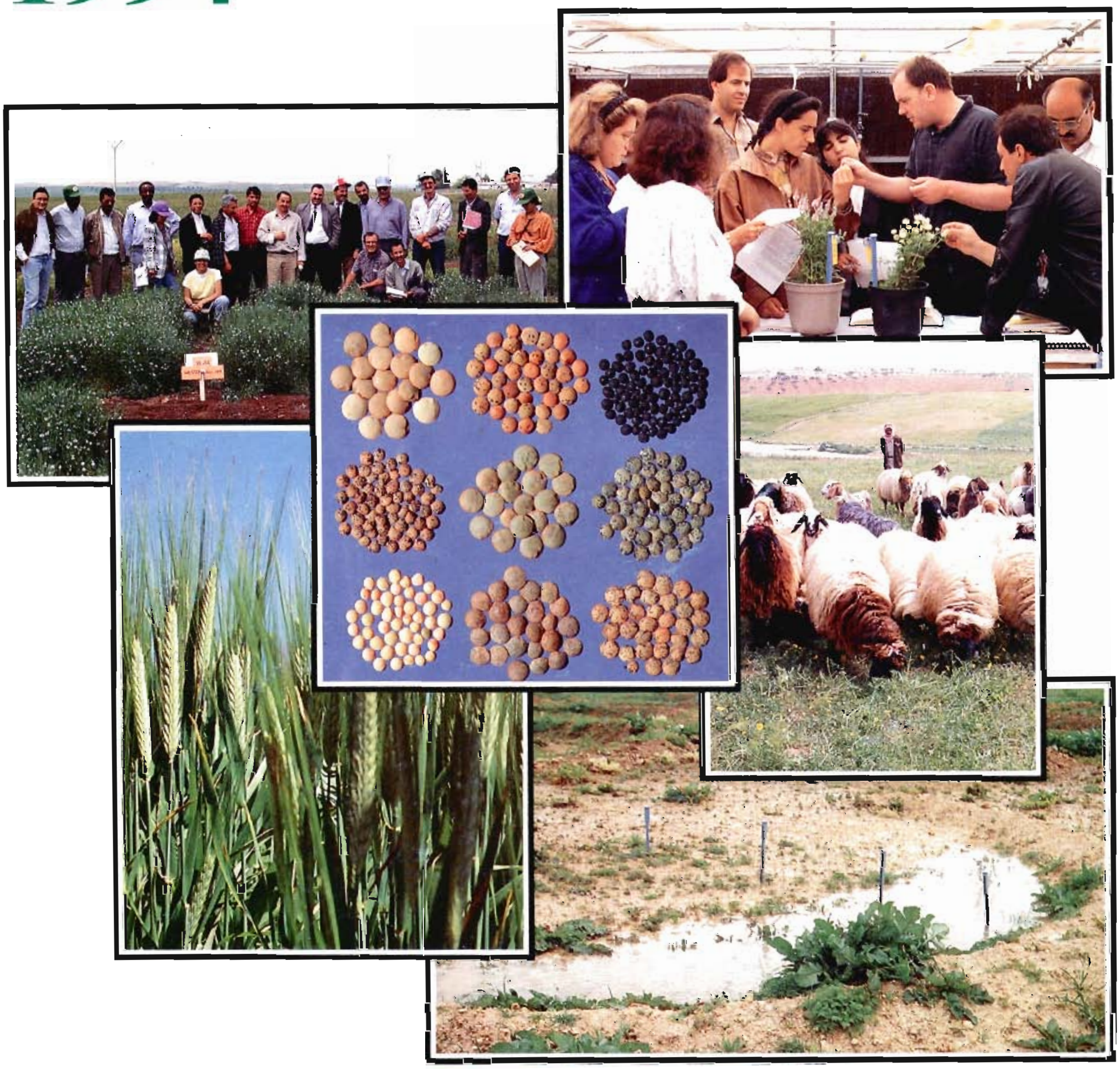
ICARDA Annual Report 1994



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.

ICARDA
Annual Report
1994

International Center for Agricultural Research in the Dry Areas

P.O. Box 5466, Aleppo, Syria

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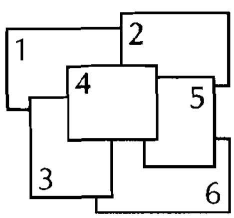
AGROVOC descriptors: *Cicer arietinum; Lens culinaris; Vicia faba; Hordeum vulgare; Triticum aestivum; Triticum durum; Aegilops; Lathyrus sativus; Medicago sativa; Pisum sativum; Trifolium; Trigonella; Vicia sativa*; chickpeas, faba beans; lentils; feed legumes; food legumes; bread wheat; durum wheat; barley; dry farming; farming systems; pastures; steppes; sheep; goats; international cooperation; training; germplasm conservation; resource management; resource conservation; Middle East; North Africa; Pakistan; Ethiopia; Sudan.

AGRIS category codes: A 50; A 01.

Cover



Windows on ICARDA's Research and Training Activities

1. Close partnerships with national programs through collaborative research.
2. Research capacity building of national partners through training.
3. Improved varieties and technologies for increased food production.
4. Collection, conservation, and utilization of genetic diversity.
5. Arresting degradation of marginal land and improving its productivity to provide nutritious feed for small ruminants and increase their productivity.
6. Efficient management of natural resources for agriculture.

Foreword

The season under review in this volume represented a milestone in the progress of ICARDA. It marked the end of the service of several veteran Board members and of the Director General, and the election of a new Board Chair and a new Director General. This period of transition calls for one or two reflections on the status of ICARDA and the direction of its future work.

Over the last few years ICARDA and, indeed, the whole of the CGIAR system, have had to absorb and adjust to many changes which severely tested the System and its individual Centers. We have emerged from the experience healthier and more robust. Nevertheless, we believe that, irrespective of their merit, the large doses of change injected into the System have stretched to the limit the ability of Centers and their staff to accommodate, in the short term, further major adjustments and the inevitable disruption they bring about in their wake. ICARDA and its sister Centers deserve a respite and a period of tranquility to digest the meaning and significance of recent developments.

This is not to argue against change but to plea for its proper management, primarily through the control of its pace. There will always be legitimate demands for adjustment that must be met. The most likely direction of these is already evident and can be gleaned from our own experience, the many studies conducted or commissioned by TAC, and the deliberations of the Rio Summit and the Cairo Population Conference. It is our task to distill the essence of their visions and, insofar as they are relevant to our work, incorporate them into our research agendas.

Such agendas need not constitute a complete break with the past but, rather, a logical evolution of work that has proved its relevance and worth. Concern with the provision of food for a world population increasing at the rate of 100 million per year must continue to be our basic guideline. Germplasm enhancement and the development of farming systems and practices that take full advantage of heritable advances would remain the backbone of the Center's work, taking full advantage of the "biotechnological revolution," which has arrived and is gathering momentum.

It is also evident that the future will see increasing concern with ecosystems research and conservation and management of natural resources. This is the sustainability dimension of our work. We subscribe to the view that we are the trustees, not owners, of these resources and that we must guard and conserve them for the benefit of future generations. They are the capital that must be conserved, and the maximum latitude we can allow ourselves is to live on the income from that capital. These concerns, which featured prominently the outcome of the Earth Summit's Agenda 21, the Climate and Biodiversity Convention and the Statement on Forestry Principles, and elsewhere, are familiar to ICARDA—which, from the start of its work, has been deeply involved in research on the conservation of the resource base. The new interest in these areas shown by the international community is thus welcome to ICARDA, and justifies its advocacy of the importance of these concerns to sustained food production.

The specific actions being undertaken by ICARDA in the pursuit of those goals should be evident from the account given in the main body of this report. This does not dwell only on the experimental and analytical aspects of research, but also recognizes the fact that agriculture, more than any other occupation, meshes man and his physical and living environments together in our intricate socioeconomic complex in which the quality of management determines the success or failure of production enterprises. New technology may have little application if it is not responsive to the social and economic circumstances of the producers and consumers for whom it is intended, and if it is not designed with an awareness of the pressures they themselves exert on the resource base, which could undermine its long-term productivity potential.

Nasrat R. Fadda
Director General

Alfred Bronnimann
Chairman, Board of Trustees

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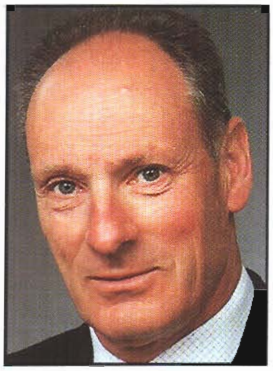
New Board Chairman



Dr Alfred Bronnimann

New Director General

Prof. Dr Adel S. El-Beltagy

Dr Alfred Bronnimann, who joined as a member of the Board of Trustees of ICARDA in 1993, was elected Chairman of the Board in 1994. He succeeded Dr Enrico Porceddu who completed his tenure both as a member and as Chairman of the Board in April 1994.

Dr Bronnimann, a Swiss national, is Director of the Swiss Federal Research Station for Agronomy. He obtained his higher academic degrees, including PhD, from the Swiss Federal Institute of Technology, Zurich. He brings with him a wealth of experience in plant pathology and resistance-breeding research, and of managing an important multidisciplinary research station collaborating with several international organizations.

Dr Bronnimann has served either as Chairman or Board member of five international and eight national research associations, and was head of the evaluation team of the CIAT (Centro Internacional de Agricultura Tropical) project on the improvement of bean production in the Central American and Caribbean region. He is the editor-in-chief of the Journal of Phytopathology.

Prof. Dr Adel S. El-Beltagy was named as ICARDA's Director General Designate by the Board of Trustees of the Center. Dr El-Beltagy will succeed Dr Nasrat Fadda on 1 Feb 1995.

Dr El-Beltagy, an Egyptian national, received his Bachelor's and Master's degrees from Ain Shams University, Egypt, and PhD from the University of Wales, U.K. In addition to a distinguished academic career, he has an extensive background in policymaking and project design at high level. He also has many years of experience as a senior research manager—with special understanding of dryland agriculture.

Currently holding the position of Board Chairman, Agricultural Research Center (ARC), Ministry of Agriculture, Egypt, Dr El-Beltagy's previous responsibilities have included the positions of Director General, ARC; First Under Secretary of State for Land Reclamation, Agricultural Foreign Relations, Deputy Prime Minister's Office, Ministry of Agriculture, Egypt; and Coordinator of ministerial efforts of the World Food Council. Despite multiple demands on his time in his current position, Dr El-Beltagy maintains an active interest in teaching and research and is Professor at the Faculty of Agriculture, Ain Shams University, Cairo. He is a Fellow of the University of Wales and has over 110 scholarly publications to his credit.

His professional contributions at the regional and international levels have included his role as Secretary General, International Desert Development Commission; President, Scientific and Technical Council of Sahara and Sahel Observatory, UNESCO, Paris; Chairman of the Executive Board, Arab Center for the Studies of Arid Zones and Dry Lands; and Co-Chairman of the Government of Egypt led mission with the World Bank, UNDP, FAO, UNEP and World Food Program, to develop a report on "An Agricultural Strategy for the 1990s."

Dr El-Beltagy is no stranger to ICARDA. He was a member of the External Program and Management Review Panel for ICARDA's third quinquennial review in 1993. Earlier, he had been the Chairman of the Egyptian Steering Committee of the Nile Valley Program of the Center.

PART ONE

Major Developments in 1994

Contents

Major Developments in 1994

During 1994, ICARDA completed a process started in 1993 to rearrange its house to respond to the sudden and unexpected reversal in the funding prospects of the CGIAR System. Several cost-saving measures, including reduced expenditure on travel, transportation, insurance, and overtime pay were implemented. The major savings, however, came from staff reductions, more or less evenly spread across all staff categories. By the end of 1994, ICARDA had reduced its international staff (P and RA levels) by 34 and regional staff by 145, constituting in each case a reduction of 30%. Tentative scenarios of progressive austerity measures were developed to maintain the Center's financial health and guide management decisions.

Board of Trustees

A major task of the Board of Trustees was to complete the process of selecting a successor to Dr Nasrat Fadda, Director General, due to retire in January 1995. After a worldwide search, the Board identified Dr Adel El-Beltagy to succeed Dr Fadda as the fourth Director General of ICARDA. Dr El-Beltagy is scheduled to take up his duties on 1 February 1995.

Dr El-Beltagy, Egyptian, is currently Board Chairman, Agricultural Research Center, Ministry of Agriculture, Egypt. He brings with him an intimate knowledge of the problems of rainfed agriculture in the ICARDA-region countries, rich experience as a researcher and research manager in arid land and desert development, and skills in project and policy formulation both at national and international levels.

The Board bid farewell to five of its members: Drs Enrico Porceddu (Chair), Hoceine Faraj, Norman Halse, Gerard Ouellette and W. von Urff, who had completed their second term. At the same time, five new members were elected: Drs Ali Ahoonmanesh, John C. Davies, and Assia Bensalah Alaoui, who commenced their terms in mid-1994, and Drs Raoul J.A. Dudal and Luigi Monti who will join the Board in mid-1995.

