durum project, based at ICARDA, supports WANA countries in developing productive and adapted germplasm with resistance to abiotic and biotic stresses and superior food quality.

Hessian fly, in the case of severe infestations, can cause a total yield loss of durum wheat. Unlike bread wheat, where sources of resistance to the pest are available within the cultivated species, screening of durum germplasm lines has not yet revealed any sources of resistance. Hence, in collaboration with the Moroccan national program, resistance from other *Triticum* spp. is being introgressed through a series of backcrossing. The material generated has shown good resistance to Hessian fly in Morocco, and is now being tested in other parts of the region. To further widen the genetic base for Hessian fly resistance, several accessions of *Aegilops* spp. have also been evaluated and resistant lines used in crossing with durum genotypes adapted to temperate dryland conditions.

First Hessian fly resistant variety of durum wheat in Morocoo, developed jointly by Moroccan and ICARDA researchers.

Legume Crops

Release of New Cultivars

Fourteen chickpea cultivars were released: Ethiopia (1), Iran (3), Italy (2), Morocco (3), Oman (2), and Spain (3). Lentil cultivars were released in Australia (1), Ethiopia (2), and Lebanon (1). Dry pea varieties were released in Cyprus (1), Oman (4), and Sudan (1). Four vetch varieties were released in Morocco.

Breaking the Bottleneck: Widening the Genetic Base of Lentil in South Asia

South Asia is the largest lentil-growing region in the world, spanning the production in Bangladesh, India, Nepal and Pakistan, where the indigenous lentils are of a specific ecotype and show a marked lack of variability. The bottleneck results from the introduction into South Asia of a small founder population of lentil from the northwest around 2000 B.C. This historical accident severely limits the progress of breeders today.

The simplest approach to widening the genetic base available to breeders in South Asia is plant introduction. Introductions from West Asia into South Asia mostly come into flower as the indigenous material is maturing. This mal-adaptation results in asynchrony in flowering between the types of lentils and in the reproductive isolation of South-Asian lentils. However, the introduction of earlier flowering material has been successful. For example, Precoz (ILL 4605) was the first early-flowering, large-seeded line introduced into South Asia. It thrives in the wetter areas of Pakistan, where it was released as Manserha in 1990.

Pakistani lentil breeder, with his grandson, proudly inspects the performance of lentil Masoor 93 in his village, which he selected from a cross of local x exotic parent (from ICARDA), using hybridization techniques learned as an ICARDA trainee.

The genetic base in South Asia can also be widened through hybridization. This has been a major thrust of the ICARDA program. West Asia has a comparative advantage over South Asia in artificial crossing because of synochrony in lentil flowering. The crosses are distributed as segregating populations for national programs to select for local adaptation and disease resistance.

As a result, Falguni was released in Bangladesh in 1993 as the first rust-resistant lentil cultivar and another rust-resistant line Bari Masur-2, with additional resistance to stemphylium blight, was registered in 1995.

Combined Disease Resistance in Lentil

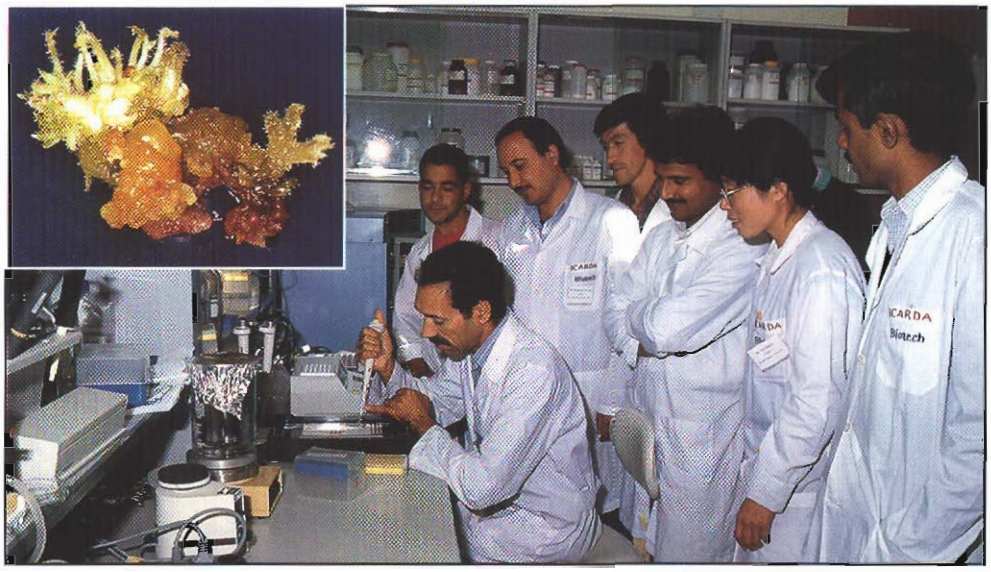
Lentil vascular wilt (*Fusarium oxysporum* f.sp. *lentis*) is one of the diseases limiting lentil production in WANA. In addition, viruses transmitted by aphids, such as faba bean necrotic yellows virus (FBNYV), and a number of luteoviruses, also limit lentil production in some parts of WANA. Since host-plant resistance is the most economic and environmentally-sound means of controlling these disease, a large number of lentil lines were evaluated for resistance to fusarium wilt and FBNYV, using artificial inoculation. ILL 323, 6458, 6994, 6198, and 7216 revealed a high level of resistance to both the virus and fusarium wilt and will be used in cultivar development for areas where these diseases are common.

Multiple-Stress Resistant Chickpeas

Three kabuli chickpea germplasm lines, FLIP 91-178C, FLIP 93-53C and FLIP 93-98C, with combined resistance to ascochyta blight, fusarium wilt and cold, have been developed by the ICRISAT-ICARDA Kabuli Chickpea Project based at ICARDA. All lines proved resistant to six "races" of the blight pathogen, *Ascochyta rabiei*, from Syria, to the Tel Hadya isolate of *Fusarium oxysporum* f. sp. *ciceri*, and to cold when sown in winter at low to medium altitude in Mediterranean environments. In addition, these lines have highly acceptable seed size (a 100-seed weight of 40, 33, and 36 g, respectively). FLIP 91-178C has a normal plant height and is late maturing, whereas FLIP 93-53C and FLIP 93-98C are tall and early maturing. This is the first time that chickpea lines with resistance to three important stresses have been developed through hybridization.

Interspecific Crosses in *Cicer*

To introduce novel sources of resistance against biotic (ascochyta blight, cyst nematodes) and abiotic (cold, drought) stresses, interspecific crosses were made between cultivated chickpea (*Cicer arietinum*) and its wild relatives (*Cicer judaicum, C.bijugum* and *C. pinnatifidum*). The major reason for the failure of interspecific crosses in *Cicer* is the early abortion of the hybrid embryo. To overcome this barrier, one-day old pollinated flowers have to be cultured *in vitro* where nutrients and hormones are artificially provided in order to enable the development of hybrid embryos. However, for a successful regeneration of interspecific hybrid plants it seems beneficial to keep flowers growing on plants as long as possible and the necessary embryo rescue should be delayed as much as possible. To achieve this, hormones (8 mg GA3, 1 mg Kinetin, 1 mg NAA) have to be applied to the freshly cross-



Regeneration of shoots from callus of the embryo rescued from interspecific hybridization of chickpea (inset).

Young researchers from several developing countries receive training in biotechnology at ICARDA. Here, trainees from India, China, Colombia, Lebanon, and Algeria learn DNA-marker techniques.

pollinated flowers. Since the *in vitro* cultured embryos do not develop directly into plantlets, a callus is induced from the hybrid embryo. From this callus tissue only shoots can be obtained which have to be grafted on other root stocks to develop into viable hybrid plants.

Underground Vetch for Marginal Areas

Underground vetch (*Vicia sativa* ssp. *amphicarpa*), which is a native of non-arable, rocky marginal lands, in the central Anatolian region in Turkey, produces both aerial and underground pods. ICARDA's research on domesticating this wild species has been very encouraging.

One of the major bottlenecks of the wild ecotypes of amphicarpous vetch is its low herbage yield, because the plant spends much of its energy in producing a large number of underground pods well before the aerial parts come to flower. Hence, a hybridization program was started using common vetch (*Vicia sativa* ssp. *sativa*) and, through multiple trait selection in F_2 to F_4 generations, families with more vigorous and leafy foliage, non-shattering aerial pods and only 4-9 underground pods/plant were selected. Some of these selections produced 3 times as much above-ground biomass and 40% less under-ground pods than the original amphicarpous

F_1 of a cross between common and amphicarpous vetch.

parent. Seeds of these lines are now being multiplied for use in ley-farming trials and for rehabilitating marginal lands.

Seed Production

ICARDA's seed production unit continued to catalyze the WANA Seed Network activities. In 1995 the Council of the Network met in Antalya, Turkey and reviewed the progress achieved by each member-country: WANA Directory of Seed Industry

Participants, prepared by Egypt; WANA Catalog of Varieties, by Morocco; WANA List of Important Weed Seeds, by Cyprus; a study by Ethiopia of the different Variety Release Mechanisms in WANA; a sur-vey by Iraq of the opportunities for formal education in seed technology in WANA; two WANA referee tests by Morocco for seed testing laboratories in which several laboratories of the region participated; WANA Catalog of Seed and Field Standards, by Syria; a study of WANA seed policies, by Sudan; and a study of WANA seed certification systems, by Turkey.

Resource Management and Conservation

On-Farm Water Husbandry in WANA

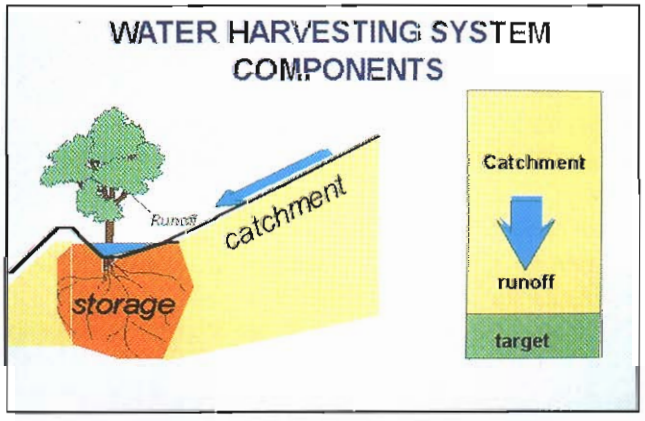
Following a suggestion from TAC, ICARDA took up the challenge of preparing a proposal for an eco-regional initiative for WANA focused on the highly strategic issue of water. To guide the preparation a planning workshop was held at Tel Hadya in March, with participation from other expert centers, invited consultants, and representatives of eight WANA countries (Egypt, Jordan, Libya, Morocco, Oman, Pakistan, Syria, and Tunisia). Later, Iraq also volunteered to participate.

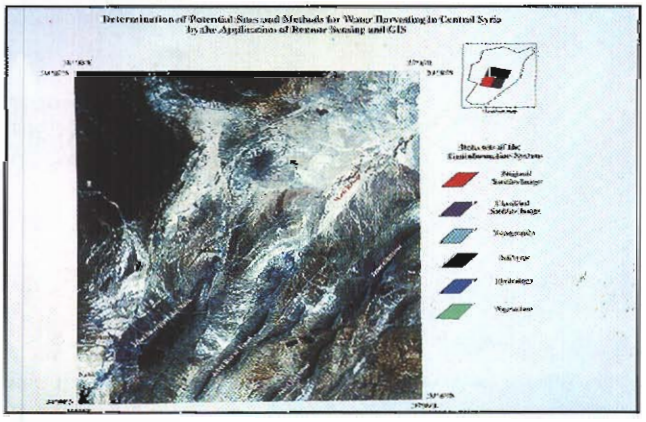
The workshop focused on water harvesting and supplemental irrigation options for dry areas where production is otherwise dependent on low and extremely variable rainfall. The main issues identified were: sustainability of water supply, efficiency of water utilization, and sustainability of production based on it. A consensus was reached to center the proposed initiative on water harvesting, with conjunctive use of the harvested water with that from other sources, where available. Its stated purpose is the optimization of dryland on-farm water husbandry, defined as "the strategic and tactical integration of the use of limited water supplies from more than one source (rainfall, surface runoff, groundwater, etc.) to optimize agricultural production in dry environments." Work across nine countries will address four broad themes: (i) water in present land-use systems; indigenous knowledge and end-use perceptions and participation. (ii) water resources and potential for water capture, (iii) options for water utilization, and (iv) dissemination, development, and impact.

At its July 1995 meeting, TAC commended the proposal, and financial support has been advanced to initiate activities during 1996.

Water Harvesting Studies with Remote Sensing and GIS

In cooperation with the University of Karlsruhe, Germany and the General Organization for Remote Sensing in Syria, ICARDA has started a study to identify potential areas and suitable methods for water harvesting in central Syria. The project area lies between latitudes 33.8° and 35.5° N and longitudes 36.6° and 38.8° E, and is covered by one full LANDSAT TM scene.





The project aims at developing methodologies for using the remotely sensed data and GIS for planning water harvesting on a large scale.

A system is now established for the 33,000 km^2 area with digital datasets of classified satellite images, topography, drainage systems, soil types, vegetation, and climate. Image processing, classification and the entry of all datasets together with special expert criteria for the applicability of various water harvesting methods will result in an image representing the classification of the whole area. The image may be used by the Syrian national program for water harvesting development in this particular area, but the developed methodology is expected to be suitable for use in all steppe areas of WANA and other similar areas of the world.

By-Product Feed Blocks

The Iraqi national program, with support from the ICARDA-coordinated Mashreq Project, has developed the technology to produce multinutrient feed blocks from agroindustrial by-products. The feed blocks help enhance sheep production.

The materials used in the feed blocks include date pulp, wheat bran, rice bran, poultry waste, brewers' grain, reeds, maize cobs, beet pulp, tomato pomace, bagasse and whey. Urea is added as a source of nitrogen and calcium sulphate to supply sulphur. Ten different formulations were developed according to the by-products available.

Agricultural by-products feed block plant in Iraq established by the private sector.

The first private feed block plant was established in Mosul in 1994 with a daily capacity of 4 tonnes. The total quantity of feed blocks produced by the agricultural research institute and the private plant in Mosul during 1994 was 1043 tonnes. The blocks were sold to 483 sheep owners. By the end of 1994, nine plants were operating with a total capacity of 50 tonnes per day, and by June 1995, some 3152 tonnes had been sold to 13,565 sheep owners. The use of feed blocks resulted in a 50% reduction in the use of concentrate feed.

The Sheep-Shuttle Seeder

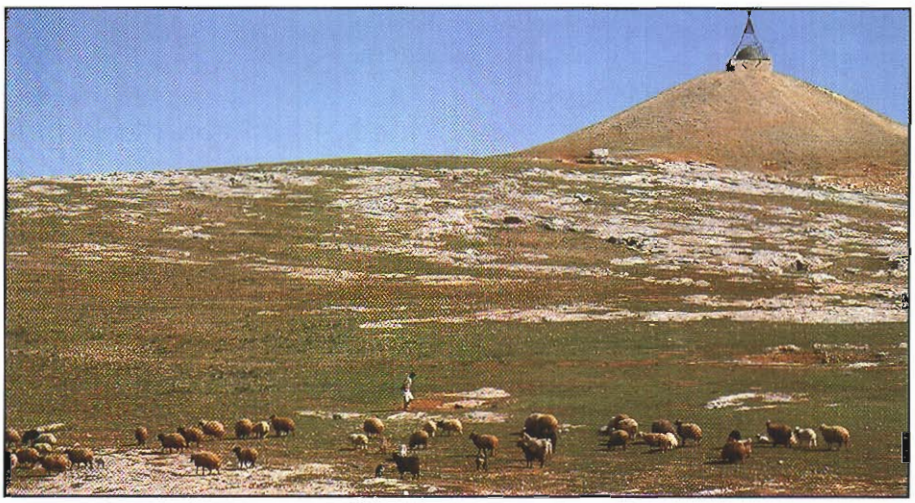
In 1995 a study was started to transfer legume seed from an improved site to a degraded 'target' pasture. Nick-named at ICARDA as "sheep-shuttle seeder," the study covers an area in Batajek village in El Bab, 70 km northeast of Aleppo.

There are two fields, the first an improved pasture of 4 ha, part of a 32-ha rehabilitated marginal land that was oversown in 1993 using different legume seeds and phosphate. The second field (target pasture) is an adjacent 2-ha piece of degraded pasture.

In consultation with the flock owners, 220 sheep were introduced to the improved pasture at 6:00 a.m. They were supplied with water and left to graze for 12 hours. At 6:00 p.m. the sheep were moved to the target pasture and left there to drop their pellets. The hypothesis is that some of the seeds consumed on the improved pasture would pass through the digestive tract of the sheep undigested onto the target pasture.

Twenty cages were placed in the target pasture before introducing the sheep. Pellet samples were taken at the end of the 4-day experiment, and the seeds in the pellets counted and identified. After four days, an average of 450 seeds/m^2 were found transferred by sheep from the improved to the target pasture. A field visit late in November confirmed that seeds in some of the pellets were beginning to germinate. The botanical composition and productivity of the site will be assessed in spring 1996.

If the sheep-shuttling of seeds of annual legumes works out successfully, this technique could be easily used by farmers for marginal land rehabilitation.



Marginal land rehabilitation in Syria using "sheep-shuttle seeder." The germination and botanical composition of seeds that the sheep deposit with their pellets is being studied.

Performance of Awassi Lambs Grazing Common Vetch in On-Farm and On-Station Trials

Lamb fattening trials on common vetch (*Vicia sativa*) have been conducted on ICARDA's main research station from 1980 to 1983 and 1987 to the present, and in El Bab on farmers' fields using vetch and chickling (*Lathyrus sativus*) from 1987 to 1992. Fully-weaned lambs were grazed in spring until the pasture was fully consumed. The objective of the experiments is to introduce legume crop rotations into wheat- or barley-based farming systems in northwest Syria and also to use forage legumes to fatten lambs.

On station, the average rainfall was 339 mm/yr; 36 lambs/ha grazed vetch for an average of 42 days; lambs had an average daily weight gain of 196 g or a liveweight production of 263 kg/ha. El Bab received an average rainfall of 275 mm/yr during the trial period. Grazed forage legumes supplied the feed needs of 33 lambs/ha for 33 days/yr with an average daily weight gain of 184 g or a liveweight production of 196 kg/ha.

Lamb fattening on forage legumes as an on-farm practice provides several benefits. The plants add nitrogen and organic matter to the soil and a rotation with cereals may give farmers a solution to the local problem of *Abu Ulaiwi*, and other diseases of cereal monoculture. The grazing option avoids the expense and logistical difficulties of mechanically harvesting forage legumes and, because the plants are grazed when green, some water is saved in the profile for the subsequent cereal crop.

Impact Assessment and Enhancement

Impact of Technology Transfer Activities

In cooperation with the NARS of Iraq, Jordan and Syria, studies were conducted to determine the impact of the on-farm barley technology transfer activities implemented during the first phase of the Mashreq Project (1989-1994). Surveys covered three groups of barley farmers in each country: those who hosted barley technology demonstrations in their fields, those who attended project field days to show and explain the new technology, and those who did not participate in project activities. The last group served as the control against which to measure project impact. The results show that in all three countries the project had a significant impact on the adoption of improved barley technologies.

In Iraq the demonstrated package consisted of only two components: a new barley variety and the application of fertilizer. Some 52% of farmers

hosting demonstrations adopted one or both of the components. None of the field-day attenders and none of the non-participants adopted the new variety, and only 37% of the two groups combined adopted fertilizer application. The levels of adoption were substantially higher in Jordan and Syria, where farmers were exposed to a larger array of components, including improved cultivars, fertilizer application, proper seed rates, and use of seed drills in planting. In Jordan, 81% of demonstration farmers adopted one or more of these components, while 72% of field-day attenders did so. The corresponding figure for the non-participant control group was 58%. In Syria, the differences were greater. Two-thirds of the demonstration farmers adopted at least one package component, and 40% of field-day attenders adopted new technologies. In contrast, technology use among non-participants in Syria remained virtually unchanged over the five-year period. These patterns indicate that seeing new technology perform in someone else's field may encourage adoption, but actual experience of using the technology is more convincing.

Potential Improvement in Wheat Production in Libya

Recent diagnostic research in Libya has revealed a dramatic deficit and instability in wheat production. There are large annual fluctuations: in crop area, between 53,000 and 270,000 ha; in mean yield, between 0.17 and 1.45 t/ha; and in total production, between 18,000 and 210,000 tonnes. Moreover, during the last two decades, wheat imports have increased by 1400%; and the current self-sufficiency ratio of 22% is projected to fall to 18% by the year 2000.

New improved wheat varieties from ICARDA/CIMMYT, tested for four years (1991-1994) under supplemental irrigation, yielded more than 5.5 t/ha. Improved adoption of the new varieties so far released, along with some improvement in farmers' agronomic practices, has the potential to triple and stabilize Libyan wheat production. However, the establishment of an effective and efficient mechanism for improved seed multiplication and distribution, and the formulation of proper marketing and pricing policies are urgently needed to realize that potential.

Training

In 1995, ICARDA offered training to 712 individuals. Training participants came from 35 countries including 22 in WANA, 2 in Latin America, 2 in Asia and Pacific region, and 9 in Europe. Of these, about 35% were trained in courses at ICARDA headquarters in Aleppo and the remainder in in-country, sub-regional, and regional training courses. About 17% of the participants were women.

ICARDA continued to gradually decentralize its training activities. Eight headquarters courses and 31 in-country, regional and sub-regional courses were offered. Two group courses were conducted, one each in collaboration with UNEP and IPGRI; and one regional/sub-regional group course was conducted jointly with each of CIHEAM, AOAD, CLIMA, FAO, AGERI, and UNDP.

For the UNDP-supported project entitled "Technical Assistance to Agricultural Investment in the Southern Region-Phase II," Syria, 10 short-term specialized training courses were organized in collaboration with the Egyptian International Center for Agriculture in Cairo, Egypt, the Arab Planning Institute in Kuwait, and the national programs of Morocco and Tunisia. Eighty-six senior officials of the project participated in these training courses.

Information Dissemination

During the year, ICARDA produced its first CD-ROM and a video film to increase public knowledge of its work. Almost every important event was covered by a press release, so the Center was more conspicuous in the national, regional and international media than ever before. A new general-audience newsletter, *ICARDA Caravan*, was launched and the first issue produced.

Three in-house databases and ISI Current Contents were made available on-line at ICARDA.

A training course on automated library management and modern information technologies was offered to information professionals from Cyprus, Ethiopia, Jordan, Sudan, and Syria. Two colleagues from the Arab Center for Studies of the Arid Lands were trained in AGRIS/CARIS systems and computer applications in information management.

A traveling workshop was organized in collaboration with the Syrian National Center for Agricultural Information and Documentation, to survey the information sources, expertise, and technology available within the country.

A volume of workshop proceedings was copublished with the World Bank. An agreement was reached with ICRISAT to produce a joint poster on chickpea for which the two centers share the mandate.

Computing and Biometrics

The upgrading of computer facilities continued. Fifty-two Pentium-class PCs were added. Efforts continued to establish connection to the Internet.

The Meteorological Database application was completed with daily, weekly, 10-day, fortnightly, monthly, and yearly report generation facilities. The Trials Management System was further developed with the modules for data entry and data transformation, analyses of single or multi-factor complete block designs such as CRD, RCBD, Latin Square and Factorial, and storing the statistical data generated from such analyses.

A program, SEEDLIFE, was developed to predict the storage life of seed. The Erdas Imagine image processing software was installed on a workstation for water harvesting research.

Expressions for estimates of time-trends and the time required to detect statistically significant time-trend in yield of a seasonal annual crop under two-course crop rotations were derived. A procedure for combined analysis of a series of yield trials with common checks conducted in incomplete blocks was developed. Experimental designs were provided for the five long-term trials planned in Egypt to study the sustainability of resources, and for the joint Iran/ICARDA project on cereals.

The Oracle Personnel System is now fully in use. The Project Management and Data Registry System was further developed and is now ready for use.

Four training courses were conducted in which 57 NARS personnel took part.

Outreach Activities

International Cooperation and the six Regional Programs of ICARDA which serve the sub-regions of North Africa, the Nile Valley, the Arabian Peninsula, West Asia, Highland Areas, and Latin America, continue to provide the mechanism for conducting collaborative research and training in partnerships with NARS. Increasingly, more of ICARDA's research is being decentralized in a partnership mode as the capacity of NARS for undertaking independent research expands.

Highland Regional Program

The Highland Regional Program, with its regional base in Ankara, Turkey coordinates research and training activities for the highland areas (>700 m altitude) of the WANA region. The countries included in the program are Turkey, Iran, Afghanistan, and Pakistan in West Asia, and Algeria, Morocco, and Tunisia in North Africa.

Pakistan: ICARDA continued its collaboration with the Arid Zone Research Institute in Quetta through a mini-project on range management and small ruminant improvement.

Turkey: A total of 11 collaborative research activities were carried out by the Turkish scientists in close collaboration with ICARDA. In addition, efforts to transfer winter chickpea technology were accelerated with support from the FAO/ICARDA Winter Chickpea Technology Transfer Project in the Central Highlands and the Aegean Region.

A visit by wheat scientists from 10 countries in the region to the Turkey/CIMMYT/ICARDA Winter/Facultative Wheat Program was jointly organized.

ICARDA and Turkey have been collborating in developing barley for highland environments. Here, Dr Huseyin Tosun (third from right) from Turkey presents his promising barley material to ICARDA visitors, including the Center's Director General, Prof. Dr Adel El-Beltagy (fourth from right).

The study tour enabled participants to select wheat germplasm for evaluation in their respective countries.

Iran: As part of the Iran/ICARDA project and to strengthen the technical competence of national researchers, 15 national researchers were sponsored for Ph.D. studies overseas. Two in-country courses, one on farm survey methodology and the other on cereal diseases methodology, were held.

Mediterranean Highlands: During its first year of operation in 1995, the EU/ICARDA Mediterranean Highlands Project initiated collaborative work in Algeria, Morocco, Tunisia, and Turkey. A meeting of the project was held as part of the Annual Coordination Meeting in November in Ankara, Turkey.

Newly Independent Republics of Central and West Asia: With support from GTZ of Germany, ICARDA coordinated a workshop for the Newly Independent Republics of Central and West Asia (NIR-CWA), in Tashkent, Uzbekistan. The meeting was attended by high-level officials from Uzbekistan, Kazakhstan, Turkmenistan, Tadjikistan, Azerbaijan, Georgia and Armenia, together with scientists from ICARDA, CIMMYT, ISNAR, UC Davis (SR-CRSP), and staff of BMZ and GTZ. The needs of these Republics in agricultural research and seed production, both at national and regional levels, were identified. These will be formulated into proposals for cooperative research.

Arabian Peninsula Regional Program

During the year a proposal for Phase II of the Arabian Peninsula Program was finalized and submitted to donors. The proposal has the overall objective of increasing food security in the Arabian Peninsula through increased productivity of field crops and livestock based on optimization of water-use efficiency, conservation of natural vegetation, prevention of soil degradation and desertification, and strengthened cooperation among the participating countries.

Partial financing of the proposal has been secured from the Arab Fund for Economic and Social Development (AFESD) and co-financing has been promised by IFAD. It is hoped that implementation will start in 1996.

An agreement was signed between the Agricultural Research and Extension Authority (AREA) of the Republic of Yemen and ICARDA through which ICARDA will assist AREA in the implementation of a research component of an Agriculture Sector Management Support Project financed by the International Development Association (IDA) of the World Bank. The placing of long-term graduate students in overseas universities has commenced and the recruitment of experts to be located at AREA is under way. This specific set of activities in Yemen will be coordinated through the ICARDA Nile Valley and Red Sea Regional Program.

Dr Ebrahim Al-Shareeda, Director General, Arab Planning Institute, Kuwait presented certificates to the trainees who successfully completed the ICARDA training course on planning, evaluation, and monitoring of research projects.

During the year, 19 researchers from the Arabian Peninsula region participated in ICARDA training courses. ICARDA participated in the "Saudi Agricultural Show 95," held in Riyadh.

Nile Valley and Red Sea Regional Program

The Nile Valley Regional Program (NVRP) was, in 1995, extended to include Eritrea and Yemen and its name changed to the Nile Valley and Red Sea Regional Program (NVRSRP). The program continues to employ coordination and networking at national and regional levels, technology generation and transfer, and human resource development as tools to enhance sustainable productivity of a wide range of major food crops covering cool-season food legumes and cereals (wheat, in cooperation with CIMMYT, and barley).

A cooperative agreement was signed between Eritrea and ICARDA. The problem-solving Regional Networks Project was approved by the Royal Netherlands Government for three years beginning in September 1995. The project aims at strengthening basic and applied research on problems of common interest to Egypt, Ethiopia, Sudan, and Yemen.

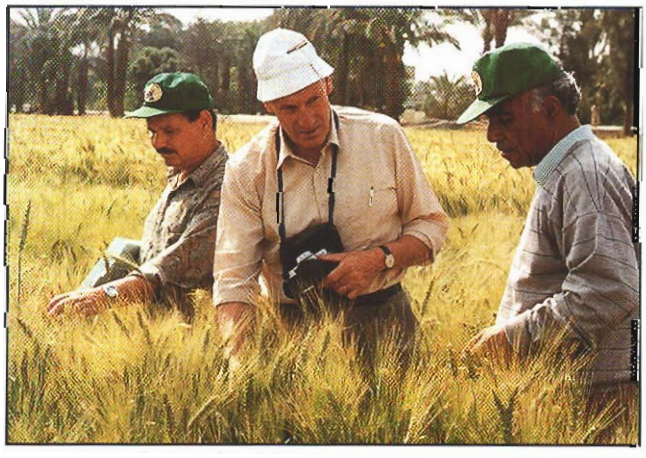
The Netherlands continued its support to the barley improvement project in Ethiopia. Its support to NVRP-Phase II of Sudan ended on 31 December 1995. A National Research Review Workshop was held from 26 to 30 August in Sudan to document research work and transfer of technology since 1988/89. The European Union continued its support to the Egyptian collaborative program. As part of the ongoing program in Egypt, a resource management component was started.

Nobel Laureate Dr Norman Borlaug joined the NVRP Regional Wheat Traveling Workshop with scientists from Egypt, Ethiopia, Sudan, ICARDA, and CIMMYT. The Chairman of the CGIAR, Dr Ismail Serageldin, and the Chairman of ICARDA Board of Trustees, Dr Alfred Bronnimann, also visited NVRP.

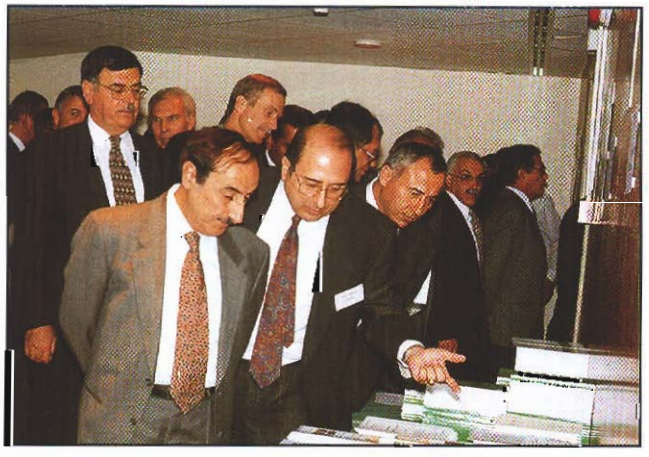
West Asia Regional Program

Annual coordination meetings were organized with Syria, Jordan, Iraq, and Lebanon during 1995. A Steering Committee Meeting and a Planning and Coordination Meeting for the Mashreq & Maghreb (M&M) Project were also held.

Two traveling workshops were organized, one regional in Jordan and another national in Lebanon, and five regional training courses—four in Jordan and one in Iraq—were conducted. Presently, more than 15 graduate students, working for MSc and PhD degrees, are enrolled with universities in Jordan, Lebanon, Iraq, and Syria with ICARDA scientists as co-supervisors.



ICARDA Board of Trustees Chairman, Dr Alfred Bronnimann (center) and Egyptian scientists visit on-farm wheat demonstration trials in Upper Egypt.



H.E. Mr Mansour Iben Tarif, Minister of Agriculture, Jordan visits the ICARDA publications display after inaugurating the symposium on crop-livestock integration in Amman.

A symposium on crop/livestock integration in the dry areas of WANA was hosted in Jordan and attracted 120 scientists from 15 countries.

Through the M&M project, linkages with IFPRI have been strengthened in the areas of "policy" and "common property" as they impinge upon technology transfer. A first policy workshop was organized jointly with IFPRI in Tunisia in October; and a workshop with ILRI, on future livestock research priorities in WANA, was conducted in Jordan in November.

North Africa Regional Program

The North Africa Regional Program focuses on the rainfed areas of Algeria, Morocco, Tunisia, and Libya.

Interregional cooperation: There was increased interaction between North Africa countries and NARS in the West Asia region and Turkey. Exchange of experience and technology transfer were boosted by both the M&M project and the Mediterranean Highland Project funded, respectively, by IFAD/AFESD and the EU.

ICARDA/NARP cooperation: Over 100 scientists from the Maghreb were involved. The 5th ICARDA/Maghreb Annual Regional Coordination Meeting and the M&M Policy Seminar and Technical Planning Meeting took place in Tunis. Moreover, NARS in Tunisia and Morocco carried out germplasm collection missions with ICARDA, CLIMA (Australia) and IPGRI, and socioeconomic surveys based on issues identified with ICARDA/IFPRI.

ICARDA and its Maghreb partners carried out 12 training activities, 3 traveling workshops, and 5 coordination meetings. The ICARDA/Tunisia collaboration permitted the identification of barley lines with resistance to net blotch, the most yield limiting disease in the Maghreb, and of wheat lines with resistance to septoria blotch. The ICARDA/Morocco researchers identified Hessian fly resistance genes in wild wheat relatives and used them to develop synthetic hexaploid wheats. Genetic resistance to septoria, Hessian fly and rusts was combined in bread wheat through the use of the double-haploid technique.

Researchers from North Africa jointly assess the performance of durum wheat segregating populations at Merchouch, Morocco.

Latin America Regional Program

Stripe rust has caused severe grain yield losses to barley producers in the Pacific rim of South America, since its introduction from Europe to Colombia in 1976. It moved from Colombia to Chile in the Southern Cone, and then to Mexico. From Mexico, wind-transported spores continued to move north through Texas, Colorado, and Idaho, reaching epidemic proportions in the Pacific Northwest in 1995.

Four years ago, Oregon State University barley breeders and ICARDA's Latin America regional coordinator based at CIMMYT Mexico initiated a breeding project on stripe rust. The transfer of stripe rust resistance genes from varieties released in South America to susceptible cultivars adapted to the USA was achieved in a short time, utilizing the double-haploid breeding technique. The Oregon State University Biotechnology Laboratory is collaborating in the mapping of genes responsible for the resistance, not only to stripe rust, but also to leaf rust, scald, and barley yellow dwarf virus.