The CGIAR

In 1994, the CGIAR entered a new phase of its evolution characterized by a return of optimism and an aggressive pursuit of actions designed to revitalize it. The key event was the launching by new CGIAR Chair, Dr Ismail Serageldine, at the Mid-term Meeting, held in New Delhi in May 1994, of a major initiative for the renewal and revitalization of the Group, its associated Centers, and its technical and administrative arms. As part of the process, the CGIAR is probing innovative modes of operation including the presenta-

On his visit to ICARDA in May 1994, Dr Ismail Serageldine (second from left), CGIAR Chairman, visited the farm and laboratories of the Center and delivered a seminar on "Overcoming the Crisis: The CGIAR Financing Plan." Standing next to him is Mr Alexander von der Osten, Executive Secretary, CGIAR Secretariat.

tion of the System to the donor community in a more transparent way than before.

Of potential far-reaching significance is a ministerial-level meeting to be convened by the CGIAR Chair in February 1995 in Lucerne, Switzerland. This meeting is seen as a revisit of the Bellagio meeting of the early 1970s, where recommendations were formulated which have guided the CG-System for two decades. The meeting is expected to bring about a renewed commitment of the international community to agricultural research and its sustained support at adequate levels to pursue the objectives of bridging the food gap and conserving natural resources for agriculture.

Research and Training Highlights

The Weather in 1993/94

The 1993/94 cropping season in West Asia and North Africa (WANA) was marked by a heat wave in the eastern Mediterranean region in April and May which adversely affected crop yields. In other parts of West Asia, yields suffered from warm, dry weather in spring and disease pressures during winter. In central and western Turkey, the fall of 1993 was the driest in 35 years. In western Pakistan, 1993/94 was one of the driest seasons on record and crop failure was widespread.

In North Africa, Morocco enjoyed high rainfall during fall and winter, ending a two-year drought and leading to an above-average crop in spite of lower than average rainfall at the end of the season. Algeria faced successive dry periods during the growing season that was warmer than usual, resulting in below-average to average yields. In Tunisia and Libya, planting was delayed by a dry fall, and crops were stressed by inadequate rainfall and high temperatures during spring. Yields were below average.

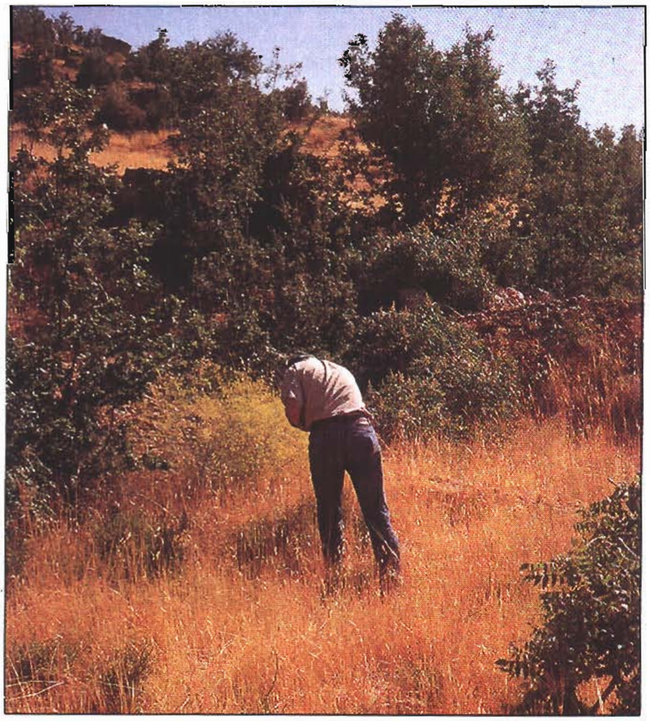
In Ethiopia, the main summer rains were generally adequate, though somewhat late. Yields were good except in some parts of the country. The rainy season in Eritrea and Yemen started late and ended early, reducing crop yields to below average.

Germplasm Conservation

Collection Missions

In 1994, germplasm collection in collaboration with NARS (National Agricultural Research Systems) continued in countries of The Fertile Crescent. Cereal germplasm was collected in southern and northeastern Syria and Lebanon, and forage legumes in Syria. The latter were also sampled in two surveys in Morocco and Tunisia.

A total of 107 cereal wild relatives and 65 cultivated wheat and barley landraces were collected and, in addition, several hundred single plants were sampled from the natural populations of wheat wild progenitors for analysis of genetic diversity. Surveys in Syria and Lebanon revealed an alarming state of genetic erosion in wheat wild progenitors. There is an urgent need to conserve representative populations of wild progenitors of cultivated wheats, i.e., *Triticum urartu, T. boeoticum, T. dicoccoides, Aegilops speltoides,* and *A. tauschii* in their natural habitat.



Wild emmer, *Triticum dicoccoides*, being collected in a typical oak forest habitat in the vicinity of Rashayya, northwest slopes of Mount Hermon, Lebanon.

The collections in Morocco and Tunisia yielded 1120 new accessions of forage and pasture legumes and ample data on species distribution and natural habitat characteristics.

In Tunisia, the survey was conducted in collaboration with national researchers and CLIMA (Center for Legumes in Mediterranean Agriculture, Perth, Australia) as Phase II of the collaborative project. This, along with the first mission in 1992, provided good coverage of pasture and forage legumes in the major areas of Tunisia (annual rainfall 200 to 1000 mm). During this mission, 902 accessions from 16 genera and 71 species of pasture and forage legumes were collected at 91 sites. The following observations emerged:

- Forest areas were extremely overgrazed, with no genetic resources of legumes left.
- *Hedysarum* species, especially *H. coronarium*, were common on the high pH, heavy clay Vertisols (40 sites) and were tolerant of heavy grazing. *H. spinosissimum* was found in the lower rainfall areas, whereas *H. coronarium* was distributed over the whole range of rainfall. These species have significant potential for both forage and pasture production in North Africa because of their large biomass and pod production, and good tolerance to overgrazing.
- *Lathyrus ochrus* was abundant, while *L. cicera* was rare. Narbon vetch, *Vicia narbonensis*, was concentrated around Bizarte. *Scorpiorus muricatus* and *S. vermiculatus* were both common.

Seed Stock Control of Genetic Resources

ICARDA has developed a seed stock control module for its germplasm database, which includes information on weight and number of seeds in the active and base collections; seed viability; location in the seed store; safety duplication in other collections; designation for conservation in the FAO network; need for testing for 'pathogen-free' and 'virus-free' status; and a record of distribution of samples to users.

During the past two years, the stock of all collections (over 100,000) has been determined and computerized, and distribution of samples since 1989 registered. Software was developed to monitor the stock and assist the gene bank manager in handling seed movement.

Germplasm Enhancement

Cereal Crops

Release of New Cultivars

Barley: By exploiting the existing biodiversity in Syrian landraces, a white-seeded pure line, Arta, was identified. After extensive collaborative testing in farmers' fields, it was released by the Syrian national program as 'Improved Arabi Abiad' for Zone B (250-350 mm annual rainfall). Iraq released Rihane-03, IPA 99, and IPA 7; and Algeria, Rihane-03. IPA 7 is tolerant to salinity.

'Improved Arabi Abiad' (Arta), a single-line selection from landrace Arabi Abiad, has been released for large-scale cultivation in the dry areas of Syria.

Durum wheat. Syria released Cham 5 (Omrabi 3) for drier zones of durum cultivation—an outcome of the joint CIMMYT/ICARDA Durum Wheat Improvement Project. It is derived from a cross between Syrian durum landrace Haurani and a high-yielding cultivar Jori C 69 from CIMMYT. It has better resistance to stripe rust and *Septoria tritici* blotch as well as cold. Iraq released Waha Iraq for rainfed cultivation in recognition of its high and stable yields.

Bread wheat. Iraq released three cultivars (Adnanya, Hamra, and Abu Gharaib) as did Algeria (Ziad, Mimouni, and Ain Abid), while Egypt released four (Giza 166, Giza 167, Beni Suef 3, and Sahel 1). Because of better yellow rust resistance, cultivar Nesser was distributed to selected farmers by the Lebanese national program.

Dr Nasrat Fadda (left), Director General of ICARDA, presents the seed of bread wheat cultivar Nesser to His Excellency Mr Adel Cortas, Minister of Agriculture, Lebanon, to replace rust-susceptible varieties.

Barley for Highlands of Ethiopia

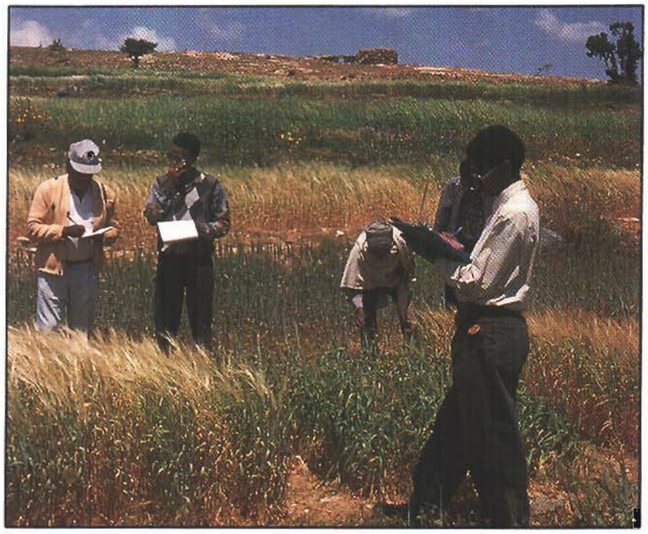
Barley yields in Ethiopia suffer primarily because of susceptibility of prevailing cultivars to scald and net blotch diseases. In collaboration with the Institute of Agricultural Research, Ethiopia, 124 to 260 lines were tested at several research stations for their reaction to the prevailing pathotypes of these diseases. Three lines (50-16, 3479-9, and 3479-16) were resistant to scald and two (3302-8 and 3304-11) to net blotch. Field screening of several Ethiopian landraces also yielded sources of resistance to these two diseases, as well as of tolerance to Russian wheat aphid (*Diuraphis noxia*) and barley shoot fly (*Delia arambourgi*).

Decentralization of Spring Barley Breeding

To encourage NARS partners to exploit specific adaptation of barley germplasm to their locations, decentralization of breeding efforts was continued to cover Egypt, Iraq, and Lebanon in the WANA region, as well as India, Korea, Vietnam, and Thailand. Special sets of nurseries were developed to meet specific cropping-system and agroecological needs. Breeding spring barley for Tunisia, Morocco, Algeria, and Libya has already been successfully decentralized.

DNA-Markers for Quality in Durum

The economic value of durum wheat depends mainly on its processing quality. In collaboration with the University of Tuscia, Italy, Polymerase Chain Reaction (PCR) markers were developed to differentiate durum lines with good pasta-making quality from poor ones. The pasta-making quality depends on low molecular weight (LMW) glutenin subunits. Good quality is expressed in the presence of LMW2, bad quality in the presence of LMW1. The DNA sequence of responsible genes was identified and PCR markers can now distinguish the two alleles of the same gene. The technique allows fast screening of a large number of durum lines and is not influenced by environment.



Evaluation of improved barley landraces and germplasm in Ethiopia.

Hessian Fly Resistance Using Double Haploids

A series of double haploids (DH) developed for Hessian fly (HF) resistance were evaluated in collaboration with the Moroccan national scientists at a hot spot location (Jemaa Shaim, Morocco) in a yield trial. Yields of several DH lines exceeded mean yields of HF-susceptible parents by 24 to 53%, and of HF-resistant parents by 8 to 21%. The lines are now being multiplied for multilocation testing.

Evaluation of double-haploid bread wheat lines, resistant to Hessian fly, at Jemaa Shaim, Morocco.

Development of a Simple Test for Virus Detection

The Enzyme-linked Immunosorbent Assay (ELISA) for plant virus detection has been in use for a long time, and efforts have been under way to improve and simplify the test. The work at ICARDA over the past three years has led to an improved Tissue-blot Immunoassay (TBIA) for detection of viruses in plant tissues. The procedure requires only three hours as opposed to two days for regular ELISA, it does not need sample extraction, and yet remains highly sensitive. This procedure has permitted detection of barley yellow dwarf virus in infected cereal tissues even at maturity.

Food Legumes

Release of New Cultivars

National programs participating in the Legume International Testing Program identified several lines for multilocation testing, on-farm trials, prerelease multiplication, and release for general cultivation. Chickpea cultivars were released by Ethiopia (DZ-10-16-2), Iraq (Rafidian and Dijla), Sudan (Jabel Mara-1), the USA (Sanford and Dwelley), and Turkey (Aziziye and Damla 85). Lentil cultivars were released by Ethiopia (NEL 27040), Sudan (Rubatab 1), and Pakistan (Masoor-931 and Masoor-932). Sudan released three faba bean cultivars (Basabeer, Hudeiba 93, and Shambat 616). Dry pea varieties were released by Cyprus (Kontemenos) and Ethiopia (061K-2P-2192).

Screening for Vascular Wilt Resistance in Lentil

Vascular wilt is a major fungal disease of lentil in the Mediterranean region. Studies at ICARDA have shown that every 1% increase in wilt incidence at reproductive stage causes a 0.85% decrease in seed yield. Several screening methods developed at ICARDA, using its field-sick plot, pots, and cone-shaped plastic tubes with sterilized soil in plastic house, and test tubes with semi-solid Hoagland medium in the laboratory, were compared. Field screening gave high reproducibility over seasons as well as good correlation between early season and final, late-season field scores. Also, field screening correlated well with the laboratory screening.