Barley workers in Latin America now receive uptodate information on the genetic makeup of their barley varieties through the ICARDA/Oregon State University collaboration.

PART TWO

Research and Training Overview

Contents

Research and Training Overview

Outreach Activities

Resources for Research and Training

Research and Training Overview

ICARDA carries out its research and training activities in close collaboration with National Agricultural Research Systems (NARS). The Center's research follows a three-dimensional approach (Fig. 1) to bring out the interlinkages between the various facets of its work: (i) the agroecological dimension which defines the broad setting in which the Center's work is conducted, (ii) the commodity dimension which responds to the requirements of enhancing the germplasm and improving the production and management of the mandated commodities, and (iii) the activity dimension which introduces a matrix/project-based approach that cuts across the boundaries between other aspects of the Center's research.

The Center has identified seven integrative activities central to its current research program. These are: agroecological characterization, germplasm conservation, germplasm enhancement, farm resource management, 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 has a global responsibility for the improvement of barley, lentil and faba bean, and a regional responsibility—in West Asia and North Africa (WANA)—for the improvement of wheat, chickpea, pasture and forage crops, small ruminants, and farming systems.

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 17). The report that follows represents only a selection of important results achieved in collaboration with NARS during the 1994/95 cropping season. Progress in transfer of technology and strengthening partnerships with NARS is summarized under "Outreach Activities." A full report of each major program/unit (see Appendix 2) is available on request.

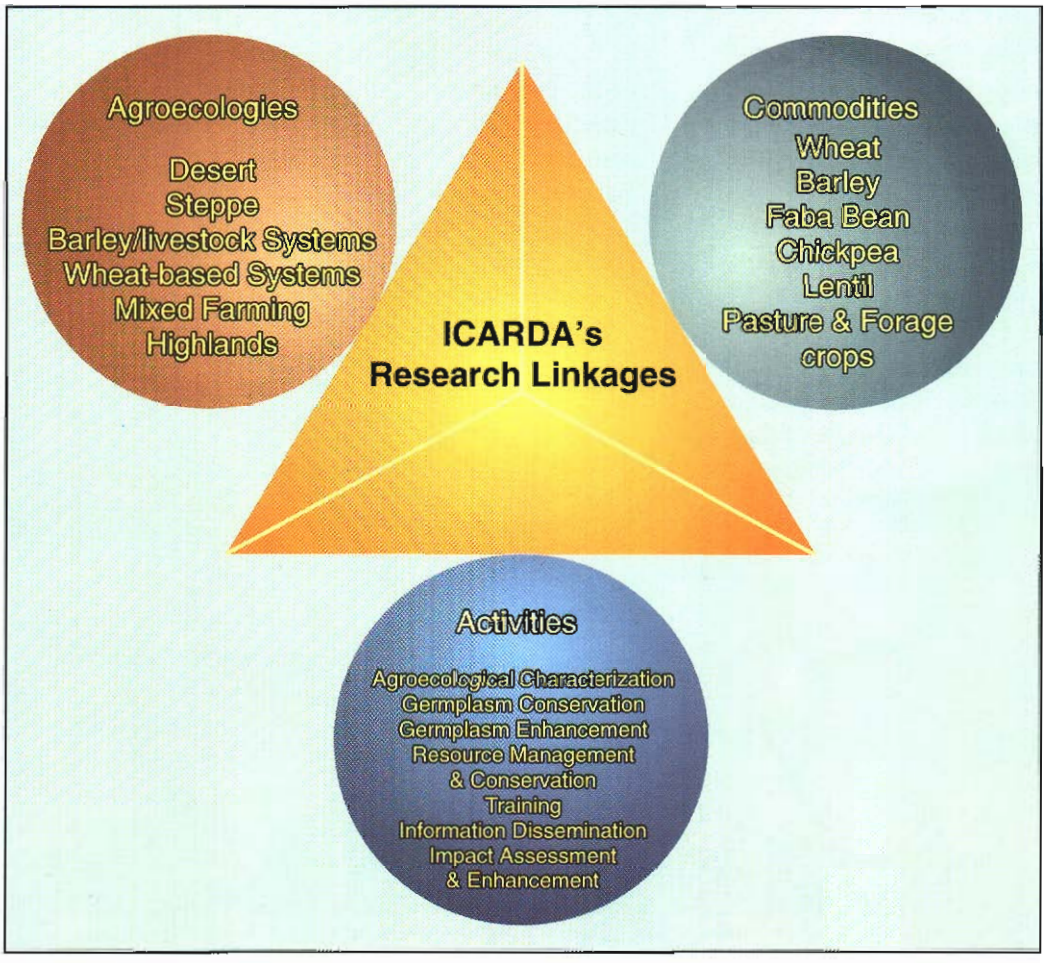


Fig. 1. ICARDA's research linkages.

The Weather in WANA, 1994/95

The key event in the 1994/95 season was the drought in Morocco. Practically no rain fell from November until February and little thereafter. Seasonal rainfall totals from November to June were below 50% of the long-term average across most of the country, and below 25% of that in the north. Because of the drought, cereal production dropped to one-fifth of that of the previous year and was the lowest in 30 years. In Tunisia also, in spite of good rains in October, seasonal rainfall totals stayed below 50% of the long-term average except in the northwestern part and extreme south. For Tunisia, thus, this was the second poor harvest season in a row. Algeria, in contrast, had a better growing season than in 1993/94, with average grain yields. This was mainly due to slightly above-average rainfall in the eastern half of the country, whereas the western half was affected by drought from November to February. The coastal areas of Libya and Egypt received approximately the long-term average of seasonal rainfall, a large part of it falling during a stormy period in November.

In the Near East, the season was fairly dry. In Jordan and across large parts of Syria and Lebanon, the seasonal rainfall stayed below the long-term average. However, the intra-seasonal distribution was such that crop yields did not suffer. Above-normal rains early in the season were followed by a prolonged dry period from January to April, with some more rain towards the end of the cropping season. The result was a very good harvest, except in some small areas, mostly in Jordan, where the rains at the end of the season came too late to benefit the crops. Figure 2 shows the rainfall during the 1994/95 season at ICARDA's main research station at Tel Hadya.

Judging from seasonal precipitation totals, which were above average, and from the mild winter in Anatolia, Turkey, too, should have achieved a good cereal harvest. But the intra-seasonal distribution of precipitation was poor. Along the southern coast, a significant part of the rain fell during autumn, too early to benefit the spring crops, while elsewhere much of it was late and interfered with the harvest, so that production remained below average.

Seasonal rainfall in Iraq was above average except for some areas along the border with Iran. It can, therefore, hardly be attributed to unfavorable weather that cereal production declined compared to the previous season and fell below the average of the last couple of years. While precipitation was below average in western and central Iran and along the Caspian coast, it was higher than normal in parts of the northwest, the south, and the east. With much of the precipitation falling during spring, when it benefited the crops, cereal yields were average to above average. In parts of Saudi Arabia, Qatar and Bahrain, seasonal rainfall was more than three times the long-term average, but most of it came as erratic, violent storms in March.

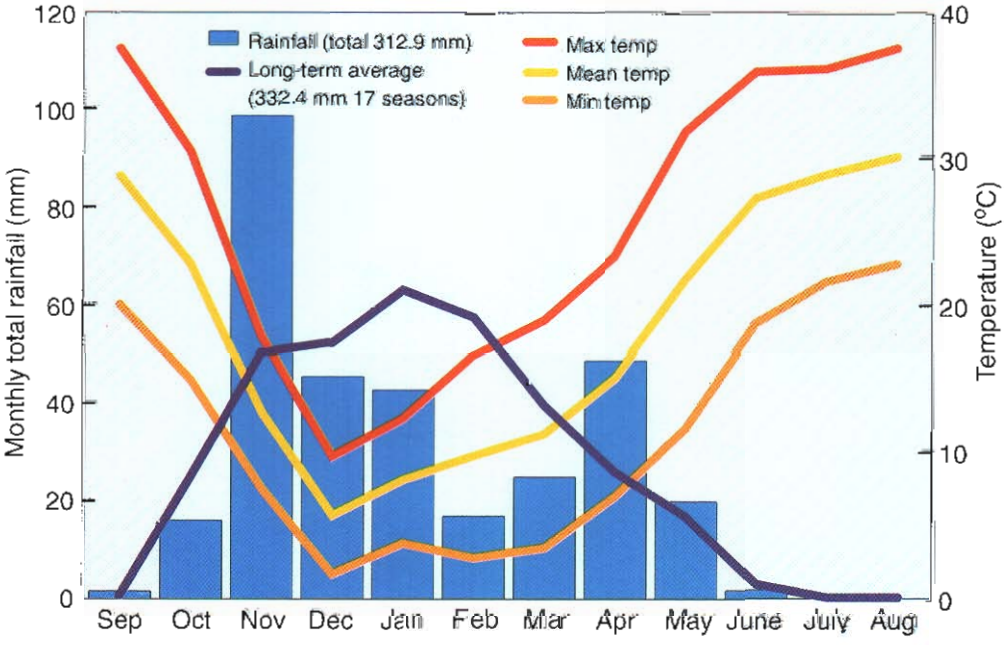


Fig. 2. The weather at Tel Hadya, ICARDA's main research station near Aleppo in Syria.

Afghanistan benefited from high rainfall during winter and spring, while in the winter-rainfall dryland farming areas of Pakistan, rainfall was around average, higher in the north, lower in the south.

In Yemen, rainfall was adequate for the winter-season cereals grown during the first half of 1995, resulting in a slightly above-average harvest, while the conditions for the minor-season crops grown in the same period in Ethiopia were less favorable and yields remained below average. The main rainy season of 1995 started with lower-than-average rainfall during May to July, but was generally favorable across Yemen, Ethiopia, Eritrea, and Sudan. Across the majority of the region, crop yields were average to above average, but some localized flood damage occurred during August in central Ethiopia, and crop losses due to drought were reported from some areas of southern Sudan.

Germplasm Conservation

ICARDA continued to contribute to the global efforts on saving and utilizing plant biodiversity. Joint collection missions with NARS yielded 1300 new accessions; another 1900 were received from other institutions. These additions raised the Center's gene bank holdings to 111,000 accessions. More than 30,000 seed samples were distributed during 1994/95: 21,000 to ICARDA researchers; 269 to Australia; 431 to the USA and Canada; 1158 to Europe; 1144 to Asia (India and China); and 6859 to WANA countries. Moreover, 5000 chickpea and 1800 lentil accessions were sent to ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) and NBPGR (National Board for Plant Genetic Resources) in India, respectively, for safety duplication.

ICARDA holds its germplasm accessions in trust under the auspices of FAO.

Collection of Legume Germplasm in Bangladesh and Nepal

In Bangladesh *Lathyrus sativus* L., known as 'khesari,' is the number one pulse crop accounting for 31% of the area and 32% of the production, followed by lentil (*Lens culinaris* Medik.) with 27% of the area and 26% of the production of pulses. The predominance of khesari is because it tolerates drought and waterlogging. While lentil does tolerate drought, it is highly susceptible to water-logging. In Nepal, lentil is the most important pulse crop accounting for half of the country's pulses area and production. *Lathyrus sativus* known there as 'latari,' accounts for 11.8% of the area and 9.8% of the production of pulses. Faba bean (*Vicia faba* L.) is grown in the mid-hills and throughout the *tarai* in Nepal.

There has been some collection of lathyrus and lentil but little of pea (*Pisum sativum* L.) in Nepal. While there has been extensive collection of lathyrus and lentil in some areas of Bangladesh, further collections are necessary from areas not previously covered. There has been no collection of faba bean germplasm in Nepal or Bangladesh.

Collection missions were carried out in Bangladesh and Nepal in collaboration with national researchers. In Bangladesh, 142 germplasm accessions were collected from 17 districts, and in Nepal, 714 accessions from 164 sites. Six accessions of faba bean collected in Bangladesh and 93 accessions collected in Nepal are the first collected from these two countries. The majority of the accessions from Bangladesh were of lathyrus (62), followed by lentil (39). The 21 accessions of *Vicia sativa* L., with the exception of one collected in a faba bean field, were found as weeds in lentil fields. The collection in Nepal consisted of 140 accessions of lentil, 90 of lathyrus, and 116 of pea (including var. *arvense*), 70 of desi chickpea (*Cicer arietinum* L.), and a large number of pasture and forage accessions of *Vicia* spp. and *Medicago* spp. (mostly *polymorpha*) collected as weeds in the pulse crops. Both lentil and lathyrus were widely present throughout the *tarai*.

This first-ever collection of faba bean in Bangladesh may prove valuable for several important traits such as earliness and heat tolerance, as the crop grew outside the range of its normal environments. In Nepal, faba bean was only expected in the mid-hills region but was extensively found in the *tarai*. The accessions found in the mid-hills were the large-seeded broad-bean types. Small-seeded types were found in the *tarai*, with both black/purple and cream-colored seed, in most cases as a mixture. These types are also grown in India in kitchen gardens.

Survey and Collection of Wild Wheat Biodiversity in Turkey

In June 1995 a joint mission comprising researchers from ICARDA, the Aegean Agricultural Research Institute (AARI), Menemen, Izmir and the Central Research Institute for Field Crops (CRIFC), Ankara collected germplasm in Gaziantep Province, Southeast Anatolia, Turkey. The Province is not adequately represented in the global and national *ex-situ* collections of wheat wild progenitors. The mission was financially suppoprted by the United Nations Environment Program (UNEP) and had the following objectives: (i) to survey and collect natural populations of wild progenitors and close relatives of wheat and barley; (ii) to sample natural populations of wild *Triticum* spp. for genetic diversity studies; and (iii) to identify suitable populations for *in-situ* conservation in the original habitat.

The survey revealed that Gaziantep Province is rich in wheat and barley wild progenitors. All four wild *Triticum* species were found in a number of sites. In total, 154 populations were bulk-sampled and 1225 single-plant samples of wild wheat were collected for genetic diversity analyses. Wild *Triticum* spp. were collected (Table 1) from 32 sites, with altitude ranging from 465 to 1035 masl and annual rainfall from 350 to 720 mm. Eight sites were identified as suitable for *in-situ* conservation of wheat and barley wild progenitors. The mission findings for target species are summarized below.

Table 1. Wild wheat species and other cereal wild relatives collected in Gaziantep, Turkey, 1995.

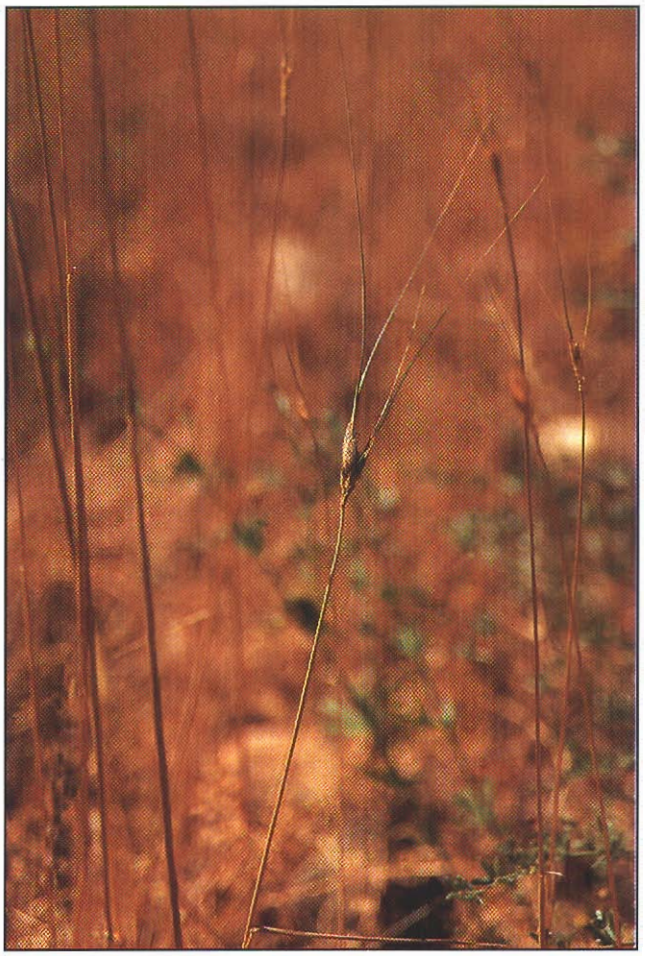
Species	No. bulk samples (populations)	No. single head samples
T. monococcum subsp. *aegilopoides*	31	583
T. urartu	17	292
T. turgidum subsp. *dicoccoides*	18	290
T. timopheevii subsp. *araraticum*	7	60
Ae. speltoides var. *speltoides*	23	-
Ae. speltoides var. *ligustica*	15	-
H. vulgare subsp. *spontaneum*	36	-
Aegilops spp.	5	-
Cult. *Triticum* spp.	2	-
Total	154	1225

Triticum monococcum L. subsp. *aegilopoides* (Link) Thell. (Syn. T. *baeoticum*) was the most abundant wild wheat (Table 1), found mostly on basaltic soils and vertisols. It is not well adapted to low-rainfall environments. It may be the dominant species in undisturbed habitats. A high morphological diversity was found in many sites.

Triticum urartu Tumanian ex Gandilyan was mainly found in low-rainfall and disturbed habitats. Of the 17 populations collected, only one was found growing in relatively undisturbed habitat. Low variation in spike forms was typical for the Province's populations. A white-spiked race was a successful colonizer of roadsides, field borders, and ditches. It may be a weed, but this could not be verified because the adjacent cereal fields had been harvested.

Triticum turgidum L. subsp. *dicoccoides* (Körn ex Asch. & Graebn.) Thell. is well adapted to relatively undisturbed habitats and can be, jointly with *T. aegilopoides*, a dominant species of natural grasslands. Diversity in spike color and forms was found in some populations but all spikes were glabrous.

Triticum timopheevii Zhuk. subsp. *araraticum* (Jakubz.) Mackey. One of the major objectives of the mission was to confirm the presence of *T. araraticum* in Gaziantep Province, far to the west from other *araraticum* wheat sites. The only previous report of the species is by the 1976 Japanese mission in the north of the province. The present mission not only confirmed the *araraticum* wheat occurrence in the north with four new sites, but also discovered three species-specific sites in the southwest of the Province; the southernmost one is some 10 km from the Syrian border. The species was mostly present in higher rainfall habitats (all sites have more than 500 mm annual rainfall). It was never a dominating species on the site. The highest morphological diversity was observed within a population in one of relatively undisturbed sites, where some plants had pubescent spikes of different color.



The discovery of a small *Triticum araraticum* population in Gaziantep Province near its border with Syria has extended the known geographic distribution of this taxon to the west.

Aegilops speltoides Tausch is believed to be the donor of the G genome of *T. araraticum* and *T. timopheevi* and, possibly, of the B genome of *T. dicoccoides* and cultivated durum and bread wheats. Variety *speltoides* was more frequent than *ligustica* (Savign.) Fiori, 23 versus 15 sites. The two subspecies seemed to differ in ecological requirements. Subspecies *speltoides* tolerated calcareous soils, while *ligustica* was never abundant in such habitat. However, the latter may dominate in grasslands on basaltic soils in sites with more than 500 mm rainfall. The best developed *ligustica* 'meadows' were found in the vicinity of Akçaburç village in the north of Gaziantep Province.

Hordeum vulgare L. subsp. *spontaneum* (C. Koch) Thell. This wild progenitor of barley may be encountered in a wide range of habitats. It was the most frequent target species, present in 36 sites of the total 44 collected. *Hordeum spontaneum* was mostly present on limestone-derived soils, and was well adapted to low-rainfall and low-fertility soils. It was not abundant in basaltic soil grasslands.

Other cereal wild relatives: The Gaziantep Province is also rich in other *Aegilops* species. In addition to *Ae. speltoides*, which was a target species, the most frequent species were *Ae. triuncialis* L., *Ae. biuncialis* Vis. and *Ae. columnaris* Zhuk. Other species found were *Ae. umbellulata* Zhuk, *Ae. caudata* L., and *Ae. neglecta* Reg. ex Bertol. *Hordeum bulbosum* L. was ubiquitous, especially in overgrazed areas.

The mission results indicated that Gaziantep Province in Turkey should be considered a priority area for wheat wild progenitors biodiversity conservation in the Near East arc, the center of diploid and tetraploid wheat origin.

Rhizobium Diversity Conservation

Collection and conservation of rhizobia associated with ICARDA's mandate legumes is essential for the development and implementation of sustainable farming systems, in which atmospheric nitrogen fixation by *Rhizobium* spp. plays an important role. A large rhizobial collection has been assembled and is held at ICARDA. The total of 1512 accessions consists of 99 *R. ciceri*, 481 *R. leguminosarum*, 700 *R. meliloti*, and 232 *R. trifolii* accessions. Of these, over 70% accessions were collected by ICARDA staff in collaboration with NARS, the rest were received from other organizations. A *Rhizobium* database has been developed, which includes both passport and evaluation data. Most of ICARDA's rhizobial collection originated in WANA (Table 2). The best geographical coverage is for *R. meliloti* in WANA countries: Syria, Morocco, Turkey, Jordan, and Lebanon. Legume rhizobia are collected as host plant root nodules specific for rhizobia or both nodules and soil samples. Almost half of the total *Rhizobium* holdings are specific for medics (Table 3), followed by

Table 2. Geographic origin of ICARDA rhizobial collections.

Country	No. of accessions	% Total
Syria	400	26.5
Morocco	319	21.1
Jordan	238	15.7
Turkey	190	12.6
Egypt	80	5.3
Lebanon	71	4.7
USA	42	2.8
Tunisia	30	2.0
Cyprus	17	1.1
India	16	1.1
Sudan	12	0.8
Ethiopia	10	0.7
Other countries	65	4.3
Unknown	22	1.5
Total	1512	100.0

Table 3. Crop specificity of ICARDA rhizobial collections.

Crop/Genus	No. of accessions	% Total
Lentil	236	15.6
Chickpea	99	6.5
Faba bean	132	8.7
Medicago spp.	692	45.8
Trifolium spp.	232	15.3
Vetch	57	3.8
Trigonella spp.	36	2.4
Pea	14	0.9
Lathyrus spp.	1	0.1
Astragalus spp.	1	0.1
Unknown	12	0.8
Total	1512	100.0

those for lentil (15.6%) and *Trifolium* spp. (15.3%). The passport information is presented in Table 4. Country of origin is known for 98.5% of accessions. Evaluation data on nitrogen fixation efficiency are available for two-thirds of the accessions. A total of 409 accessions (27.0%) have been lyophilized and stored in ampules at 4°C for the long-term. Duplicate dry-frozen samples will be held at ICARDA in the long-term store at -20°C. *Rhizobium* strains held at ICARDA are freely available to users worldwide.

Table 4. Status of passport information of ICARDA rhizobial collections.

Descriptor	No. of cases	% Total
Originator	1270	84.0
Form received	351	23.2
Collection date	769	50.9
Isolation date	1175	77.7
Rhizobium species	1512	100.0
Geographic origin	1490	98.5
Collection site	1287	85.1
Latitude/Longitude	677	44.8
Altitude	314	20.8
Crop specificity	1500	99.2
Trap species	709	46.7
Evaluation	1021	67.5
Ampules (long-term storage)	409	27.0

Genetic Diversity and Taxonomic Relations in Wild Relatives of Lentil

Debate still continues over the classification within the genus *Lens*, particularly on the position of *L. odemensis*, and the status of two "differentiated cytotypes" of *L. nigricans* which are interfertile with each other, yet reproductively isolated from other *L. nigricans*.

A study was undertaken to determine intraspecific genetic diversity and taxonomic relationships within the genus *Lens* by measuring allozyme polymorphism in the ICARDA wild lentil collection (339 accessions) and 100 landrace accessions of cultivated lentil. Starch gel electrophoresis was used to resolve isozymes in seven different enzymes.

The percentage of polymorphic loci, number of allozymes per locus, and mean genetic diversity for each taxon are given in Table 5. The percentage of polymorphic loci provides a rough guide to the level of genetic variation. The mean number of alleles per locus emphasizes allelic richness, one component of diversity. Nei's mean genetic diversity, which is independent of sample size, provides an estimate of allelic evenness. In contrast to other diversity studies of the genus *Lens*, this study showed the level of diversity in the cultivated species to be low, relative to the wild species. The discrepancy between this

Table 5. Percentage of polymorphic loci, number of alleles per locus, and mean genetic diversity in *Lens* taxa.

Taxon	Percentage of polymorphic loci	Mean number of alleles/locus	Mean genetic diversity
L. culinaris subsp. *culinaris*	45.5	1.64	0.161
L. culinaris subsp. *orientalis*	90.9	3.55	0.234
L. odemensis	72.7	2.36	0.183
L. ervoides	72.7	2.55	0.107
L. nigricans	72.7	2.25	0.232

study and previous work can be explained by the use of a larger sample size in this study, particularly for the wild species.

In addition, genetic diversity measured in the wild species indicated that different genetic structures existed within the different taxa. *Lens culinaris* subsp. *orientalis* possessed the greatest diversity according to all three measures. It possessed both allelic richness and evenness. *Lens nigricans* showed an even distribution of genetic variation, as opposed to allelic richness. This is in contrast to *L. ervoides* and *L. odemensis*. This suggests that taxon delimitation and diversity within *L. nigricans* is more complex than is generally recognized, particularly in view of the existence of the differentiated cytotype, its existence in contrasting ecological niches and the possibility of it being a relic of ancient cultivation.

Nei's genetic distance was computed for phenetic analysis (Fig. 3) to understand the taxonomic relations within the genus *Lens*. This evidence suggests that *L. odemensis* should retain its specific status; however, further crossability studies need to be carried out on a range of genotypes to assess the potential for gene flow. The evidence also shows the cytotype to be quite distinct from *L. nigricans*, the taxon to which it is currently assigned, and indicates that the cytotype should be raised to the specific status; however, further investigation of *L. nigricans* is required to fully separate and define a new taxon.

Predicted group membership, calculated using discriminant function analysis, revealed that, on the basis of isozyme data alone, overall 87.7% of accessions could be classified correctly. This suggests that isozymes may be of some use in validating species classification initially determined by morphological characters. In particular, this technique may be useful in discriminating between *L. culinaris* subsp. *orientalis*, *L. odemensis* and *L. nigricans* where morphological differences are small and the predicted group membership percentages are high. Each of these three taxa possesses unique alleles.

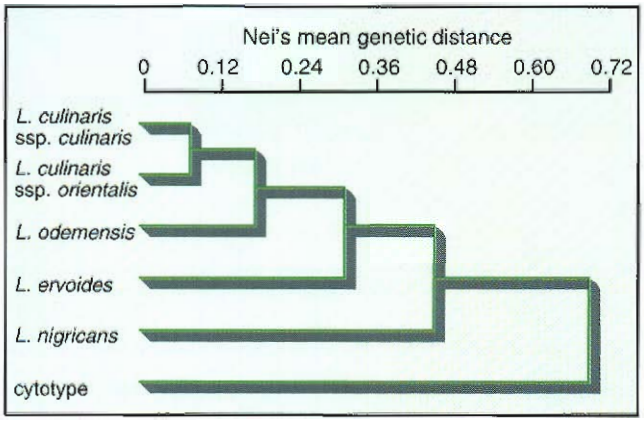


Fig. 3. Phenetic relationship of taxa within the genus *Lens* and a cytotype, derived from allozyme polymorphism.

Genetic Structure of Lentil Landraces

To study the genetic structure of lentil landraces, 160 accessions (10 each from the following 16 countries: Afghanistan, Bulgaria, Chile, Egypt, Ethiopia, India, Iran, Jordan, Lebanon, Morocco, Nepal, Pakistan, Spain, Syria, Turkey and Yemen) were analyzed for variation at the DNA level using randomly amplified polymorphic DNA (RAPD). The four primers used in RAPD analysis revealed a total of 22 variable repeatable bands. An example of amplification products is shown in Figure 4.

The relationship of germplasm from different countries was measured using Nei's genetic distance and illustrated in the form of a dendrogram using cluster analysis (Fig. 5). The division into two major groups is striking. The first major group, a South Asian group, consists of India, Nepal, Pakistan and

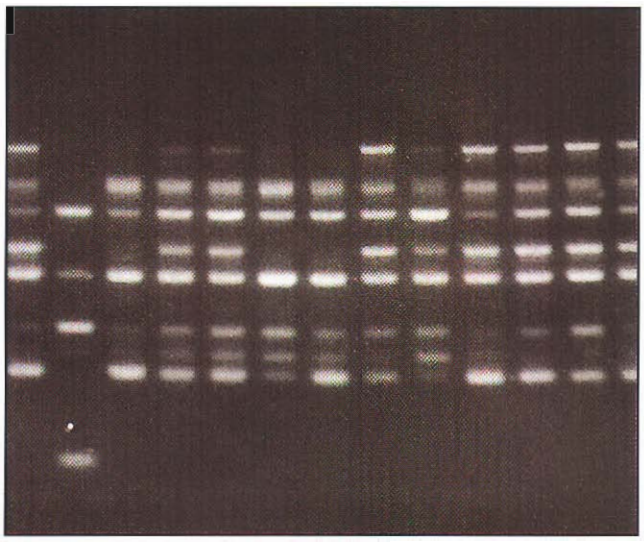


Fig. 4. Amplified products from RAPD analysis of lentil landraces.

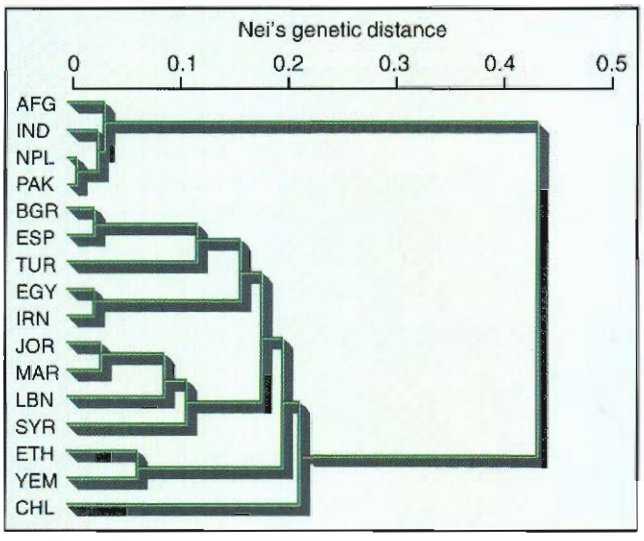


Fig. 5. Relationship of lentil landraces from 16 countries according to Nei's genetic distance, based on RAPD data.

Afghanistan, which are all closely related to each other, yet very different from all other countries. A second, subsidiary group, is that of Ethiopia and Yemen. A third Levantine group consists of Syria, Jordan and Lebanon, with Morocco also included. A fourth group consists of Iran and Egypt and a fifth, a European group, consists of Bulgaria and Spain. Phylogenetic analysis suggested that germplasm from Spain originated from Europe (because of its affinity with Bulgarian germplasm), whereas that of Morocco originated from the Middle East.

Shannon's Information Index was used to calculate diversity per country. The greatest diversity was found in the Levantine group with Jordanian germplasm revealing the highest values, followed by Syria and Morocco. The lowest diversity was found in the South Asia group, Nepal followed by Pakistan and Afghanistan. The low levels of genetic diversity in South Asia may have resulted from compounding the natural effects of self-fertilization since lentil was first introduced to South Asia around 2000 B.C.

Genetic Diversity in Annual Wild *Cicer* Species

The cultivated chickpea (*Cicer arietinum* L.) is thought to have originated in present-day south-eastern Turkey and the adjoining area in Syria. All eight annual wild *Cicer* species (*C. bijugum* K.H.Rech., *C. chorassanicum* (Bge) M.Pop., *C. cuneatum* Hochst. ex Rich, *C. echinospermum* P.H.Davis, *C. judaicum* Boiss., *C. pinnatifidum* Jaub. & Sp., *C. reticulatum* Lad., and *C. yamashitae* Kitamura) are found in WANA. The two most closely-related species to the cultigen (*C. reticulatum* and *C. echinospermum*) are endemic in the eastern Turkey/northern Iraq area. Collections of annual wild *Cicer* are much smaller than for the cultigen. However, the collection at ICARDA, consisting of 268 accessions, is the largest in the world.

A study was conducted to determine genetic diversity in annual *Cicer* species by the use of isozyme polymorphism, and to establish allelic frequencies within species. The data on variation for isozyme loci was used to determine phylogenetic relationships among the annual *Cicer* species and the genetic diversity within the genus, and to ascertain whether any correlation exists among isozyme variation and geographical origin of accessions.

A total of 139 accessions of *Cicer* representing 36 *C. arietinum*, 20 *C. bijugum*, 5 *C. chorassanicum*, 5 *C. cuneatum*, 11 *C. echinospermum*, 18 *C. judaicum*, 19 *C. pinnatifidum*, 20 *C. reticulatum*, and 5 *C. yamashitae*, were used for this study. Allozyme variation of 10 enzymes encoded by 14 loci was studied

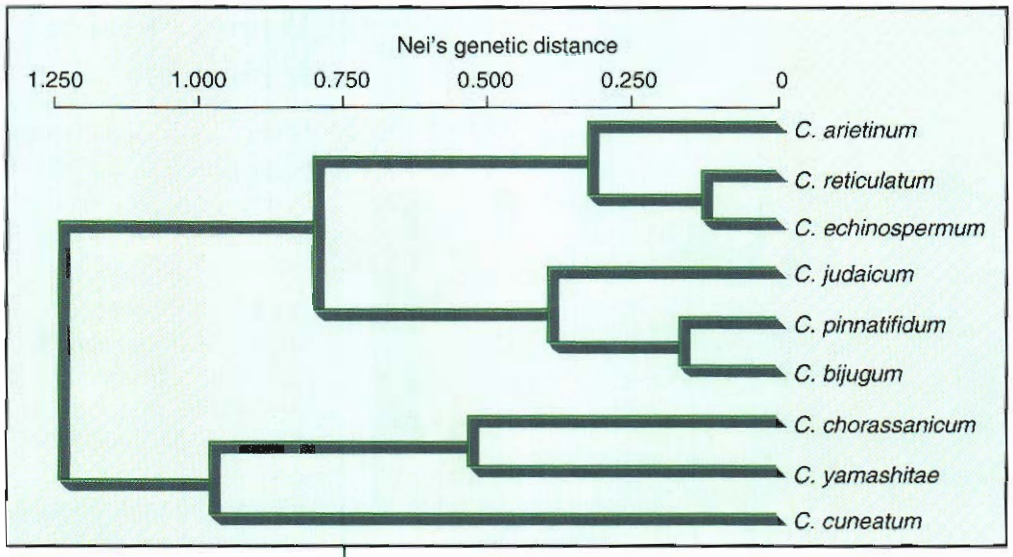


Fig. 6. Dendogram of relationships among annual *Cicer* species.

by horizontal starch gel electrophoresis using a 12% starch gel. Fourteen loci were assayed from the 10 enzyme systems analyzed.

Nei's identities and distances were calculated to compare the genetic affinities of the nine species. The genetic distances observed between *C. arietinum*, *C. reticulatum* and *C. echinospermum* were much smaller than any other species. The phenogram drawn from these values displays four different groups of annual *Cicer* species (Fig. 6). *Cicer arietinum*, *C. reticulatum* and *C. echinospermum* are clustered in the first group, *C. judaicum*, *C. pinnatifidum* and *C. bijugum* in the second, *C. chorassanicum* and *C. yamashitae* in the third, and *Cicer cuneatum* formed a fourth group. *Cicer cuneatum* had the largest genetic distances from the three species of the second group (1.466 to 1.697). The two species of the third group had large genetic distances from all other species.

The reduced variability found in the isozyme profiles of *C. arietinum* compared to the other two species found in the primary and secondary gene pool is probably a reflection of the "founder effect" (a small pioneer community expands and evolves in genetic isolation from the main population). The genetic diversity value for *C. arietinum* was only 0.0547 compared with 0.3105 for the wild progenitor, *C. reticulatum*.

Germplasm Enhancement

Release of New Varieties

Promising germplasm lines jointly developed by ICARDA and national programs are distributed as international nurseries to a large number of cooperators throughout the world every year for testing and adaptation. Some of these nurseries are targeted for specific environments. During 1994/95, national programs within and outside WANA released several varieties of cereal, legume and forage crops. These are listed in Appendix 2.

Improvement of Ethiopian Barley Landraces

Ethiopia is one of the centers of genetic diversity for barley, and Ethiopian barley germplasm has been used internationally as a source of useful genes for such traits as disease resistance and protein quality. In collaboration with the Ethiopian national program, ICARDA initiated a project in 1989 to use useful genes from Ethiopian landraces in breeding improved barley varieties for the country. From 1989 to 1993, over 600 pure lines from 30 Ethiopian barley landraces, along with the original populations,

Participatory evaluation of improved barley landraces in Ethiopia by researchers, donor representative, and farmers.

were evaluated in Ethiopia. Three lines significantly outyielded the local landrace in some of the test sites and had a higher average grain yield across sites and seasons (Fig. 7). One line, 3336-20, was consistently superior to the local check in all locations and was, therefore, promoted to on-farm testing. This line, extracted from a population originally collected in the Arsi region at 2915 masl and selected in Bekoji, is under consideration for release in Ethiopia.

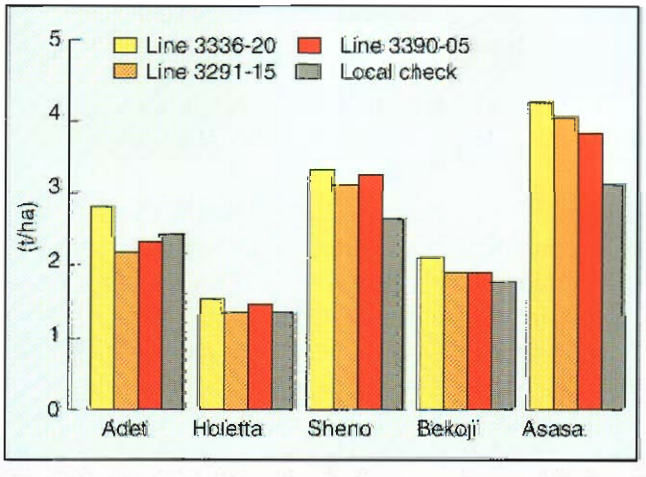


Fig. 7. Grain yield of three barley landrace lines and the local check in five locations in Ethiopia over five years of testing.

Winter and Facultative Barley Improvement

Winter and facultative (W&F) barley lines are predominant in the continental Mediterranean highlands of WANA and are an essential component of the cereal/livestock/pastoral farming system.

Over 756 new accessions, mainly originating from WANA, have been evaluated for a number of agronomic traits and 507 selected. To incorporate increased tolerance to biotic and abiotic stresses into locally adapted germplasm, 710 new cross-combinations have been made for evaluation.

New W&F barley lines identified for release in Iran: Using the decentralized approach to germplasm improvement, five lines were identified in Iran for cold highlands (yield 4.3 to 5.3 t/ha), and two for mild cold/warm highlands (5.8 to 5.9 t/ha). These lines produced 35-50% higher yield than the local checks. With the exception of Tokak, all lines were resistant to barley leaf stripe and scald. The lines are being multiplied for seed, and possible release to farmers.

Forage and dual-purpose barley: Eight forage barley lines with green forage yield (at tillering stage) of 11,595 to 15,840 kg/ha and a crude protein content of 13.5 to 21.3% were identified. The grain yield from the ratoon crop ranged from 470 to 1190 kg/ha, and from unclipped plots 3154 to 5229 kg/ha. The correlation coefficient suggests that it is possible to develop dual-purpose lines with superior total biomass and grain yield.

Relationship between Barley Straw Quality and Yield

ICARDA is conducting a three-year experiment in which 32 varieties of barley are grown in four replicates. The total yield and yield of grain are measured and the straw is fed to four sheep for five weeks, so that the exact amount they eat is measured. During the five weeks they get one of three kinds of inexpensive supplement: minerals, cotton-seed cake or urea. The results for 1994 are shown in

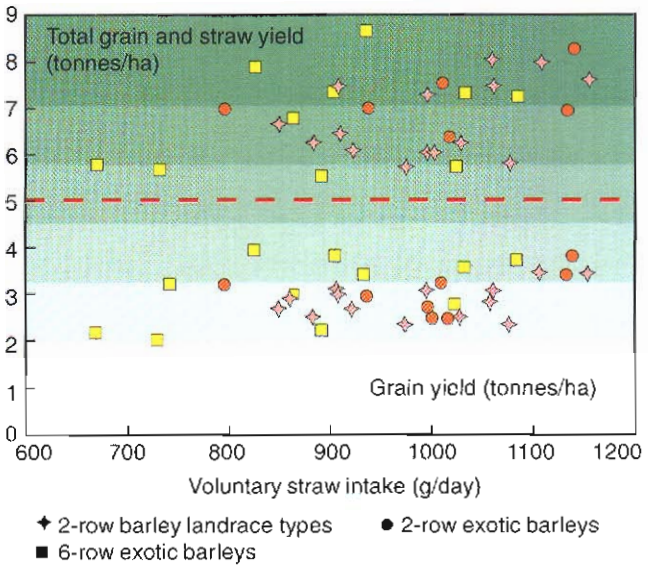


Fig. 8. Relationship between barley straw quality and yield.

Figure 8. For each of the three types of barley, there was no suggestion that selecting barley for straw quality reduces grain yield or total biological yield. If anything, the two varieties that were not liked by sheep did not produce very well, either. Farmers in WANA want to know about straw quality as well as grain yield before they adopt new varieties of barley. Now that it is possible to achieve both, ICARDA is conducting rapid laboratory tests on the straw quality of breeding material.

Collaborative Barley Improvement in WANA

Studies in seven areas in Ethiopia have helped delineate four barley production systems based on specific production constraints (Table 6), farmers' preferences, and possible location-specific management techniques. Results of demonstration and popularization trials in two zones in 1994/95 revealed a high yield advantage with a package of improved cultivar, high seed rate, fertilizer application, and hand weeding (Fig. 9). Application of nitrogenous fertilizers (46 kg N/ha) increased grain yield

Table 6. Major barley production systems and constraints to productivity in Ethiopia.

Production system	Major constraints
Short-season Barley System "Belg"	Unreliable rains, aphid attack and sprouting
Early Barley System	Late onset of rainfall, diseases, waterlogging, shattering and sprouting
Long-season Barley System	Poor soil fertility, waterlogging, diseases, insect pests and frost
Residual-moisture Barley Production System	Moisture stress

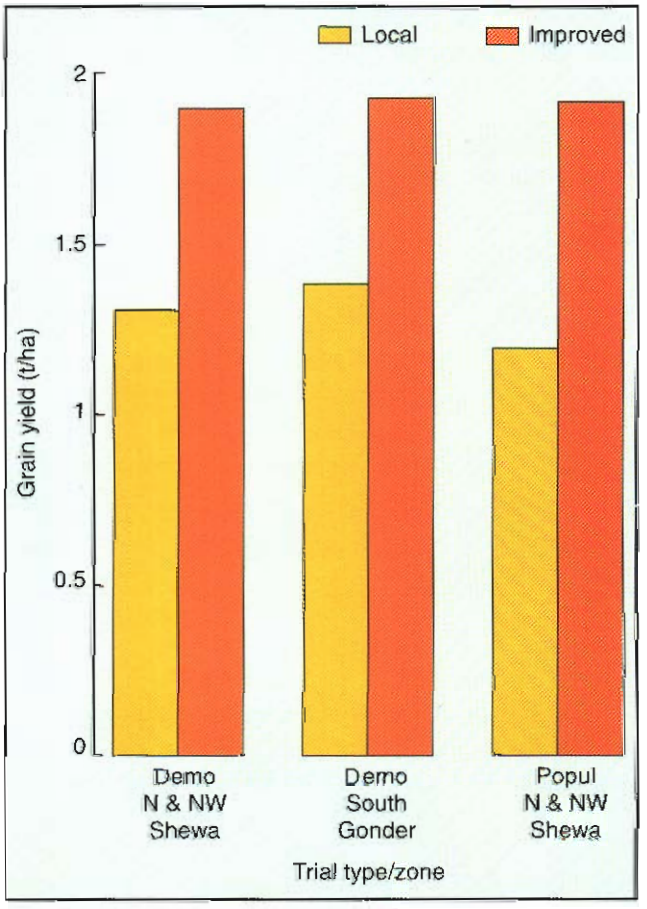


Fig. 9. Barley grain yields for participant-farmers (Improved) in demonstration (Demo) and popularization (Popul) plots and non-participant farmers (Local) in two zones in Ethiopia, 1994/95.

by 82% and also enhanced straw yield. Landraces were as responsive to fertilizers as improved cultivars.

In Egypt, barley is the main crop in rainfed areas of the Northwestern Coast and North Sinai. Its total area there increased from 22,056 ha in 1993/94 to 260,777 ha in 1994/95 mainly due to higher rainfall and promotion of new drought-tolerant cultivars which resulted in a yield increase from 0.67 to 1.68 t/ha. In demonstration trials in the Northwestern Coast, the newly released cultivars, Giza 125 and Giza 126, outyielded the traditional ones by 664 kg/ha (62%) and 718 kg/ha (67%), respectively.

Selection of barley lines better adapted to harsh environments of North Africa continued, using locally adapted germplasm. Specialized nurseries, targeted for low or moderate rainfall areas and high-elevation areas proved useful for the Maghreb NARS. In Algeria, several lines with desirable traits were identified (Table 7).

Table 7. Important traits in cereal international nurseries for selection in target environments in Algeria.

Species	Location and nurseries	Useful characters in nurseries
Barley	Setif (LRA)	Terminal drought
Bread wheat	Sidi Bel Abbes (LRA)	Drought, heat and frost
Durum wheat	Khroub (MRA) Tiaret (MRA and HAA)	Yield potential and disease resistance

MRA, Moderate-rainfall areas; LRA, Low-rainfall areas; HAA, High-altitude areas.

Net blotch of barley is the most common disease in North Africa. During 1995, resistance to this disease was identified in the following lines: 527/NK 1272 ICB 84-323-8AP-OAP; Trebi CI 936; Turk CI 14400; LA Mesita; Can Lake Shore (CI 2750); Tifang (CI 14373); and CI 6688.

In 1994, Iraq released Rihane-3, a new barley variety developed from ICARDA-provided germplasm, for its rainfed areas in the northern region. Multilocation on-farm testing indicated that Rihane-3 exceeded the local barley landrace by 14% in straw yield and 31% in grain yield. In 1994 farmers planted Rihane-3 on about 500 ha and achieved an average yield of 1544 kg/ha. In 1995 the area planted increased to 5000 ha. Rihane-3 has gained popularity among farmers for its lodging resistance, high yield, and suitability for bread-making when mixed with wheat.

Photoperiod and Vernalization Studies with Mediterranean Rainfed Bread Wheat

An understanding of the vernalization and photoperiod requirements of the germplasm used in breeding is essential for developing cultivars well adapted to target environments. To develop an effective evaluation method, 20 bread wheat lines were grown under two controlled environments and high ambient air temperatures under field conditions at Tel Hadya, Syria in the 1994/95 season. Vernalized and non-vernalized seedlings were transplanted into pots and placed under three photoperiod regimes (8, 12 and 16 h light) in the greenhouse or in growth chambers. Days to anthesis decreased with increasing photoperiod. Vernalized plants flowered earlier than non-vernalized. There was a significant correlation ($r = 0.88$, $P = 0.001$) between days to anthesis in the greenhouse and growth-chamber experiments. The effect of vernalization and photoperiod on the phenological development of the lines tested in the two environments were positively correlated with each other. Growth habit and heading date differences among the lines in the field were highly correlated with the main effect of vernalization in the two controlled environments.

The results indicate that selection for vernalization response in a large number of genotypes can be made under high ambient air temperatures in the field and the selected material can subsequently be screened for photoperiod response under greenhouse conditions. This technique is now routinely used for screening breeding material in the CIMMYT/ICARDA joint bread wheat improvement project.

Combining Productivity and Yield Stability in Durum for the Mediterranean Drylands

Durum wheat in WANA is grown mainly under dryland conditions, characterized by drought, cold, terminal stress, and soil and nutrient problems (alkalinity, boron toxicity and micronutrient deficiencies). In addition, almost all diseases, insects, and viruses that attack durum are widespread in the region.

The performance of stable-yielding durum genotypes combining yield potential with resistance to abiotic and biotic stresses is shown in Table 8. The mean for stable productivity of newly developed CIMMYT/ICARDA durum genotypes was 34.1% higher than for Cham 1, the standard check.

Table 8. Durum genotypes with stable productivity for the Mediterranean continental areas.

Entry no.	Name	Mean grain yield (kg/ha)	Stability		
			MDMYL	RS (%)	Rank
8	Om Rabi 5	3053	0.122	188	2
11	Massara	3000	0.120	192	1
4	Genil 3	2956	0.146	157	3
10	Om Rabi 3	2925	0.158	146	4
2	Omruf 2	2824	0.212	108	5
	Cham 1	2803	0.230	100	7
	LSD (0.05)	334			

MDMYL = Mean of difference from highest yielder at each location divided by location mean. RS = Relative stability (%) = (MDMYL of Check/MDMYL of Test Entry) x 100.

In Syria and Tunisia, Om Rabi 3 has been released for commercial production. This variety is a cross between Haurani and Jori C69. It was first tested at Tel Hadya, Syria using the CIMMYT/ICARDA selection strategy, and then through the international nurseries in the WANA region. Om Rabi 3 combines high productivity with resistance to drought and cold. It also possesses good quality traits for making burghul and pasta.

Resistance to Barley Yellow Dwarf Virus in Wheat Derived from Interspecific Hybrids

Wheat breeding lines derived from the crosses wheat x *Thinopyrum intermedium* and wheat x *Thinopyrum ponticum* were evaluated for their resistance to barley yellow dwarf virus (BYDV). BYDV resistance levels in some of the evaluated lines was much higher than in the currently used wheat cultivars. Virus resistance levels in some of these lines as indicated by symptoms produced, virus titers, and yield losses due to infection suggested that genes for BYDV resistance available in *Th. intermedium* or *Th. ponticum* are nonexistent in the genus *Triticum*. Moreover, the *Th. ponticum* derived lines suggest that genes for BYDV immunity exist in this wheat wild relative. However, since this resistance in the derived lines seems not to be stable, efforts are in progress to enhance the translocation of resistance genes from the telocentric chromosomes (originated from *Th. ponticum*) to the 42 wheat chromosomes through culturing of tissue from immature spikes and regeneration of wheat plants from callus tissue produced. This research is being conducted in collaboration with Laval University and Agriculture Canada Research Station at Saint Foy, Quebec, Canada and CIMMYT.

Wheat interspecific hybrid (right), produced from callus tissue.

Collaborative Research on Wheat Diseases in North Africa

Samples of wild *Hordeum* spp., *Triticum* spp., *Avena* spp. and *Aegilops* spp., selected in previous years were used for combining resistance to septoria, Hessian fly and rusts in bread wheat through the double-haploid technique, and the introgression of *H11,H25* and other genes into durum wheat and the development of synthetic hexaploid wheats resistant to Hessian fly. The results are shown in Table 9.

Table 9. Interspecific and intergeneric hybridization in durum and bread wheat in North Africa, 1994/95.

Male parent	Female parent	Cross objectives	No. of hybrids
Ae. tauschii	*T. durum*	BW synthetic	12
T. monococcum	*T. durum*	Gene transfer	4
Ae. geniculata	*T. durum*	Gene transfer	36
T. araraticum	*T. durum*	Gene transfer	47
Ae. tauschii	*T. aestivum*	Gene transfer	12

T.: Triticum; Ae.: Aegilops

Lentil in Sinai

The lentil area in Egypt declined from 8400 ha in 1985 to 4600 ha in 1995 in the Delta and Nile Valley, primarily because of its reduced profitability compared with other winter field crops, such as Egyptian clover and wheat. To encourage farmers to grow lentil, the crop is being introduced, as part of the Nile Valley and Red Sea Regional Program, not only in the newly reclaimed lands of North Egypt but also in the rainfed areas of North Sinai, where it may be grown in rotation with cereals.

The introduced line Precoz (ILL 4605), which is characterized by its extreme earliness in flowering and maturity, is well adapted to the low-rainfall environments found in the region because of its ability to escape drought. On average, Precoz yielded 1040 kg/ha and exceeded Giza 9, the check from irrigated conditions, by 52%. Precoz is becoming popular in North Sinai, where it is commonly known as 'Shami' (from Damascus). Demonstration

Governor of Sinai (left) visiting lentil plots on Farmers' Day, North Sinai, Egypt.

plots were sown and the Governor of Sinai attended a field day to promote the crop locally.

Research is under way to identify varieties of lentil which have better adaptation and yield potential in the harsh environments of North Sinai, as there is a need for crop diversification without necessitating large monetary inputs. Studies are also under way to develop optimum agronomic practices that may reduce production costs and the risk associated with crop production in that area. The possibility of growing lentil in mixture with barley is being investigated. The initial season of an intercropping experiment of wheat-lentil in the Northwest coast of Egypt showed that the best wheat grain yield (0.97 t/ha) was obtained by intercropping wheat and lentil, using a seed rate of 75% and 25% , respectively.

Use of Molecular Markers to Map Fusarium Resistance Genes in Lentils

Fusarium wilt is the most severe disease of lentil in many countries. Genes for resistance to this disease are available in ICARDA germplasm and can be transferred to other lines through conventional crossing techniques. However, when two different genes are combined in one line, it becomes difficult to establish which of them came by trans

fer. Molecular markers can be used as an indirect selection tool to monitor the transfer of a gene to a different genetic background. ICARDA is using Polymerase Chain Reaction (PCR) molecular markers to establish linkages between a marker and the resistance gene. One such linkage analysis was done on an F_2 population segregating for 72 markers. One marker was linked to the resistance gene. However, segregation analysis in an F_2 population with RAPD-markers is not very precise, so recombinant inbred (homozygous) lines (F_8) have been developed from the same F_2 lines. The recombinant inbred lines represent an eternal population as all alleles are fixed and homozygous. Therefore, not only can the fusarium resistance be mapped but also all the genetic differences between the parents can be located on the chromosome and tagged (molecular markers) for all the mapped characters.

Interspecific Hybridization in *Cicer*

Three interspecific hybridization programs were initiated during 1989 to transfer genes for resistance to cyst nematode and cold, and for high yield, from the wild species, *Cicer echinospermum* and *C. reticulatum*, to cultivated varieties.

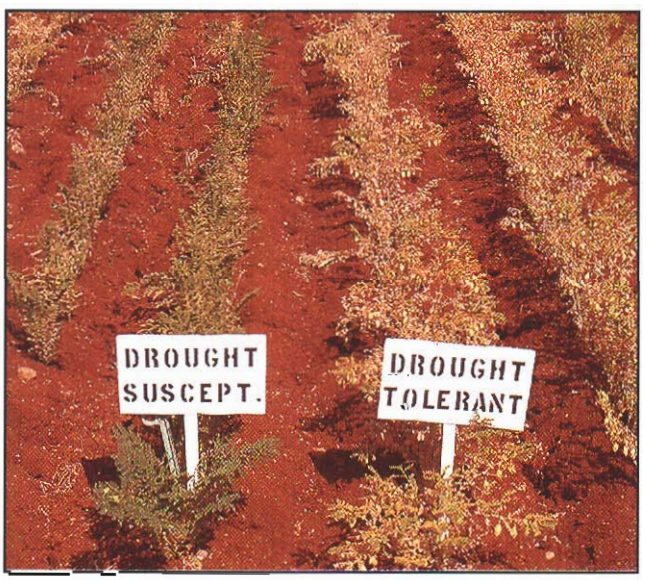
For cold tolerance, many F_6 lines showed the same high level of cold tolerance as the wild species during the 1992/93 evaluation. The plant and seed characters of derived plants were similar to the cultigen parent. Evaluation of cold tolerance in these lines was not possible during 1993/94 and 1994/95 seasons due to mild winters. The F_9 progenies will be sown for reconfirming their cold tolerance during the 1995/96 season.

Some F_8 derived lines with resistance to cyst nematode were similar to the cultigen except for their seed quality. They have been backcrossed with the cultigen parent to improve their seed quality. In another experiment, the F_1 progenies from the interspecific cross were backcrossed with the cultigen parent. Many progenies from this cross in F_4 generation during 1994/95 showed the same level of resistance as the wild parent, and were similar to the cultivated parent for other characters. Resistance to cyst nematode will be reconfirmed in the F_5 generation.

Improved chickpea line (center) generated from crosses with wild *Cicer* species.

Drought Tolerance in Spring Chickpea

ICARDA, in collaboration with ICRISAT, has developed a simple drought-screening technique for evaluating a large number of germplasm and breeding lines. In preliminary screening, the material is sown late by about three weeks, around 20 March at Tel Hadya, and is evaluated on a 1-9 scale, where



First drought-tolerant lines of chickpea developed at ICARDA.

1 = no damage from drought and 9 = all plants killed. Using this technique, 4185 lines were screened during 1992-1994, and 85 identified as promising.

In final screening, promising lines are sown with and without supplemental irrigation in replicated trials around 20 March at Tel Hadya (average rainfall 328 mm). Lines which produce high yields (more than the mean of the trial) under drought conditions as well as under irrigated conditions, and respond to supplemental irrigation by producing substantially higher yield, are selected. Following these criteria, 23 tolerant lines have been identified. This is the first report of drought-tolerant kabuli chickpea lines for a Mediterranean environment.

NARS Benefit from Dry Pea Trials

Research on dry pea was initiated at ICARDA in 1986/87. The work done indicates that dry pea can be an advantageous legume crop in WANA because of its fast growth and development which permits it to escape drought.

ICARDA has initiated a Pea International Adaptation Trial (PIAT), which is constructed using elite lines received from various institutions working on dry pea improvement. The trial is sent to a large number of cooperators within and outside WANA. Cyprus, Sudan, and Oman have identified and released one (Kontemenos), two (Krema 1 and Ballet), and four (Collegian, MG 102 703, A0149 and Syrian Local) varieties, respectively, for general cultivation. Some of the PIAT lines have yielded up to 8 t/ha in small-plot trials in the UK.

Collaborative Research on Food Legumes in North Africa

Progress has been achieved in developing chickpea lines resistant to ascochyta blight and wilt. Three lines (84-92C, T17W1, and INRAT 92), possessing good seed size and acceptable disease resistance, are being multiplied in Tunisia in preparation for distribution to farmers.

In Algeria, several lentil and chickpea lines were selected for nationwide testing (Table 10).

Table 10. Lines selected from ICARDA legume nurseries based on good yield at several sites in Algeria.

Yield range (q/ha)*	Lines
Lentil	
14-36	FLIP 90-13L, 90-8L
7-22	FLIP 88-6L, 90-41L, 87-48L
7-9	FLIP 88-71L
Chickpea	
15-23	FLIP 90-105C, 90-58C, 86-50C
6-13	FLIP 90-76C, 90-77C, 89-93C
9-13	FLIP 87-96C, 89-62C, 90-96C, ILC6043

* 1 q (quintal) = 100 kg.

Collaborative Research on Food Legumes in Egypt, Sudan, and Ethiopia

Chickpea: As part of the efforts to improve chickpea production in Egypt, two new cultivars have been released: Giza 531 for traditional areas and Giza 195 for newly reclaimed lands. An improved production package involving the use of improved cultivar, fertilizers, *Rhizobium* inoculation and seed dressing resulted in increased seed yield by 31% and straw yield by 36% over farmers' practices, and increased net benefits by about 38%. Two new promising lines (X89 TH300 and L 1131) gave yields of 3.4 and 3.3 t/ha, respectively, outyielding local cultivars by 28 and 24% in four out of six test sites.

In Ethiopia, the newly released chickpea cultivar Akaki for mid- to high-altitude areas has given yields of 1.5 to 2.1 t/ha. Several chickpea cultivars have been found resistant to wilt/root-rot diseases, while rust-resistant cultivars were identified in germplasm screening repeated over three seasons. Promising strains of *Rhizobium* were also identified for increasing chickpea yield.

In Sudan, demonstration of improved technology packages was associated with chickpea yield increases of 4 to 154% in three areas and high profitability as indicated by the marginal rates of return (MRR) of 544 and 526% in two of these areas. On-

Food legumes regional traveling workshop in Sudan. Participants included the members of the Netherlands (donor) review mission.

farm verification of weed control at Rubatab illustrated higher timely yield (78%) and profitability (608% MRR) with hand weeding as compared with farmers' practice. The genotype ICCV-2 proved highly resistant to wilt/root-rot diseases as reflected by only 0.6% plant mortality in infected soils. Its seed yield was 1.09 t/ha—95% higher than farmers' variety. It is a candidate for release for river flood areas as it has resistance to disease and tolerance to soil moisture stress; research will continue on agronomic practices to improve its productivity.

Lentil: Two new lentil cultivars, the large-seeded Gudo with a yield potential of 1.0 to 1.6 t/ha and the rust-resistant Ada'a which yields 1.0 to 1.5 t/ha, have been released for mid- to high-altitude areas in Ethiopia. On-farm verification of production packages in four locations in Enewary area showed the highest yield of 1.3 t/ha with the combination of the cultivar Chalew and improved levels of the other factors, compared with 1.08 t/ha for Chalew with farmers' practices and 0.84 t/ha for farmers' cultivars under local practices. The improved package was economically viable, based on its net benefits as compared with those of the other two packages.

Measures to boost lentil production in Egypt included demonstrations of improved technology in the New Lands, development of production packages for short-season lentil to precede cotton in the Old Lands, introduction of lentil in rainfed areas (reported earlier), and development of early-maturing lentil lines resistant to biotic and abiotic stresses. An improved production package applied in 25 demonstration fields in traditional areas resulted in a 16% increase in seed yields.

In spite of the sharp decline in lentil area in Sudan this season, demonstration plots with improved production practices outyielded farmers' plots with increases of 12 to 115% in Zeidab, Wad Hamid and Shendi, providing an MRR of up to 2232%.

Dry pea: In Ethiopia, the 1995 season witnessed the release of two new dry pea cultivars: Hassabe and Markos at the national level with yield potentials of 1.5 to 2.0 t/ha under farmers' field conditions, and two other cultivars with similar yield potentials: Tullu and Dadimos for Bale Region. Both Hassabe and Tullu are suitable for local consumption, while Markos and Dadimos possess export qualities.

Regional Networks in the Nile Valley

In the **Wheat Rusts Network**, biological trapping of rust spores in the Nile Valley Rust Trap Nursery enabled the identification of 20 physiologic races of stem rust and 18 of leaf rust in the Nile Valley countries during 1992-1994. The leaf rust resistance genes (*Lr 1*, *2a*, *9*, *24* and *26*) as well as the stem rust resistance genes *Sr 7b*, *8a* and *Gt (36)* confer the highest level of resistance in wheat. Adapted high-yielding cultivars showing highest levels of resistance against both leaf and stem rusts included: Giza 165, Sakha 8, and Gemmeiza 1 for Egypt; Enkoy, K. 6890-Bu, Et-13, C.T. 7/K-II for Ethiopia; Condor"S" for Sudan; and Marib for Yemen.

From the Regional Chickpea Wilt/Root-Rot Nursery in the **Wilt/Root-Rots Network**, the lines ICC-93213, ICC-14914, ICC-10593, ICC-11502, and ICC-6045 had less than 20% mortality in sick plots in Ethiopia. For Sudan, the highly resistant lines were ICCV-6, ICCV-93066, ICCV-91303, ICCV-11502 and UC-15, whereas for Egypt the resistant lines were ICCV-93065, ICCV-93067, ICCV-93213, ICCV-93214, Giza 88, Giza 195, and Giza 1.

In the **Aphids and Viruses Network**, virus disease surveys were carried out in the Nile Valley countries and information documented on virus diseases of food legume crops. Mosaic/mottle symptoms were frequent in faba bean in north Sudan where Barley Yellow Dwarf Virus (BYDV) is predominant. BYDV incidence in wheat was low in Egypt, decreasing from north to south. Studies on population dynamics of *Aphis craccivora* Koch and *A. gossypii* Glover in northern Sudan revealed Chrysopa, Campylomma and Syrphid flies as natural enemies. The population build-up of these aphids was negatively correlated with temperature and relative humidity. All wheat accessions having cultivars Amigo, Bush and Largo in their genetic background had aphid resistance. Nine lines combined aphid resistance and early maturity under laboratory and field conditions. A threshold of 30% infested plants was determined for chemical control of the pea aphid in dry pea in Ethiopia where early-July sowing had less aphid infestation than late-July sowing. In Egypt, planting in early October and rouguing of infected plants proved effective in reducing the incidence of Faba Bean Necrotic Yellows Virus (FBNYV) which was further reduced by two sprays with Pirimor (pirimicarb).

In the **Thermo-tolerance in Wheat Network**, research in Upper Egypt and Sudan showed that late planting offers more opportunities to select for terminal heat tolerance than normal planting. Of 96 genotypes in the Network's Heat Tolerance Nursery, 40 were selected in Sudan and Egypt. Another seven accessions from ICARDA-provided international nurseries were marked for further evaluation. Seven cultivars were stable under heat stress in Upper Egypt. Monitoring of the performance of 18 spring wheat cultivars in different locations in Upper Egypt and Sudan showed that days to anthesis, plant height, and other yield components were reduced in Sudan because of accelerated growth.

In the **Drought-Tolerance and Water-Use-Efficiency Network**, cultivar and level of soil moisture depletion combinations in Sudan showed that the wheat cultivar El-Neilain had a higher water-use efficiency than Debeira. For chickpea, the cultivar Aribo-1, released for Jebel Marra, produced the highest yield under both wet and water-stress conditions, followed by the genotype ILL 6467. The cultivar Rubatab-1 yielded least. In lentil, water stress reduced yield by 48%. The newly released cultivar Shendi-1 had the highest yield under both wet and stressed conditions, while both Jebel Marra-1 and the local cultivar Beladi had 32% lower yield under water stress.

Collaborative Research on Forage Legumes in Turkey

The Central Highlands of Turkey (CHT) are characterized by cold winters and dry summers. Under these extreme air temperatures, forage crops are still underexploited in crop rotations. Although half of the total vetches in Turkey are grown in the CHT, farmers still use local cultivars which are spring-planted and have low productivity. This generally results in a shortage of good-quality feed especially during the winter supplemental feeding time. Considering this, a collaborative Turkey/ICARDA project

to identify annual forage legumes for both autumn and spring planting in the harsh environment of the CHT was initiated in cooperation with the Central Research Institute of Field Crops, Ankara in the 1992/93 crop season. Results of this three-year project have shown that autumn-planted annual forage legumes performed significantly better than the spring-planted ones. Among vetches, the Hungarian vetch (*Vicia pannonica* Gr.) and woolly-pod vetch (*V. villosa* Roth subsp. *dasycarpa* Ten.) were more promising than others for autumn planting and for grazing and/or hay. Narbon vetch (*V. narbonensis* L.) also performed better in autumn planting than spring planting. Grasspea (*Lathyrus* spp.) also proved a promising alternative to spring-planted vetches. Of a number of accessions evaluated, acc. 751 of Hungarian vetch and 694 of woolly-pod vetch for autumn planting, and acc. 793/A of narbon vetch and acc. 794 of grasspea (*L. sativus*) performed better than others. On-farm evaluation of the promising species and accessions has been initiated in the CHT.

Resource Management and Conservation

Cooperative Resource Management Research in Egypt

The preparatory studies of the resource management component in Egypt were completed in May 1995. These included Inventory Studies, Rapid Rural Appraisals, and Multidisciplinary Surveys in the Old Lands, the New Lands and the rainfed areas. The disciplines covered included agronomy and cropping systems, soil fertility and management, water management, crop-livestock integrated systems, and socioeconomic studies. A total of 18 volumes of preparatory studies are being processed for publication. A Resource Management Planning Workshop was held in June 1995 in Egypt to review the outcome of the preparatory studies and develop two sets of long-term research activities on resource management:

- intensive: long-term (fixed sites) rotation trials
- extensive: on-farm monitoring activities.

In addition, strategic research work on soil and water management was discussed and approved.

Five long-term research sites have been established, three in the New Lands and one each in the Old Lands and rainfed areas.

Modeling Supplemental Irrigation Management

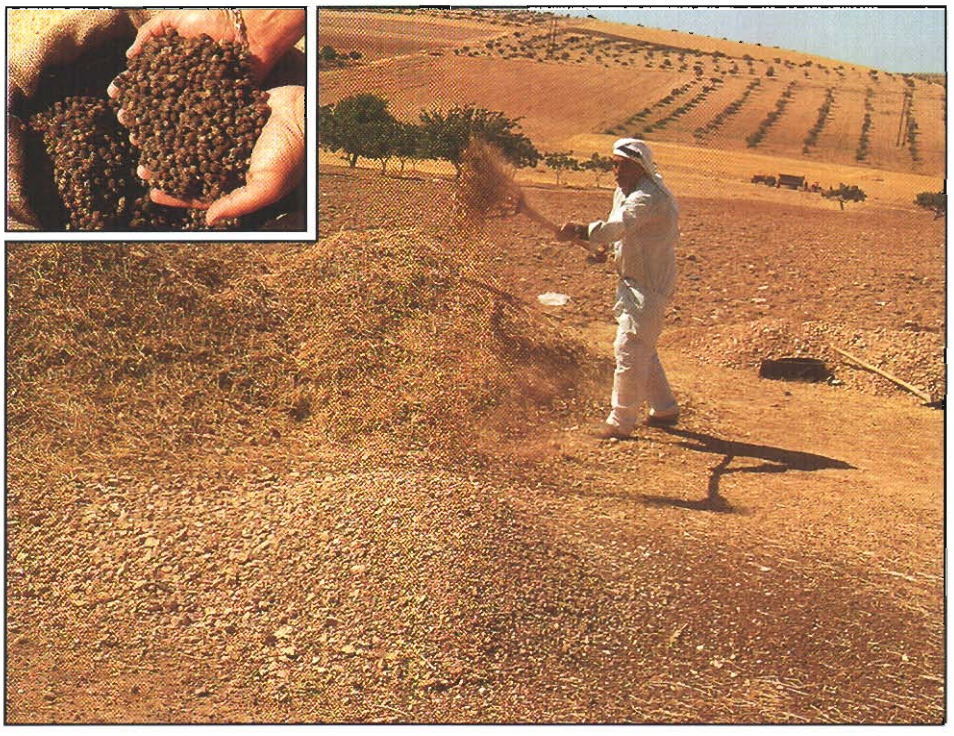
In Syria, over 40% of wheat is now grown under supplemental irrigation. Research at ICARDA has shown that the water-use efficiency in supplemental irrigation of wheat can be several times higher than in full irrigation due to the effect of the conjunctive use of rain and irrigation water.