Integrated Weed Control in Lentil

Weeds are a major constraint to increased lentil productivity in Sudan. For sustaining the self-sufficiency in lentil recently reached there, an effective, economic, and safe weed-control measure is an important prerequisite. Over the years, integrated weed-control measures have been investigated in the major production areas (Rubatab and Wad Hamid) in Sudan, involving presowing irrigation, use of selective herbicides, and mechanical weeding. A combination of selective herbicides (Pursuit and Stomp) and hand weeding proved equally effective and significantly improved lentil yields over unweeded plots.

Integrated control of weeds in lentil at Rubatab, northern Sudan.

Fusarium Wilt in Chickpea

Of 50 diseases known to attack chickpea, fusarium wilt is the second most important worldwide. In WANA, it is prevalent in the Maghreb and the Nile Valley and there are differences in pathotypes. Efficient field-screening requires a uniform wilt-sick plot. Such plots have been developed at ICARDA as well as in Tunisia, Egypt, Sudan, and Ethiopia. Using these sick plots, kabuli chickpea lines with high level of resistance to wilt have been identified.

Plant Regeneration from Callus Cultures of Chickpea

An ovule culture method has been developed to regenerate chickpea plants via callus and subsequent organogenesis. One day after pollination, the flowers are cultured on media to develop pods, which are then opened and fertilized ovules are taken out and transferred to a callus-inducing regeneration medium. Induced calli from selfed plants show morphogenesis after two months on regeneration medium. From morphogenic calli, plantlets develop. The technique is of great potential use in the interspecific hybridization of those *Cicer* species in which successful crosses have not been possible by conventional methods.

Chickpea plantlet formation from selfing on regeneration medium.

Cold Tolerance in Peas

Winter sowing of dry peas in countries around the Mediterranean Sea can provide large yield gains, but the cultivars must be cold-tolerant. Screening of germplasm for cold tolerance has yielded several promising sources at ICARDA. In a study using an 8 x 8 diallel cross, both additive and non-additive gene effects were found important with the preponderence of additive gene effects. Good general combiners with most dominant genes (cultivars K 182 and V2) were identified. The study showed that selection for cold in early generation should be effective.

Evaluation of 28 crosses and eight parents of an 8 x 8 diallel cross for inheritance of cold tolerance in pea at Tel Hadya, Syria.

Response of Some Vetch and Chickling Cultivars to Simulated Grazing

Studies conducted at Tel Hadya (Syria) and Kfardan (Lebanon) research stations, using two common vetch lines and one line each of Palestine, bitter, woolly-pod, and narbon vetch, and ochrus, common and dwarf chicklings, showed that the tested lines of common, bitter, and wooly-pod vetch can be grazed at an early stage when there is great need for herbage; Palestine vetch can be grazed at a later stage permitting regrowth for producing enough seed for next year. Narbon vetch should be used only for full maturity harvest of seed and straw. Palestine vetch was also found suitable for hay making because of its high level of leaf retention and high crude protein content, making it an ideal winter feed for sheep.

Simulated grazing trial of forage legumes at Tel Hadya, Syria, February 1994.

Seed Production

Wheat seed surveys were carried out in Jordan, major production zones in Ethiopia, and one wheat-growing district in Syria. In Ethiopia, barley and faba bean growers were also surveyed.

Farmers indicated four sources of wheat seed for planting: government, own-saved, neighbors, and others (markets). The use of own-saved seed was predominant (95.3%) in Ethiopia, followed by Jordan (58.3%) and Syria (55.9%). Seed from other sources (neighbors, markets) accounted for 25.4% in Syria, 4.5% in Ethiopia, and 7.6% in Jordan. Government-supplied certified seed accounted for 34.1%, 18.6% and 0.2% in Jordan, Syria and Ethiopia, respectively.

Resource Management and Conservation

Resource Map Database

A Resource Map Database of the Jabal Abdul Aziz area in northeastern Syria was created in GIS (Geographical Information System) format, by geographic referencing and digitizing the original hard-copy thematic maps delineated by aerial photograph interpretation. The available GIS maps are: (1) topobase map of contour lines with altitude, main roads, and villages, (2) vegetation map of 10 representative vegetation types in the test zone, (3) soil map of six categories of soil types, (4) geomorphological map of land forms and land units, and (5) degradation map of 15 categories of wind and water degradation, their severity and magnitude of area affected.

The Resource Map Database will assist in analyzing the interaction between land use, land degradation, and productivity on a short- and long-term basis, and in land-use decision making.

Assessment of Durum Wheat Production in Northwest Syria Using a Simulation Model/GIS Technology

CropSyst, a cropping system simulation model, was evaluated for its ability to simulate growth, yield, water and nitrogen use of two durum wheat cultivars (Cham 1, improved; and Haurani, local), grown under different water (rainfed, and supplemental irrigation to meet 60% and 100% of crop water requirements) and nitrogen (without and with 100 kg N/ha) regimes in a Mediterranean-type environment at Tel Hadya. Data from three growing seasons (1989/90 to 1991/1992) were used. In general, CropSyst was able to simulate the above-ground biomass, evapotranspiration, and nitrogen uptake progression throughout the season, and grain yield at harvest. Statistical analysis confirmed a high correlation and agreement between simulated versus observed data.

Fodder Shrubs for Cold, Arid Highlands

In the cold, arid highlands of Balochistan Province, Pakistan, the exotic fodder shrub, fourwing saltbush (*Atriplex canescens*), has shown potential as a supplier of feed for small ruminants and of fuelwood. Annual dry-matter accumulation by ungrazed saltbush shrubs at a density of 2000/ha reached 1300 kg/ha at a site receiving 345 mm annual rainfall with favorable soil conditions. At a heavily degraded range site receiving 440 mm rainfall annually, it was 800 kg/ha. Shrub densities up to 10,000/ha improved dry-matter yields still further and made more efficient use of rainfall. Low rainfall is the primary factor limiting plant growth in Balochistan. However, the high costs of establishing shrub plantations suggests that lower densities should make the technology acceptable to farmers.

Higher Milk Yield from Sheep Grazing Improved Rangeland

Large acreage is planted to fodder shrubs, and protected from uncontrolled grazing, in several countries of the WANA region to provide feed for small ruminants. In Syria, the area planted to shrubs has been increasing and currently exceeds 0.1 million hectares.

At Maragha in northern Syria (annual rainfall 150 mm), a joint project between ICARDA, the Steppe Directorate of the Syrian Ministry of Agriculture, and ACSAD is comparing different grazing intensities on rangelands established with *Atriplex* spp. and *Salsola vermiculata*. The 1994 results showed that milk yield from sheep grazing rangeland improved with shrubs was double that of sheep grazing unimproved rangeland (803 kg compared with 394 kg per group of 8 ewes) in 15 weeks of lactation. Similarly, lamb growth rate and final weight after 9 weeks was higher (21.6 kg) on the former, compared with 19.9 kg on the latter. This is because the shrubs contribute feed throughout the year but especially in winter and summer. In October 1994, the grazeable feed was estimated at 56 kg/ha on unimproved rangeland, compared with 700 kg/ha on that improved with shrubs.

Awassi sheep grazing shrub-seeded pasture during the winter of 1994 yielded more milk than those grazing unimproved pasture.

Efficient Milk Production from Awassi Ewes

A study of unselected Syrian Awassi ewes at Tel Hadya that suckled a lamb for one month, then began to be milked by hand, revealed that the lamb gained 8 kg of weight in the first month, and the ewes produced 730 g of milk daily in the second month, followed by 450 g of milk daily in the third month. The milk contained 6-7% fat, 5% protein, and 5% sugar.

When feed is expensive or in short supply, sheep farmers in WANA use the Awassi breed's capacity to mobilize body fat and protein reserves, i.e., they underfeed the Awassi sheep. Some of the ewes in this experiment were fed 35-40% below their energy requirements than needed in the three weeks before lambing, yet they produced just as much milk as those correctly fed in pregnancy, and their health was unaffected. When ewes were fed less (equivalent to 300 g less barley per day) than their need in the first two months after lambing, they lost 45 g/day of body weight and produced 90 g/day less milk. The effect on milk yield did not persist when feeding was restored according to ewes' needs.

Rhizobial Inoculation and Phosphorus and Zinc Nutrition for Annual Medics and Forage Legumes

In addition to phosphorus and zinc, the local adaptation of medic species and forage legumes largely depends on the presence in the soil of compatible nitrogen-fixing bacteria. In a field experiment conducted at Tel Hadya with a representative P-deficient clay soil, four medic species and three forage legumes consistently and significantly ($P<0.05$) responded to P application. *Lathyrus sativus* was an exception as it appeared to extract P more efficiently than the other legumes tested.

Similarly, a marked positive response to applied zinc was also obtained but only with adequate P and N levels. *Medicago rotata, M. aculeata, Vicia dasycarpa,* and *V. sativa* responded to rhizobial inoculation more markedly than other species. Thus, in addition to cereal fertilization with N, it may be necessary to apply P and Zn in cereal-pasture rotations as well as to stands of forage legumes. Since WANA soils often produce low-Zn forage, and since livestock depend almost entirely on grazed fresh forage or cereal stubble, the potential implications of low Zn intake for animal and human health deserve attention.

Two *Vicia dasycarpa* plots both fertilized with N and P. The difference in growth response due to the presence or absence of zinc is clearly visible.

Pitting Machine for Rangeland Reseeding

By adopting an idea generated in Australia a few years ago, ICARDA has built a simple pitting machine for use in revegetation operations on degraded rangelands. This low-cost machine consists of a single modified disk plow, mounted on a two-wheeled trailer. It creates a string of shallow pits or holes in which rainwater, organic matter, and seeds are trapped, building up a favorable environment for plant development. The length and depth of the pit can be altered by changing the disk shape. The machine is meant to operate behind an ordinary car. It is being tested in rangeland rehabilitation operations at Maragha station in Syria.

This simple pitting machine, developed at ICARDA, is useful in revegetation operations on degraded rangelands. The pits or holes made by it trap rainwater, organic matter, and seeds.

Impact Assessment and Enhancement

Adoption and Impact of New Wheat Varieties in Tunisia

In a joint study with CIMMYT and the Tunisian national program, the results of a 1991 wheat survey were analyzed to determine adoption patterns and economic impact. High-yielding varieties have been adopted almost completely by farmers in northern Tunisia, accounting for over 98% of the region's wheat area in 1990/91. Two varieties, Karim (released in 1980) and Razzak (1987), accounted for 68% and 35%, respectively, of the durum wheat area. The varieties Salambo (1980) and Byrsa (1987) accounted for 49% and 27%, respectively, of the bread wheat area.

When genetic yield gains were weighted to reflect the area grown to each variety in 1991, the adoption of new varieties in northern Tunisia resulted in an increase of about 128% for durum wheat yield and 22% for bread wheat. Adoption of new varieties accounted for about two-thirds of the increase in durum yields, but in the case of bread wheat, they accounted for only 35% of the yield and the rest was accounted for by management factors (such as fertilizer and herbicide use). For the period 1981-91, the average annual contribution of improved wheat varieties to gross farm income was estimated at USD 49 million. The increased production resulting from new variety adoption saved Tunisia an average of about USD 54 million per year in foreign exchange that would have been spent on additional wheat imports. Given that these estimated annual benefits were more than three times as high as the entire agricultural research budget of Tunisia in 1985 (including contributions from international research centers), the study shows the high benefit and returns to public investment in wheat research.

Economic Returns to Wheat Research in Upper Egypt

Wheat yields in Upper Egypt have historically been well below the national average. In 1987, the Nile Valley Regional Program (NVRP) initiated a major effort in wheat improvement and technology transfer to farmers in Upper Egypt. The effort was successful, with average wheat yields in Upper Egypt rising from 3.3 t/ha before the project to 4.9 t/ha in the period 1990-92. A survey conducted in 1992/93 by ICARDA and the Egyptian national program revealed high adoption levels of recommended technologies.

Economic returns to wheat research in Upper Egypt were estimated based on the observed adoption levels, a 12% discount rate, and a 12-year economic life of the new technology package. The net present value of benefits from research in wheat improvement for Qena and Sohag governorates was estimated at USD 10.3 million with an annualized return of USD 1.6 million. The internal rate of return for wheat research in the two provinces under prevailing prices and adoption levels was 36%, or a return of USD 1.36 for every dollar invested in research. These results indicate that wheat research in Upper Egypt has been economically efficient in obtaining a significant impact at both farm and national levels.