Long-term experimental data obtained at Tel Hadya has enabled ICARDA to model the responses of several bread and durum wheat varieties to supplemental irrigation and other management factors and alternatives. The models are used for selecting appropriate amount and timing of water application with optimal nitrogen application and planting dates. Results will help maximize water-use efficiency and profits for farmers.

Production of Medic Pods by Farmers

Medic plants drop their pods on the ground when mature; so the harvest process involves raking off the straw—an easy step to mechanize—then sweeping up the pods by broom or with the pasture seed sweeper developed at ICARDA. Medics produce more seed than other annual legumes.

ICARDA offered a deal to seven Syrian farmers to encourage medic seed production. They were offered 5 kg of barley for every 1 kg of medic pods produced by them. Most farmers realized that the maximum yield of barley they could possibly expect to harvest would be in the order of 2-3 t/ha. ICARDA researchers told the farmers about their experiences: i.e., it is possible to harvest at least 2 t pods/ha in an average year using good management—a harvest of pods equivalent to 10 t/ha of barley—by working with ICARDA. ICARDA



Medic pods produced by farmers in Syria to exchange for barley with ICARDA.

provided phosphate fertilizer and loaned its sweepers for pod harvest, and farmers arranged for sheep to graze off the weeds. The farmers also kept the medic straw, a valuable commodity.

Given 270 mm total rainfall in 1994/95 at Tah village in Idleb Province, two farmers achieved outstanding results. They produced a total of 1880 and 2130 kg/ha of pods, respectively.

Barley is worth 7 SYP/kg (about $0.14/kg) in the local market. The first farmer produced 1880 kg of pods and ICARDA traded 9400 kg of barley worth $1316. Medic pods contain about one-third seed, 626 kg, so the Center paid $2.10/kg. Using this plan, the medic seed was produced for much less than world market prices. In 1992, it cost $2.63/kg for Australian seed shipped to Syria.

ICARDA recommends pod sowing on marginal lands with rainfall greater than 250 mm/year, and where grazing can be controlled. Since the objective is to sow a seed bank, it is the least risky of all establishment methods; however, the seeds in pods will not germinate all at once. Generally speaking, 5, 15 and 25% of the medic seeds in pods will germinate in years 1, 2 and 3 after sowing. However, with each generation of medic plants, more pods with 5-7 seeds/pod will be put into the seed bank—provided the plants are permitted to set some seed through the use of proper grazing management.

Forage, Livestock, and Range Management in the Central Highlands of Turkey

Most of the pastures in the central highlands of Turkey have been replaced by cereal production over the last 50 years. Mismanagement, mainly by overstocking and too early grazing, has resulted in severe degradation of the remaining pasture species. Livestock numbers are in the region of 2 million head of large ruminants and 12 million head of sheep and goats. The deteriorating situation prompted the queston: "Is it possible to conserve in a sustainable manner pasture resources that might otherwise be lost forever?" Past experience suggests that an approach which involves the full participation of village farmers in the work is needed for rangeland rehabilitation. Also, feed production must be integrated with livestock production.

In response, the Central Research Institute for Field Crops of the Turkish Ministry of Agriculture and Rural Affairs and ICARDA initiated, in 1995, a multidisciplinary research project on the management and rehabilitation of village rangeland in three districts of Ankara Province. The project's objectives—to identify representative villages for implementation of a participatory project to increase feed availability (through range rehabilitation, forage crops and perennial legume/grass mixtures) and to develop livestock feeding recommendations based on village-based feed resources and practical livestock management techniques that will improve flock (or herd) health—have been partially fulfilled. Objective methods were used to diagnose village structure and the botanical state of the rangeland.

The large amount of valuable information obtained from the village surveys (14 villages, 141 farmers) and the biodiversity studies (on 23 sites) enabled the researchers to select and make comparisons between two villages (Kargali and Gölköy), each representative of one of two important ecosystems—the mountains and plateaux of central Anatolia in Turkey. The study shows, using cluster analysis (Table 11), that there are pockets of remnant vegetation that could be the basis of a rehabiliation program, using grazing management (on sites with good plant cover and botanical composition); phosphate fertilization to encourage annual legumes (on sites where they exist); or oversowing, fertilization and protection from grazing for the most degraded rangeland. Results of the biodiversity study clearly indicate some distinctions between the pasture species of the two areas and it appears that depletion of range species was less in the mountainous area than the plateau area, which could be due to fewer small ruminants, higher altitudes, and more favorable climatic conditions.

Good condition rangeland in Gölköy village, north of Ankara in Turkey.

Table 11. Means and significant differences for site characteristics after separation into clusters using Ward's minimum variance method.

Variable	Cluster			
	1	2	3	4
Plant cover (%)	46.6^{b}	35.6^{c}	71.7^{a}	62.0^{a}
Annual legumes (%)	1.6^{b}	1.4^{b}	3.2^{b}	10.4^{a}
Perennial legumes (%)	5.6^{a}	8.1^{a}	9.7^{a}	12.5^{a}
Grasses (%)	42.8^{ab}	39.3^{b}	59.4^{a}	39.4^{b}

Values within a row followed by different superscripted letters are significantly different at the P<0.05 level of probability.

Integration of Pasture, Forage Crops, and Livestock in North Africa

ICARDA's collaboration with the Maghreb NARS on forage seed production and rotations received added strength in 1995 from ICARDA's Mashreq/Maghreb project for crop/livestock integration. Activities in Morocco focused on forage-seed production by farmers (Settat/Safi region) using small machinery for seed/pod harvesting. The work, carried out in cooperation with the Provincial Directorates of Crop Production and Extension Services, attempts to identify farmers as potential seed producers.

In Tunisia and Libya, ICARDA continued to cooperate and support on-going research on small ruminants and the use of shrub plantations and agricultural by-products for feed; while in Algeria cooperation continued on long-term crop/pasture rotation trials with a view to integrating small ruminants into the production system.

Community Pastures

An important dimension of ICARDA's research is rangeland property rights, the fundamental stumbling block in many rangeland rehabilitation projects in the WANA region. An example from Syria illustrates the complexity of the problem.

Ten Bedouin group heads (of 72 households) signed the first contracts for one-month grazing rights for 13,000 sheep on the Maragha rangeland reserve. This 6500 ha reserve, 90 km southeast of Aleppo, is managed by the Steppe and Range Directorate of the Syrian Ministry of Agriculture and Agrarian Reform (SMAAR). Because this is the first legal private use of government saltbush (*Atriplex* spp.) and *Salsola vermiculata* shrub plantations in the steppe, and because the grazing was organized by contracts to groups, it is a significant development in Syrian rangeland management.

The Bedouins reported their calendars of feeding, grazing and flock movement, before and after the reserve was opened. The differences in sheep diets of April 1994 and April 1995 are shown in the calendar (Fig. 10). There was more hand-feeding and less grazing of unharvested barley in 1995; farmers were holding on to their barley crops in the hope of receiving a late rain (which did indeed come).

The sheep feed calendar confirms earlier studies, showing summer diets of cereal stubbles, autumn diets dominated by residues of irrigated crops, winter diets of hand-fed straws and energy feeds, and rangeland providing more than half of the spring diet. Flocks are moved to different agroecological zones to take advantage of these feed resources when they become available at low cost.

The April 1995 experimental grazing contracts at Maragha were successful and popular, judging from this small sample. Grazing contracts were largely restricted to the families who had longlasting ties with the Maragha site.

Further field studies are planned in Syria, Jordan, Tunisia, and Morocco as part of a collaborative project with IFPRI (International Food Policy Research Institute) in the Mashreq/Maghreb Project in West Asia and North Africa, with a focus on open-access and common property rangelands.

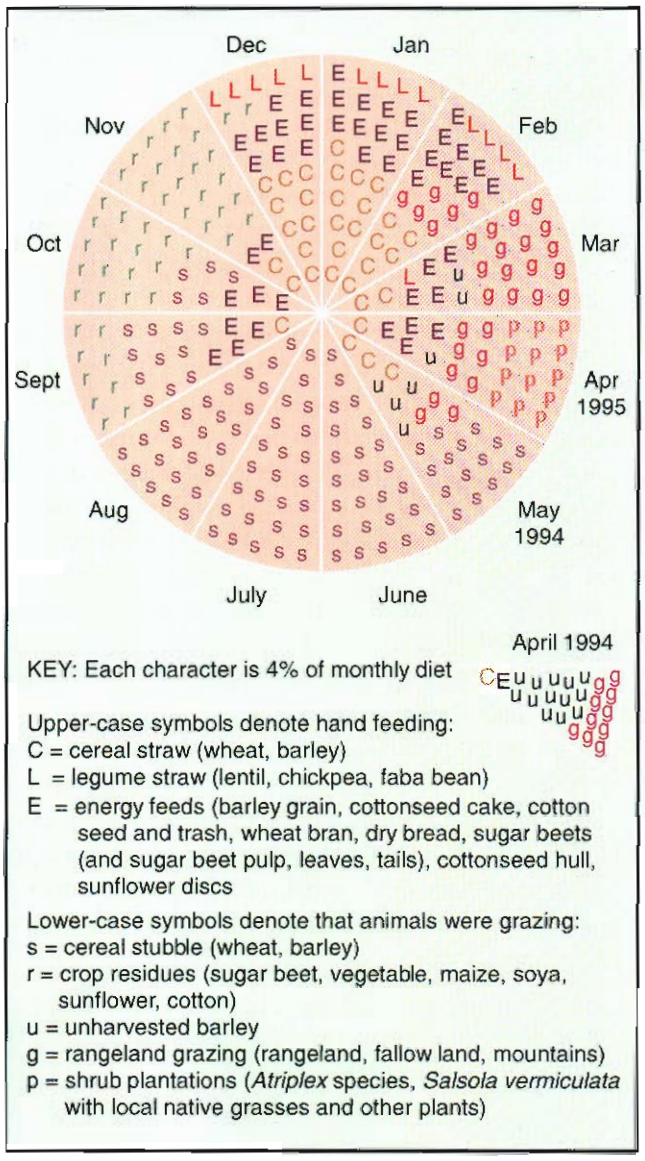


Fig. 10. Small ruminants diets reported by 10 Bedouin groups, Maragha, Syria, 1994/95.

Dryland On-Farm Research in Iran

On-farm research is still a largely untried concept to some national researchers, who have so often been inhibited by a strong research-station tradition and a lack of resources to get out and work with farmers. The establishment of the Dryland Agricultural Research Institute in Maragheh, Iran in 1992, with excellent resources and an enthusiastic young staff, has opened new opportunities for research on

dryland agriculture in northern Iran. Working with farmers to solve their problems has been given a high priority.

To ensure that on-farm research is appropriately focused, it is first essential to understand the farmers, their perspectives, and their farming systems, and to identify the main production problems. An initial training course was held in 1994, and in 1995 Iranian and ICARDA scientists undertook a farm survey in the important dryland agricultural areas of Maragheh and Hashtrod provinces. An integrated cereal/livestock farming system predominates, with most of the arable land under a rainfed wheat/fallow rotation; but chickpea is also an important crop grown by most farmers.

Wheat yields tend to be rather low. Farmers rated fertilizer, machinery, and time of first tillage as the most important factors affecting their wheat yields.

Training

Emphasis on training continued and, during 1995, ICARDA offered training to 712 individuals (Table 12). Participants came from 35 countries (WANA 22, Latin America 2, East Asia 2, and Europe 9 countries). Of these about 35% were trained in courses at ICARDA headquarters in Aleppo, and the remaining in in-country, sub-regional and regional training courses outside the headquarters. About 17% of the trainees were women.

ICARDA continued its strategy of gradually decentralizing its training activities by offering more non-headquarters courses. In 1995, the Center offered eight headquarters courses and 31 in-country, regional, and sub-regional courses.

The training offered reflected ICARDA's growing emphasis on an agroecological thrust. Besides topics in commodity programs, courses were also offered in genetic resource conservation, DNA molecular-marker techniques for crop improvement, library and information management, scientific writing and data presentation, computer applications in agricultural research, seed processing and storage, seed health testing, farm survey methodologies, experimental station operation management, and resource management and land-use planning.

Contacts were made with other regional and international research and training organizations, including CIHEAM, ACSAD, AOAD, API, AGERI, CIMMYT, IPGRI, CLIMA, FAO, UNEP and UNDP, to explore the possibilities of conducting joint training activities in areas of mutual interest. One joint group course was conducted in collaboration with UNEP and one with IPGRI, and one regional/sub-regional group course was conducted jointly with each of CIHEAM, AOAD, CLIMA, FAO, AGERI, and UNDP.

For the UNDP-assisted project entitled "Technical Assistance to Agricultural Investment in the Southern Region-Phase II", Syria, for which ICARDA is the implementing agency for the human resource development component, the Center helped conduct 10 short-term specialized training courses in collaboration with the Egyptian International Center for Agriculture (EICA) in Cairo, Egypt; the Arab Planning Institute (API) in Kuwait; and the national programs of Morocco and Tunisia. These courses were: (i) Advanced methods in breeding, management and feeding of milking cows, (ii) Planning agricultural extension programs for integrated pest management, (iii) Rural women in development, (iv) Planning agricultural extension programs for field crops and horticulture, (v) Methods and procedures of technology transfer to farmers, (vi) Advanced methods in bee keeping, (vii) Planning, management, monitoring and evaluation of agricultural projects, (viii) Water and soil conservation, (ix) Cultivation of olive trees, and (x) Study tour to the IFAD-funded projects in Egypt. Eighty-six officials from this project, including directors of agriculture in the provinces of Rural Damascus and Dara'a, participated in these training courses. These new training activities proved effective in linking national programs in the region to each other and to other regional and international organizations.

The *Manual of Training Procedures* was revised and implemented for the 1995 training activities. This manual defines categories of ICARDA training, establishes procedures for selection of training participants and details the support provisions offered to them. The Training Coordination Unit continued to collect feedback from the concerned programs/units and NARS on this document to up-

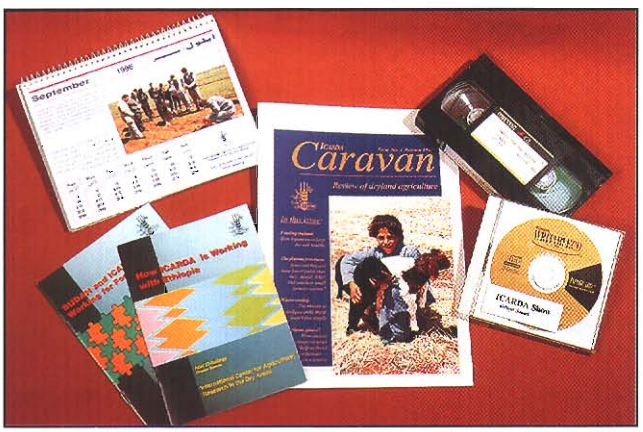
Table 12. Participants in the 1994/95 ICARDA training courses.

Country	Long-term group courses	Head-quarters short courses	Regional, sub-regional & in-country	Indiv. non-degree	Indiv. degree	Total
Albania	-	1	-	-	-	1
Algeria	2	2	9	5	1	19
Argentina	-	1	-	-	-	1
Australia	-	-	1	1	2	4
Austria	-	-	1	-	-	1
Bahrain	-	-	1	-	-	1
Chile	-	1	-	-	-	1
Cyprus	-	1	-	-	-	1
Egypt	-	7	67	7	2	83
Ethiopia	-	2	30	2	2	36
France	-	-	-	1	-	1
Germany	-	-	-	-	8	8
Greece	-	1	-	-	-	1
Iran	1	3	38	4	1	45
Iraq	-	1	34	1	1	37
Italy	-	1	-	-	2	3
Jordan	-	4	14	11	7	36
Lebanon	-	3	23	3	2	31
Libya	2	3	6	2	-	13
Morocco	1	7	46	2	-	56
Malta	-	1	-	-	-	1
Netherlands	-	-	-	-	1	1
Oman	-	1	2	-	-	3
Palestine	-	-	6	-	-	6
Pakistan	-	3	21	-	-	24
Qatar	-	-	7	-	-	7
Spain	-	2	-	1	-	3
S. Arabia	-	-	2	-	-	2
Sudan	-	5	-	-	11	16
Syria	2	23	98	41	23	187
Tunisia	1	3	11	2	-	17
Turkey	-	7	42	3	2	54
UK	-	-	3	-	2	5
Vitnam	-	-	-	1	-	1
Yemen	1	1	2	2	-	6
Total	10	84	464	87	67	712

date it for the 1996 training activities. A policy on the ICARDA Graduate Research Training Program was also revised and implemented in 1995. This policy covers not only graduate studies by NARS scientists in collaboration with ICARDA, but also provisions for ICARDA regional staff members who wish to improve their educational qualifications.

Information Dissemination

During the year, the public-awareness activities gained unprecedented momentum. A large number of news and feature stories, written by in-house staff and freelance writers, were published in the international media. Donor- and country-specific booklets were also produced. The Center produced its first CD-ROM show, as part of media material for the International Centers Week and FAO's 50th Anniversary celebrations. A general-audience publication, *ICARDA Caravan*, was launched. A video-film production unit was set up and a short film on the Center's work was produced. Through liaison with the CGIAR Secretariat, a preliminary version of an ICARDA home page was installed on the Internet. Several posters and a desk calendar were also produced, highlighting ICARDA's strategy, research activities and collaboration within and outside the region.



Some items of media material produced during 1995.

Over 75 articles were processed for submission to refereed journals, and 63 titles were published in-house, including the Annual Report and three regular newsletters: *FABIS*, *LENS*, and *Rachis*. A volume of workshop proceedings was co-published with the World Bank. The quality of the in-house newsletter, *The Week at ICARDA*, was substantially improved. Arabic translation and simultaneous interpretation services were provided to the Center's management and research staff.

Considerable progress was made in upgrading the computer hardware and software for desktop-publishing. Library Management System software was acquired for testing and implementation. Seven international agricultural databases were added to the CD-ROM library, including Books in Print-Plus, World List of Agricultural Serials, World Weather Disk, and Agronomy Journal (volumes 1 to 22, full text). The ISI Agricultural, Biology and Environmental Sciences database on CD-ROM and the updated version of SRLS (Union Catalog of Serials Holdings in the IARCs) were installed on the ICARDA network.

Inter-Center collaboration was strengthened with CIMMYT and ICRISAT. An agreement was signed with CIMMYT to jointly produce a *Literature Update on Wheat, Barley and Triticale* (six issues per year), and a joint poster on chickpea was produced with ICRISAT. A work plan of cooperative activities was signed with the National Center for Agricultural Information and Documentation (NCAID), Syria, and was implemented. ICARDA provided support to NCAID in the establishment of new databases, and NCAID cooperated with the Center in carrying out a survey of libraries and information centers in Syria. The data are being analyzed.

The third annual training course on library and information management was organized at headquarters, 24 September to 5 October, in which information professionals from Cyprus, Ethiopia, Jordan, Sudan, and Syria participated. The library also organized on-the-job training for two information staff from ACSAD on AGRIS/CARIS systems and computer applications. A course on science writing was given for Ethiopian NARS personnel in Addis Ababa.

Journal subscriptions were reviewed in the light of increasing subscription rates by analyzing the data on their use by ICARDA and NARS researchers, and the subscription list was pruned.

A major effort was made to clean up the mailing list by using a specially-designed questionnaire. The mailing-list database was transferred from ICADET to CDS/ISIS. Print runs were reduced to match the new mailing-list database, and mailing procedures were further streamlined to ensure that the Center's information material reaches the real users.

A price list for selected publications was developed. A sales policy was implemented and a modest income was realized from the sale of publications for the first time.

The photolaboratory was rearranged to provide adequate space for scientists to view the slide collection.

Impact Assessment

Farming System Change in Syria's Zone 2

Twenty years ago, farming systems in Syria's Zone 2 (defined as having 250-350 mm rainfall in not less than two years out of three and covering about 40% of the country's cultivable land) were dominated by cereal/fallow rotations and small-ruminant production. The present systems are much more complex.

To identify the trends and understand the forces driving them, a multidisciplinary team from the Syrian Department of Agricultural Scientific Research (DASR) and ICARDA undertook four rapid appraisal missions during the 1994/95 season, in northeast, northwest and southern Syria, meeting local extension officials and interviewing many farmers. This approach will be followed by more focused surveys during the 1995/96 season.

Findings so far suggest that the introduction of irrigation, using groundwater, has been a major agent of change. Under supplemental irrigation, winter cereal production has increased greatly, with wheat tending to displace barley; and, where the supply allows, commercial crops (sugar beet, potato, cotton) are grown under full irrigation in the summer, particularly in the northwest. However, the survey team noted wasteful flood irrigation and falling groundwater levels in some areas; and continuous wheat cultivation has given rise to nematode problems in the northeast.

Another widespread trend is the planting of olive and fruit trees, usually to replace barley on shallow soils or native pastures in marginal hill lands. Further, this loss of natural grazing, exacerbated by the intensification even of rainfed cropping that has largely eliminated the practice of leaving the land

fallow, has reduced sheep numbers. In the Hauran it was noted that the planting of pastures with fruit trees had led to fewer sheep, but numbers of cattle were beginning to increase. In fact, increased crop production stimulated by irrigation has increased the quantity of available crop residues, compensating somewhat for loss of pasture area. However, many farmers with irrigation have few animals of their own and prefer to save time by burning the cereal stubble rather than selling it for grazing. This practice seems likely to be detrimental to the soil. This is the broad picture. There are many local differences, based on land quality and the availability of water.

Changes in Farm Resources and Land Use in El Bab District, Syria, from 1984 to 1995

In the 250-350 mm zone of El Bab district in Aleppo Province barley-based farming systems with integration of livestock are predominant with some potential for supplemental irrigation using wells. The assessment of the sustainability of these systems was the focus of this study. To monitor changes in farm resources and land use, the district was revisited in 1995, having been previously surveyed in 1984. For the 1995 study some 100 farmers from 20 villages were interviewed.

With the subdivision of farms among their sons by farmers, the resource base becomes smaller and continuous cropping of the land becomes necessary. The use of fallow was abandoned; thus another source for grazing is no longer available, and the cereal monoculture has increased which causes diseases and yield depression. The use of fallow in crop rotations decreased by 30% (Fig. 11). The intensification of cropping is also dictated by the high population growth rate.

Over the 11 years the area of rainfed crops has decreased by 14%. Part of this land now receives supplemental irrigation; the area has increased substantially, from 2.8% in 1984 to 8%, with the land sown mainly to wheat, faba bean, and vegetables.

The increase in irrigated area during the last 11 years is also reflected in the high percentage of wells, 28%, that have been dug during that period (20% of the wells are less than 5 years old). More than one-third of wells are 10-20 years old. The average productive period of a well is 5.2 years. Currently, the average well depth is 66.4 meters.

The ground-water level in the region is declining at a rate of about 1 m per year (since the early 1960s). Farmers reported they must frequently dig existing wells deeper to maintain adequate supplies of water. An additional 18% of farmers reported that their wells had dried up during the last 10 years. Existing water resources are exhausting fast because the recharge rate is low, and new wells have to be

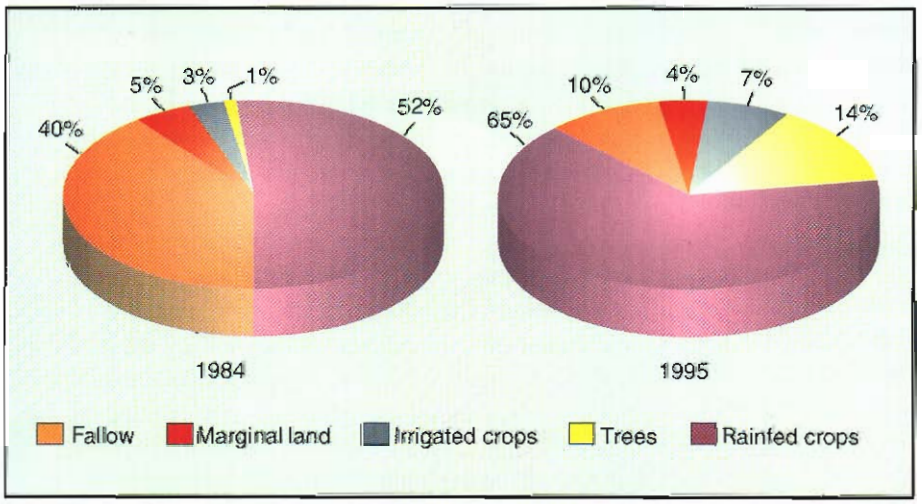
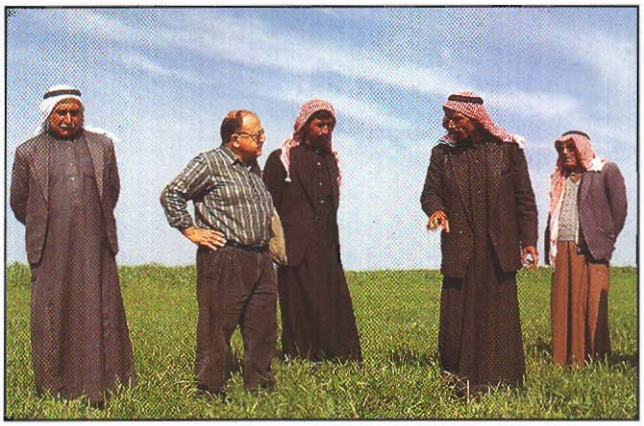


Fig. 11. Land use in farming systems in El Bab district, Aleppo, Syria, 1984-1995.



Farmers in El Bab, Syria discuss with an ICARDA researcher (second from left) changes in land use during the past decade.

dug in a different location. The cost of digging and maintenance, the uncertainty of success and the period of sufficient water availability impose a high risk on supplemental irrigators.

Private pumping of ground water remains untaxed and unregulated. The prospect of higher yields, more reliable harvests and production of high-value crops make the high investment and operating costs of irrigation economically attractive to farmers. The system appears to be unsustainable; ground-water depletion and salinization will cause degradation and environmental damage in the future. Policy makers should take measures to control the digging of wells and the amounts of water pumped by metering wells and charging the farmer for water used.

Among other major changes in the area during the 11 years was the establishment of a development project in 1986. This project has led to the removal of 11,000 ha of marginal rainfed land, of which 7000 ha have been planted with olive trees. The encouragement of tree planting catalyzed a process providing an alternative source of income for farmers from olive production. It is an investment in the future to secure the well-being of the following generations. At the same time, though, the clearing and levelling of formerly non-arable land and the lack of fallow caused a shortage of grazing land. This was mentioned as the number one constraint in animal production by the farmers interviewed in the 1995 survey, followed by the difficulty of finding a shepherd. Expenses for feed stuffs and longer hand-feeding periods make animal production less profitable and have contributed to declining flock sizes.

During the last 5 years, flock sizes have steadily decreased. In 1994 the average flock size was only 66% of that 5 years before, decreasing from 37 to 25 sheep per family. The number of farms without any sheep increased from 9 to 16%. Flocks with less than 10 head represent almost one-third today. In these small flocks the focus of production is on subsistence for the household. The number of large flocks with more than 100 head is only 5% today. In 1984, the situation was the opposite of what it is today, with a large number of flocks with more than 100 head.

In the past, many of the large flocks moved out of the district into the steppe for winter grazing. Today, with only a few large flocks left, the direction of this movement has nearly reversed; steppe-based flocks come into the El Bab district for cereal-stubble grazing in summer. The decreasing quality and quantity of range vegetation cannot sustain flocks sufficiently and forces the owners to move into the cropping areas in search of feed.

Additional income can be generated by the farming community through custom rental of machinery. More than two-thirds of households in the study area reported that family members worked in construction projects in Syria or in neighboring countries. These activities are expected to increase in importance as a source of income in the future, according to most of the respondents. More than 40% of families have started earning additional income off-farm in the last 5 years. Possible reasons for an increased need for alternative income sources outside of the farm are high population growth rates and resulting division of land and animal resources, but also the decreasing productivity of the land.

The use of feed legumes in the crop rotation would benefit on-farm fodder production and prevent diseases caused by continuous cereal growing as is being demonstrated by ICARDA's research there. The adoption of feed legumes in currently constrained by lack of mechanical harvesting methods.

Farmer Knowledge and Actual Barley Production Practices in Syria and Jordan

To improve the effectiveness of technology transfer efforts, a study was conducted with the national programs of Jordan and Syria to describe and compare farmers' knowledge of barley production with recommended production packages and actual production practices. Farmers were asked to describe what they considered to be the best combination of inputs and cultivation practices in their environments. These "ideal" practices were then compared with the farmers' knowledge of recommended technologies to see if a gap in information existed. Then "ideal" practices were compared with the farmers' actual practices to identify constraints to technology adoption.

The results indicate that farmers are generally well informed about the practices recommended by researchers and extension personnel, and a majority of those covered by the study are incorporating the recommendations in their practices. The notable exception is a widespread lack of knowledge about improved cultivars. Special efforts are needed to bridge the information gap and make farmers aware of the benefits of improved barley cultivars.

However, there remain important gaps between what farmers believe they should do and what they actually practice. In Syria, 20% farmers wished to follow a rotation other than continuous cereals; and would like, but were not able, to use fertilizer, seed drills, and deep cultivation. Overall, some 70% of small-holder farmers in Syria were not following what they themselves believed were the best barley production practices in their environments. The figures are lower for medium-sized and large farms.

In Jordan, the discrepancies between farmers' "ideal" and actual practices are even greater. Some 44% of farmers surveyed said they should, but were not able to, use a seed drill. About a third thought they should use fertilizer but did not, and a slightly lower number (29%) thought they were practicing an improper rotation. Unlike in Syria, the difference between farmer perception of the ideal and actual practices did not differ significantly among farm size groups. These results indicate that, with the exception of improved cultivars, farmer knowledge and perceptions of improved practices are not the primary constraints to enhanced adoption of improved barley production practices. Nor does risk avoidance appear to be a major issue. Rather, farm-er explanations of the gap between recommenda-tions and actual practices tend to highlight pro-blems of input availability and costs, with the additional problem of constraining land resources for small-holder farmers in Syria.

Wheat Adoption Studies in Egypt and Sudan

Adoption studies conducted in Egypt in the 1994/95 season in two wheat-producing areas revealed a high level of farmer acceptance of recommended technologies (Fig. 12). Cultivar diversification proved useful in minimizing the effect of wheat rust, largely due to the resistant cultivars Sids 1, Sahel 1, and Giza 167. Improved production packages proved successful in raising wheat yields by 25 to 77% in farmers' fields (Table 13).

Despite the unfavorably warm weather in Sudan in January 1995, the effect of improved production packages for various wheat-producing areas in on-farm demonstrations was highly positive, with 28 to 135% increase in yield (Table 14).

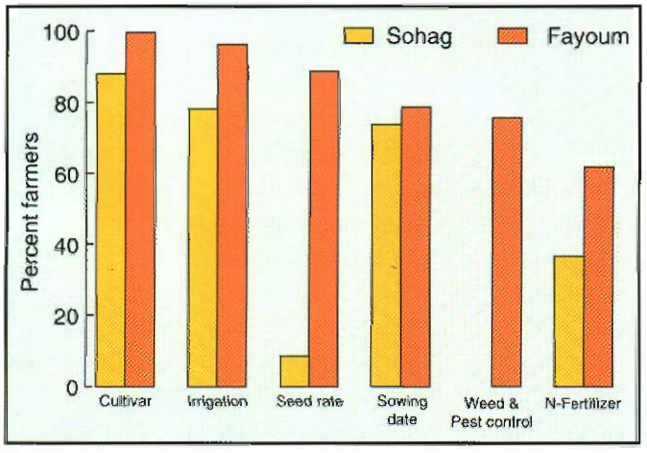
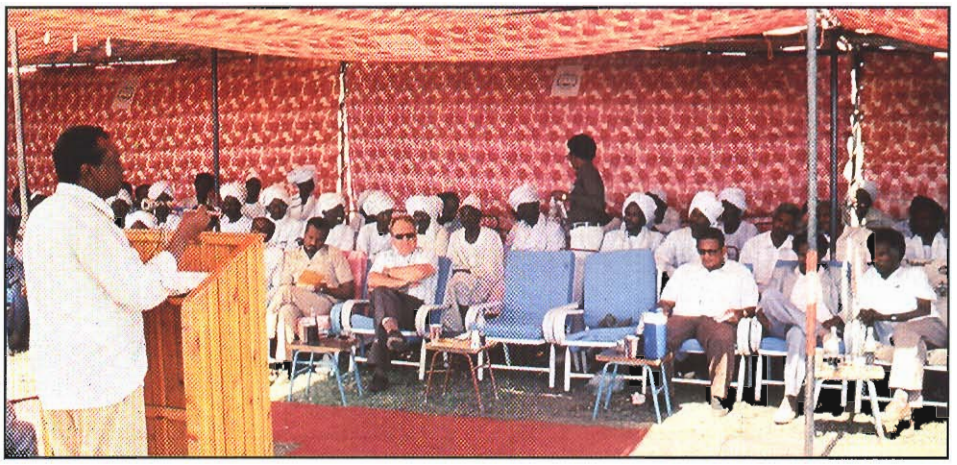


Fig. 12. Level of adoption (% farmers adopting) of improved wheat practices in two areas in Egypt, 1994/95.



National Program Coordinator answering questions of farmers on improved wheat production technology on Farmers' Day in Gezira, Sudan.

Table 13. Comparison of average wheat grain yields of participant and non-participant farmers in on-farm pilot production/demonstration plots in different governorates (agroecological zones) in Egypt, 1994/95.

Governorate	No. of sites	Grain yield (t/ha)		% Yield improvement
		Participants	Non-participants	
Fayoum	15	7.5	6.0	25
Sohag	30	6.5	4.8	35
Quena (old land)	44	6.5	5.1	27
Quena (new land)	42	5.8	4.5	29
Aswan	10	7.8	4.4	77

Table 14. Comparison of average wheat grain yields of participant and non-participant farmers in on-farm demonstration plots in different wheat-producing areas in Sudan, 1994/95.