Adoption of Fertilizer Use on Barley in Syria

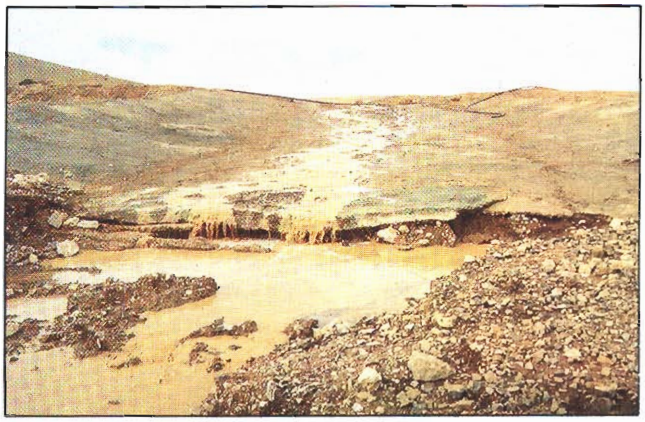
In the early 1980s, only 10% of Syrian barley farmers applied fertilizer to their crop. Research by ICARDA and the Syrian Soils Directorate showed that fertilizer application could substantially raise yields, even in the drier areas. In response, the Syrian Government

Egyptian, Sudanese, and CIMMYT/ICARDA scientists inspecting a commercial field of bread wheat variety, Giza 164, in Egypt.

embarked on a new policy to redirect fertilizer from high-rainfall areas to barley producers in the dry areas. A survey conducted in 1993 of barley producers selected at random in Zone 2 (250-350 mm annual rainfall) and the drier Zone 3, revealed that about 87% of farmers in Zone 2 and some 47% in Zone 3 are now applying fertilizer to their barley crop.

Socioeconomic Assessment of Water Harvesting Potential in Jordan

Scientists at the University of Jordan have developed a number of simple water-harvesting techniques to improve crop and livestock productivity in the drier areas (100-200 mm annual rainfall) of Jordan. In partnership with the University and the Ministry of Agriculture of Jordan, ICARDA initiated a study in the Muwaqqar area, southeast of Amman, to assess the socioeconomic potential of applying water-harvesting techniques on farms in the catchment area. The study covered the production of barley, fruit and nut trees, poultry, vegetables, and livestock, as well as rangeland utilization.



Water harvesting using small earth dams in the Muwaqqar area in Jordan has helped improve crop and livestock productivity.

The results indicated a high economic potential for applying water harvesting to barley and tree production, livestock watering, and rangeland improvement, with less potential for vegetable and poultry production. The potential returns to farmers were highest when water harvesting was used in the integrated production of barley and livestock.

Training

In 1994, ICARDA offered training to 545 participants from 27 countries, including 16 WANA, 1 sub-Saharan, 2 East Asian, and 8 European countries. Of these, 47% were trained in courses at ICARDA headquarters in Aleppo while the remaining were trained in in-country, subregional, and regional training courses. About 17% of trainees were women.

ICARDA continued its strategy to gradually decentralize its training activities by offering more non-headquarters courses. The Center offered 11 headquarter courses and 23 in-country, regional, and subregional courses.

Collaboration was expanded with sister regional and international research centers, such as ACSAD, CIHEAM, CIMMYT, FAO, ILCA and UNDP, for conducting joint training activities in areas of mutual interest. Two joint group courses were conducted in collaboration with CIHEAM, and one regional group course each with FAO, UNDP, IPGRI, and ILCA.

In response to a request from the Syrian Ministry of Agriculture and Agrarian Reform (SMAAR) and UNDP, ICARDA signed an agreement with SMAAR to act as the implementing agency for the human resource development component of a UNDP-assisted three-year project entitled "Technical Assistance to Agricultural Investment in the Southern Region—Phase II." The Center facilitated the conduct of eight training courses in collaboration with the Egyptian International Center for Agriculture (EICA), in Cairo. Thirty-nine senior staff members from this project participated in the courses.

Information Dissemination

An agreement was reached with CIMMYT to jointly provide, in collaboration with ISI-Current Contents and AGRIS, a bibliographic service on barley, wheat, and triticale to the ICARDA and CIMMYT clientele. The in-house database, ICAD, on subjects of interest to ICARDA was further enriched by adding records from CD-ROM databases and other sources. This database now contains over 310,000 records covering the period from 1970 to 1992. A database on durum wheat, DURUM, was also developed.

Eight information personnel from five WANA countries participated in a headquarters training course in information management. Here, a participant from Turkey receives his certificate upon successful completion of the course.

A training course in information was offered at headquarters in cooperation with FAO. Information professionals from Pakistan, Syria, Tunisia, Turkey, and Yemen participated. Another training course was offered in science writing in Cairo to researchers from Egypt and Sudan.

Within the framework of AINWANA, a work plan was developed with the Syrian national program to cover exchange of publications, expertise and services, and a traveling workshop within the country to assess the level of available infrastructure and expertise in key institutions.

Over 50 publications were produced, and 80 articles were processed for submission to refereed journals. Posters and other audio-visual material were produced for the CGIAR high-level meeting, scheduled to be held in Lucerne, Switzerland in February 1995. Ten press releases were issued. Over 55 stories about ICARDA appeared in the English and Arabic media.

Computing and Biometrics

Use of the computer network rose sharply in 1994. Many PC applications and databases including CDS/ISIS (implemented by CODIS), Germplasm Database (developed by GRU), Meteorological Database (developed by CBSU), and a vast array of other data can now be accessed from the computer network. The Meteorological Database contains about 1.2 million records of weather station data for Syria for the past 35 years. The popularity of electronic mail grew among the staff for internal communication.

Further progress was made on the Trials Management System (TMS). The individual modules of TMS are now integrated in a menu system to enable user-friendly access to these modules. Also, the components for access authorization and security for TMS as well as the custodian of any trial granting access privileges to others were completed. Additional modules such as printing of labels, printing or displaying the randomization plan layout, randomization for various designs data and dynamic data entry were also completed.

A statistical technique for the estimation of time-trends in long-term trials and the time required to detect a statistically significant time-trend in yield variables of a seasonal annual crop under continuous cropping was developed. The estimation procedure incorporates an autocorrelation structure for errors on the same plot over time and allows for accounting rainfall effects. A procedure for modeling germination of durum wheat, estimation of base temperature, and lag phase was also developed.

Implementation of the last two modules of the Oracle financial/administrative systems, namely, Personnel and Fixed Assets progressed well. Further development of a Project Management and Central Data Registry System was carried out and test data loaded.

Over 141 ICARDA staff attended 13 in-house training courses. For NARS staff, three courses (two in collaboration with CODIS) were organized in which 41 persons participated.

Outreach Activities

International cooperation and the six regional programs of ICARDA which serve the subregions of North Africa, the Nile Valley, West Asia, the Arabian Peninsula, the West Asian Highlands, and Latin America, provide the mechanism for conducting collaborative research and training with NARS. Increasingly, this collaboration relies on the expertise available within NARS for its implementation. Over the years, the modes of cooperation between ICARDA and its NARS partners have been evolving, with the objective of transferring greater responsibilities to NARS as their research capacity builds up.

Highland Regional Program

Pakistan

The USAID-funded project at the Arid Zone Research Institute (AZRI) in Quetta, Pakistan ended in mid-1994. The project's aim was to strengthen the research and research management capabilities of AZRI by posting ICARDA resident scientists. AZRI staff were also sent for M.S. and Ph.D. programs at universities in the USA. The project was successful in demonstrating the genetic potential of the two main sheep breeds, on-farm testing of fourwing saltbush (*Atriplex* spp.) as a forage shrub and fuelwood supplier, assessing the technical and economic potential of water harvesting, and in the identification and multiplication of several lines of wheat, barley, forage legumes, and lentils. A research management system using protocols was established which made it possible to monitor research progress. The project generated a solid base of scientific knowledge necessary to drive the new on-farm-oriented research activities.

Turkey

In Turkey, the ICARDA/Turkey Highlands Project further helped strengthen research activities and facilities in the Central Anatolian highlands and Taurus Mountain areas. The collaborative work with the Central Research Institute for Field Crops (CRIFC) resulted in the identification of barley, lentil, and vetch cultivars superior to local checks. The cereal and food legume pathology research at CRIFC was strengthened with support from ICARDA pathologists. A three-year program of the Turkish/ICARDA/CIMMYT pathologists to survey cereal diseases in the Central Anatolian Plateau was concluded in the 1993/94 crop season. The results will guide the formulation of the winter/facultative wheat improvement work in Turkey.

Three new research activities were initiated: strengthening of cereal and legume pathology work in the Central Anatolian Plateau; rehabilitation and management of common village pastures; and assessment of the importance of boron toxicity problem in barley. Scientists from Turkey and ICARDA agreed to mount joint collection missions for cereal and legume wild progenitors in Turkey.

A new three-year EU-funded project to improve and sustain crop production in the Mediterranean highlands of Tunisia, Algeria, Morocco, and Turkey was started. The project will help establish scientific and information networks in these four countries.

Iran

The Iran/ICARDA collaborative project on wheat and barley improvement encompasses all activities covered under ICARDA's mandate. Therefore, the project is not only multidisciplinary but also multidimensional in nature. Activities implemented during 1993/94 focused particularly on farm resource management and cereal improvement.

Three Iranian researchers were sponsored for conducting Ph.D. studies in Australia, one in the USA, and one in the U.K. Arrangements are under way with universities around the world to sponsor another 23 candidates for higher studies.

Three in-country training courses were organized. Additionally, Iranian researchers participated in training courses at ICARDA headquarters, and in a Regional Traveling Workshop on Winter Cereals, organized in Iran during May/June. Scientists from Azerbaijan, Kazakhestan, Pakistan, Afghanistan, Turkey, Japan, ICARDA, CIMMYT, and IPGRI also participated in the workshop.

Arabian Peninsula Regional Program

This program continued with financial support from the Arab Fund for Economic and Social Development (AFESD). While routine work on germplasm exchange, evaluation and improvement, technical backstopping of natural resource management activities, and training continued as before, an increased emphasis was placed on formulating new collaborative activities which better respond to the priority needs of the small agricultural sector of the region.

Discussions are under way with the Agricultural Research and Extension Authority (AREA) of the Republic of Yemen concerning the involvement of ICARDA in the implementation of specific activities within the agricultural research component of the

Agriculture Sector Management Support Project (ASMSP) financed by the International Development Association (IDA) of the World Bank.

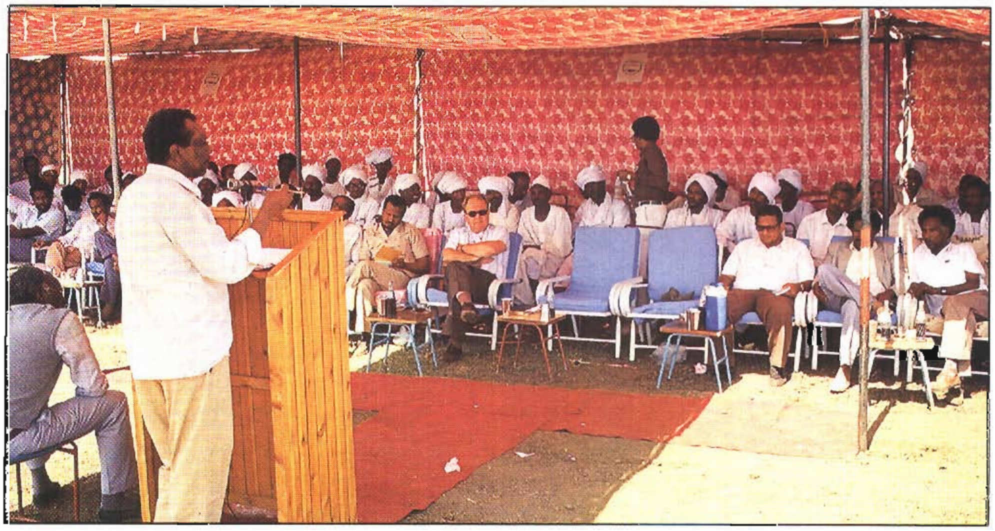
Nile Valley Regional Program

The Nile Valley Regional Program (NVRP), covering Egypt, Sudan and Ethiopia, is based on a tripartite cooperation among NARS, ICARDA/other IARCs, and donors. The Program employs networking at national and regional levels, farmer participation in 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 (faba bean, chickpea, and lentil) and cereals (wheat in cooperation with CIMMYT in Egypt and Sudan; and barley in Egypt and Ethiopia). Field pea is also included in Ethiopia's food legume component. Resource management is a new facet added to the Egyptian component. As part of its strategy to strengthen basic research, the NVRP has established six problem-oriented regional networks that dwell on a multidisciplinary and multi-institutional approach for efficient utilization of expertise, human resources, and infrastructure in member countries and ICARDA. As a partner, ICARDA collaborates with the countries in developing annual work plans; providing germplasm, technical backstopping and training opportunities; and coordinating activities at national and regional levels.

The 1993/94 season witnessed new developments in the funding and staffing of NVRP. In Egypt, the European Union approved financial support for the NVRP-Phase II for five years. Two national professional officers were posted in Cairo Office to work on natural resource management. In Ethiopia, the Swedish Agency for Research Cooperation with Developing Countries (SAREC) provided NVRP with financial support to complete the 1993/94 food legumes season. The Royal Netherlands Government agreed to provide support for barley improvement in Ethiopia. An ICARDA barley scientist/pathologist was posted in Holetta on 1 May 1994, to work closely with national scientists. In Sudan, a Royal Netherlands Review Mission was held from 28 January to 16 February 1994. The Mission Report documented the impact of NVRP on the development and transfer of technology and institution building. The Mission noted that "the implementation procedures as defined, have been very instrumental in the successful operation of the project," and strongly recommended the extension of the project. As a result, the project was extended up to 30 September 1995.