Area	Grain yield (t/ha)		% Yield improvement
	Participants	Non-participants	
Gezira	1.94	1.06	83
Managil	1.83	1.33	37
Rahad	2.48	1.76	41
Blue Nile	1.75	1.17	50
White Nile	1.93	1.32	46
Shendi	3.22	2.22	45
Zeidab	2.02	0.86	135
Burgaig	2.82	2.20	28

Faba Bean Adoption in Egypt, Ethiopia, and Sudan

Since 1991, six faba bean cultivars resistant to chocolate spot disease and three cultivars resistant to *Orobanche* have been released for different agroecological zones in Egypt and their seeds multiplied. Adoption of improved cultivars monitored in the 1994/95 season was high (Fig. 13).

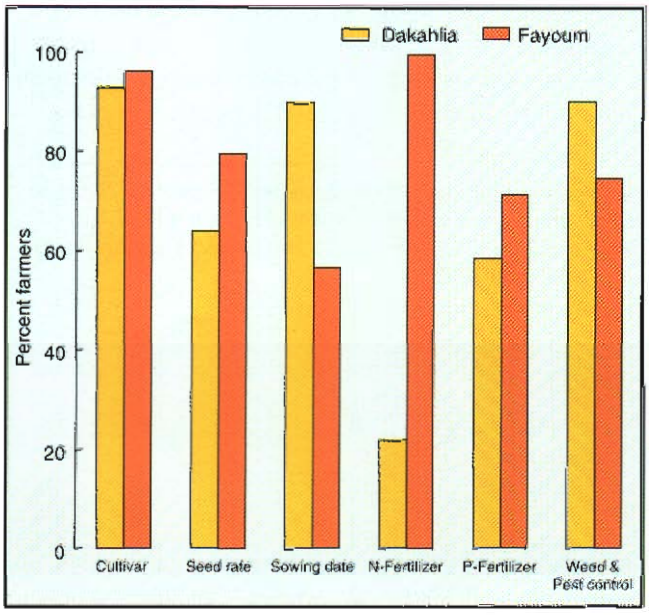


Fig. 13. Adoption levels (% farmers adopting) of improved faba bean practices in two areas in Egypt, 1994/95.

Improved production packages were demonstrated in various farming systems to resolve relevant constraints. Yield increases with the packages were associated with marginal rates of return exceeding 50% and indicating good prospects for technology adoption. In demonstrations trials in the newly reclaimed areas of Nubaria, Giza Blanca and Giza 716 produced 3.51 and 3.65 t/ha, respectively, with 42 and 47% yield advantages over the farmers' cultivar. *Orobanche* control demonstrations in Assuit, Beni Suef, Nubaria, and Beheira revealed 44 to 103% yield advantage over the control due to reductions in number of *Orobanche* spikes.

In Ethiopia, improved faba bean production packages of new cultivars, early sowing, higher seed rate, fertilizer application and hand weeding resulted in high yield advantage and monetary benefits over usual farmers' practices in two areas (Table 15). A major achievement is that, for the first time in 15 years, two new faba bean cultivars—Bulga 70 for high altitudes and Tesfa for mid-altitudes—have been released. These two cultivars have yield potentials of 2.0 to 2.5 t/ha under farmers' field conditions.

The technology demonstrated in earlier seasons in traditional faba bean growing areas of northern Sudan is being monitored for adoption levels, which were appreciable in the 1994/95 season (Fig. 14). In non-traditional areas south of Khartoum, high adoption rates of faba bean cultivation were noted in Gezira (100%) and Rabad (50%) in selected areas

Table 15. Faba bean grain yields and financial benefits in on-farm demonstrations (Improved) as compared with farmers' practices (Farmer) in two areas (Arsi and Adet) in Ethiopia, 1994/95.

Area	Arsi		Adet	
	Improved	Farmer	Improved	Farmer
Seed yield (t/ha)	3.0	2.2	1.4	0.6
Variable costs (Birr/ha)	942	708	385	166
Net benefits (Birr/ha)	4312	3189	1935	865
Average improvement (%)	135	-	224	-
Marginal rate of return (%)	480	-	490	-

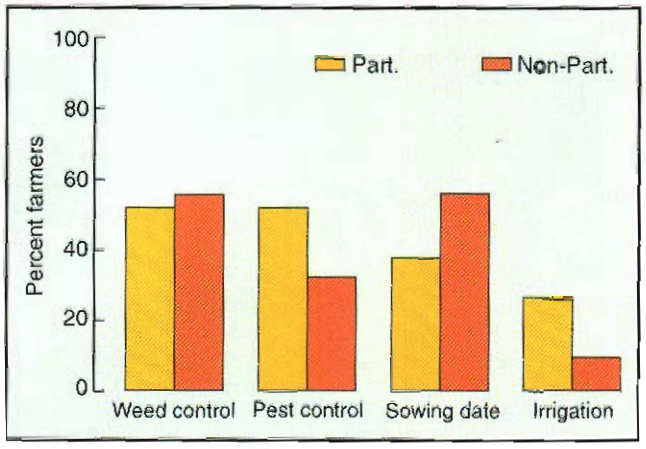


Fig. 14. Adoption levels (% farmers adopting) of improved faba bean practices in the Nile State in Sudan for participating (Part.) and non-participating (Non-Part.) farmers, average of five areas, 1994/95.

where farmers previously participated in on-farm trials. Faba bean demonstrations of three different options of improved technological packages involving different combinations of timely planting, frequent irrigation, pest control and weed management in five faba bean producing areas in northern Sudan resulted in yield increases reaching 78% with high profitability.

An economic study using mathematical programming, to predict farmers' prospects for using improved technology under prevailing farming-system constraints in small-pump schemes in Sudan, illustrated the potential of medium-technology for faba bean, but high-technology potential with low land/water ratios. Impact analysis of grain markets in Ethiopia showed that market liberalization had encouraged 55% of the farmers to increase faba bean production, 53% to use more fertilizers in faba bean, and 58% to apply more herbicides in wheat and teff.

Mechanized Harvesting of Lentil in Syria

The cost of harvesting lentil by hand in Syria accounts for 36% of the total value of grain and straw in years of normal harvest. The cost increases to 73% in years of poor harvest.

A technological package for mechanized harvesting of lentils has been developed and successfully tested on farmers' fields. The package includes a new variety (taller, with less tendency to lodging than local cultivars), better seed-bed preparation (land leveling), the use of a seed drill for sowing, rolling and harvesting the crop by a modified cereal combine (for large plots) or a tractor-powered double-knife cutter bar (for small and medium-sized plots).

In an adoption survey of lentil mechanization conducted recently in Syria, it was found that with efficient application of the mechanized harvesting package, harvesting cost was only 44% of hand-harvesting cost. Therefore, farmers who harvested the crop mechanically achieved increases in net revenues of 69% in a normal season, and 10% in a good season (Fig. 15). In years of poor harvest, adopters of mechanized harvesting realized a small profit, whereas non-adopters suffered serious losses.

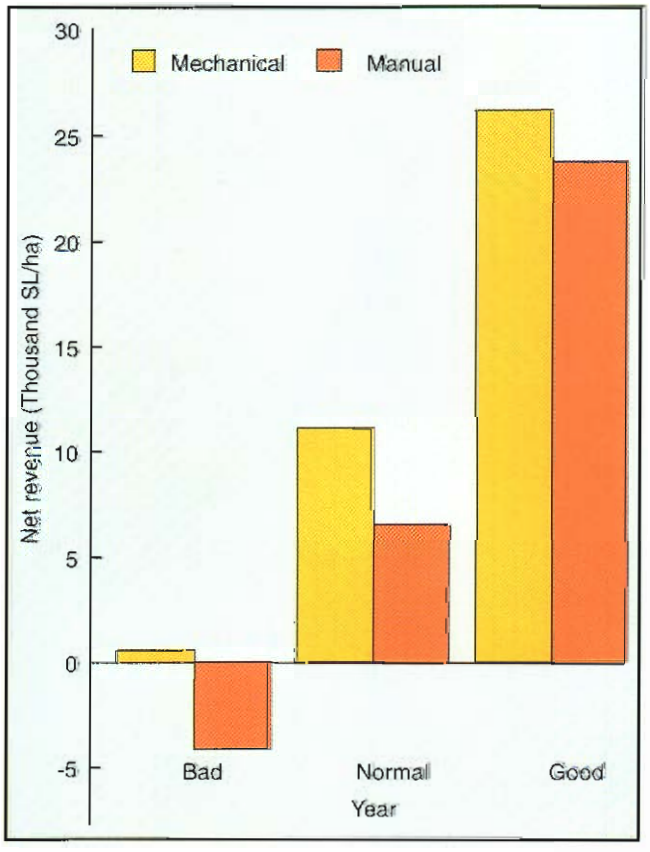


Fig. 15. Mechanized *vs* hand harvesting of lentil.

Expansion in Forage Legumes in the Mashreq Region

In response to farmers' demand and to enhance farmer adoption, the Mashreq/Maghreb project expanded its activities in the demonstration of "Bekia" (*Vicia sativa*) in the three Mashreq countries: Syria, Jordan, and Iraq. The main purpose is to use Bekia for direct grazing by sheep. However, farmers were given the option of harvesting part of their fields for seed production.

In Jordan, 20 demonstrations were conducted with a total area of 37.8 ha. A total of 2578 small ruminants, divided into 20 flocks were grazed on Bekia for a period ranging from 9 to 30 days depending on flock size. In Syria, 7 ha were planted in nine locations, and a total of 801 sheep and goats grazed the area for 6 to 60 days depending on flock size. In northern Iraq, four on-farm studies were conducted in which sheep grazed on Bekia at stocking rates of 10, 15 and 20 ewes per hectare.

As a result of these trials, Iraq and Jordan have started a seed-increase program for Bekia to make seed available for farmers.

Survey of Constraints to Livestock Productivity

A detailed survey of 51 flocks, each containing at least 10 sheep, was conducted in Syria with particular emphasis on the indigenous knowledge of the farmers concerning sheep management. Flock size increased from 19 on farms where sheep provided milk products and meat to the house-hold, to 88 on farms where sheep were the dominant enterprise.

Variation in lambing rates from 70 to 95% indicates scope for improvement. Equally significant, weaning rates in these flocks were only 36%, indicating high levels of lamb mortality due to diseases such as enterotoxemia, diarrhoea, helminth parasites, and lameness.

Farmers mentioned that steadily rising feed prices were a major constraint to flock profitability, and this was exacerbated by a gradual reduction in the availability of communal grazing and fallow lands. The information will help in designing management strategies.

Outreach Activities

The success of ICARDA's research and training activities largely depends on the active participation of national programs. Since its establishment, the Center has diligently worked to develop partnerships within WANA and beyond.

Besides a large number of joint activities with other CG 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 (Fig. 16). 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 long-term vision of the impact of ICARDA's work.

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 complementaries between countries, promote transfer of technology, and encourage self-reliance in research and development. They also help in identifying cells of particular expertise in NARS to decentralize ICARDA's research and training activities. Where appropriate, they also play a catalytic role in attracting donor funding with 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. Much of this research is the result of collaboration between researchers based at ICARDA's main research station at Tel Hadya, in Syria, and national scientists. Here, a brief overview of the activities aimed at promoting cooperation in research and technology transfer between and among the countries in each region, and between each region and ICARDA, are summarized to provide an indication of the multifaceted roles of the regional programs.

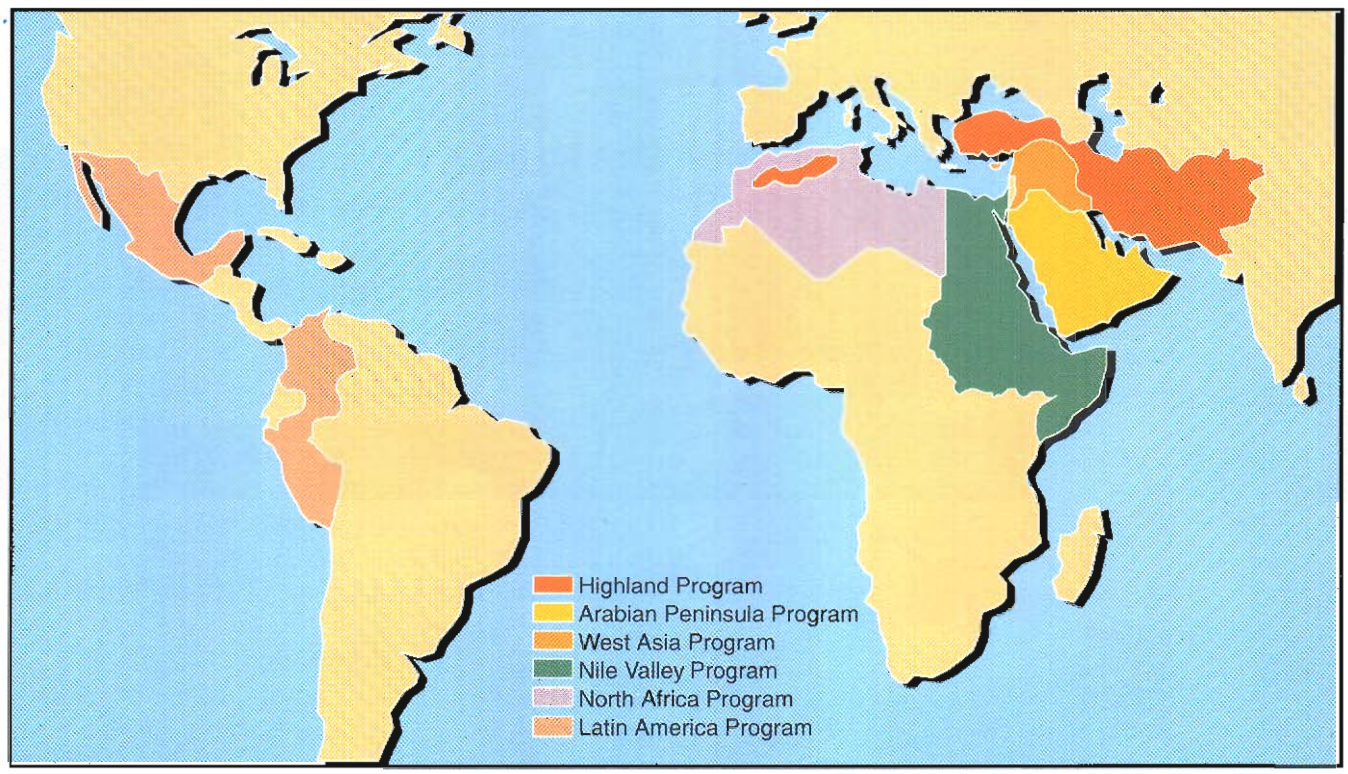


Fig. 16. ICARDA's outreach activities are grouped into six regional programs, based on commonalities of geography, ecology, and constraints to production in each region.

North Africa Regional Program

The North Africa Regional Program (NARP) focuses on the arid and semi-arid areas of Algeria, Morocco, Tunisia, and Libya. ICARDA coordinates NARP activities from Tunis, making use of the capacity of NARS for the benefit of the whole Maghreb region.

Agronomy and Forage Traveling Workshop

Scientists from ICARDA, in cooperation with INRA-Morocco, organized an Agronomy and Forage Traveling Workshop for the benefit of scientists from Libya, Tunisia, Algeria, and Morocco. Visits were made to key activity sites; the discussions covered a wide range of subjects including the forage crop production and integration of the existing agronomic practices with cultivar breeding.

Cereal Traveling Workshop

The cereal breeders at ICARDA organized for the first time a North Africa Cereal Traveling Workshop in Aleppo for researchers from Tunisia, Algeria, Libya, and Morocco. Selection was carried out from Maghreb trials and nurseries grown in Syria, as well as from the jointly developed germplasm for North Africa. Strategies to increase the efficiency of shuttle breeding between Aleppo and Maghreb programs were discussed.

Maghreb and Mashreq Project

This project, funded jointly by AFESD and IFAD, now in its first year, aims at increasing livestock and crop production, and verifying and transferring technologies in farmers' fields in both Maghreb and Mashreq countries. The Mashreq expertise in animal research, for example, is benefiting the Maghreb. On the other hand, the Maghreb experience in integrating socioeconomic research with crop improvement is important for the Mashreq. The project involves researchers, teachers, and extension personnel from the two regions and is integrating the efforts of Mashreq and Maghreb NARS, IFPRI and ICARDA. A new dimension of this project is the joint effort to identify and remove policy and common-property constraints to the adoption of improved technologies by farmers.

CIMMYT/ICARDA Bread Wheat Breeder (left) and national researchers in Morocco have jointly identified a promising bread wheat line resistant to Hessian fly, one of the most serious insect pests in the country.

Faba Bean Projects in Morocco

ICARDA, through NARP, continued to cooperate in faba bean improvement efforts in Morocco which include both the Moroccan-German Food Legumes Improvement Project (Amélioration de la Culture des Légumineuses Alimentaires, ACLA), and the German-supported faba bean network for North Africa (Réseau Maghrébien de Recherche sur la Fève, REMAFEVE).

Meetings

The Fifth North Africa Regional Coordination Meeting was held in Tunis, Tunisia in October 1995. It was combined with the Technical Meeting of the Mashreq and Maghreb (M&M) Project. A First Policy Seminar of the Project preceded the meeting. Sixty-two scientists from the Maghreb and Mashreq NARS, ICARDA and IFPRI developed joint work plans for both on-going collaborative activities and for the M&M Project.

Human Resource Development

Fifty-nine Maghreb researchers participated in 13 training courses offered by ICARDA. Several others participated in traveling workshops and coordination meetings, and yet others visited Aleppo headquarters to exchange knowledge and experience.

Nile Valley and Red Sea Regional Program

The Nile Valley Regional Program (NVRP), covering Egypt, Sudan and Ethiopia, was extended in 1995 to include Eritrea and Yemen, and renamed the Nile Valley and Red Sea Regional Program (NVRSRP). The Program dwells on tripartite cooperation among the NARS, ICARDA and donors, and covers a wide range of major food crops including cool-season food legumes and cereals (wheat, in cooperation with CIMMYT, and barley). Resource management is an important component of the collaborative program in Egypt.

Research Collaboration and Management

The 1994/95 work plans for Egypt, Ethiopia, and Sudan for the improvement of cool-season food legumes and cereals and resource management were developed jointly with ICARDA in three separate National Coordination and Management Meetings. In addition, the joint Regional Coordination Meeting reviewed and discussed regional research work and support activities and developed the 1995/96 work plans, particularly for the following problem-solving regional networks: rusts of wheat, wilt/root-rots of food legumes, integrated control of aphids and viruses, drought and water-use efficiency, and socio-economic studies. The Royal Netherlands Government approved financial support for the Regional Networks Project for three years, beginning with September 1995. The leadership of most of these networks is in the hands of national program scientists. For example, Egypt provides backstopping in the work on rusts of wheat and aphid resistance,

The European Union Audit Team visiting an on-farm verification site in the newly reclaimed areas in Upper Egypt.

while Sudan and Ethiopia provide backstopping in heat-tolerance and wilt/root-rots research, respectively. Yellow rust has been added as an area of regional interest and Ethiopia is taking the lead. ICARDA continued to provide the lead in research on viral diseases. The 1994/95 work plans were implemented by national programs with backstopping from ICARDA.

Expansion of Collaborative Research

Yemen attended the 1995 NVRP Steering Committee Meeting for the first time, and Eritrea and ICARDA signed an agreement of cooperation early in 1995. Also, Yemen started participating in the Regional Networks Project, and the NVRSRP started coordinating the ICARDA involvement in the Agricultural Sector Management Support Project of the World Bank for that country.

Evaluation and Monitoring

Program monitoring and evaluation during the season were done through workshops involving multidisciplinary teams of national, regional, and international scientists. Five national and two regional traveling workshops were conducted.

The Wheat Regional Traveling Workshop in Egypt, for example, involved scientists from Egypt, Ethiopia, Sudan, ICARDA, CIMMYT, and Global 2000. Dr Norman Borlaug, Nobel Prize Winner and Honorary Director of Global 2000, commended the achievements of the wheat program, particularly the long-spike germplasm at Sids Research Station. He delivered a seminar to high-ranking officials, decision-makers, and donors on the impact of agricultural research in reducing human suffering through increased food production.

The scientists participating in the Ethiopian Regional Legumes Workshop from Ethiopia, Egypt, Yemen, and ICARDA were impressed by the productivity of the newly released chickpea and lentil cultivars and the performance of demonstration fields under low-input conditions. The ICARDA Board Chairman visited the NVRSRP activities in Upper Egypt, North Sinai, and the Delta, including on-farm activities and interaction with extensionists and farmers.

A Resource Management Planning Workshop, held in June 1995 in Egypt, marked the beginning of the implementation phase of long-term strategic research on resource management in rainfed areas, and the Old and New Lands. The Workshop involved specialist scientists from seven research institutes in Egypt, and from Sudan, India, ICARDA, IIMI, and ISNAR. The Workshop reviewed preparatory studies on resource management (inventory studies, rapid rural appraisals and multidisciplinary surveys) for different agroecological zones to identify production constraints and threats to sustainability. Based on the outcome, work plans were developed on intensive and extensive long-term research including rotations and on-farm monitoring. Through collaboration with ICARDA, five long-term research sites were established in Egypt.

A Research Review Workshop, held in Sudan in August 1995, marked the end of the seven-year research project supported by the Royal Netherlands

Nobel Laureate Dr Norman Borlaug (fourth from right) participated in the 1995 NVRSRP Regional Wheat Traveling Workshop along with researchers from Egypt, Ethiopia, Sudan, ICARDA, CIMMYT, and Global 2000.

Government for the improvement of cool-season food legumes and wheat in Sudan. The Workshop, in which scientists from Egypt and ICARDA also participated, developed a strategy and guidelines for future research.

Human Resource Development

In addition to individual and group short-term training at ICARDA headquarters, four in-country and regional training courses were organized for 60 scientists from the three Nile Valley countries using ICARDA, ILRI, and local expertise. Through support from NVRSRP, national programs organized 21 training courses for extensionists on transfer of technology to farmers. A total of 340 scientists from Egypt, Ethiopia, and Sudan participated in coordination meetings (both national and regional), workshops, and conferences. Degree training continued for four Sudanese graduate students in virology, plant breeding, stress physiology and soil-water-plant relations, and for two Ethiopian graduate students in barley breeding and entomology.

West Asia Regional Program

The West Asia Regional Program (WARP) promotes technology transfer activities in Syria, Jordan, Iraq, Lebanon, Cyprus, and lowland areas of Turkey. Much of WARP activities are supported by the Mashreq Project co-financed by UNDP and AFESD. Emphasis is placed on strengthening adaptive research through implementing on-farm trials involving researchers, extensionists, and farmers.

Strengthening Partnerships

Through the Mashreq and Maghreb (M&M) Project, and in cooperation with ILRI, a workshop on future livestock research priorities in WANA was held in Jordan in November 1995.

With support from OPEC, a network of socioeconomic scientists in the Mashreq countries was established. A socioeconomist was appointed at the WARP office in Amman to coordinate and strengthen the socioeconomic activities in the Mashreq countries.

An agreement of cooperation was signed between ICARDA and INWRDAM to strengthen the cooperation in the area of water resources development and management, and staff training.

Cooperation with Silsoe College, UK

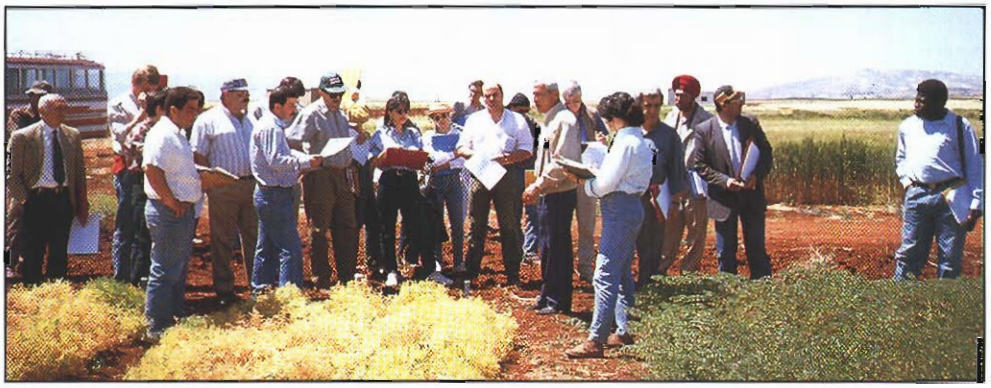
Cooperation between ICARDA and Jordan was further strengthened through the expertise that ICARDA provided to the Jordan Arid Zone Productivity Project. This was through a consultancy in a project funded by the European Union and administered by the University of Jordan and Silsoe College, UK, on socioeconomics, rangeland improvement, forage legumes, sheep production, and supplemental irrigation and water-harvesting. ICARDA specialists, in cooperation with their Jordanian colleagues and Silsoe College specialists, visited project sites and assisted in the development of work plans and an implementation schedule. The ICARDA scientists will continue to monitor and follow-up with the implementation of the activities during the growing season, provide training to the project staff, and supervise graduate students.

Coordination Meetings

Annual coordination meetings were organized with Jordan, Iraq, Lebanon, and Syria. These meetings brought together national scientists from different institutions of each country to exchange views and develop joint activities in cooperation with ICARDA.

Human Resource Development

Four regional training courses were conducted during 1995. Two were organized by the M&M Project on farm survey methodologies and rangeland and marginal land improvement. The third, on germplasm collection and conservation, was organized by the Center's Genetic Resources Unit in cooperation with IPGRI. The fourth course was



Traveling workshop in Lebanon. ICARDA and Lebanese researchers visit an experimental site in the Beka'a area.

conducted in Iraq on winter chickpea technology in cooperation with the Iraqi national program.

The in-country training in Mashreq countries received greater emphasis through the M&M Project. Farmer training also received emphasis. A total of 467 technicians and farmers participated in short training courses in Jordan, Syria, and Iraq. On-the-job training for technicians was initiated, and proved useful. Interaction between countries within the region and between the two regions was also enhanced through the participation of lecturers from Turkey, Morocco, Jordan, Syria, and Iraq in the training courses.

Two traveling workshops were organized: one regional, in Jordan, and the other national, in Lebanon. The regional workshop allowed 30 scientists from Syria, Iraq, Lebanon, Jordan, Tunisia, and ICARDA to visit experimental and farmers' fields, discuss production strategies, and exchange ideas and experience.

In Lebanon, the workshop helped in promoting interaction between Lebanese institutions and the on-going UNDP- and IFAD-funded project in the Beka'a and Baalbeck.

A symposium on crop-livestock integration systems in the dry areas of WANA was conducted in Jordan with the participation of 120 scientists from 15 countries. Sixty-nine papers were presented on four main themes: barley, forage, rangeland and marginal land improvement; small-ruminant production improvement; crop-livestock integration; and, adoption and impact of technologies. The symposium developed useful recommendations on crop-livestock integration systems for the dry aerea.

ICARDA scientists cooperated with NARS in Jordan, Lebanon, Iraq, and Syria as co-advisors to graduate students working for MSc and PhD degrees. More than 15 students are enrolled in these programs working on breeding and improvement of lentil, chickpeas, wheat and barley; tillage and residue management; and small-ruminant nutrition and management.

Barley Production Technology Contest in Jordan

The Mashreq project in Jordan organized a contest among barley farmers in north, center and south of Jordan. Over sixty farmers participated in the contest. A technical committee was established to evaluate farmers fields and measure their yield. The 15 farmers who obtained the highest yield by following the barley technology of early sowing, fertilization, using the improved cultivar and the seed drill, were selected as winners. In a celebration day, the Minister of Agriculture met with the farmers and gave them recognition certificates and in-kind contribution of 0.5 tonne fertilizer for each winner.

Highland Regional Program

The Highland Regional Program (HRP) focuses on collaborative research and training activities with national programs based in highland areas (usually 750 meters above sea level) of Turkey, Iran and

Pakistan in West Asia, and Morocco, Algeria and Tunisia in North Africa. These areas are characterized by low temperatures that severely limit agricultural productivity.

Iran

As part of the Iran/ICARDA project and to strengthen the technical competence of national researchers, 15 national researchers were sponsored for PhD studies overseas. Two in-country courses, one on farm-survey methodology and the other on cereal-diseases methodology, were held.

Turkey

The Turkey/ICARDA Highland Project, supported by the Government of Italy from 1990 to 1994, was continued in 1995 through ICARDA's core funds. The project, now consisting of 10 small projects, aims at generating improved technology for different aspects of agriculture in the Central Anatolian highlands and the Taurus Mountain areas of Turkey. During the year, work on the transfer of winter/early spring technology was initiated with financial support from FAO. Work on seven of these projects was conducted in partnership with the Central Research Institute of Field Crops (CRIFC), Ankara, and one each with Ankara University and the University of Çukurova, Adana. Work on boron toxicity in barley was conducted in partnership with three institutes, namely, CRIFC, Transitional Zone Agricultural Research Institute (TZARI), Eskisehir, and the Soil and Fertilizer Research Institute (SFRI), Ankara. Efforts to transfer improved varieties of wheat, barley, lentil, chickpea and vetches were intensified in the Central Anatolian highlands under the aegis of the EC/ICARDA Mediterranean Highlands Project.

Farmer Participation in Research

In addition to backup research at experimental stations, farmer participation in research and technology transfer was emphasized during 1995. On-farm demonstrations of wheat, barley, and chickpea, conducted in Sivas-Kayseri region, were not only managed by farmers but were also evaluated jointly by them and CRIFC researchers. Also, some of the collaborating farmers were invited to visit research plots at the Haymana Research Station of CRIFC. This is expected to facilitate and enhance farmer acceptance of the improved and registered varieties that were demonstrated on their farms during the year.

In another new, small project on rehabilitation and management of common village pastures in Central Anatolia, active farmer participation was introduced. Based on surveys of *Muhtars* (village chiefs) and farmers of 14 villages in three districts of Polatli, Kalecik, and Cubuk of Ankara Province and their responses and interests, two project sites in different environments were selected. Furthermore, informal farmer/researcher meetings were organized to brief farmers on project objectives and their role in the project, and to learn from their past experiences of such village activities. Feeding calendars were constructed with their participation for both small and large ruminants. Also, farmers were invited to attend the annual coordination meeting of the project which provided them opportunities to interact with researchers and extension agents.

New Options for Taurus Mountain Farmers

As a result of the work carried out in the Taurus Mountains of southern Turkey, farmers will now have new options for their small-scale farming. These include new crops such as triticale and improved varieties of bread wheat (Gun 91, Bezostaya), barley (Bulbul-89, Hamidiye 85), and chickpea (ILC 482 S). Also, they now have options to grow forage legumes, such as common vetch, a mixture of vetch and oat, or a sole crop of sainfoin for feed. These options have already resulted in decreased fallow land in the area. Farmers will also be able to enhance their income through improved honey bee keeping and raising their own queen-bees. These developments have helped the small-scale farmers enhance their agricultural production, and develop faith in agricultural research.

Mediterranean Highlands Project

In 1995, the EC/ICARDA Project on enhancing agricultural production in the Mediterranean Highlands of North Africa and Turkey completed its first year. The project emphasizes development of information and scientific networks between scientists of the highlands of North Africa and Turkey.
In its first year, the project succeeded in establishing linkages between the scientists for the exchange of experience and information. This occurred through the exchange of scientific visits and participation in the Annual Coordination Meeting of the project held in conjunction with the Annual Coordination Meeting of the Turkey/ICARDA Highland Project at CRIFC, Ankara.

Coordination Meeting

The Annual Coordination Meeting of the Turkey/ICARDA Highland Project was organized at CRIFC, Ankara in November 1995. Over 70 scientists from agricultural research institutes (CRIFC, SFRI and RARI, Ankara; CARI, Adana; SEAARI, Diyarbakir; EAARI, Erzurum; TZARI, Eskisehir; and AARI, Izmir) and universities (Ankara and Çukurova) of Turkey, and ICARDA attended the meeting.

Training and Human Resource Development

Scientists and technicians from Turkey participated in short training courses organized by ICARDA at Aleppo and elsewhere in the region. In addition, study visits were arranged to different programs of ICARDA. Four cereal scientists participated in the Regional Cereal Traveling Workshop held in Aleppo in May 1995, and two scientists visited the Pasture, Forage, and Livestock Program for analyzing their village survey data. A 10-day training course on Seed Health Testing was organized in Ankara and was attended by 15 scientists of the Seed Registration and Certification Organization of Turkey.

Two workshops were organized in Turkey during the year: (i) WANA Seed Network Workshop in Antalya in April, which was attended by over 40 scientists from 17 WANA countries, GTZ, UPOV, FAO, and ICARDA, and (ii) Biodiversity Workshop at Izmir in October, which was attended by 48 scientists from Egypt, Iran, Iraq, Jordan, Lebanon, Palestine, Syria, Turkey, UK, ACSAD, UNEP, IPGRI, IFPRI, and ICARDA.

Newly Independent Republics

To strengthen linkages with the Newly Independent Republics of Central and West Asia (NIR-CWA), ICARDA scientists visited Kazakhstan, Kyrghizhistan, Turkmenistan, and Uzbekistan during the crop season. Furthermore, at ICARDA's initiative, a workshop to assess the needs in agricultural research and seed production was jointly organized by ICARDA/GTZ/Uzbekistan in Tashkent, in December 1995. The workshop, attended by 58 scientists from seven NIR-CWA, GTZ, BMZ, EC-Cereals Project/Turkmenistan, Agha Khan Foundation Project/Tadjikistan, CIMMYT, ISNAR, and ICARDA, helped understand agricultural production and the associated constraints both at the national and regional levels, and the action needed to improve the situation. The workshop participants invited ICARDA's assistance in developing a regional project for these Republics and seeking funding for its implementation.

ICARDA's DG Prof. Dr Adel El-Beltagy (right) discusses joint research proposals with Academician Dr S.N. Usmanov, President of Uzbekistan Academy of Sciences (middle), and Dr Z. Khalikoulov of the Uzbekistan Ministry of Foreign Affairs during the Tashkent workshop held in December 1995.

Arabian Peninsula Regional Program

The Arabian Peninsula Regional Program (APRP) was generously financed by the Arab Fund for Economic and Social Development (AFESD) for five years (1988-1992). An additional one-year no-cost time extension of the project was approved by the donor to cover the 1993/94 season activities. A proposal for a Phase II of APRP was developed for funding. In early 1995, AFESD and IFAD agreed to co-finance the project for a three-year period (1996 to 1999).

The major objectives of APRP are to enhance agricultural research and provide appropriate training for improving barley, bread wheat, durum wheat, food and feed legumes, pasture, forage and livestock production, and the related farming systems in the Arabian Peninsula. Countries participating in APRP are: the United Arab Emirates (UAE), Bahrain, Qatar, Kuwait, Saudi Arabia, Oman, and Yemen.

The principal constraints to agricultural research and production in the Arabian Peninsula are drought, heat, salinity, diseases and pests, weeds, inadequate seed industry, and lack of trained personnel.

During the 1994/95 season, cooperation was further strengthened among the participating countries and with ICARDA through visits by researchers to evaluate joint research trials and discuss cooperative research and training activities.

In the 1994/95 season, the program activities were focused on the following three major areas.

Germplasm Exchange, Evaluation and Improvement

On request, seven participating countries were provided with 69 different nurseries of barley, bread wheat, durum wheat, chickpea, lentil, dry pea, and forage legumes. Special wheat and barley germplasm developed for drought, heat, and salt tolerance was also sent for evaluation at different locations in the United Arab Emirates, Saudi Arabia, Oman, and Yemen. Other wheat germplasm was sent to Yemen for evaluation against wheat rusts. A new cereal aphids resistance nursery was distributed for evaluation at selected locations in the Arabian Peninsula.

Human Resource Development

Nineteen national scientists from the Arabian Peninsula participated in ICARDA training courses organized at its headquarters in Aleppo as well as in the Arabian Peninsula countries. In addition, a regional training course on "Computer Applications in Agricultural Research" was organized in Doha, Qatar.

Saudi Agricultural Show

For the first time, ICARDA participated in the Saudi Agricultural Show-95 in Riyadh, Saudi Arabia. During the show, several contacts were made with the private and public agricultural sectors in Saudi Arabia and the region, and visits were made to several agricultural organizations in Saudi Arabia including the Ministry of Agriculture and Water, the King Abdul Aziz University for Science and Technology, and the Gulf Cooperation Council.

Prof. Dr Adel El-Beltagy, ICARDA's DG (left, center), discusses joint research activities at the Al-Hamraneiah Agricultural Research Station in the UAE.

Latin America Regional Program

The Latin America Regional Program (LARP), based at CIMMYT in Mexico, works on barley production for areas with higher precipitation than in the WANA region. These areas require a different type of barley germplasm which LARP has been developing in cooperation with national partners and advanced research institutes. The germplasm has proved useful not only in Latin America but also elsewhere, for example, in China and the USA.

Cooperation between Oregon State University and the LARP was further strengthened with the development of a series of double-haploid (DH) populations to meet different objectives. For countries such as the USA, where stripe rust occurrence was firmly established in 1995, these populations are sources of resistance for immediate use. For example, BSR45, resistant to stripe rust and barley yellow dwarf virus, has been identified as having good malting quality and good agronomic performance at Oregon. In addition, this line has been used as the resistant parent in crosses with susceptible varieties (Steptoe and Colter), to transfer two genes that confer stripe rust resistance to the progeny. Thirteen Steptoe-derived lines were identified as stripe rust resistant by marker-assisted selection, a biotechnological procedure that allows the selection of resistant types in the absence of rust. Further field testing in Mexico confirmed the efficiency of the procedure in the Steptoe background, but the system failed for the Colter derivatives.

During the last three years, serious economic losses have been reported in the USA for small grains infected with head scab, a disease caused by several species of *Fusarium*. Barley and wheat losses exceeding one billion dollars were reported in the Upper Midwest in 1993 (*Barley Newsletter* 1994). Rejection of scabby grain with a vomitoxin content higher than 2 ppm for wheat and 4 ppm for barley was the main cause of the losses.

In cooperation with Oregon State University, a set of 98 DH lines were developed by crossing Zhenmai-1, a scab-resistant variety widely grown in China, and a cultivar with excellent malting quality. The promising results of screening the DH lines with *F. graminearum* at Toluca Experiment Station in the summer of 1995 will be confirmed through further testing at various locations and over several years. Testing for scab resistance using two inoculation methods confirmed the presence of two resistance mechanisms in barley: Type 1 resistance against initial infection, and Type 2 against spreading of hyphae within the spike.

In Latin America, head scab occurs in barley but is not considered a major problem. The role of mycotoxins produced by the fungus seems to have been ignored, and analyses to detect toxin content are not performed in the region. Barley researchers were made aware of the toxins' effect on human and animal health at a meeting in Cochabamba, Bolivia, in 1995.

The Ecuadorian seed program produces relatively small quantities of certified seed of the new barley varieties at its main experimental station near the capital city; however, barley producers living far away from the capital do not have access to this seed. A preproposal on seed production and distribution was offered to INIAP for submission to potential donors.

The Canadian Province of Alberta is a major barley producer with 1,061,600 ha devoted to this crop. A new barley variety, Kasota, was released in 1995 because of its wide adaptation to Alberta. Kasota and three more varieties released in the past (Falcon, Tukwa and Seebe) were selected from segregating populations sent to Alberta from the LARP.

In Mexico, barley is traditionally used by the malting industry. The barley producing area has decreased due to the high cost of production. In cooperation with national scientists and farmers, the LARP continues to explore new potential uses of barley, for example, grazing early-maturing barley planted in association with ryegrass or medics (*Medicago polymorpha*). This barley-based cropping system is a profitable enterprise according to verification trials carried out in farmers' fields. With the development of new early-maturing, taller types producing greater biomass, hay or silage production will become another option for cooperating ranchers.

Resources for Research and Training

Finance

ICARDA's programs are funded by its generous donors (Table 16, see also Appendix 11). In 1995, the Center's grant funding was USD 19.319 million. Combined with other income of USD 3.72 million, the total revenue was USD 23.039 million. The operating expenses during 1995 amounted to USD 22.583 million, resulting in a surplus of USD 0.456 million. This surplus in 1995—as compared to the 1994 deficit of USD 0.482 million—was attributed to the fund-raising activities of the CGIAR, which improved the Center's revenue in 1995.

Table 16. Sources of funds for ICARDA's programs and capital requirements (x 1000 USD), 1995 and 1994.

	1995	1994		1995	1994
Arab Fund	1179	765	Iran	517	319
Australia	379	276	Italy	1079	935
Austria	90	90	Japan	550	373
Canada	446	580	Netherlands	1916	2204
CGIAR	24	-	Norway	309	266
China	30	30	OPEC	35	75
Denmark	367	312	Spain	149	125
Egypt	150	-	Sweden	493	510
European Eco. Commission	1421	1051	UNDP	416	355
FAO	15	-	UNEP	200	-
Ford Foundation	37	14	UK	743	850
France	437	355	USAID	1850	2000
Germany	1498	1125	Exchange gain, net	1939	1700
IBRD	4510	5105	Earned income	1013	566
IDRC	14	65	Other income	768	568
IFAD	427	32			
India	38	25			
IMPHOS	-	12	Total	23,039	20,683

Staff

During 1995, the following senior staff members joined ICARDA: Prof Dr Adel El-Beltagy, as Director General; Dr Ahmed Mori, as Assistant Director General (Government Liaison); Dr Aden Aw-Hassan, as Dryland Management Project Coordinator; Dr Michael Norvelle, as International Facilitator (seconded from the World Bank); Mr Mike Robbins, as Science Writer/Editor; and Dr Nabil Chaherli, as Post-doctoral Fellow (Policy Economist).

The following senior staff members left ICARDA during 1995: Dr Nasrat Fadda, Director General; Mr Terence Duplock, Director of Administration; Dr K.B. Singh, Chickpea Breeder (seconded from ICRISAT); Dr Luis Materon, Microbiologist; Dr Susanne Weigand, Entomologist; Dr Haruhiro Fujita, Resource Information Scientist (seconded from Japan); Mr Tomas Bedö, Systems Programmer Network Administrator; and Mr Hanna Sawmy Edo, Research Associate.

Dr Aart van Schoonhoven, Deputy Director General (Research), proceeded on sabbatical leave.

Computing and Biometrics

General and Technical Support

A major upgrade of personal computers was carried out, with 52 Pentium-class and four 486-class personal computers, and eight notebook models. Several PC applications were upgraded to new versions.

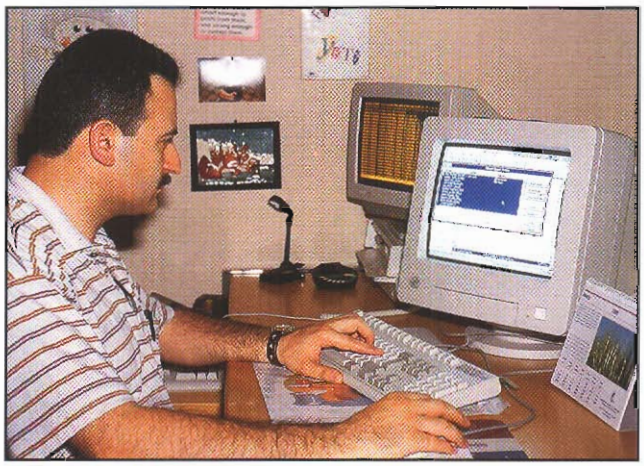
Utilization of the local area network further increased. The network printing resources were improved for most programs with fast laser printers. One of the Macintosh personal computers was connected to the network for the first time. There are now over 20 applications available on the network for users.

The VAX 4500 computers were further upgraded with additional disk storage raising the total on-line storage from 10 to 16 GB. The VMS operating system was also upgraded to version 6.0. A UNIX-based graphical workstation was installed for image-processing work.

A limited external electronic mail facility became available, but a full service is expected early in 1996.

The Oracle database was upgraded to version 7.0 and the client-server environment was tested with a view to implementing it on the Oracle financial and other applications. Database administration was carried out to ensure its integrity and availability.

User requests for assistance on various programs and packages, resolution of software problems, installation of software and hardware maintenance were promptly attended to. Preventative maintenance was carried out on all computer and UPS equipment.



A limited external e-mail facility became available at ICARDA in the last quarter of 1995.

Scientific Computing

Modules for data entry, queries, analyses and reports were added to the Trials Management System (TMS). Dynamic data entry and general data entry forms have been developed. A program for generating new variables calculated from the original variables based on user-specified formula and subset of locations and factor levels was added to TMS. Routines were included to perform statistical analyses of multi-factor trials in complete block designs such as CRD, RCB, Latin Square, Factorial and Augmented, and store the means and other summary statistics in the database. Query and reporting of original, transformed or summary data is now possible. The randomization corresponding to the first location or sample can now be duplicated for other locations or samples. An additional randomization program for RCB with systematic checks design was included.

The Meteorological Database (METDB) application was further refined and is expected to be put to general use in 1996. Modules for daily data entry in user-designed forms based on user-selected climatic variables were added. A special data-entry form for Tel Hadya station to enter long-term summary data has been added. Data-entry forms for specific regions, countries, districts, basins and weather stations were further enhanced. Daily meteorological data from approximately 20 weather stations in Syria for the past 16 years are now available in METDB. Performance of on-screen queries has been improved. The user can produce summarized reports for daily, weekly, 10-day, fortnightly, monthly and yearly periods. The weekly meteorological report on ICARDA's weather stations as published in *The Week at ICARDA* can now be generated from METDB. Also, a routine to update the summary of climatic data by either on-line or batch process based on user-selected data sets and climatic variables has been developed.

A program SEEDLIFE was written for the Seed Unit that can predict storability of various crops by calculating a parameter based on user-specified fixed or range of parametric values for initial or final viability, storage period, moisture content and temperature.

A GIS working group was established to guide the development and promote the use of GIS applications. A DEC Alpha AXP workstation based on UNIX was installed, and ERDAS Imagine image-processing software was installed.

The SCALEDAT electronic scale to PC program has been modified to work with two additional types of digital scales. Two statistical software packages, AGROBASE and MSUSTAT, were reviewed against the statistical computing needs of ICARDA and NARS researchers.

Biometrics

Support was rendered to researchers on the planning of experiments, analysis of data, interpretation and presentation of results. Statistical reviews were conducted on a number of research manuscripts. Experimental designs were offered for multilocational trials to evaluate the effects of dates of planting and maturity groups of barley/wheat genotypes; genotypes of barley/wheat on seed viability and germination at low temperature; prolonged winter condition on relationship between vernal genes and agronomic traits of barley/wheat; mixtures in barley/wheat; high temperature on barley/wheats; osmotic adjustment in barley; and for water runoff and soil loss on mountainous and plain areas of Hassake and at Tel Hadya.

Assistance was provided on the analysis of yield data combined over years to model the effects of delay in planting, amount of supplemental irrigation and nitrogen on bread wheat and durum wheat varieties; evaluation of inter-relationships among barley lines and analysis of the mixing ability of double-haploid lines; evaluation of physiological and morphological traits of amphicarpic legumes collected from several quadrats over line transacts in grazed and protected lands in Syria; analysis of data from underground vetch/barley rotation trials; wheat emergence to evaluate effects of sowing date, moisture level, and profile depth; analysis of rotation experiment on tillage, stubble burning and carbofuron on nematode numbers in wheat rotation; analysis of wheat data from rotation trial and from continuous cropping trials; analysis of effects of hardseededness and seed size of pastures on digestibility; clustering of spots based on satellite information on six frequency bands and aerial biomass.

The following biometric techniques were developed.

Precision of means of lines selected from breeding populations: When breeding lines are ranked on the basis of their estimated yields, the estimated quantities form the order statistics. The variance-covariance matrix of the order statistics are needed to provide a comparison among rank-selected lines. A coefficient, as ratio of standard error of mean of rank-selected lines to that of randomly-selected lines, was obtained to help compute the standard error of the mean of rank-selected lines. A program was developed to analyze data from randomized complete blocks, including selection of a specified number of lines for high yield, and printing their means and associated standard errors.

Analysis of a series of yield trials with common checks—A computational approach using GENSTAT: Often, when evaluating a large number of genotypes, These are grouped in a number of trials with a number of common checks across trials. Even with a large number of genotypes, these trials may be conducted in incomplete blocks. This analysis incorporates adjustments due to incomplete blocks within each trial and due to common checks across trials. The GENSTAT 5 program produces, for each trial, restricted maximum likelihood estimates of variance components, means and their standard errors under incomplete block design and when ignoring the incomplete blocks, adjusted and unadjusted values with ranks and tests for various comparisons involving check and test entries.

Estimation of time-trends in two-course rotations: Expressions for variance of time-trend estimate and minimum time required to detect significant time-trend in two-course rotations were obtained. The procedure models linear and quadratic effects of rainfall, and accounts for dependence in observations over time arising from the same plot through a first-order autocorrelation structure.

A consultancy workshop for plant breeders on planning experiments and data analysis was organized in Iraq , Baghdad, and another in Egypt to assist in the development of statistical designs for the five long-term trials on sustainability of production systems. Advisory services were also provided to 10 participants from six NARS.

Management Information Systems

Oracle Financials

Implementation of the Personnel System was

largely accomplished. The new version of the Oracle Financial Systems was installed, and maintenance was carried out on Purchasing and Inventory Control modules. A total of 20 old reports were modified, and 28 new reports were developed. Staff from programs were trained on the Purchasing module to enable direct purchase-request entry into the system. For the General Ledger and the Accounts Payable modules, a parallel run of the old MAS system was maintained. The old system is scheduled to be phased out early in 1996.

Other Applications

For the Project Management and Data Registry System, major modifications were carried out including new entry forms and tables. New project and activity query forms were also added. A Windows-based database application for Visitors Section was developed. A new Oracle-based Training Information System was developed for all trainees. Information and data-entry work was initiated. A procedure for producing visitors' briefing for ICARDA management was initiated and is being tested.

Training and Visits

A total of 237 ICARDA staff participated in 14 computer courses covering MS DOS, Microsoft Windows, Lotus 123 for Windows, Lotus Macros, WP under Windows, WP Macros, Basics on VAX/VMS and DOS Usage, SAS Basics and SAS ANOVA, QuattroPro, and Harvard Graphics. Training was also carried out for Personnel and Finance staff on the use of the Oracle financial/administrative systems suite.

The following courses were organized for NARS: Data Analysis and Presentation, in cooperation with ILRI, at Addis Ababa, Ethiopia for 16 participants from Ethiopia; Statistical Methods with Computer Applications in Agricultural Research, at headquarters, for 13 participants from Syria, Jordan, Lebanon, Turkey, Pakistan, Iran, Sudan, and Egypt; Biometrical Methods in Agricultural Research, in Tunisia, for 16 participants from Tunisia, Libya, Morocco, and Algeria; and Computer Applications in Agricultural Research, in Doha, Qatar, for 12 participants from the Arabian Peninsula.

In addition, the Unit participated in the following courses: Morphological Variety Description Course, organized by the Seed Unit; and Breeding Methodology in Cereals and Legumes, organized by the Germplasm Program at headquarters.

The head of the computer unit at SPII, Iran spent two weeks at the Center to get acquainted with various biometrical methods, and two scientists from Syria stayed for four weeks to analyze their experimental data.

Farms

ICARDA operates five sites in Syria (including its main research station at Tel Hadya) and two in Lebanon (Table 17). These sites represent a variety of agroclimatic conditions, typical of those prevailing in the WANA region.

Table 17. 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	350
Bouider	35°41'N	37°10'E	35	268	210
Ghrerife	35°50'N	37°15'E	2	320	280
Breda	35°56'N	37°10'E	76	300	280
Jindiress	30°24'N	36°44'E	10	210	470
LEBANON					
Terbol	33°49'N	35°59'E	39	890	600
Kfardane	34°01'N	36°03'E	50	1080	430

At its Tel Hadya site, ICARDA is testing safflower (*Carthamus tinctorius*) and oilseed rape (*Brassica* spp.) for their suitability for integration into cereal/legume rotations. A setback in the 1995

Safflower, a potential oilseed crop suitable for cereal/legume rotations in West Asia and North Africa.

season was the heavy infestation with *Orobanche* spp. in *Brassica napus* and a light infestation in safflower. Both crops could grow without irrigation in the 300-350 mm rainfall zone, but will only be of interest if *Orobanche*-resistant lines become available.

For biological rodent control, it was possible to attract common kestrels (*Falco tinnunculus*) not only into nesting boxes installed on quarry walls and buildings, but also into a similar nesting box on a 6-m high pole in the open fields. This opens more options for habitats for these birds of prey.

Appendixes

Contents

Appendix 1

Precipitation (mm) in 1994/95

	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	TOTAL
SYRIA													
Tel Hadya													
1994/95 season	1.3	15.7	98.1	45.1	42.4	16.5	24.5	48.3	19.5	1.5	0.0	0.0	312.9
Long-term average (17 seasons)	0.5	24.8	50.0	52.2	62.8	57.3	39.3	25.6	16.5	2.7	0.0	0.8	332.4
% of long-term average	260	63	196	86	68	29	63	189	118	56	-	0	94
Breda													
1994/95 season	12.2	2.2	59.8	48	35.2	18.2	14.8	31.8	15.2	6.8	0.0	0.0	244.2
Long-term average (37 seasons)	1.6	14.4	30.0	50.0	47.5	40.0	32.2	28.6	16.3	1.4	0.0	0.0	262.0
% of long-term average	762	15	199	96	1.12	46	46	111	93	485	-	-	92
Bouider													
1994/95 season	8.7	5.1	79.4	27.3	30.6	11.6	12.2	22.6	1.4	4.2	0.0	0.0	203.1
Long-term average (22 seasons)	0.5	17.7	27.4	35.4	42.3	36.1	26.2	16.6	9.6	7.0	0.1	0.0	218.9
% of long-term average	1740	29	290	77	72	32	47	136	15	60	0	-	93
Ghrerife													
1994/95 season	1.8	3.8	45.8	38.6	30.7	10.3	18.8	23.8	2.8	4.2	0.0	0.0	180.6
Long-term average (10 seasons)	0.5	25.8	29.9	37.3	46.5	42.8	31.4	11.4	16.4	2.9	0.0	0.0	244.9
% of long-term average	360	15	153	103	66	24	60	208	17	145	-	-	74
Jindiress													
1994/95 season	0	25	151.3	75.9	85	32.8	58.2	58	27.6	5	3.4	0	522.2
Long-term average (35 seasons)	1.5	29.6	57.3	91.4	85.0	74.7	61.9	41.1	22.5	4.0	0.1	1.4	470.5
% of long-term average	0	84	264	83	100	44	94	141	123	125	34	0	111
LEBANON													
Terbol													
1994/95 season	4.6	11.2	151.2	177.8	73.2	46.4	46.2	19.4	0.6	0.0	0.0	0.0	530.6
Long-term average (14 seasons)	0.4	24.1	73.1	102.5	118.3	104.2	89.0	22.8	16.4	2.4	0.2	0.0	553.4
% of long-term average	1150	46	207	173	62	45	52	85	4	0	0	-	96
Kfardan													
1994/95 season	0.0	17.0	110.8	104.4	52.0	31.3	42.6	6.9	0.0	0.0	0.0	0.0	365.0

Note: For location, area, and elevation of these sites, see Table 17 on page 65.

Appendix 2

Cereal and Legume Varieties Released by National Programs

Barley

Country/year	Variety
Algeria	
1987	Harmal
1992	Badia
Australia	
1989	Yagan
1991	High
1993	Kaputor, Namoi
Bolivia	
1991	Kantuta
1993	Kolla
Brazil	
1989	Acumai
Canada	
1993	Falcon
1994	Kasota
Chile	
1989	Leo/Inia/Ccu, Centauro
China	
1986	Gobernadora
1988	Shenmai 1
1989	V-24
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
Ethiopia	
1981	BSH 15
1984	BSH 42
1985	Ardu
Iran	
1986	Aras
1990	Kavir, Star (Makui)
Iraq	
1994	Rihane-03, IPA 7
Italy	
1992	Salus, Digersano (naked)
Jordan	
1984	Rum (6-row)

Barley (contd.)

Country/year	Variety
Lebanon	
1989	Rihane-03
Libya	
1992	Wadi Kuf, Wadi Gattara
Mexico	
1986	Mona/Mzq/DL71
Morocco	
1984	Asni, Tamellat, Tissa
1988	Tessaout, Aglou, Rihane, Tiddas
Nepal	
1987	Bonus
Pakistan	
1985	Jau-83
1987	Jau-87, Frontier 87
1993	Jau-93
Peru	
1987	Una 87, Nana 87
1989	Bellavista
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, Improved Arabi Abiad (Arta)
Thailand	
1987	Semang 1 IBON 48 Semang 2 IBON 42
Tunisia	
1985	Taj, Faiz, Roho
1987	Rihane"S"
1992	Manel 92
Turkey	
1993	Tarm-92, Yesevi 93
1995	Orza
Vietnam	
1989	Api/CM67//B1
Yemen AR	
1986	Arafat, Beecher

Durum Wheat

Country/year	Variety
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
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
1993	Zahra 3
1995	Zahra 7, Zahra 9
Morocco	
1984	Marzak
1989	Sebou, Om Rabi
1991	Tensif
1994	Anouar, Jawhar
Pakistan	
1985	Wadhanak
Portugal	
1983	Celta, Timpanas
1984	Castico
1985	Heluio

Country/year	Variety
Durum Wheat (contd.)	
Saudi Arabia	
1987	Cham 1
Spain	
1983	Mexa
1985	Nuna
1989	Jabato
1991	Anton, Roqueno
Syria	
1984	Cham 1
1987	Cham 3, Bohouth 5
1993	Om Rabi 3, Cham 5
Tunisia	
1987	Razzak
1993	Khiar
Turkey	
1984	Susf bird
1985	Balcili
1988	EGE 88
1990	Cham 1 = Sam 1
1991	Kiziltan Firat 93
1993	Om Rabi = Aydin 93
Iran	
1994	Haran 94
1995	Om Rabi 5
Bread Wheat	
Algeria	
1982	Setif 82, HD 1220
1989	Zidane 89
1992	Zidane, Nesser, ACSAD 59 = 40DNA, 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
Ethiopia	
1984	Dashen, Batu, Gara
Greece	
1983	Louros, Pinios, Arachthos
Iraq	
1994	Adnanya, Hamra, Abu Ghraib

Country/year	Variety
Bread Wheat (contd.)	
Iran	
1986	Golestan, Azadi
1988	Sabalan, Darab, Quds
1990	Falat
Jordan	
1988	Nasma = Jubeiha, L88 = Rabba
1990	Nesser
Lebanon	
1990	Seri
1991	Nesser = Cham 6
1995	Roomy
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
Tunisia	
1983	T-VIRI-Veery 'S', 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
1988	Mukhtar, Aziz, Dhumran
1983	Ahgaf
1988	SW/83/2
1995	Radfan, SW/88/7, SW/88/6, SW/88/8, SW/89/3, SW/89/7
Kabuli Chickpea	
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)
Egypt	
1993	ILC 195
France	
1988	TS 1009 (ILC 482) TS 1502 (FLIP 81-293C)
1992	Roye Rene (FLIP 84-188C)
Iran	
1995	ILC 482, ILC 3279, FLIP 84-48C
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)
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), Douyct (FLIP 84-92C)

Country/year	Variety
Kabuli Chickpea (contd.)	
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)
1993	Jebel Mara 1 (ILC 915)
Syria	
1982/86	Ghab 1 (ILC 482)
1986	Ghab 2 (ILC 3279)
1991	Ghab 3 (FLIP82-150C)
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	Damla 89 (FLIP 85-7C), Akcin (87AK 11115)
1992	Aydin 92 (FLIP 82-259C), Menemin 92 (FLIP 85-14C), Izmir 92 (FLIP 85-60C)
1994	Aziziye (FLIP 84-15C)
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
1993	Digger (FLIP84-51L)

Country/year	Variety
Lentil (contd.)	
	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-2 (Sel. from ILL 4353 x ILL 353)
Canada	
1989	Indian Head (ILL 481)
Chile	
1989	Centinela (74TA 470)
China	
1988	FLIP87-53L (ILL 6242)
Ecuador	
1987	INIAP-406 (FLIP 84-94L)
Egypt	
1990	Precoz (ILL 4605)
Ethiopia	
1980	R 186
1984	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	FLIP 87-53L (ILL 6243)
Pakistan	
1990	Manserha 89 (ILL 4605)
Sudan	
1993	Rubatab 1 (ILL 813) Aribo 1 (ILL 818)
Syria	
1987	Idleb 1 (78S 26002)
Tunisia	
1986	Neir (ILL 4400) Nefza (ILL 4606)

Country/year	Variety
Lentil (contd.)	
Turkey	
1987	Firat '87 (75kf 36062)
1990	Erzurum '89 (ILL 942) Malazgirt '89 (ILL 1384)
1991	Sazak '91 (ILL 854)
USA	
1991	Crimson (ILL 784)
Faba Bean	
Egypt	
1991	Reina Blanca, Giza 461
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)
Ethiopia	
1994	061K-2P-2192
Oman	
1995	Collegian, MG102703, A0149, Syrian Local
Sudan	
1989	Karima-1
1994	Ballet
Forage Legumes	
Jordan	
1993	*Vicia villosa* subsp. *dasycarpa* (IFLVD 683) *Vicia sativa* (IFLVS 715) *Lathyrus ochrus* (IFLLO 101/185)
Morocco	
1990	*Vicia sativa* (ILF-V-1812)
1992	*Vicia villosa* (IFLVV 2053)
1994	*Vicia narbonensis* (IVLVN 2387) *Vicia narbonensis* (IVLVN 2391) *Vicia sativa* (IVLVS 709)

Appendix 3

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, and publications produced at ICARDA as well as for ICARDA by other publishers. Some of the titles published in 1993 and 1994 but not captured for reporting in the Center's 1994 Annual Report are also included. A complete list of publications, including book chapters and papers published in conference proceedings, is published separately and is available on request.

Journal Articles

Termanini, A., A. Goodchild, T.T. Treacher, S. Rihawi and E. Owen. 1993. The effects of urea treatment, urea supplementation and coarse milling on the nutrient intake of sheep fed barley straw. Animal Production 56(3): 449.

Udupa, S.M., A. Sharma, R.P. Sharma and R.A. Pai. 1993. Narrow genetic variability in *Cicer arietinum* L. as revealed by RFLP analysis. Journal of Plant Biochemistry and Biotechnology 2: 83-86.

Christiansen, S. and P.S. Cocks. 1994. Changes in seed bank size and botanical composition of medic pastures in rotation with barley in north-west Syria. Al-Awamia 87: 141-148.

Ghazal, H.M., A.N. Haloubi and A.E. Osman. 1994. A study on the performance and nutritional value of some legumes in ley farming with barley. Research Journal of Aleppo University - Agricultural Sciences Series 22: 9-22. Ar. English summary.

Goodchild, A.V. and N.P. McMeniman. 1994. Intake and digestibility of low quality roughages when supplemented with leguminous browse. Journal of Agricultural Science, Cambridge 122(1): 151-160.

Newbold, C.J., S.M. El Hassan, R.J. Wallace, X.B. Chen, A.V. Goodchild and L. Arthaud. 1994. Influence of African multipurpose trees on activity of rumen protozoa and bacteria *in vitro*. Animal Production 58(3): 461.

Abd-El Moneim, A.M. and M.C. Saxena. 1995. Demand for meat and milk in WANA increases urgent need for feed from forage legumes. Diversity 11(1-2): 120-121.

Abou-Zeid, N., W. Erskine and B. Bayaa. 1995. Preliminary screening of lentil for resistance to downy mildew. Arab Journal of Plant Protection 13(1): 17-19.

Annicchiarico, P., L. Pecetti and A.B. Damania. 1995. Relationships between phenotypic variation and climatic factors at collecting sites in durum wheat landraces. Hereditas 122(2): 163-167.

Bayaa, B., W. Erskine and A. Hamdi. 1995. Evaluation of a wild lentil collection for resistance to vascular wilt. Genetic Resources and Crop Evolution 42(3): 231-235.

Ceccarelli, S., S. Grando and J.A.G. van Leur. 1995. Barley landraces of the Fertile Crescent offer new breeding options for stress environments. Diversity 11(1-2): 112-113.

El-Awad, A., A.V. Goodchild and O. Guersoy. 1995. Effects of underfeeding Awassi ewes in late pregnancy and early lactation on body weight changes and milk production. Annales de Zootechnie 44(Supplement): 319.

El-Naimi, M. and O.F. Mamluk. 1995. Occurrence and virulence of wheat rusts in Syria. Arab Journal of Plant Protection 13(2): 76-82.

Goodchild, A.V., A. Termanini, I. Said and M. Bluemmel. 1995. Using sheep preference, near-infrared reflectance and laboratory tests for predicting voluntary intake from small samples of barley straw. Annales de Zootechnie 44 (Supplement): 44.

Gowda, C.L.L., S.C. Singh, S.C. Sethi, K.B. Singh, B.V. Rao, M.M. Rahman, J. Kumar and M.A. Rahman. 1995. Registration of 'ICCV 10' chickpea. Crop Science 35(2): 588.

Inagaki, M.N. and M. Tahir. 1995. Comparison of crossabilities of tetraploid wheat with *Hordeum bulbosum* and maize. Cereal Research Communications 23(4): 339-343.

Ismail, S.F., O.F. Mamluk and M.F. Azmeh. 1995. New pathotypes of common bunt of wheat from Syria. Phytopathologia Mediterranea 34: 1-6.

Jones, M.J. and M. Singh. 1995. Yields of crop dry matter and nitrogen in long-term barley rotation trials at two sites in northern Syria. Journal of Agricultural Science, Cambridge 124: 389-402.

Keatinge, J.D.H., D.P. Beck, L.A. Materon, N. Yurtsever, K. Karuc and S. Altuntas. 1995. The role of rhizobial biodiversity in legume crop productivity in the West Asian highlands. IV. *Rhizobium ciceri*. Experimental Agriculture 31: 501-507.

Keatinge, J.D.H., L.A. Materon, D.P. Beck, N. Yurtsever, K. Karuc and S. Altuntas. 1995. The role of rhizobial biodiversity in legume crop productivity in the West Asian highlands. I. Rationale, methods and overview. Experimental Agriculture 31: 473-483.

Keatinge, J.D.H., A. Qi, I. Kusmenoglu, R.H. Ellis, R.J. Summerfield, W. Erskine and S.P.S. Beniwal. 1995. Defining critical weather events in the phenology of lentil for winter sowing in the west Asian highlands. Agricultural and Forest Meteorology 74: 251-263.

Keatinge, J.D.H., A. Qi, I. Kusmenoglu, R.H. Ellis, R.J. Summerfield, W. Erskine and S.P.S Beniwal. 1995. Using genotypic variation in flowering responses to temperature and photoperiod to select lentil for the west Asian highlands. Agricultural and Forest Meteorology 78: 53-65.

Labhilili, M., P. Joudrier and M. Gautier. 1995. Characterization of cDNAs encoding *Triticum durum* dehydrins and their expression patterns in cultivars that differ in drought tolerance. Plant Science 112: 219-230.

Malhotra, R.S., L.D. Robertson and M.C. Saxena. 1995. Stability of performance of determinate faba bean (*Vicia faba* L.). Journal of Genetics and Breeding 49: 1-8.

Mamluk, O.F., D.G. Gilchrist and M. Singh. 1995. Variation in virulence in isolates of *Mycosphaerella graminicola* from six geographical wheat-growing regions. Phytopathologia Mediterranea 34: 45-51.

Materon, L.A., J.D.H. Keatinge, D.P. Beck, N. Yurtsever, K. Karuc and S. Altuntas. 1995. The role of rhizobial

biodiversity in legume crop productivity in the West Asian highlands. II. *Rhizobium leguminosarum*. Experimental Agriculture 31(4): 485-491.

Materon, L.A., J.D.H. Keatinge, D.P. Beck, N. Yurtsever, K. Karuc and S. Altuntas. 1995. The role of rhizobial biodiversity in legume crop productivity in the West Asian highlands. III. *Rhizobium meliloti*. Experimental Agriculture 31(4): 493-499.

Materon, L.A. and J. Ryan. 1995. Rhizobial inoculation and phosphorus and zinc nutrition for annual medics adapted to Mediterranean environments. Agronomy Journal 87(4): 692-698.

Mayer, M., A. Gland, S. Ceccarelli and H.H. Geiger. 1995. Comparison of doubled haploid lines and F_2 bulks for the improvement of barley in the dry areas of North Africa. Plant Breeding 114: 45-49.

Mosaad, M.G., G. Ortiz-Ferrara, V. Mahalakshmi and R.A. Fischer. 1995. Phyllochron response to vernalization and photoperiod in spring wheat. Crop Science 35: 168-171.

Mosaad, M.G., G. Ortiz-Ferrara, V. Mahalakshmi and J. Hamblin. 1995. Leaf development and phenology of *Triticum aestivum* and *T. durum* under different moisture regimes. Plant and Soil 170(2): 377-381.

Mossad, M.G., G. Ortiz-Ferrara and V. Mahalakshmi. 1995. Tiller development and contribution to yield under different moisture regimes in two *Triticum* species. Journal of Agronomy and Crop Science 174: 173-180.

Nishikawa, H., L. Gruner, M. Giangaspero and D. Tabbaa. 1995. Parasite nematode infections in Awassi adult sheep: distribution through Syrian farm flocks. Veterinary Research No. 26: 162-167.

Robertson, L.D. 1995. Faba bean genetic resources at ICARDA. Grain Legumes (8): 25-26.