Expansion of on-farm research dominated the season's research activities focused on the assessment of technology adoption and impact for most of the crops in the three countries. Despite unfavorable weather in 1993/94, results of technological improvements have been outstanding.

Regional cooperation among the three Nile Valley countries was strengthened further through exchange of germplasm and improved technology, participation in regional problem-solving networks, traveling workshops, training courses, the Regional Coordination Meeting, and a Regional Socioeconomics Workshop.



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

With the support of NVRP, 59, 82, and 55 national scientists/technicians received various types of non-degree training in Egypt, Ethiopia and Sudan, respectively. A total of 204, 101, and 120 scientists from the three Nile Valley countries in the same order, participated in professional visits, workshops, coordination meetings, and conferences. In addition, nine graduate students are being supported for MSc degree training.

West Asia Regional Program

This Program, which coordinates the "Mashreq Project," and is cofinanced by UNDP and AFESD, continued its technology transfer activities in Syria, Jordan, Iraq, Lebanon, Cyprus, and the lowland areas of Turkey. Emphasis was placed on strengthening adaptive research capabilities through implementing large numbers of on-farm trials involving researchers, extensionists, and farmers in both crop and animal production activities.

To foster interregional cooperation, a study tour to Morocco was conducted. Three scientists each from Jordan, Syria, and Iraq, and the Regional Coordinator of the Program participated in the tour. The group was hosted by ICARDA North Africa Regional Program. The group shared experiences with Moroccan colleagues in the area of barley, forage and sheep production, and met with government officials to discuss programs of mutual interest.

Four traveling workshops were held in Syria, Iraq, Jordan and Lebanon, in which 90 researchers participated. Several training activities were sponsored by the Project, including 42 in-country courses, two regional courses, two study tours, and four workshops. Ten MSc students were registered at the Faculty of Agriculture, University of Jordan, in joint programs with ICARDA.

Mashreq project scientists from Syria, Jordan, and Iraq visit a barley field in Jordan.

To support the extension workers in the Project, six television extension films were produced covering project technologies in Syria and Jordan.

Although the Project came to an end in 1994, its activities were incorporated into a new and expanded Mashreq/Maghreb Project for the development of integrated crop/livestock production in West Asia and North Africa. The new project is cofinanced by AFESD and IFAD and, in addition to continued emphasis on transfer of technologies, it incorporates a social science and policy component to be implemented in cooperation with IFPRI in 1995. A final technical report on the AFESD/UNDP-financed Mashreq Project is available.

In addition to activities financed from the Mashreq project, other collaborative efforts continued in 1994. These included assistance to the National Center for Agricultural Research and Technical Transfer (NCARTT) in Jordan, jointly with ISNAR, on the development of a research strategy and medium-term plan, collaborative work on natural resource management including water harvesting, and increased emphasis on marginal land improvement and small ruminant production.

During the year, contacts were established with the Occupied Palestine Territories and a workshop was held in the region to evaluate priority research needs. Also, extensive activities took place in the subregion in support of the formulation of a proposal on agrobiodiversity and resource conservation in the Fertile Crescent. The proposal is now under consideration of donors for funding.

North Africa Regional Program

The North Africa Regional Program (NARP), coordinates the "Maghreb Project," which focuses on the arid and semi-arid rainfed areas of Algeria, Morocco, Tunisia, and Libya. The Program employs a multi-institutional, multidisciplinary approach, involving the expertise and infrastructure available in the participating countries. National research priorities are assessed each year in annual planning meetings, while regional cooperative endeavors are reviewed in the annual

A North African scientist (left) and ICARDA's Regional Coordinator examine the performance of a barley variety for its resistance to net blotch, a disease that has been discouraging farmers from adopting improved technologies.

regional coordination meeting, making full use of the complementarity between NARS and ICARDA programs.

After years of on-station research, emphasis is now on on-farm research, applying verified technology to specific local conditions in the semi-arid regions (Sidi Bel-Abbes in Algeria, Kef in Tunisia, Settat in Morocco, and Derna in Libya). Many of the activities will be financed through the new Mashreq/Maghreb project cofinanced by AFESD and IFAD.

Collaborative biotechnology research started in the Maghreb with support from ICARDA/UNDP in three key areas: embryo rescue in durum wheat x *Aegilops* crosses for Hessian fly resistance in Morocco, haploid production in Tunisia using Jenah Khotifa and Azizi durum landraces, and variability studies on androgenesis of local durum wheat germplasm in Tunisia using two media.

All NARP activities were supported by in-country training courses, traveling workshops, and national and regional coordination meetings.

Latin America Regional Program

The Latin America Regional Program continued to operate from the ICARDA barley breeding program based at CIMMYT, Mexico. It focuses on the improvement of barley and barley-based cropping systems in the subregion.

A rapid increase in the hull-less barley area is taking place in Alberta, Canada, which coincides with the release of superior varieties, namely, Falcon, Tukwa, and Seebe.

Mexico, in cooperation with different institutions and farmers, is exploring the use of barley for purposes other than malt. Grazing early maturity barley as a companion crop to ryegrass and medic (*Medicago polymorpha*) has proved promising in several verification trials carried out in farmers' fields. Ranchers, who are exploring the new system, have found that it increases total number of grazing days for their livestock.

Agricultural policy changes in Colombia, where barley imports are replacing local malting barley, offer an opportunity to farmers to grow hull-less barley for animal feed as an alternative crop. Colombian researchers are testing two hull-less varieties and exploring markets for the crop.

In cooperation with Oregon State University, the ICARDA Latin America Regional Program is developing a catalog of genes for stripe rust resistance. In countries where the stripe rust pathogen is newly appearing, such as the United States, this information will aid in the development of resistant cultivars when needed. Double haploids with the susceptible malting variety Galena are being produced.

Ecuador has identified several advanced barley lines with partial resistance to leaf rust. In Peru, a barley line yielded 10 times more than the national average.

Oregon scientists recording stripe rust in Mexico for mapping stripe rust resistance genes.

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 overall program of the Center comprises seven integrative activities central to its mandate of improving crop and livestock productivity in the dry areas. The activities are: agroecological characterization, germplasm conservation, germplasm enhancement, resource management and conservation, training, information dissemination, and impact assessment and enhancement. The Center has a global responsibility for the improvement of barley, lentil, and faba bean (genetic resources activities only), and a regional responsibility—in West Asia and North Africa—for the improvement of wheat, chickpea, pasture and forage crops, livestock, 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 22). The text here represents only a selection of important results achieved in collaboration with NARS during the 1993/94 cropping season. Progress in transfer of technology and strengthening partnerships with NARS are summarized under "Outreach Activities." A full report of each major program/unit (see Appendix 2) is available on request.

The Weather in 1993/94

The 1993/94 cropping season in West Asia and North Africa (WANA) was marked by a heat wave in April and May in the eastern Mediterranean region, which adversely affected crop yields. In Turkey, the fall of 1993 was the driest in 35 years, but favorable precipitation during winter saved yields from falling below average. Iran and, to a lesser extent, Iraq and Afghanistan enjoyed above-average precipitation and favorable growing conditions, leading to another bumper crop in Iran. In western Pakistan, the season was one of the driest on record and crop failure was widespread.

In North Africa, Morocco enjoyed high rainfall during fall and winter, ending a two-year drought and leading to an above-average crop in spite of lower than average rainfall at the end of the season. Algeria faced successive dry periods during the growing season that was warmer than usual, resulting in below-average to average yields. In Tunisia and Libya, planting was delayed by a dry fall, and crops were stressed by inadequate rainfall and high temperatures during spring. Yields were below average.

In Ethiopia, the main summer rains were generally adequate, although somewhat late. Yields were good except in some parts of the country. The rainy season in Eritrea and Yemen started late and ended early, reducing crop yields to less than average.

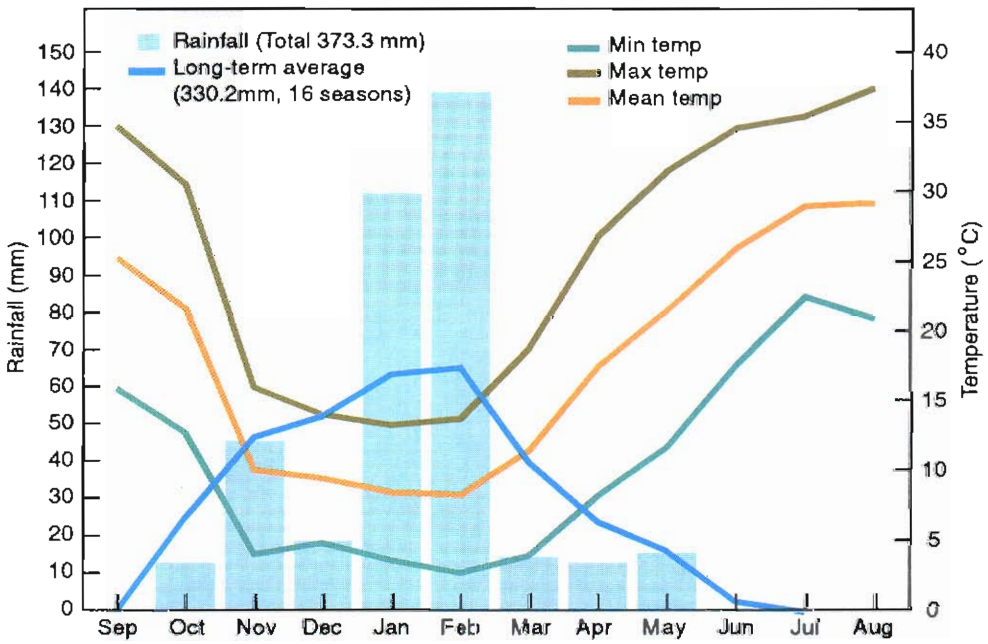


Fig. 1. The weather in 1993/94 at Tel Hadya, ICARDA's main research station about 35 km southwest of Aleppo, Syria.

Agroecological Characterization

Assessment of Durum Wheat Production in Northwest Syria Using a Simulation Model/GIS Technology

The impact of soil and crop management practices on productivity cannot be analyzed independently of weather, soil characteristics, field hydrology, crop characteristics and rotations, and other factors. Computer simulation models, which can capture the long-term effects of weather fluctuations and the effects of various soil properties and management practices on the soil-water balance, nutrient dynamics, and crop growth, can contribute to further our understanding of cropping systems performance. CropSyst, a management-oriented cropping system model, was calibrated for Cham 1 (improved) and Haurani (local) durum wheat crops with three years of data (1989/90 to 1991/92 seasons) from a line-source sprinkler experiment at Tel Hadya under different water and nitrogen regimes.

Calibration of crop-input parameters with two treatments (rainfed, no fertilizer; and water requirement fully met, 100 kg N/ha) in the optimum season (1991/92) allowed CropSyst to satisfactorily mimic the changes in green-leaf area index, above-ground biomass, evapotranspiration and N uptake, when validated with 18 combinations of 3 water and 2 nitrogen levels and 3 growing seasons. Above-ground biomass, grain yield, cumulative evapotranspiration, and nitrogen uptake at harvest for the same combinations were also predicted reasonably well. The agreement between predicted and observed values ranged between 92 and 98%.

After calibration, the model was further validated with data from on-farm trials of fertilizer application to wheat, conducted in northwest Syria, 1986 to 1990. The model was also used in combination with a GIS technology, ARC/INFO, to predict the optimum sowing date for an improved durum wheat cultivar (Cham 1) for different soil types and rainfall zones of northwest Syria. Predicted grain yield of Cham 1 sown on 15 November is illustrated in Fig. 2.