Robertson, L.D. and M.H. El-Sherbeeny. 1995. Autofertility in a pure-line faba bean (*Vicia faba* L.) germplasm collection. Genetic Resources and Crop Evolution 42: 157-163.

Robertson, L.D. and C. Francis. 1995. CLIMA: an international partnership. Diversity 11(1-2): 25.

Rodríguez, A. and L. Mayer. 1995. Development of sheep fattening schemes in highland Balochistan, Pakistan. Small Ruminant Research 18(3): 193-200.

Rodríguez, A., I. Ali, N.A. Shah, M. Afzal and U. Mustafa. 1995. Price expectations of sheep and goats by producers and intermediaries in Quetta market, Pakistan. Agricultural Economics 12: 79-90.

Ryan, J., M. Abdel Monem, M. Mergoum and M. Azzaoui. 1995. Nitrogen and phosphorus fertilization of triticale varieties in the Settat area of Chaoui. Al Awamia (88): 93-101.

Ryan, J., L.A. Materon and S. Christiansen. 1995. Networks for research collaboration in the dryland West Asia-North Africa region. Journal of Natural Resources and Life Sciences Education 24(2): 155-160.

Singh, K.B. and W. Erskine. 1995. Modern research conducted on ancient chickpea and lentil crops. Diversity 11(1-2): 116-118.

Singh, K.B., G. Bejiga, M.C. Saxena and M. Singh. 1995. Transferability of chickpea selection indices from normal to drought-prone growing conditions in a Mediterranean environment. Journal of Agronomy and Crop Science 175(1): 57-63.

Singh, K.B., R.S. Malhotra and M.C. Saxena. 1995. Additional sources of tolerance to cold in cultivated and wild *Cicer* species. Crop Science 35(50): 1491-1497.

Singh, M. and K. Hinkelmann. 1995. Partial diallel crosses in incomplete blocks. Biometrics 51: 1302-1314.

Singh, M. and S. Ceccarelli. 1995. Estimation of heritability using variety trials data from incomplete blocks. Theoretical and Applied Genetics 90(1): 142-145.

Singh, M., N.P. Saxena and M.C. Saxena. 1995. Estimation of pinnule area in chickpea leaves: an errors-in-variables approach. Journal of Applied Statistics 22(1): 37-43.

Solh, M.B. 1995. The Nile Valley Regional Program. Diversity 11(1-2): 24.

Tabbaa, D., M. Giangaspero and H. Nishikawa. 1995. Sero-epidemiological survey of border disease (BD) in Syrian Awassi sheep. Small Ruminant Research 15(3): 273-277.

Thomson, E.F. and F.A. Bahhady. 1995. A model-farm approach to research on crop-livestock integration. I. Conceptual framework and methods. Agricultural Systems 49(1): 1-16.

Thomson, E.F. and F.A. Bahhady. 1995. A model-farm approach to research on crop-livestock integration. II. Experimental results. Agricultural Systems 49(1): 17-30.

Thomson, E.F., F.A. Bahhady, T.L. Nordblom and H.C. Harris. 1995. A model-farm approach to research on crop-livestock integration. III. Benefits of crop-livestock integration and a critique of the approach. Agricultural Systems 49(1): 31-44.

Valkoun, J., L.D. Robertson and J. Konopka. 1995. Genetic resources at the heart of ICARDA mission throughout the Mediterranean region. Diversity 11(1-2): 23-26.

Venora, G., B. Ocampo, K.B. Singh and F. Saccardo. 1995. Karyotype of the kabuli-type chickpea (*Cicer arietinum* L.) by image analysis system. Caryologia 48(2): 147-155.

Yau, S.K. 1995. Regression and AMMI analyses of genotype x environment interactions: an empirical comparison. Agronomy Journal 87(1): 121-126.

Yau, S.K., M.M. Nachit, J. Ryan and J. Hamblin. 1995. Phenotypic variation in boron-toxicity tolerance at seedling stage in durum wheat (*Triticum durum*). Euphytica 83(3): 185-191.

Newsletter Articles

Malhotra, R.S., K.B. Singh and M.C. Saxena. 1995. Effect of nitrogen fertilizer application on cold tolerance in chickpea. International Chickpea and Pigeonpea Newsletter (2):24-25.

Omar, M. and K.B. Singh. 1995. Development of early mutants with ascochyta blight resistance or leaf miner resistance. International Chickpea and Pigeonpea Newsletter (2): 10-11.

Singh, K.B., M.C. Saxena and S. Varma. 1995. Working with nature for higher chickpea yields. Development and Cooperation No. 2/1995: 22-23.

Yau, S.K., J. Ryan, M. Nachit, G. Ortiz-Ferrara and J. Hamblin. 1995. Screening for boron toxicity resistance in durum and bread wheat. Annual Wheat Newsletter 40: 205-206.

Scientific Reports and Manuals

Annual report for CIMMYT/ICARDA regional bread wheat yield trials 1992/93. 72 pp.

Annual report for CIMMYT/ICARDA regional bread wheat nurseries 1992/93. 107 pp.

Annual report for CIMMYT/ICARDA regional bread wheat observation nurseries 1993/94. 89 pp.

Annual report for CIMMYT/ICARDA regional durum wheat nurseries 1992/93. 138 pp.

Annual report for CIMMYT/ICARDA regional durum wheat observation nurseries 1993/94.149 pp.

Annual report for CIMMYT/ICARDA regional durum wheat yield trials 1992/93. 82 pp.

Annual report for the international barley nurseries 1992/93. 173 pp.

Annual report for the international barley yield trials 1992/93. 125 pp.

Annual report for the International barley observation nurseries 1993/94. 138 pp.

Farm resource management program annual report for 1994. 288 pp.

Germplasm program cereals annual report for 1994. 258 pp.

Germplasm program legumes annual report for 1994. 316 pp.

ICARDA annual report 1994. 128 pp.

Seed unit annual report for 1994. 44 pp.

Aw-Hassan, A., E. Ghanem, A.A. Ali, M. Mansour and M.B. Solh. 1995. Economic returns from improved wheat technology in Upper Egypt. ICARDA Social Science Paper No. 1. 31 pp. ICARDA, Aleppo, Syria. ISBN: 92-9217-027-10.

Beg, A. 1995. Oilseed crops research and production in Iran. 26 pp. ICARDA, Aleppo, Syria.

Khan, M.A., I. Begum, S. Ahmad, S.A. Jalil and E.F. Thomson. 1992. Germplasm evaluation in the arid highlands of Balochistan: annual report of the AZRI Germplasm Evaluation Research Group 1991/92. 56 pp.

Nordblom, T.L. and F. Shomo. 1995. Food and feed prospects to 2020 in the West Asia/North Africa region. ICARDA Social Science Paper No. 2. 56 pp. ICARDA, Aleppo, Syria. ISBN: 92-9127-033-4.

Rodríguez, A. 1995. Challenges for the agricultural sector in developing Mediterranean countries. ICARDA Social Science Paper No. 3. 35 pp. ICARDA, Aleppo, Syria. ISBN:92-9127-029-6.

Singh, M., R.S. Malhotra and S. Ceccarelli. 1995. Precision of mean of lines selected from populations of breeding material. Project 4: spring barley and project 12: dry peas. 22 pp. Biometric Report No. 2/1995. ICARDA, Aleppo, Syria.

Singh, M., S. Grando and S. Ceccarelli. 1995. Analysis of sets of yield trials having common checks: a computational approach using GENSTAT. Project 4: spring barley. 27 pp. Biometric Report No. 3/1995. ICARDA, Aleppo, Syria.

Tutwiler, R.N. 1995. The great chickpea challenge: introducing winter sowing in the Mediterranean region. ICARDA Social Science Paper No. 4. 30 pp. ICARDA, Aleppo, Syria. ISBN: 92-9127-028-8.

Reference Books and Conference Proceedings

Ahmad, S.I. 1995. Legume seed technology: proceedings of the train-the-trainer course on legume seed production. 5-14 Apr 1994, Sahiwal, Pakistan. FSCD/ICARDA. 192 pp. Federal Seed Certification Department, Sahiwal, Pakistan. ISBN: 969-37-0142-9.

Ahmed, S.I. (ed.). 1995. Legume seed health testing: proceedings of the training course. 14-20 Mar 1995, Islamabad, Pakistan. 66 pp. FSCD/ICARDA. Federal Seed Certification Department, Islamabad, Pakistan. ISBN: 969-37-0142-9.

Di Fonzo, N., F. Kaan and M. Nachit. 1995. Durum wheat quality in the Mediterranean region: proceedings of the seminar on durum wheat quality in the Mediterranean region. 17-19 Nov 1993, Zaragoza, Spain. Serie A: Seminaires Mediterraneens, No. 22, Options Mediterraneennes. En/Fr. 284 pp. CIHEAM/ICARDA/CIMMYT. CIHEAM, Zaragoza, Spain. ISSN 1016-121-X.

Dos R. Furtado, J.I., A. van Schoonhoven and S. Hamed (ed.). 1995. Sustainable agricultural development in the dry areas of West Asia and North Africa. Report on natural resources and environmental management in the dry areas of West Asia and North Africa. 16-27 Feb 1992, Aleppo, Syria. 110 pp. EDI/ICARDA/AOAD. ICARDA, Aleppo, Syria.

Hussain, A., A. Samad, M. Ibrahim, M. Latif, M. Ashraf and Ilhamuddin. 1995. Wheat and barley varieties of Pakistan. 105 pp. ICARDA/National Seed Registration Department. National Seed Registration Department, Islamabad, Pakistan. ISBN: 969-8288-02-3.

ICARDA, Amman (Jordan). 1995. Regional symposium on integrated crop-livestock systems in the dry areas of West Asia and North Africa: abstracts. 6-8 Nov 1995, Amman, Jordan. Ar, 80 pp. IFAD/UNDP/AFESD/ICARDA. ICARDA, Amman, Jordan.

Keatinge, J.D.H. and I. Kusmenoglu. 1995. Autumn-sowing of lentil in the highlands of West Asia and North Africa: proceedings of the workshop on "Towards improved winter-sown lentil production for the West Asian and North African highlands." 12-13 Dec 1994, Antalya, Turkey. 125 pp. Ministry of Agriculture and Rural Affairs, Turkey/British Overseas Development Administration Plant Sciences Research Programme/University of Reading/ICARDA. Central Research Institute for Field Crops, Ankara, Turkey.

Periodicals/Newsletters

Dryland Pasture, Forage and Range Network News. No. 11, En, 28 pp.

FABIS Newsletter. 1993, No. 33, En/Ar, 44 pp. 1994, No. 34-35, En/Ar, 57 pp.

ICARDA Caravan: Review of Dryland Agriculture. 1995, No. 1, En, 20 pp.

LENS Newsletter. 1994, Vol. 21, No. 2, En/Ar, 52 pp.

Mashreq project Newsletter. 1995, No. 7, Ar, 12 pp. *(Available from: ICARDA, P.O. Box 950764, Amman, Jordan.)*

Rachis. 1993, Vol. 12, No. 1-2, En/Ar, 68 pp. 1994, Vol. 13, No. 1-2, En/Ar, 59 pp.

Seed Info. 1995, No. 8, En, 18 pp.

Literature Update on Wheat, Barley, and Triticale. 1995, Jan-Feb Vol 1, No. 1, 92 pp., No. 2, 122 pp., No. 3, 117 pp., No. 4, 115 pp., No. 5, 113 pp. CIMMYT/ICARDA. CIMMYT, Mexico City, Mexico. *(Restricted distribution from CIMMYT.)*

Other Publications

Change of Director General, 23 January 1995. Ar., En. 61 pp.

Il cece in cucina: ricette da tutto il mondo. It. 51 pp. ISBN: 92-9127-025-03.

WANA seed directory (West Asia and North Africa) with organizations and names. 85 pp. WANA Seed Network Publication No. 9/95.

WANA catalogue of field and seed standards, cereals and legumes. 80 pp. WANA Seed Network Publication No. 8/95.

Christiansen, S., I. Haidar and W. Bou Moghlebay. 1995. Manual for the MAKTABI/ICARDA thresher. Ar, En. 21 pp.

El-Beltagy, A. 1995. How ICARDA is working with Ethiopia. 10 pp. ICARDA, Aleppo, Syria.

El-Beltagy, A. 1995. Sudan and ICARDA: working for food security. 12 pp. ICARDA, Aleppo, Syria.

Robertson, L.D., K.B. Singh and B. Ocampo. 1995. A catalog of annual wild *Cicer* species. 171 pp. ICARDA, Aleppo, Syria.

Regional Program Publications

Nile Valley Regional Program

(Available from: ICARDA, 15 G. Radwan Ibn El-Tabib Giza, 11th Floor, P.O. Box 2416, Cairo, Egypt)

Nile Valley regional program on cool-season food legumes and wheat: annual report 1993/94, Sudan. 186 pp.

Nile Valley regional program high-lights (1994/95) and workplan (1995/96), regional coordination meeting, 24-27 Sept 1995, Aleppo, Syria. 34 pp.

Nile Valley regional program barley annual report, 1994/95, annual coordination meeting, 10-14 Sept 1995, Cairo, Egypt. 131 pp.

Nile Valley regional program on cool-season food legumes and cereals, workplan and budget, 1994/95, Egypt. 94 pp.

West Asia Regional Program

(Available from: ICARDA, P.O. Box 950764, Amman 11195, Jordan)

The development of integrated crop/livestock production in West Asia and North Africa (Mashreq/Maghreb Project): the region, the project objectives, approach, target areas and work plans summary. 77 pp.

The development of integrated crop/livestock production in West Asia and North Africa (Mashreq/Maghreb Project): detailed country work plans 1995/1996 growing season. ICARDA/IFAD/AFESD. 233 pp.

Snobar, B. and N. Haddad. 1995. Food legume improvement project (1980-1992): project activities and achievements. General Knowledge Series 1/95. Ar, 59 pp. University of Jordan, Amman, Jordan.

Sweidan, Y. 1995. The first annual technical report of Mashreq/Maghreb project for the development of integrated crop/livestock production in the 1994/95 season. Ministry of Agriculture and Agrarian Reform/ICARDA/IFAD/AFESD. Ar. 79 pp.

Highland Regional Program (Pakistan)

Khan, M.A., A. Sarfraz, S.A. Jalil, Z. Mirza and A.S. Alvi. 1993. Germplasm evaluation in the arid highlands of Balochistan: 1993 annual report of the AZRI germplasm research group. MART/AZR project research report No. 80. 33 pp. *(Available from: Arid Zone Research Institute, PARC, P.O. Box 362, Quetta, Pakistan.)*

Highland Regional Program (Turkey)

(Available from: ICARDA, P.O. Box 39, EMEK, Ankara, Turkey)

Development of small-scale farmers of Taurus mountains of Turkey. Highland regional program: Cukurova University/ICARDA Taurus Mountains Collaborative Project annual report 1992/93. 40 pp.

Enhancing productivity and sustainability of crop production in the Mediterranean highlands. Highland Regional Program: EC/ICARDA Mediterranean Highlands Project (MED/94/b7-4080) work plan and budget-1994/95. 19 pp.

Materon, L.A., J.D.H. Keatinge, D.P. Beck, N. Yurtsever, K. Karuc and S. Altuntas. 1995. Survey of *Rhizobium* numbers and symbiotic effectiveness in the West Asian highlands. Final project report. 66 pp.

Syria/ICARDA Collaborative Program

ICARDA/Syria collaborative research and training program: annual report 1993/94. Ar. 226 pp.

Iran/ICARDA collaborative project and research and training program: third planning and coordination meeting 1995/96, 2-5 Sept 1995, Maragheh, Iran. 79 pp. ICARDA, Aleppo, Syria.

Appendix 4

Graduate Theses Produced with ICARDA's Assistance

The following list also includes titles of graduate theses produced with ICARDA's assistance in 1990, 1991, 1993 and 1994, not reported in the Annual Reports for those years.

Master's

1990

SY* University of Aleppo

Mahmoud Haitham Sayed (SY). [Ecological study of important wild genetic resources of wheat and barley]. 235 pp. (In Arabic, English summary.)

1991

LB Lebanese University

Jihad Alamee (LB). Use of *Hordeum spontaneum* in barley breeding under stress conditions. 74 pp.

1993

SY University of Aleppo

Ahmad Naser Holobi (SY). Agronomic and ecological evaluation of some native legumes at two locations in Syria. (In Arabic, English summary.)

1994

DE University of Hohenheim

Andrea Pape (DE). Der Beitrag der Frauen in Arbeits-und Entscheidungsprozessen von Bedouinenfamilien: Ein Beispiel aus Syrien [The contribution of women to labor and decision making processes in Bedouin families: an example from Syria]. 111 pp. (In German.)

Susanne Pecher (DE). Beeinflussung der Stickstoffaufnahme von Gerste Durch Leguminosenstroh und va Mykorrhiza im Trockenfeldbau. 87 pp. (In German.)

DE University of Leipzig

Undine Optiz (DE). Die Etablierung von Medicago-Weiden durch die Aussaat ganzer Hulsen in einer Weide-Gerste-Rotation in Syrien. 45 pp. (In German.)

JO University of Jordan

Ayman Abdallah Ahmed Suleiman (JO). Moisture content and some physical properties of vertisols under different tillage and crop residue management practices. 85 pp. (Arabic summary.)

Rami Yousef Abdel Fattah (JO). Survey of fungal pathogens transmitted by wheat seeds in Jordan. 85 pp. (Arabic summary.)

LB American University of Beirut

Amir Mohamed Hussein Ibrahim (SD). Association of morphophysiological traits with grain yield under heat-stressed conditions in bread wheat (*Triticum aestivum*, desf.). 75 pp.

LB Lebanese University

Joyce Mitri (LB). Medic pasture establishment using pods sown into barley in the year prior to the pasture phase. 45 pp. (French summary.)

SY Damascus University

Shabab Naief Nasser (SY). Agricultural systems analysis in dry land areas: Al-Hassakhe province. 196 pp. (In Arabic, English summary.)

SY Tishreen University

Safaa M. Ghassan Kumari (SY). A study on seed-borne viruses of lentil in Syria. 105 pp. (In Arabic, English summary.)

Ahmad M. Mouhanna (SY). Survey of virus diseases of wild and cultivated legumes in the coastal region of Syria. 133 pp. (In Arabic.)

SY University of Aleppo

Saadullah Filo (SY). Effect of feeding, system and level, on some productive and reproductive characteristics of Awassi ewes. 249 pp. (In Arabic, English summary.)

1995

JO University of Jordan

Mohammed Noor Al-Hamad (JO). Variation and co-variation in segregating populations in lentils. 85 pp. (Arabic summary.)

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* See Appendix 14 for country codes.

LB American University of Beirut

Mohamed Ahmed Mohamed Adlan (SD). Response of chickpea nodulation, nitrogen fixation and growth to salinity. 115 pp.

Hassan Khaled Ali. (SD). The effect of field location, basic cations, phosphorus and irrigation on the cooking quality of lentils. 80 pp.

Hassan Ahmed Ali Tambal (SD). Extent of variability in flower number per inflorescence in lentil (*Lens culinaris* Medikus). 103 pp.

SY University of Aleppo

Suhaila Arslan (SY). Improving productivity and tolerance to cold in peas for forage and dry seeds by using the genetic stock of 10 genotypes and 4 wild species in Syria. 136 pp. (In Arabic, English summary.)

TR University of Cukurova

Adel I. El-Awad (SD). Effect of nutrition in late pregnancy and early lactation on the milk production in Awassi ewes. 94 pp.

Doctoral

1994

EG Alexandria University

Hossam El-Din Ibrahim (EG). Tolerance and adaptation of chickpea to heat stress. 152 pp.

FR Université de Montpellier II

Daniel Dauro (FR). Les trefles annuels des hauts plateaux Ethiopiens: etude de la regeneration des peuplements et utilisation agronomique [Annual *Trifolium* spp. of the Ethiopian highlands: study on the regeneration of plant population and potential agronomic utilization]. 225 pp. (In French, English summary.)

GB University of Nottingham

Ahmed M. Mounir Mazid (SY). Factors influencing adoption of new agricultural technology in dry areas of Syria. 505 pp.

NL Vrije Universiteit te Amsterdam

Margretha Jacoba Van Hezewijk (NL). Germination ecology of *Orobanche crenata* -implications for cultural control measures. 162 pp. (Dutch summary.)

SD University of Gezira

Atif Mohamed Abdel Malik (SD). Intake, degradability, passage rate and digestibility of wheat straw, barley straw and sorghum stover fed with protein and urea supplements by sheep. 207 pp.

1995

DE Justus-Liebig-Universitaet Giessen

Ghufran Kattach (SY). Phenological and physiological characterization of native legumes in the Syrian steppe. 212 pp. (In German, English Summary.)

FR Ecole Nationale Supérieure Agronomique de Montpellier

Mohamed Labdi (TN). Etude de l'hérédité de la résistance à l'anthracnose (*Ascochyta rabiei*) chez le pois chiche (*Cicer arietinum*). 107 pp. (In French, English summary.)

FR L'Université Claude-Bernard-Lyon I

Sarah Mohamed Nour (SD). Diversité des souches nodulant le pois-chiche (*Cicer arietinum* L.) caractérisation génétique, phénotypique fonctionnelle et implications taxonomiques. 151 pp. (In French.)

GB University of Reading

Sonia Garabet (SY). Fertilizer use efficiency and nitrogen dynamics in rainfed and irrigated wheat under a Mediterranean-type climate. 283 pp.

NL Universiteit Utrecht

H.A.G.M Van den Boogard (NL). Variation among wheat cultivars in efficiency of water use and growth parameters. 155 pp.

ES Universidad de Cordoba

Bruno Ocampo (IT). Study on the interspecific relationships among the annual *Cicer* species for the improvement of chickpea *Cicer arietinum*. 224 pp.

TR Selcuk Universitesi

Ismail Küsmenogü (TR). [A research on development of screening method for winter hardiness and association of winter hardiness with morphologic traits and isozyme markers in lentil. 181 pp. (In Turkish.)

Appendix 5

Agreements

The following is a list of important agreements* relating to the establishment of ICARDA, its cooperation with national governments, universities, regional and international organizations, and others.

Agreements for the Establishment of ICARDA

These agreements were negotiated and signed by the International Development Research Centre (IDRC) of Canada acting as Executing Agency on behalf of the Consultative Group on International Agricultural Research.

17 Nov 1975 CHARTER of the International Center for Agricultural Research in the Dry Areas (En, Fr). Signed for IBRD, FAO, UNDP, and IDRC.

16 Dec 1976 General by-laws of the International Center for Agricultural Research in the Dry Areas (En).

Sept 1990 Second Amendment to the CHARTER (En).

Agreements of Cooperation with National Governments (not including agreements for specific work plans).

Normally, these agreements set the modalities for cooperation in individual countries, identify the kind of facilities that each party will make available to the other, and give ICARDA's staff privileges equivalent to those accorded to the staff of the United Nations.

ALGERIA

Country

16 Sept 1981 avec le Ministère de l'Agriculture et de la Révolution Agraire de le REPUBLIQUE ALGERIENNE DEMOCRATIQUE ET POPULAIRE (Fr).

8 Oct 1986 avec la REPUBLIQUE ALGERIENNE DEMOCRATIQUE ET POPULAIRE (Fr).

3 April 1994 Headquarters Agreement between the Government of the PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA and the International Center for Agricultural Research in the Dry Areas (ICARDA) (Ar, En, Fr).

AUSTRALIA

18 Feb 1993 Letter of Agreement with the Centre for Legumes in Mediterranean Agriculture (CLIMA) (En).

BULGARIA

28 Feb 1988 with the Institute of Plant Introduction and Genetic Resources, IPIGR, Sadovo, BULGARIA (En).

CANADA

18 Oct 1989 with the University of Saskatchewan, CANADA (En).

CENTRAL ASIAN REPUBLICS

26 Nov 1995 Agreement between the Newly Independent Republics of Central Asia and the International Center for Agricultural Research in the Dry Areas (ICARDA) (Ru, En).

CHINA

20 Aug 1987 with the Chinese Academy of Agricultural Sciences, CAAS, CHINA (Ch, En).

CYPRUS

Country

5 Feb 1979 with the Government of CYPRUS (En).

Other

7 Feb 1982 with the Agricultural Research Institute, ARI, CYPRUS (En).

6 July 1987 with the Agricultural Research Institute, ARI, CYPRUS (En).

29 May 1990 with the Agricultural Research Institute, ARI, CYPRUS (En).

16 March 1993 with the Agricultural Research Institute, ARI, CYPRUS (En).

EGYPT

Country

29 Mar 1978 with the Government of EGYPT (En).

31 May 1980 with the Government of EGYPT (Ar, En).

26 May 1987 with the Ministry of Agriculture and Land Reclamation of the Arab Republic of EGYPT (En).

Other

19 Sept 1987 with the University of Alexandria, EGYPT (En).

12 May 1994 EC/ICARDA Phase II Consultancy Contract of the Nile Valley Regional Programme, Egypt and Contract Extension of Rider No. (3) (En).

11 Nov 1993 Agreement of Cooperation with the Faculty of Agriculture, University of Suez Canal, Ismailia (En).

* When the different parties to an agreement signed on different dates, the date of the agreement is given as that of the last signature.

ERITREA

12 Apr 1995 Agreement between the State of Eritrea and the International Center for Agricultural Research in the Dry Areas (ICARDA) (Er, En).

ETHIOPIA

26 June 1989 with Alemaya University of Agriculture, ETHIOPIA (En).

5 June 1993 Agreement between the Institute of Agricultural Research of the Transitional Government of Ethiopia (IAR) and ICARDA (En).

FRANCE

30 Oct 1981 avec l'Office de la Recherche Scientifique et Technique Outre-Mer ORSTOM-FRANCE (Fr).

13 May 1986 avec l'Institut National de la Recherche Agronomique INRA. Centre de Coopération International pour le Développement CIRAD, et l'Institut Francais de Recherche Scientifique pour le Développement en Coopération, ORSTOM, FRANCE (En, Fr).

10 July 1992 L"Ecole Nationale Supérieure Agronomique de Toulouse (ENSAT) (Fr).

INDIA

15 Dec 1986 with the Indian Council of Agricultural Research, ICAR, INDIA (En, Hi).

IRAN

20 July 1976 Agreement with the Imperial Government of IRAN to establish a Principal Station on Iranian territory (En, Fa).

10 Oct 1984 with the Government of the Islamic Republic of IRAN (En).

1 Sept 1987 with the Government of the Islamic Republic of IRAN (En).

22 Nov 1990 with the Government of the Islamic Republic of IRAN (En).

25 Nov 1993 Explanatory Note of the Joint Collaborative Project between ICARDA and Iran (En).

IRAQ

6 Sept 1986 with the Government of IRAQ (Ar, En).

ITALY

16 June 1982 with the Consiglio Nazionale delle Richerche, CNR, ITALY (En, It).

28 Nov 1985 with the University of Tuscia, ITALY (En).

JAPAN

29 Sept 1987 with the Tropical Agricultural Research Center, TARC, JAPAN (En).

6 Apr 1989 with the Tropical Agricultural Research Center, TARC, JAPAN (En).

JORDAN

Country

27 Oct 1977 with the Government of JORDAN (En).

Other

21 Mar 1988 with the Jordan University of Science and Technology, JORDAN (En).

LEBANON

Country

6 July 1977 Agreement with the Government of the LEBANON to permit operations on Lebanese territory (Ar, En).

Other

25 Mar 1978 with the Agricultural Research Institute, ARI, LEBANON for the provision of lands (En).

11 Apr 1991 Explanatory Memorandum between Agricultural Research Institute, ARI, LEBANON and ICARDA to the agreement signed on 25 Mar 1978 (Ar, En).

12 Apr 1991 with the American University of Beirut, LEBANON (En).

28 April 1994 Agreement of Cooperation between the Lebanese University, Faculty of Agricultural Sciences, Beirut, LEBANON and ICARDA (En).

11 Oct 1994 Letter of Agreement between Lebanon Agricultural Research Institute (LARI) and ICARDA defining the collaborative role of each party on the IFAD funded Project in LEBANON "Smallholder Livestock Development" (En, Ar). Also the Land Protocol for the provision of lands in Lebanon for the operations of this project (Ar).

LIBYA

20 Feb 1992 A Cooperative Agreement with the Great Socialist People's LIBYAN Arab Jamahiria (Ar, En).

MOROCCO

18 Jan 1985 with the Kingdom of MOROCCO (Ar).

26 June 1986 with the Ministry of Agriculture and Agrarian Reform of the Government of the Kingdom of MOROCCO for the posting of ICARDA scientists in Morocco (Ar).

NEPAL

30 Aug 1988 with the National Agricultrual Research Coordination Committee, NARCC, NEPAL (En).

PAKISTAN

19 Mar 1980 with the PAKISTAN Agricultural Research Council (En).

30 Nov 1989 with the PAKISTAN Agricultural Research Council, PAKISTAN (En).

RUSSIA

17 May 1993 Agreement of Cooperation with the N.I. Vavilov All-Russian Scientific Research Institute of Plant Genetic Resources (Ru, En).

29 Mar 1995 Agreement between the Krasnodar Research Institute of Agriculture (KRIA) and the International Center for Agricultural Research in the Dry Areas (ICARDA) (Ru, En).

SPAIN

Other

18 Feb 1994 Agreement between the National Insitute of Agricultural Research (INIA) and the International Center for Agricultural Research in the Dry Areas (ICARDA) (En, Sp).

SUDAN

Country

21 Oct 1978 with the Government of the Democratic Republic of the SUDAN (Ar, En).

Other

15 Sept 1985 with the University of Gizira, SUDAN (En).

28 Jan 1987 with the University of Khartoum, SUDAN (En).

SYRIA

Country

28 June 1976 Agreement with the Government of the SYRIAN ARAB REPUBLIC (Ar, En, Fr) for the establishment of the International Center for Agricultural Research in the Dry Areas (ICARDA) on the Syrian territory. Reprinted. Incorporates ratification dates.

14 July 1977 Agreement with the Government of the SYRIAN ARAB REPUBLIC for the provision of lands (Ar, En).

28 June 1987 of the original agreement and the amended articles dated 1 June 1985 of the By-law No. (22) dated 2 April 1977 of the endorsed agreement.

Other

30 May 1977 with University of Aleppo SYRIA (Ar, En).

21 Nov 1985 with Tishreen University, SYRIA (Ar).

22 Apr 1989 with University of Aleppo, SYRIA (Ar, En).

8 Oct 1989 with the Meteorological Department of the SYRIAN ARAB REPUBLIC (Ar, En).

21 Jan 1992 with the University of Damascus, SYRIA (Ar, En).

18 Jan 1994 Agreement for Scientific Collaboration between Al-Baath University, Homs, SYRIA and ICARDA (En, Ar).

TUNISIA

11 Mar 1980 with the Government of TUNISIA (Ar).

20 Nov 1989 with the Government of the Republic of TUNISIA (Ar, En).

TURKEY

Country

29 Sept 1985 with the Ministry of Agriculture, Forestry and Rural Affairs of TURKEY (En).

6 Mar 1990 with the Ministry of Agriculture, Forestry, and Rural Affairs of TURKEY (En).

Other

9 July 1990 with Cukurova University, TURKEY (En, Tr).

3 Dec 1990 with Ankara University, TURKEY (En, Tr).

UNITED ARAB EMIRATES

19 Dec 1992 Agreement of Cooperation with the UNITED ARAB EMIRATES (Ar, En).

USA

14 Apr 1987 with North Carolina State University, USA (En).

USSR

2 Aug 1988 with V.I. Lenin All-Union Academy of Agricultural Sciences-VASKhNIL, Moscow, USSR (En, Ru).

19 May 1989 with V.I. Lenin All-Union Academy of Agricultural Sciences-VASKhNIL, Moscow, USSR (En, Ru).

YEMEN

9 Dec 1987 with the Government of the YEMEN ARAB REPUBLIC (Ar, En).

7 May 1995 Agreement between the International Center for Agricultural Research in the Dry Areas (ICARDA) and the Government of the REPUBLIC OF YEMEN (Ye, En).

7 May 1995 Letter of Understanding between the Agricultural Research and Extension Authority (AREA) of the REPUBLIC OF YEMEN and The International Center for Agricultural Research in the Dry Areas (ICARDA) (Ye, En).

Agreements with International and Regional Organizations (not including agreements for specific work plans)

ACSAD

12 Dec 1982 with the Arab Center for Studies of the Arid Zones and Dry Lands, ACSAD (Ar).

AOAD

5 Apr 1982 with the Arab Organization for Agricultural Development, AOAD (Ar).

CIHEAM

21 Feb 1989 with the International Center for Advanced Mediterranean Agronomic Studies, CIHEAM (En, Fr).

CIMMYT

15 Sept 1987 with the Centro Internacional de Mejoramiento de Maize y Trigo, CIMMYT (En).

ESCWA

17 June 1993 Memorandum of Understanding for Collaboration and Coordination between Economic and Social Commission for Western Asia - ESCWA, JORDAN and ICARDA (Ar, En).

FAO

26 Oct 1994 Agreement between the Food and Agriculture Organization of the United Nations (FAO) and ICARDA placing collections of plant germplasm under the auspices of FAO (En).

15 Jan 1995 Letter of Agreement. Provision of funds by the Food and Agricultural Organization of the United Nations (FAO) to the International Center for Agricultural Research in the Dry Areas (ICARDA) (En).

IBPGR

14 Mar 1990 with the International Board for Plant Genetic Resources, IBPGR (En).

22 July 1992 Memorandum of Understanding with the International Board for Plant Genetic Resources, IBPGR (En).

ICRISAT

1978 with the International Crops Research Institute for the Semi-Arid Tropics, ICRISAT, on chickpea research (En).

6 Oct 1993 Memorandum of Agreement with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) (En).

IFDC

5 Apr 1980 with the International Fertilizer Development Center, IFDC (En).

IFPRI

31 Oct 1994 Memorandum of Understanding between the International Food Policy Research Institute (IFPRI) and ICARDA (En).

IIMI

9 Feb 1995 Agreement between the International Center for Agricultural Research in the Dry Areas (ICARDA) and The International Irrigation Management Institute (En).

IMPHOS

29 Nov 1988 with the World Phosphate Institute, IMPHOS (En).

9 Jan 1995 Memorandum of Understanding for Collaboration and Coordination between The Inter-Islamic Network on Water Resources Development and Manangement (INWRDAM) and the International Center for Agricultural Research in the Dry Areas (ICARDA).

IRRI

24 June 1991 with the International Rice Research Institute, IRRI (En).

UNEP

20 Jan 1993 Memorandum of Understanding with the United Nations Environment Programme, UNEP (En).

WINROCK

5 May 1987 with the Winrock International Institute for Agricultural Development (En).

Appendix 6

Special Projects

During 1995, 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 contributions 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.

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.

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 Programme for the Development of Integrated Crop/Livestock Production in West Asia and North Africa.

CANADA

IDRC (International Development Research Centre), Canada

Scientific Support to Dryland Resource Management Research in the Highlands of Yemen.