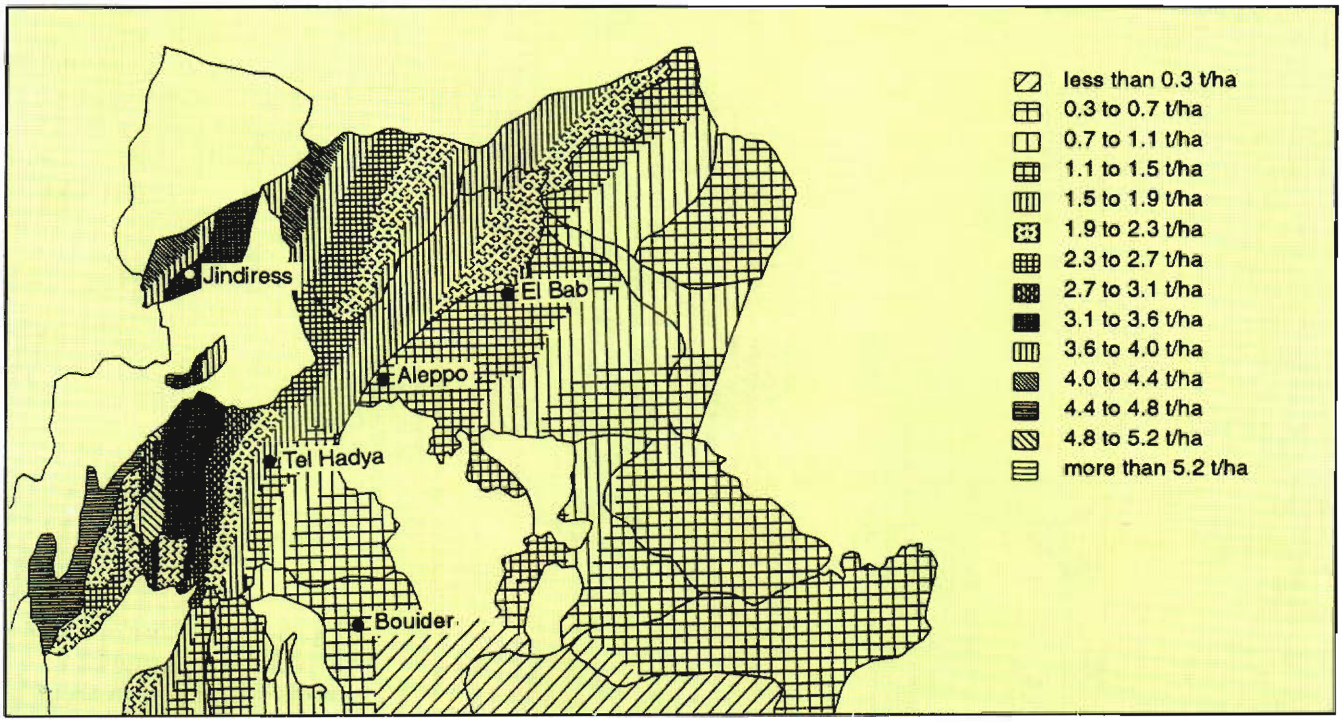


Fig. 2. Predicted grain yield (t/ha) of Cham 1 durum wheat in northwest Syria. Planting : 15 November.

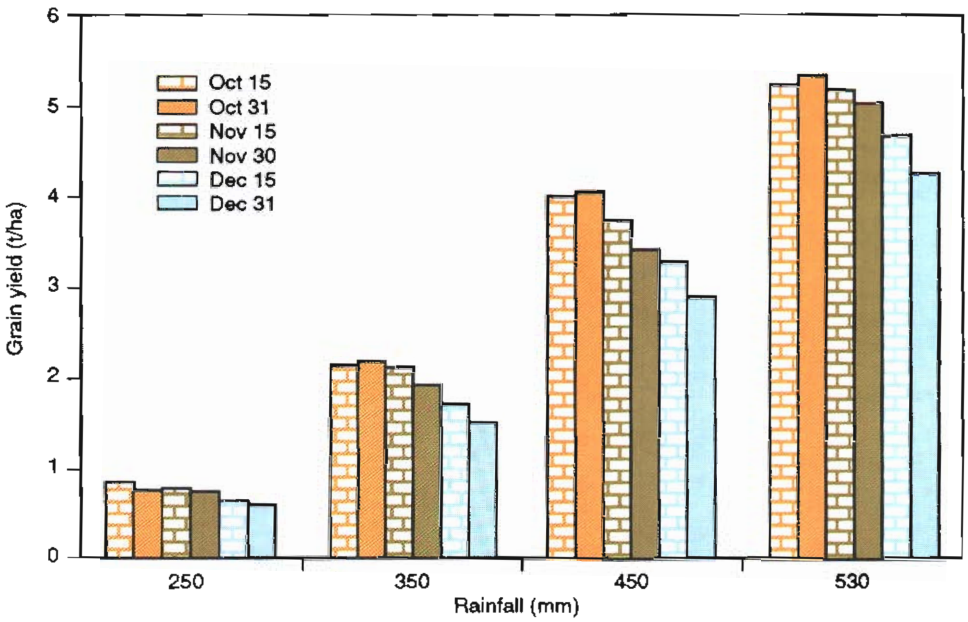


Fig. 3. Predicted mean yield of Cham 1 durum wheat in different rainfall areas.

Predicted yields ranged from 0.5 t/ha under 250 mm rainfall to more than 5 t/ha under 500 mm rainfall on Calcixerollic Xerochrept soil—the most common in northwest Syria. No yield differences were found between sowing dates before mid-November, and there was about 0.4 t/ha yield reduction for every 15 days of delay in sowing thereafter (Fig. 3). This leads to a recommendation that decreasing the risks involved in wheat production is possible by sowing before mid-November.

Under rainfall conditions with optimum date of sowing, the nitrogen fertilizer requirement was about 25 kg N/ha at 250 mm rainfall and 100 kg N/ha at over 500 mm rainfall, which matches the results obtained earlier in on-farm trials, i.e. about 16% of the target area requires less than 50 kg N/ha; 65%, between 50 and 80 kg/ha; and the rest, more than 90 kg/ha under variable rainfall conditions.

Supplemental irrigation can stabilize wheat production, irrespective of rainfall. In northwest Syria, 65% of the area provides 6.0 to 6.5 t/ha predicted yield under supplemental irrigation. The water requirement decreases with increasing rainfall from 400 mm supplemental irrigation in the 250-mm rainfall zone to about 100 mm in areas receiving over 500-mm rainfall. Nitrogen requirement of durum wheat ranges from 90 to 115 kg/ha in 90% of the cropping area with supplemental irrigation.

Germplasm Conservation

ICARDA fully shares the global concern about the ongoing loss of biodiversity, and the urgency to conserve it (UNCED Agenda 21, Convention on Biological Diversity). In 1993/94, the Center focused on the study of genetic diversity in natural populations of wild progenitors and relatives of its mandate crops, genetic structure of landraces, and methodology of *in-situ* conservation. However, germplasm acquisition, characterization, documentation, conservation, and distribution activities remained equally important.

Joint collection missions with NARS yielded 1400 new accessions, and another 2800 were received from other institutions. These additions raised the total number of the Center's gene bank holdings to 110,000 accessions.

More than 27,000 seed samples were distributed from ICARDA's gene bank to users worldwide (including samples for safety duplication): USA and Canada, 1280; Australia and New Zealand, 445; Japan, 48; Europe, 1776; other industrialized countries, 6317; WANA, 8572; and ICARDA, 8978.

As a joint response from the CGIAR centers to the international concern about *ex-situ* germplasm collections, all accessions in ICARDA's gene bank were placed under the auspices of FAO as designated germplasm, in conformity with the agreement signed on behalf of ICARDA by the CGIAR Chairman in October 1994. Thus, ICARDA will hold the designated germplasm in trust for the benefit of the international community, particularly developing countries.

Collection of Wild Relatives of Wheat and Barley in Lebanon and Syria

Collecting missions in 1994 to Lebanon and Syria focused on the geographical distribution of wild progenitors of wheat and barley in the western part of the Fertile Crescent, and sampling of the natural populations for genetic diversity analyses and *ex-situ* conservation. The extent of habitat destruction and identification of suitable sites for *in-situ* conservation were other important objectives of the missions conducted in collaboration with the respective NARS and the University of California, Riverside.

The mission results included the (1) discovery of *Triticum urartu* and *Triticum baeoticum* populations in the extreme northeast Syria; (2) existence of large populations of the putative durum and bread wheat progenitor and the donor of the B genome, *Aegilops speltoides*, in the northern part of Hassakeh province, Syria; (3) discovery of *Aegilops tauschii* (donor of the bread wheat D genome) populations adapted to low-rainfall (below 200 mm), extremes of temperature and low-fertility soils in Raqqa province; (4) presence of a small *Triticum dicoccoides* population in the vicinity of Hama, which may be seen as representing the missing link between north Syria and south Turkey populations and those in the Anti-Lebanon and Jebel Al-Arab mountains in southwest Syria and southeast Lebanon; and (5) identification of two sites each in Lebanon and Syria for *in-situ* conservation of wheat wild progenitors.

The increasing destruction of the natural habitat of wild plants, including progenitors of important crops, resulting from overgrazing, reclamation and/or cultivation of grazing land, and urbanization is a matter of great concern and calls for urgent action. To challenge this negative trend, ICARDA has initiated a consortium on biodiversity conservation through natural resources management in the Near East countries.

In the missions to Lebanon and Syria, 34 wild *Triticum*, 21 *Hordeum spontaneum*, and 57 *Aegilops* spp. populations were sampled.

Members of the joint Syria, University of California, Riverside, and ICARDA collection mission interview farmers for information on wheat wild progenitors in the protected site at Jebel Abd Al Aziz area, Syria.

Urbanization of a natural habitat of plant genetic diversity is leading to a gradual loss of a wild relative of wheat in one of the WANA countries.

Ecogeographic Survey of Native Pasture and Forage Legumes in Northern and Coastal Tunisia

In 1992, INRAT (Institut National de la Recherche Agronomique de Tunisie) and ICARDA conducted a joint collection mission in central Tunisia, in areas between Sfax-Kasserine and Kef-Sousse. Over 375 accessions of 49 species were collected, mainly from areas with low to moderate rainfall and moderate fertility.

The second phase of collection, in 1994, included the collaboration of the Centre for Legumes in Mediterranean Agriculture (CLIMA), Australia and covered the area north of Kef-Sousse, including the northern and eastern coasts.

During this mission, 902 accessions of 16 genera and 71 species of pasture and forage legumes were collected. The largest number of accessions were of *Medicago* with 20 species, and of *Trifolium* with 19 species. This material was collected from 91 sites in northern and coastal Tunisia (Fig. 4).

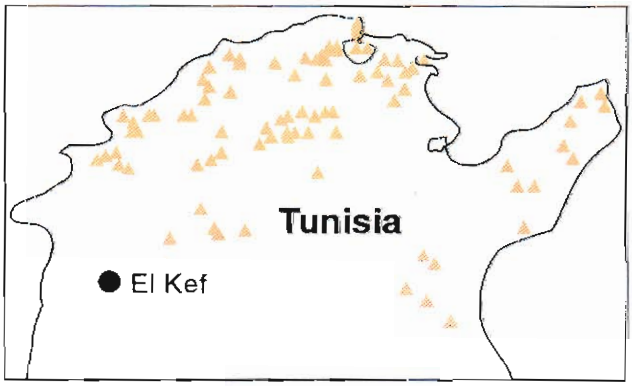


Fig. 4. Collection mission sites in Tunisia, 1994.

Forest areas were extremely overgrazed and no genetic resources of legumes were found.

Hedysarium species, especially *H. coronarium*, were common on the high pH, heavy clay vertisols (40 sites) and were tolerant of heavy grazing. *H. spinosissimum* was found in both missions, mostly in the lower rainfall areas, whereas *H. coronarium* was distributed over the full range of rainfall. These species have a significant potential for both forage and pasture production in North Africa because of their heavy biomass production, high production of pods, and good tolerance of overgrazing.

Perennial *Trifolium* species were rare, except for strawberry clover (*T. fragiferum*), which was found at 30 sites. *T. subterraneum* was found at only four sites.

V. narbonensis (16 accessions) was found concentrated in an area around Bizerte. It was also found in north-central Tunisia and close to Tabarka. The only common species of *Lathyrus* in the northern and coastal regions was *L. ochrus*, which was found at 31 sites.

Geographical Distribution, Ecology and Diversity of *Triticum urartu* Populations in Jordan, Lebanon, and Syria

Wild diploid wheat *Triticum urartu* was discovered in 1930 in Armenia by Tumanian and scientifically described in 1972 by Gandilyan. Subsequently, *urartu* wheat has been identified as a wild progenitor of cultivated durum and bread wheats and a donor of their A genome chromosomes.

It was originally believed that the species is endemic to Armenia; later, it was also found in Iran, Iraq, Lebanon, and Turkey. Its presence in Syria was first reported in 1981. Exploration and collection trips, which focused not only on *T. urartu* but also on other wild *Triticum* species, were conducted by ICARDA in Jordan (1991), Lebanon (1993 and 1994), and Syria (1991, 1992, 1993, and 1994) in cooperation with the respective NARS.

The exploratory trips showed that *T. urartu* is a typical element of the flora of the southwestern part of the Fertile Crescent where it is more common than the other diploid wild wheat, *Triticum baeoticum*. The geographical distribution in this region of *urartu* wheat is presented in Fig. 5.

In general, its distribution overlaps with that of *Triticum dicoccoides*. However, it is rare in Jordan and in the lowlands of the Hauran plain in southern Syria. *T. urartu* is better adapted to stressful environments than *T. dicoccoides* and can be found in drier

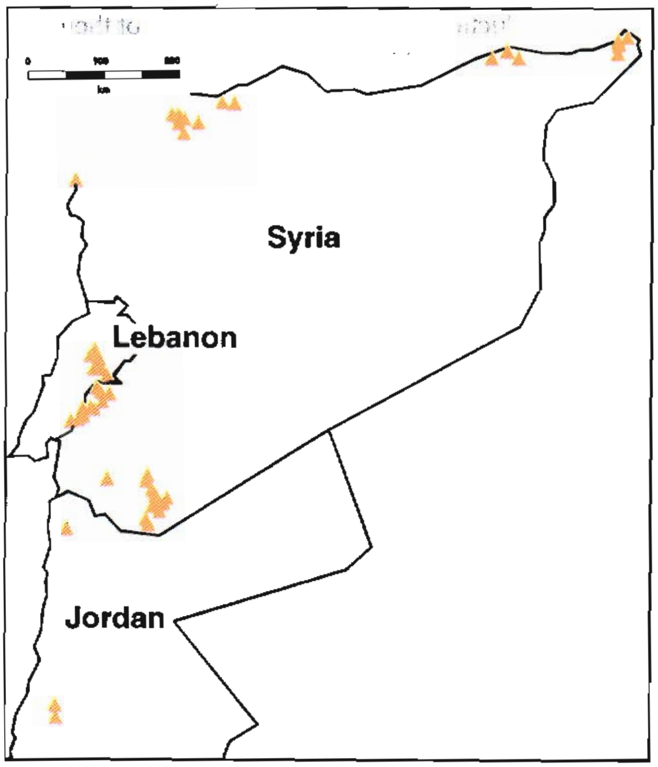


Fig. 5. Distribution of *Triticum urartu* in Jordan, Lebanon and Syria.

parts of the Beka'a Valley in Lebanon and low-rainfall sites in northern Syria, close to the border with Turkey. It can resist the harsh environment of higher mountains and occurs at altitudes above 1800 m asl in the Lebanon and Anti-Lebanon mountains. In these high sites it was accompanied by wild barley, *Hordeum spontaneum*, but no other *Triticum* or *Aegilops* species were present.

Of the total of 50 *T. urartu* populations presently identified in Jordan, Lebanon and Syria, 16 were allopatric; 29 and 10 were sympatric to *T. dicoccoides* and *T. baeoticum* populations, respectively. The last species is absent in Jordan and rare in Lebanon and southern Syria.

The *urartu* wheat showed a preference for volcanic soils derived from a basaltic parent rock, as well as good adaptation to high elevations and low rainfall.

The geographical pattern of *T. urartu* was studied in seven Syrian populations and two subpopulations from Jordan by means of discriminant analysis using the following six descriptors: time to heading, time to maturity, spike length, awn length, number of spikelets per spike and plant height. Three major groups were identified: (1) populations from southern Syria, which were early and short-awned; (2) Jordanian germplasm—early and long-awned; and (3) populations from northern Syria—late and short-awned.

Table 1. *Triticum urartu* population frequency distribution by genetic diversity categories.

	Nei heterozygosity index (H_e)			
Country	<0.35	0.35–0.70	>0.70	Total
Jordan	1	1	—	2
Lebanon	5	3	—	8
Syria	8	3	7	18
Total	14	7	7	28

Genetic diversity within populations was estimated from gliadin polymorphism data. Mean Nei heterozygosity index values (H_e) were calculated for 28 populations as an average of the two loci data. The results are summarized in Table 1. The most diverse populations ($H_e > 0.70$) of *T. urartu* were found in Jebel Al-Arab in southern Syria, and in the northern part of Jebel Sema'an in Aleppo province, northern Syria.

Yellow Rust Resistance in Natural Populations of Wild *Triticum* Species

The wheat progenitors, wild einkorns—*Triticum urartu* and *T. baeoticum*—and wild emmer—*T. dicoccoides*, have coexisted with their pathogens much longer than cultivated wheats have, and during that time they may have accumulated resistance genes to different diseases.

In the 1993/94 season, a large number of single-plant progenies of wild *Triticum* spp. were planted in the field for characterization of genetic diversity. As the season was favorable to yellow rust, the pathogen inoculum spread from a nearby infection nursery and a heavy epiphytotic developed in the whole field. This opportunity was used to study the natural population structure of the wild wheats in relation to yellow rust response.

The single-plant progenies represented 1 population of *T. baeoticum*, 12 of *T. urartu*, and 8 of *T. dicoccoides* from the western part of the Fertile Crescent including provinces of Jordan (Irbid, Tafila), Syria (Aleppo, Damascus, Sweida), and Turkey (Gaziantep, Urfa). Some populations of different species were sympatric, i.e. two or three species were collected in the same site (Table 2).

Table 2. Reaction of 606 single-plant progenies (SPP) derived from 21 natural populations of wild *Triticum* spp. to an epiphytotic of yellow rust, Tel Hadya, Syria, 1993/1994.

	Yellow rust reaction					SPP
	0	3	5	7	9	total
Population	R	MR	M	MS	S	
TB_ALP1[a]	8	14				22
TU_TAF1			1	9	2	12
TU_TAF2			1	4	16	21
TU_SWD1			4	13	4	21
TU_SWD2			6	25		31
TU_SWD3[b]			5	21	6	32
TU_SWD4[c]		6	6	16	2	30
TU_ALP1	20	20				40
TU_ALP2[a]	8	11				19
TU_ALP3		32				32
TU_ALP4		16				16
TU_GAZ1		4	19			23
TU_URF1		9	7	9		25
TD_IRB1		2	17			19
TD_SWD1		52	16	6	4	78
TD_SWD2[b]			2	14	22	38
TD_SWD3	6	15	7	8	4	40
TD_SWD4	9	10	6	2	3	30
TD_SWD5[c]				6	23	29
TD_DAM1		6	12	6	2	26
TD_ALP1[a]					22	22
Total	51	197	109	139	110	606

a : Population acronyms were developed in the following way: the first two letters refer to a species and the other three to a province. Identical superscripts indicate sympatric populations. 0 = resistant (R), 3 = moderately resistant (MR), 5 = medium (M), 7 = moderately susceptible (MS), and 9 = susceptible (S).

A large proportion (>40%) of the single-plant progenies possessed resistance to yellow rust (Table 2). The genes conferring the resistance are very important to wheat-breeding programs for the Near East because the inoculum applied in the nearby infection nursery, which was the initial source of the epiphytotic, was a mixture of local biotypes.

T. urartu populations displayed a distinct geographical pattern of diversity in the disease response. Those from Aleppo province were resistant to yellow rust, whereas populations from Jordan and Sweida province in the south of Syria were susceptible, except one type, which included moderately resistant progenies. Turkish populations showed intermediate reactions.

Diversity in wild wheat single-plant progenies in their reaction to yellow rust, Tel Hadya, 1994.

A Lentil Progenitor and its Center of Diversity

A study is under way to identify geographical clines or patterns of closely related genotypes of *Lens culinaris* ssp. *orientalis* using Random Amplified Polymorphic DNA (RAPD). This technique provides a quick method of detecting polymorphism at the DNA level and is useful for the study of within-population variation and within-species variation. *L. culinaris* ssp. *orientalis* is recognized as the wild progenitor of the cultivated lentil, *L. culinaris* ssp. *culinaris*.

The four prominent genotype patterns resulting from screening 131 accessions of *orientalis*, using two different primers, show that accessions from Turkmenistan, Uzbekistan and Tadjikistan are all very similar (Fig. 6). All genotype clusters, including three rare genotypes, were found to overlap in southeastern

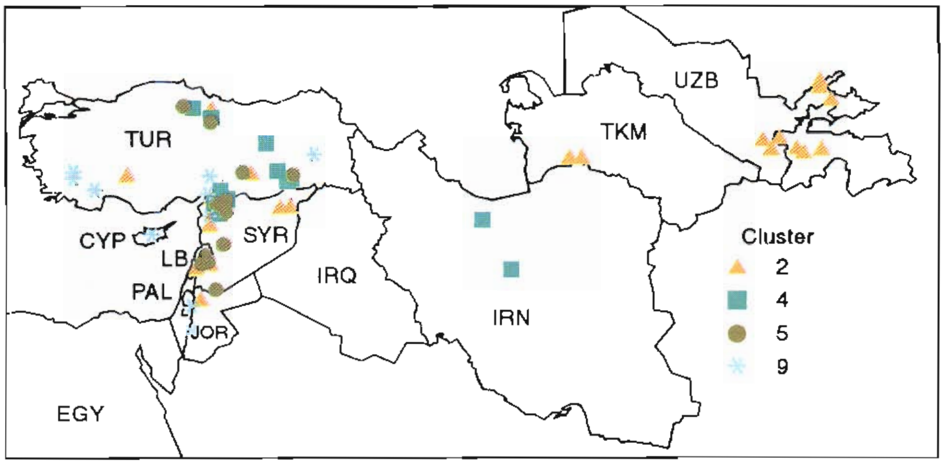


Fig. 6. Geographical distribution of four *Lens culinaris* ssp. *orientalis* clusters based on Jaccard's Coefficient of Similarity from RAPD data.

Turkey and northern Syria. An index of diversity for nine regions (Table 3) indicates that southeastern Turkey and northern Syria are the centers of diversity. This is also the region where lentil is believed to have been domesticated and where incipient speciation has been noted.

Table 3. Genetic diversity of *Lens culinaris* ssp. *orientalis* in nine geographical regions.

Region	No. accessions	Nei's genetic diversity
Uzbekistan, Tadjikistan and Turkmenistan	12	0.091
Iran	2	0.068
Northern Turkey	5	0.176
Cental eastern Turkey	5	0.223
South western Turkey	7	0.331
Cyprus	3	0.042
South eastern Turkey and northern Syria	64	0.778
Lebanon, south western Syria and central Syria	22	0.532
South Syria, Palestine and Jordan	10	0.270

Seed Health Laboratory

The Seed Health Laboratory (SHL), established in 1982, continued to inspect all seed shipments from and to ICARDA. Seed samples from outside sources, after testing in the laboratory, are grown for one generation in the postquarantine area for further inspection. SHL strictly adheres to national quarantine regulations.

Flag smut (*Urocystis agropyri*), observed at Tel Hadya during 1986 to 1992, was brought under control in 1993/94 season when only one plant was detected.

The Slide Agglutination Test (Antisera Test) has been introduced for the detection of *Pseudomonas syringae* pv. *pivi* in imported and exported pea seeds. With this technique the pathogen was detected in 15 out of 79 pea seed samples produced at Tel Hadya as well as 4 out of 20 samples received from external sources.

A research project was initiated to study the genotype x environment interaction on seed infection by *Pyrenophora graminea* at three sites in northern Syria. The results indicated that cultivars Vada, Betzes, and Zanbaka were resistant under natural conditions.

Germplasm Enhancement

Cereal Crops

ICARDA has a world responsibility for encouraging national research efforts to improve the productivity and yield stability of spring, winter, and facultative barley. In cooperation with CIMMYT (Centro Internacional de Mejoramiento de Maiz y Trigo), it carries out research on the improvement of bread and durum wheats in the dry areas of WANA. Research on barley for Latin America and other areas with similar agroecologies is conducted by ICARDA from CIMMYT in Mexico.

International Cereal Testing Program

Genetic material is shared with national partners as international and regional trials and nurseries. In 1994, a durum nursery for high-altitude areas, a crossing block each for bread and durum wheats, and three barley germplasm pools containing lines resistant to net blotch, scald or powdery mildew were distributed for the first time. In consultation with national scientists, the number of lines in the joint CIMMYT/ICARDA durum observation nursery for favorable areas was reduced. Special field trials of material specifically developed for Algeria, Egypt, Libya, Morocco, and Tunisia were provided in place of the regular international nurseries. Over 464 sets of barley, 285 of durum, and 424 of bread wheat trials and nurseries were distributed to cooperators in 48 countries for the 1994/95 season. Cooperators in several NARS identified promising lines for multilocation testing, on-farm trials, prerelease multiplication, and release for general cultivation (see Appendix 2).

Cham 5, a high-yielding durum wheat cultivar with resistance to different biotic and abiotic stresses, was released in 1993/94 for the dry areas in Syria.

Exploiting Genetic Resources of the Fertile Crescent: A New Barley Variety for Syria

The Fertile Crescent in the Near East, where many of the species of temperate-zone agriculture originated and were first domesticated, is still rich in the wild relatives of many crops. In Syria, which is located in the Fertile Crescent, barley production is mostly based on two landraces, Arabi Abiad (white seed) and Arabi Aswad (black seed). The first is common in relatively favorable environments (annual rainfall between 250 and 400 mm) and the second, in harsher environments (annual rainfall <250 mm).

Considerable heterogeneity exists both between landraces in different farmers' fields and between individual plants within the same farmer's fields. This was noted when a number of single-head progenies were analyzed from a collection made in 1981. The collection consisted of 100 individual heads from each of 60 farmers' fields spread all over Syria. From one of those heads collected in 1981 in a field at Um-Zeitoun, near Sweida, about 100 km east of Damascus, in the Haurani plateau, a new pure-line barley variety was derived which has been released as improved Arabi Abiad (Arta) in Syria (see also page 5).

Arta was tested for the first time in 1984/85 at one of ICARDA's dry substations (rainfall in 1984/85: 277 mm) at Breda in Syria and selected for grain yield and 1000-kernel weight. In 1985/86 it was tested again with other lines derived from landraces in larger plots and promoted to the 1986/87 advanced yield trials together with other breeding material (Table 4). The

Table 4. Grain yield of SLB 39-58 in the advanced yield trials in 1986/87 at Tel Hadya, Breda, and Bouider in Syria.

Entries	Grain yield (kg/ha)		
	Tel Hadya (343 mm)*	Breda (245 mm)*	Bouider (164 mm)*
SLB 39-58	3738	1203	84
Rihane-03	3290	723	17
Soufara-02	2647	586	7
Harmal	2871	804	97
A. Aswad	2500	726	62
A. Abiad	2929	724	63
Mean	2655	671	32

* Rainfall.

season was dry and cold, particularly at Breda (245 mm rainfall and 46 frost days) and Bouider (164 mm rainfall and 52 frost days), a second dry testing site of ICARDA in Syria. Rainfall was higher (343 mm) at the main ICARDA station at Tel Hadya but low temperatures (36 frost days) reduced yield. Arta yielded 14% more than the best check (Rihane-03) at Tel Hadya and 50% more than the best check (Harmal) at Breda. Even at Bouider, where there was a crop failure, Arta yielded as much as the local landraces. All these trials were rainfed, with no fertilizers, pesticides, or weed control.