Water Harvesting (Jordan).

Integrated Watershed Development (Syria).

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.

FAO (Food and Agriculture Organization of the United Nations)

Promotion of Winter Sown Chickpea Technology in WANA.

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.

FRANCE

Support to ICARDA's project on 'Use of Biotechnology for the Improvement of ICARDA Mandated Crops'.

Amélioration de l'intégration de l'élevage ovin dans les systèmes céréaliers et pâtures de l'Afrique du Nord (Improved integration of sheep, cereal and pasture in rainfed farming systems of North Africa).

GERMANY

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

Development of National Seed Production Organizations in WANA.

Collaborative Project between ICARDA and Frankfurt University on DNA Fingerprinting in Chickpea.

Characterization of the Causal Agent of an Apparently New Virus Disease of Faba Bean, Lentils and Chickpea in WANA.

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

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.

GTZ (German Agency for Technical Cooperation)

Workshop on Privatization of the Seed Industry in the WANA Region.

Workshop on the Assessment of Research and Seed Production Needs in Dryland Agriculture in the West and Central Asian Republics.

IDA (International Development Agency) / World Bank

Agriculture Sector Management Support Project (ASMSP), Yemen.

IFAD (International Fund for Agricultural Development)

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

IRAN

ICARDA/Iran - Scientific and Technical Cooperation.

NETHERLANDS

Development of National Seed Production Organizations in WANA.

Nile Valley Regional Program - Sudan Phase II: Strengthening Research and Transfer of Technology to Increase Production of Wheat and Cool Season Food Legumes.

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.

OPEC Fund for International Development

Barley Development Program: Devolution of Barley Breeding to Maghreb.

Adoption and Impact of ICARDA/NARS Technologies in West Asia.

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)

Use of Biotechnology for the Improvement of ICARDA Mandated Crops.

Increased Productivity of Barley, Pasture and Sheep in the Critical Rainfall Zones - Mashreq Project.

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

UNEP (United Nations Environment Programme)

Promotion of Drylands Biodiversity Conservation through Integrated Management.

UNITED KINGDOM

ODA (Overseas Development Administration)

Measurement of Biodiversity within the Genus *Lens*.

Fixation and Cycling of Nitrogen in a Dryland Legume/Cereal Production System.

UNITED STATES OF AMERICA

NCISE National Committee for International Science and Education

NCISE-IARC Pilot Linkage Program Research Fellowship: Cooperative Development of Statistical Methods Useful for Agricultural Research in Dry Areas.

USAID (United States Agency for International Development)

ICARDA/CIMMYT/Ministry of Agriculture and Land Reclamation, Egypt, Collaborative Project: Improvement of Maize and Wheat in Egypt.

USDA/FAS/OICD (United States Department of Agriculture. Foreign Agricultural Service. Office of International Cooperation and Development)

Strengthening Seed Availability for Disaster Stricken Areas in West Asia and North Africa.

Appendix 7

Collaboration in Advanced Research

ICARDA's collaborative activities with advanced institutions in industrialized countries, regardless of funding source:

International Centers and Agencies

CIAT (Centro Internacional de Agricultura Tropical):
- ICARDA is participating in the System-wide Soil Water and Nutrient Management Initiative, coordinated by CIAT.

CIHEAM (International Center for Advanced Mediterranean Agronomic Studies):
- Joint training courses and information exchange.

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.
- ICARDA and CIMMYT jointly produce a biobliographic publication *Literature Update on Wheat, Barley and Triticale*.

CIP (International Potato Center):
- CIP and ICARDA share offices in Tunisia.

FAO (Food and Agriculture Organization of the United Nations):
- ICARDA participates in the Inter-agency Task Forces convened by the FAO-RNEA (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.

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics):
- Chickpea improvement: ICRISAT has seconded a chickpea breeder to ICARDA.
- 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 System-wide Soil Water and Nutrient Management Initiative.
- ICARDA is collaborating with ICRISAT on insect pests of grain legumes within the System-wide Initiative on Integrated Pest Management.
- ICARDA is collaborating with ICRISAT and ILRI in 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 System-wide Livestock Initiative on Feed Resources Production and Utilization.

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 System-wide Water Resources Management Programme coordinated by IIMI.

IITA (International Institute of Tropical Agriculture):
- ICARDA is collaborating with IITA on parasitic weeds within the System-wide Initiative on Integrated Pest Management.

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 System-wide Livestock Initiative on Feed Resources Production and Utilization coordinated by ILRI.
- ICARDA conducted a training course on Data analysis and presentation/scientific writing with ILRI-Ethiopia, at ILRI, Addis Ababa, in March 1995.

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 System-wide Genetic Resources Program, coordinated by IPGRI.

ISNAR (International Service for National Agricultural Research):
- ICARDA and ISNAR cooperate in research management for NARS in WANA.
- ICARDA is currently hosting a senior scientist from ISNAR.

UNEP (United Nations Environment Programme):
- Promotion of drylands biodiversity conservation through integrated management.

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 anti-nutritional factors: *Lathyrus* spp. and *Vicia* ssp.

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 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

Royal Veterinary and Agricultural University, Copenhagen:
- Powdery mildew resistance in barley.

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).
- Monitoring and on-farm data analysis of parasitic diseases of small ruminants.
- Nitrogen fixation and growth of annual legumes in low temperatures (with ENSIA, Nancy).

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

GERMANY

Institute for Biochemistry and Plant Virology, Braunschweig:
- Characterization of faba bean necrotic yellows virus (FBNYV).

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.

- Socio-economics analysis of farming systems in marginal areas of Syria.
- 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:
- Agro-ecological characterization: generation of weather data.

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

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

International Agricultural Centre, Wageningen:
- Contribution by ICARDA to international seed technology training.

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

Royal Tropical Institute, Amsterdam:
- *Orobanche* control.

University of Utrecht:
- Efficiency of water use in wheat and barley.
- Population dynamics studies in barley.

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

Krasnador Agricultural Research Institute:
- Wheat and barley breeding.

Scientific Research Institute for South East:
- 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.

UNITED KINGDOM

University of Birmingham:
- Measurement of biodiversity within the genus *Lens*.
- Botanical surveys and assessment of communal pastures in Turkey.

Institute for Grassland and Environmental Research (IGER), Aberystwyth:
- Evaluation of cereal straw quality.

University of Reading:
- Nitrogen cycling in dryland legume/cereal rotations.
- 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 providing consultancies in support of Jordan Arid Zone Productivity Project implemented by Silsoe College.

UNITED STATES OF AMERICA

University of California, Riverside:
- Collection of wheat wild relatives and inheritance studies of gliadins in diploid wheats.

Cornell University, Department of Breeding and Biometrics, Ithaca:
- Association of molecular markers with morphophysiological traits associated with constraints of Mediterranean dryland conditions in durum wheat.

University of Nebraska-Lincoln, Department of Biometry:
- Cooperative development of statistical methods useful for agricultural research in dry areas.

Oregon State University; Kansas State University; Texas A&M:
- Collaborative interdisciplinary research and training program using winter and facultative wheat and barley germplasm to stimulate the agricultural sector in less developed countries.

US Department of Agriculture (USDA), Kansas State University:
- Screening bread wheat germplasm for Hessian fly resistance under dryland conditions in WANA.

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

Washington State University:
- Mapping economic genes of lentil.
- Adaptation of peas for Mediterranean environments.
- Ascochyta blight resistance in chickpea.

Washington State University; Texas A&M University; European Parasite Laboratory (USDA-ARS):
- Survey of Russian wheat aphid and its natural enemies in WANA.

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 grass pea.	Germplasm Program	52 countries worldwide; ICRISAT	ICARDA Core funds
SEWANA Durum Wheat Research Network	Durum breeder and crop improvement scientists from southern Europe, West Asia and North Africa (SEWANA) complement each other'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, Spain, Morocco, Tunisia, Turkey, Syria, France, Greece, Italy, Canada, USA	ICARDA Core funds
Soil Test Calibration Network	To standardize methods of soil and plant analyses used in the WANA region and promote training and soil-sample exchange. Evaluate relationships between laboratory determination of soil fertility status and crop response to nitrogen and phosphate. Establish procedures to integrate soil, climate and management to optimize fertilizer recommendations.	Farm Resource Management Program	Algeria, Libya, Morocco, Tunisia, Syria, Jordan, Iraq, Cyprus, Turkey, Pakistan, Yemen	ICARDA, UNDP, IMPHOS
Dryland Pasture and Forage Legume Network	Communication linkages among pasture forage and livestock scientists in WANA.	Pasture, Forage and Livestock Program	WANA; Europe; USA; Australia	ICARDA, FAO-RNEA

Research Networks Coordinated by ICARDA

Title	Objectives/Activities	Coordinator	Countries/ Institutions involved	Donor Support
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 worldwide of 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 worldwide of 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
WANA Seed Network	Encourages (1) stronger regional seed sector cooperation, (2) exchange of information, (3) regional consultations, and (4) inter-country seed trade.	Seed Unit	Algeria, Morocco, Iraq, Cyprus, Turkey, Iran, Jordan, Syria, Egypt, Sudan, Libya, Yemen, Lebanon, Tunisia, Ethiopia, Pakistan, S. Arabia	ICARDA, GTZ, DGIS
Agricultural Information Network for WANA (AINWANA)	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 auspices of the Dryland Resource Management Project.	Farm Resource Management Program	Egypt, Libya, Lebanon, Jordan, Syria, Pakistan, Tunisia, Yemen	Ford Foundation IDRC

Research Networks Coordinated by ICARDA

Title	Objectives/Activities	Coordinator	Countries/ Institutions involved	Donor Support
Global Grain Legume Drought Research Network (GGLDRN)	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	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	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 identified for specific activities to serve as the liaison country between specialists in the identified area.	HRP	Iran, Pakistan, Turkey; Central Asian Republics; Trancaucasian Republics	ICARDA, CIMMYT
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	Algeria, Morocco, Tunisia, Turkey	EEC

Research Networks Coordinated by ICARDA

Title	Objectives/Activities	Coordinator	Countries/ Institutions involved	Donor Support
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	DGIS, Netherlands
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	DGIS, Netherlands
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	DGIS, Netherlands
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 management 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.	ARC, Sudan	Egypt, Ethiopia, Sudan, Yemen, ICARDA, CIMMYT	DGIS Netherlands
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	DGIS, Netherlands

Research Networks Coordinated by ICARDA

Title	Objectives/Activities	Coordinator	Countries/ Institutions involved	Donor Support
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	DGIS, Netherlands
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
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

International School of Aleppo

Higher admission standards for students were implemented at the International School of Aleppo (ISA) for the year 1995/96. A certification program was initiated for all full-time contract teachers to be appropriately trained.

An accreditation pre-candidacy visit took place in November. The Accreditation Team will visit in late 1996 or early 1997 when ISA is expected to become a K-12 accredited school.

The I.B. academic program continued in grades 11 and 12. There was an expansion in the number of courses offered in the general curriculum of the secondary school. The number of courses offered in International General Certificate of Secondary Education (in Grades 9 and 10) also increased.

Curriculum development for the elementary school continued to draw upon the curricula from many countries.

Thirteen students graduated in 1995. ISA graduates continue to be accepted at major universities around the world.

Enrollment at ISA stood at 283 students in 1995. Nearly 31 countries were represented in the student body during the 1994/95 school year.

Appendix 10

Visitors to ICARDA

During 1995 ICARDA received 2255 visitors (Fig. 17). These included scientists, members of diplomatic corps, consultants, conference participants, government officials, trainees, students, farmers, and others from over 54 countries. Of these, 57% came from the host country, Syria, 7% from other Arab countries, 5% from other countries in Asia, 16% from Europe, 5% from the USA and Australia, and 10% from Africa.

Among the many distinguished visitors, ICARDA was honored by the visit of H.E. Mr Asaad Mustafa, Minister of Agriculture, Syria; H.E. Dr Adel Kortas, Minister of Agriculture, Lebanon; H.E. Mr Carl-Dieter Spranger, Minister of Economic Cooperation and Development, Germany; H.E. Dr Fawzi Al-Sultan, President of IFAD; and Dr Mohamed A. Nour, Former Director General of ICARDA.

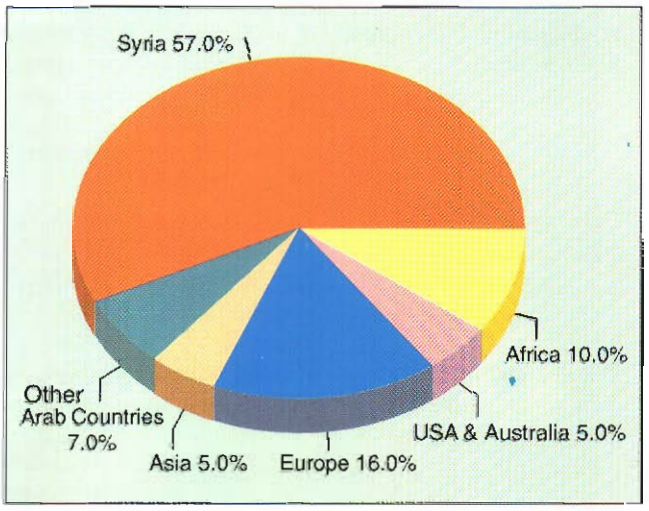


Fig. 17. Visitors to ICARDA, 1995.

Appendix 11

Statement of Activity

For the Year Ended 31 December 1995

(x 1000 USD)

	1995	1994
REVENUE		
Grants	19,319	17,849
Exchange gains/(loss), net	1,939	1,700
Interest income	1,013	566
Other income, net	768	568
Total revenue	23,039	20,683
EXPENSES		
Research		
Farm Resource Management	3,127	2,633
Germplasm Program	5,381	5,331
Pasture, Forage, and Livestock	3,088	2,514
Genetics Resources Unit	1,116	1,254
Total research	12,712	11,732
Research support	3,927	3,355
Cooperative programs	545	1,124
Training	766	581
Information	819	855
General administration	2,112	1,966
General operation	1,702	1,552
Subtotal	9,870	9,433
Total operating expenses	22,583	21,165
(DEFICIT) EXCESS OF REVENUE OVER EXPENSES	456	(482)
ALLOCATED TO		
Capital invested in property, plant and equipment	211	94
Operating fund	245	(576)
(Deficit) / Surplus	456	(482)

Statement of Grant Revenue

For the Year Ended 31 December 1995

(x 1000 USD)

	Funds received	Receivable 31 Dec 1995	(Advance) 31 Dec 1995	Current year grants	Previous year grants
CORE UNRESTRICTED					
Australia	(187)	-	-	187	177
Austria	(90)	-	-	90	90
Canada	(446)	-	-	446	580
China	(30)	-	-	30	30
Denmark	(367)	-	-	367	312
Egypt	(150)	-	-	150	-
France	(312)	-	-	312	285
Germany	(832)	-	-	832	731
India	(38)	38	-	38	25
Intl. Bank for Reconstruction and Dev. (World Bank)	(4,510)	-	-	4,510	5,105
Italy	(450)	-	-	450	500
Japan	(270)	-	-	270	373
The Netherlands	(637)	-	-	637	549
Norway	(309)	-	-	309	266
Spain	(125)	-	-	125	125
Sweden	(488)	-	-	488	460
United Kingdom	(706)	-	-	706	734
United States Agency for International Development	(1,850)	-	-	1,850	2,000
	(11,797)	38	-	11,797	12,342
CORE RESTRICTED					
Arab Fund	(1,569)	509	(169)	1,179	765
Australia	(266)	-	(180)	192	99
CGIAR	(94)	4	(85)	24	-
European Economic Commission	(1,343)	-	(367)	1,421	1,051
Food and Agricultural Organization	(40)	-	(25)	15	-
Ford Foundation	(103)	-	(134)	37	14
France	-	-	(42)	125	70
German Agency for Technical Co-operation	(656)	55	(400)	666	394
IMPHOS	-	10	-	-	12
International Development Research Centre	(59)	7	(73)	14	65
International Fund for Agricultural Development	(400)	5	-	427	32
Iran	-	52	(567)	517	319
Italy	(450)	-	(112)	629	435
Japan	(280)	-	-	280	-
The Netherlands	(718)	-	(704)	1279	1,655
ODA - United Kingdom	(24)	-	(3)	37	116
OPEC Fund for International Development	(41)	-	(18)	35	75
Spain	-	-	(6)	24	-
Sweden	(1)	-	-	5	50
United Nations Development Programme	(279)	95	(47)	416	355
United Nations Environmental Programme	(200)	-	-	200	-
Closed projects	(3)	178	-	-	-
	(6,526)	915	(2,932)	7,522	5,507
TOTAL	**(18,323)**	**953**	**(2,932)**	**19,319**	**17,849**

Appendix 12

Board of Trustees

Two new members joined the Board of Trustees (BoT) in 1995: Dr Raoul A. Dudal and Dr Luigi Monti.

Dr Raoul A. Dudal

Dr Raoul A. Dudal, of Belgium, is Secretary, Working Group on Soils and Geomedicine, International Society of Soil Science. He obtained his M.Sc. in 1949 and Ph.D. in 1955 from K.U. Leuven, Belgium, and has had a distinguished career. He was Professor of Soil Science, University of Indonesia, 1958 to 1959; Director, Land and Water Division, FAO, 1976 to 1984; and Professor, Soil Geography, Soils of the Tropics and Land Evaluation, K.U. Leuven, Belgium, 1984 to 1991. His international assignments have included Secretary General and other senior offices of International Society of Soil Science; Chairman, FAO Inter-Departmental Working Group on Environment and Energy; and Member, Technical Advisory Committee of the CGIAR.

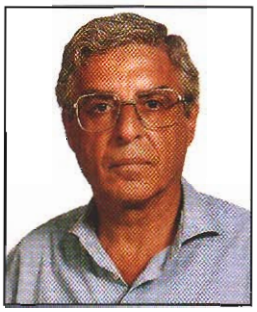
Dr Dudal has served as Member/Honorary Member of the Royal Academy of Overseas Sciences, Belgium; Deutsche Bodenkundliche Gesellschaft, Federal Republic of Germany; Soil Conservation Society of America, USA; American Soil Science Society, USA; Association française pour l'Etude du Sol, France; and Norwegian Academy of Sciences and Letters, Norway.

He has been awarded honorary doctorate degrees by Rijksuniversiteit, Gent, Belgium; Cranfield Institute of Technology, U.K.; and University of Aberdeen, U.K. He has authored over 90 scholarly publications, with special reference to developing countries.

Dr Dudal brings to the Board of Trustees a wealth of knowledge and experience in land use and soils of the tropics and sub-tropics, land evaluation, soil survey, and soil management and conservation.

Dr Luigi Monti

Dr Luigi Monti, from Italy, is Professor of Plant Genetics at the University of Naples. His current professional responsibilities also encompass his role as Director of the Research Center for Vegetable Breeding, CNR; Chair of the Post-graduate School of Plant Biotechnology, University of Naples; and Director of the national research program of the Ministry of Agriculture on "Genetic Resistance of Plants to Biotic and Abiotic Stresses."



Dr Monti is a Board member of IPGRI (as official representative of Italy); the Experimental Institute for Tobacco; and the CNR Institute of Mechanism of Biosynthesis in Plants. He was a Panel member of the TAC Quinquennial Review of ICARDA in 1983; Board Member of IBPGR, 1989-93; and Chairman of the Italian Society of Agricultural Genetics, 1990-92.

Dr Monti has authored or co-authored about 100 scholarly papers. He brings with him to the Board of Trustees a rich research experience in biotechnology, cytogenetics, mutagenesis and breeding of seed legume species and vegetables.

Full Board, 1995

On 31 December 1995, the membership of ICARDA's Board of Trustees was as follows:

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Board Meetings, 1995

The Board held the following meetings during 1995:

23 Jan, Aleppo	Extraordinary Meeting of the BoT
24-25 Jan, Aleppo	24th Meeting of the Program Committee
22-23 Apr, Aleppo	25th Meeting of the Program Committee
24 Apr, Aleppo	33rd Meeting of the Executive Committee
25 Apr, Aleppo	29th BoT Meeting
6 Nov, Washington, D.C.	34th Meeting of the Executive Committee

Appendix 13

Senior Staff
(as of 31 December 1995)

SYRIA (Aleppo: Headquarters)

Director General's Office

Prof. Dr Adel El-Beltagy, Director General
Dr Aart van Schoonhoven, Deputy Director General (Research) - on sabbatical leave
Dr Robert Booth, Assistant Director General (International Cooperation)
Dr M.C. Saxena, Research Coordinator
Dr Elizabeth Bailey, Project Officer
Mr Vijay Sridharan, Internal Auditor
Ms Afaf Rashed, Administrative Assistant to the BoT

Government Liaison and Public Relations

Dr Ahmed Mori, Assistant Director General
Mr Ahmed Mousa El Ali, Public Relations Officer

Finance

Mr John E. Noisette, Director of Finance/Director of Administration
Mr Suresh Sitaraman, Finance Officer, Financial Operations
Mr Edwardo Estoque, Finance Officer, Financial Reporting
Mr Mohamed Samman, Treasury Supervisor

Farm Resource Management Program

Dr Michael Jones, Program Leader/Barley-based Systems Agronomist
Dr Mustafa Pala, Wheat-based Systems Agronomist
Dr John Ryan, Soil Fertility Specialist
Dr Richard Tutwiler, Socioeconomist
Dr Theib Oweis, Water Harvesting/Supplemental Irrigation Specialist
Dr Abelardo Rodríguez, Agricultural Economist
Dr Aden Aw-Hassan, Coordinator Dryland Management Project
Mr Wolfgang Göebel, Agroclimatologist
Dr Ahmed Mazid, Agricultural Economist
Dr Abdul Bari Salkini, Agricultural Economist
Mr Sobhi Dozom, Research Associate

Germplasm Program

Dr Mohan C. Saxena, Program Leader
Dr Habib Ketata, Senior Training Scientist
Dr Salvatore Ceccarelli, Barley Breeder
Dr Guillermo Ortiz-Ferrara, Bread Wheat Breeder (seconded from CIMMYT)
Dr Omar Mamluk, Plant Pathologist
Dr Miloudi Nachit, Durum Wheat Breeder (seconded from CIMMYT)
Dr Muhammed Tahir, Plant Breeder, and Country Coordinator, Iran
Dr John Peacock, Cereal Physiologist
Dr Franz Weigand, Biotechnologist
Dr Khaled Makkouk, Plant Virologist
Dr William Erskine, Lentil Breeder
Dr Ali M. Abd El Moneim, Forage Legume Breeder
Dr Michael Baum, Biotechnologist
Mr Issam Naji, Agronomist
Dr Stefania Grando, Research Scientist
Dr Sui K. Yau, International Nurseries Scientist
Dr Mustafa Labhilili, Post-Doctoral Fellow
Dr R.S. Malhotra, International Trials Scientist
Dr S.M. Udupa, Post-Doctoral Fellow
Mr Mohamed Asaad Mousa, Research Associate
Mr Alfredo Impiglia, Research Associate
Dr Bruno Ocampo, Research Associate
Mr Fadel Afandi, Research Associate

Pasture, Forage and Livestock Program

Dr Gustave Gintzburger, Program Leader
Dr Ahmed El Tayeb Osman, Pasture Ecologist
Dr Thomas Nordblom, Agricultural Economist
Dr Scott Christiansen, Grazing Management Specialist
Dr Anthony Goodchild, Ruminant Nutritionist
Dr Euan Thomson, Livestock Scientist
Mr Faik Bahhady, Assistant Livestock Scientist
Dr Nabil Chaherli, Post-Doctoral Fellow Policy Economist
Mr Nerses Nersoyan, Research Associate
Mr Safouh Rihawi, Research Associate
Ms Monika Zaklouta, Research Associate
Mr Farouk Shomo, Research Associate

Genetic Resources Unit

Dr Jan Valkoun, Head
Dr Larry Robertson, Legume Germplasm Curator
Mr Jan Konopka, Germplasm Documentation Officer
Mr Bilal Humeid, Research Associate
Ms Siham Asaad, Research Associate
Ms Morag Ferguson, Research Associate

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Dr Surendra Varma, Head
Ms Souad Hamzaoui, Center Librarian
Mr Guy Manners, Science Editor/Writer
Mr Mike Robbins, Science Writer/Editor
Mr Nihad Maliha, Information Specialist

Training

Dr Samir El-Sebae Ahmed, Head of Training and Acting Regional Coordinator for the Arabian Peninsula

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 Tomas Bedö, System Programmer Network Administrator
Mr C.K. Rao, Senior Programmer
Mr Awad Awad, Data Base Administrator

Seed Production Unit

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Mr Ahmed Shahbandar, Assistant Farm Manager
Mr Bahij Kawas, Senior Horticultural Supervisor

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Dr Nasri Haddad, Coordinator, West Asia Regional Program

CIMMYT, Mexico

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

Rabat, Morocco (Camp Office)

Dr Mohamed Mekni, Coordinator, N. Africa Reg. Program

Tunis, Tunisia

Dr Mohamed Mekni, Coordinator, N. Africa Reg. Program

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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
Dr Haru Nishikawa, JICA Representative/Parasitologist
Dr K.B. Singh, Chickpea Breeder
Dr Nasr El-din Sharaf El-din, Entomologist

Appendix 14

Acronyms and Abbreviations

AARI	Aegean Agricultural Research Institute (Turkey)
ACLA	Amelioration de la Culture des Legumineuses Alimentaires (Morocco)
ACSAD	Arab Center for Studies of the Arid Zones and Dry Lands (Syria)
AFESD	Arab Fund for Economic and Social Development (Kuwait)
AOAD	Arab Organization for Agricultural Development (Sudan)
API	Arab Planning Institute
APRP	Arabian Peninsula Regional Program
BMZ	Federal Ministry of Economic Cooperation (Germany)
CG	Consultative Group (USA)
CIHEAM	Centre International de Hautes Etudes Agronomiques Mediterrancennes (France)-International Center for Advanced Mediterranean Agronomic Studies
CGIAR	Consultative Group on International Agricultural Research (USA)
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo (Mexico)
CLIMA	Center for Legumes in Mediterranean Agriculture (Australia)
CRIFC	Central Research Institute for Field Crops (Turkey)
EICA	Egyptian Agricultural Center for Agriculture
FAO	Food and Agriculture Organization of the United Nations (Italy)
GTZ	German Agency for Technical Cooperation (Germany)
HRP	Highland Regional Program
IIMI	International Irrigation Management Institute (Sri Lanka)
IBPGR	International Board for Plant Genetic Resources (Italy)
IBRD	International Bank for Reconstruction and Development (The World Bank, USA)
INWRDAM	The Inter-Islamic Network on Water Resources Development and Management (Jordan)
ICARDA	International Center for Agricultural Research in the Dry Areas (Syria)
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics (India)
IDRC	International Development Research Center (Canada)
IFAD	International Fund for Agricultural Development (Italy)
IFPRI	International Food Policy Research Institute (USA)
ILRI	International Livestock Research Institute (Kenya)
IMPHOS	Institut Mondial de Phosphate (Morocco)
INRA	Institut National de la Recherche Agronomique (Morocco)
IPGRI	International Plant Genetic Resources Institute (Italy)
ISNAR	International Service for National Agricultural Research (The Netherlands)
LARP	Latin America Regional Program
NARP	North Africa Regional Program
NARS	National Agricultural Research Systems
NBPGR	National Board for Plant Genetic Resources
NCAID	National Center for Agricultural Information and Documentation
UNEP	United Nations Environment Programme (USA)
NVRP	Nile Valley Regional Program
NVRSRP	Nile Valley and Red Sea Regional Program
ODA	Overseas Development Administration (UK)
OPEC	Organization of Petroleum Exporting Countries (Austria)
REMAFEVE	Reseau Maghrebien de Recherche sur la Feve
SMAAR	Syrian Ministry of Agriculture and Agrarian Reform (Syria)
UNDP	United Nations Development Programme (USA)
UNEP	United Nations Environment Programme
UPOV	International Union for the Protection of New Varieties of Plants (Switzerland)
USAID	United States Agency for International Development (USA)
WANA	West Asia and North Africa
WARP	West Asia Regional Program

Units of measurement

°C	degree Celsius
cm	centimeter
hr	hour
ha	hectare
g	gram
kg	kilogram
km	kilometer
m	meter
mm	millimeter
t	ton (1000 kg)

Countries

DE	Federal Republic of Germany
DZ	Algeria
EG	Egypt
ES	Spain
FR	France
GB	United Kingdom
JO	Jordan
LB	Lebanon
NL	The Netherlands
SD	Sudan
SY	Syria
TR	Turkey

Appendix 15

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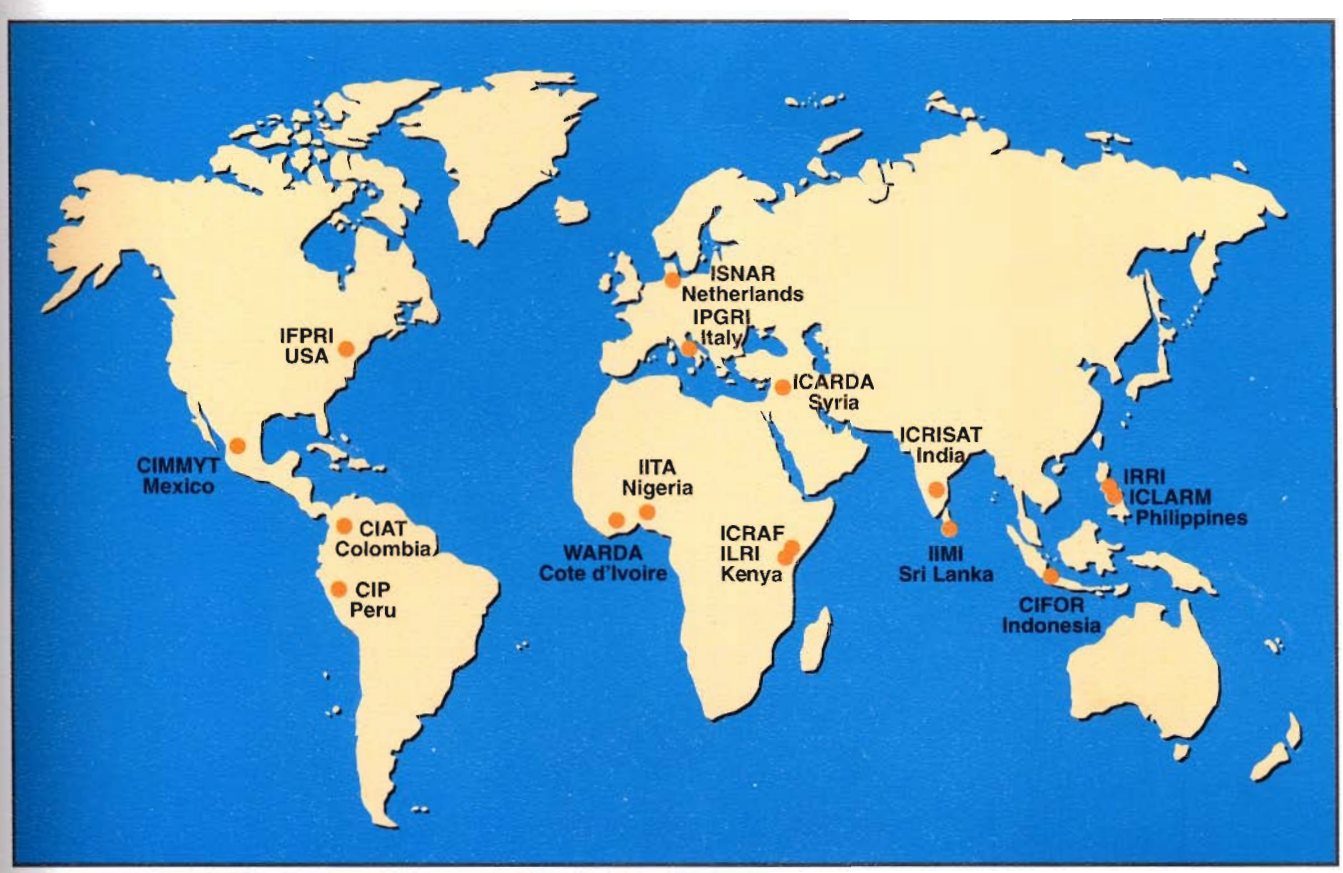
The CGIAR Centers

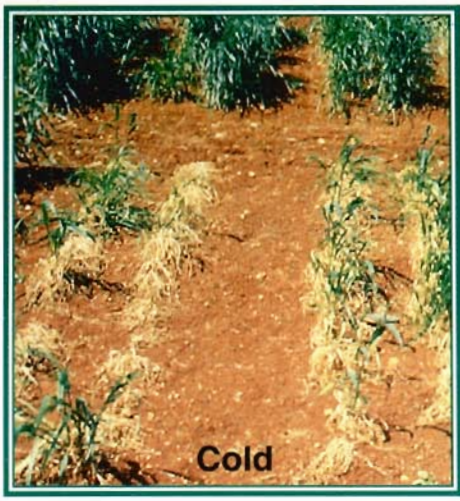


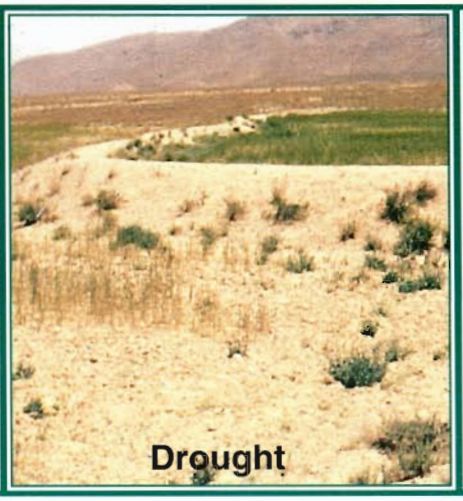
Back cover:

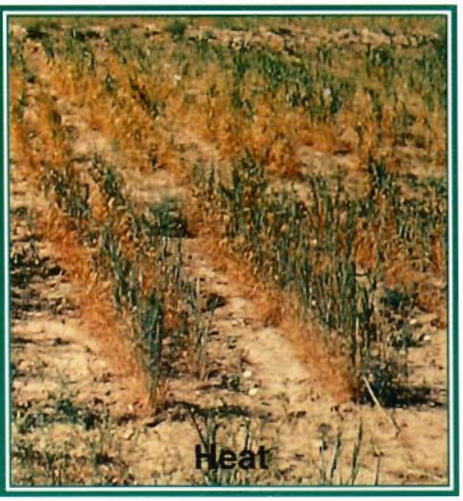
Top: Cold, drought, and heat are the key stresses that limit crop production in the dry areas.

Below: An Ethiopian researcher obtains farmers' perceptions of improved barley-production packages jointly developed with ICARDA. The joint activities, collaborated through the Center's Nile Valley and Red Sea Regional Program, provide strong back-up support to Ethiopia through improved crop production technologies, exchange of germplasm and expertise, training, and networking.

ICARDA-025/5000/July 1996


Cold


Drought


Heat