Arta was included in the Barley Observation Nurseries in 1986/87 and 1987/88. It ranked 12th (out of 120 entries) in Tel Amara, Lebanon; was visually selected at two locations in Pakistan (Sariab and Khuzdar) in 1986/87; and it performed well in Dromolaxia (Cyprus) and Terbol (Lebanon) in 1987/88.

Arta was first promoted to on-farm testing in Syria in 1988/89. By 1992, data were available from a total of 40 locations (Table 5). In each of the four years, Arta ranked first and yielded between 5 and 52% more than Arabi Abiad and between 2 and 33% more than the next best line. It was also higher yielding than Arabi Aswad although it was not meant for areas where the black-seeded landrace is dominant.

Table 5. Performance of Arta during four cropping seasons in on-farm trials[a] in Syria.

Year	No. of sites	Mean yield	Rank	% Over A. Abiad	A. Aswad	Best line
1988/89	4	1814	1	+18.6	+10.6	+18.6
1989/90	9	1962	1	+12.3	+5.8	+3.5
1990/91	10	2341	1	+5.0	+18.5	+5.0
1991/92	13	3358	1	+31.6	+10.8	+1.8
1991/92	4[b]	3263	1	+52.5		+33.5

[a] Two or three replications with 32 m^2 plots.
[b] Unreplicated with 1000 m^2 plots.

Arta has excellent winter growth and better cold tolerance than Arabi Abiad. Phenology and plant height are similar to Arabi Abiad and seeds are larger. Farmers who have tested Arta on 2- to 5-ha plots have reported an average yield increase of 20% over local landrace without additional inputs. Arta has been recommended for zone B (annual rainfall <250 mm) in Syria, excluding the provinces of Raqqa and Hassakeh where the black-seeded landrace is dominant.

Adaptability and Yield Stability in Winter Barley

Stability of production and adaptability to different high-elevation environments of winter barley primarily depends on its cold tolerance, winter hardiness and growth habit, which are interlinked and related to vernalization and photoperiodism. A technique has been developed to separate locally adapted germplasm of continental highlands origin into spring types (without vernal genes) and pure winter types (with vernal genes). Newly developed germplasm of winter and facultative barley is evaluated in summer (minimum temperature >10°C). Lines that head (not having vernal genes) are discarded, and those with partial heading (facultative type) or no heading (strong vernal genes) are selected and evaluated under controlled environments to determine their photoperiod and vernalization requirement. This strategy has brought about a major shift from spring to facultative and winter types in ICARDA's breeding material, and helped in better targeting the material for diverse requirements of the WANA highlands (Fig. 7). In 1990, 71% of the material tested was of spring type and only 20 and 9% was of facultative and winter types,

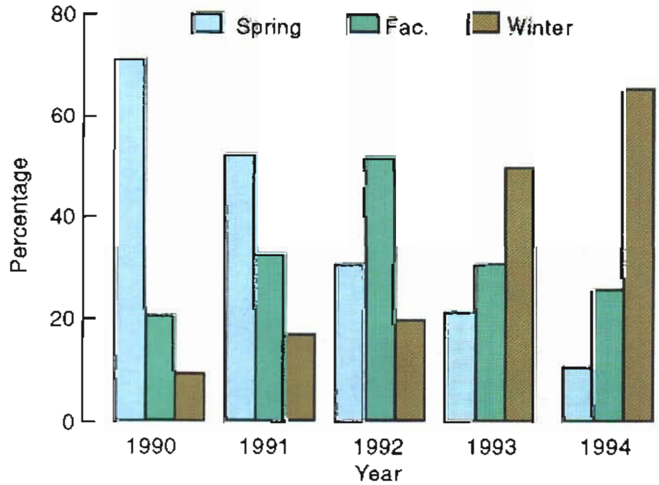


Fig. 7. Genetic shift in growth habit of winter and facultative barley germplasm based on screening for vernalization requirements.

respectively. However, in 1993/94 the proportion of winter and facultative types greatly increased with 65, 25, and 10% of the material being of winter, facultative and spring types, respectively.

By supplying targeted material to NARS, progress has been made in identifying cold-tolerant, better adapted, and high-yielding lines. The best lines at Ardabil, a very cold location in Iran, yielded 25 to 77% more than the widely cultivated variety Zarjau.

The top-yielding lines in the 3rd International Winter and Facultative Barley Yield Trial at Karmanshah, Iran—where diseases such as scald, rather than severe cold, drastically reduce productivity—showed that the selected lines were also resistant to major diseases. Although only two of the five selected entries gave significantly higher yield than the national check, the other three lines also yielded 15 to 20% higher. These entries are now being tested by NARS in the highlands of WANA.

Molecular Markers for the *Mlg* Locus in Barley

Barley lines Tadmor and WI2291, as well as a differential set of lines with known resistance genes to powdery mildew (*Erysiphe graminis* f.sp. *hordei*), were infected with different powdery mildew isolates (Table 6). A comparison of the reaction revealed the presence of the *Mlg* resistance locus in WI2291. The *Mlg* gene was located on barley chromosome 4, and the Restriction Fragment Length Polymorphism (RFLP)-marker MWG 032 about 2 cM from it. To develop more closely linked markers, clone MWG 032 was sequenced and two specific PCR primers were synthesized based on the sequence data of MWG 032.

With this primer pair an amplification product was generated with the genome DNA of the parents Tadmor and WI 2291. Unfortunately, no variation in the length of the product was found. Therefore, the amplified products in each parent were cloned and sequenced to detect mutations (basepair changes) between them. In the area of the RFLP-marker no variation could be found between the DNA sequence of the parents. Subsequent inverted PCR was used to amplify DNA sequences in the flanking region of the RFLP-marker. The direction of the two primers was therefore inverted.

With this strategy, a 180-bp fragment could be amplified with primer 239-Invl in Tadmor, and sequenced. With a new primer, efforts will be made to amplify this region also in WI2291 to analyze the DNA sequence. Differences in the sequences in Tadmor and WI2291 can then be used to design PCR primers specific to the *Mlg* locus.

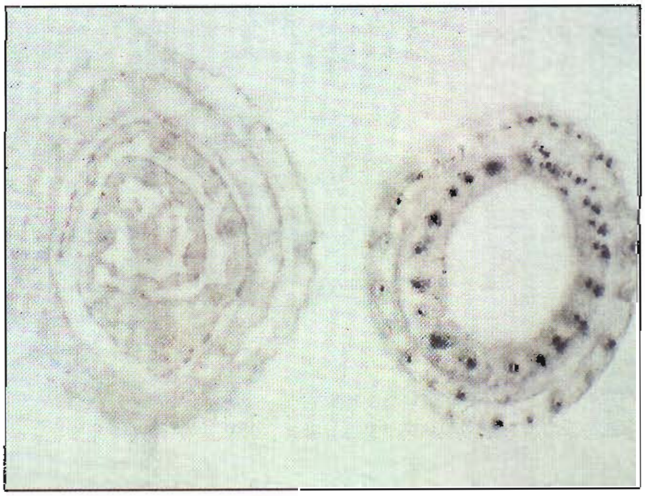
Table 6. Comparison of resistance spectrum of barley varieties, with known genes for resistance to powdery mildew, and Tadmor and WI2291 after infection with different powdery mildew isolates. Resistance shown on 0-IV scale with 0 = resistant, IV = susceptible; figure following resistance rating gives fraction of leaf surface covered by powdery mildew.

		Powdery mildew isolate											
Cultivar	Gene	WE-3	GI-1	TR-2	RU-3	VO-2	AL-1	VA-3	PS-IS-2	AR-4	AR-1	129-13	Apex-4
Gitte	*MlaI*	I 0.1	IV 0.5	0	0	0	IV 0.3	0	III-IV 0.2	0	0	0	0
Voldagsen	*Mla6*	0	0	IV 0.4	0	IV 0.6	0	0	III-IV 0.2	IV 0.5	0	IV 0.5	IV 0.5
Ortolan	*Mla7/Mlk*	III-IV 0.5	II 0.1	IV 0.4	IV 0.6	II 0.3	II 0.1	II 0.3	0	I 0.1	I 0.1	IV 0.6	I 0.1
Welam	*Mla9*	IV 0.7	0	0	IV 0.7	0	0	0	III-IV 0.1	0	0	0	0
Sultan	*Mla12*	I 0.2	IV 0.5	0	IV 0.6	II 0.4	IV 0.3	III 0.3	III-IV 0.5	IV 0.5	IV 0.5	I 0.1	IV 0.5
Rupal	*Mla13*	I 0.05	0	0	IV 0.7	I 0.05	0	0	0	0	0	0	0
Villa	*Mlg*	IV 0.7	IV 0.5	IV 0.5	IV 0.5	0	0	0	III-IV 0.1	IV 0.5	IV 0.4	IV 0.5	IV 0.5
Bollo	*Mlh*	IV 0.8	IV 0.6	IV 0.5	IV 0.8	IV 0.8	0	IV 0.8	III-IV 0.5	IV 0.7	IV 0.1	IV 0.7	IV 0.6
Vada	*Mlla*	III 0.5	IV 0.3	III 0.4	III 0.5	IV 0.7	II 0.1	IV 0.6	III-IV 0.5	II 0.1	III 0.2	III 0.5	III 0.5
H.T. 253	*Mla* (new)	I 0.1	0	0	II-III 0.4	I 0.1	0	0	I 0.1	0	0	II. 0.1	0
Hln	*Mlo*	0	0	0	0	0	0	0	0	0	IV 0.01	0	0
Po-2	*Mla3*	I 0.1	I 0.05	0	I 0.2	II 0.1	I 0.05	I 0.1	II 0.1	I 0.1	0	IV 0.5	I 0.05
Tadmor		IV 0.6	IV 0.6	IV 0.5	IV 0.6	IV 0.7	IV 0.6	IV 0.5	IV 0.2	IV 0.6	IV 0.6	IV 0.6	IV 0.6
WI2291	*Mlg*	IV 0.4	IV 0.5	IV 0.2	IV 0.6	0	0	0	IV 0.5	IV 0.5	IV 0.6	IV 0.5	IV 0.5

Development of a Simple Test for Virus Detection

The development of enzyme-linked immunosorbent assay (ELISA) for plant viruses in 1977 facilitated virus testing with improved sensitivity. Since then efforts have been made to further improve the procedure. Over the last three years, ICARDA has made intensive efforts to adapt and improve the tissue-blot immunoassay (TBIA) for the detection of legume and cereal viruses. The improved procedure can be completed in three hours as opposed to two days required for the regular ELISA procedure. The most important feature of TBIA is that it does not require sample extraction, a very time-consuming step with other procedures. The shortening of the procedure did not reduce the sensitivity of the test. Because of its simplicity and low cost, the test is recommended for virus surveys, screening for virus resistance, seed-certification programs, and detection of seedborne viruses, especially in countries where sophisticated virus-testing facilities are not available. TBIA permitted the detection of barley yellow dwarf virus in infected cereal tissue even at maturity.

The TBIA procedure has also been effective in detecting the seedborne infection of broad bean stain comovirus in lentil at seedling stage before the disease symptoms appear.



Detection of barley yellow dwarf luteovirus in phloem vessels of an infected barley plant (right) using the tissue-blot immunoassay. A blot of a healthy plant stem is also shown.

Cereal Germplasm Resistant to Barley Yellow Dwarf Virus

Barley yellow dwarf virus (BYDV) affects cereal production worldwide. Surveys conducted in the WANA region indicated that BYDV can reach epidemic levels and cause economic losses in some countries, e.g. Morocco, Tunisia, Algeria, and Egypt.

Cereal germplasm screening over the last few years at ICARDA has provided genotypes resistant or tolerant to BYDV, and adapted to the agroclimatic conditions of the region. The most important genotypes include: barley BKL-86-35, BKL-92-65, and BKL-93-75; durum wheat DON-LRA-86-25, 12th-IDSN-227, and DKL-93-25; and bread wheat WKL-91-138, WKL-92-151, and WKL-92-222. These genotypes could suffer only 20-25% yield loss due to BYDV infection as compared with 80-90% for susceptible genotypes. Higher levels of BYDV resistance were identified in wheat breeding lines derived from a cross of wheat x *Thinopyron intermedium*.

Survey of Nematodes of Barley in Syria

Nematodes are known to cause severe damage to winter cereals including barley. A survey was conducted in March 1994 in collaboration with ARC (Agricultural Research Center), Douma, Syria and the Instituto di Nematologia Agraria, C.N.R., Bari, Italy. Ninety soil and root samples were collected, mainly from barley fields, in the provinces of Raqqa, Hama, El-Bab, and Hassakeh.

Of 90 root samples, only seven were free of nematodes. *Pratylenchus* spp. were the most frequent (72 samples). It is possible that these root-lesion nematodes included both *P. thornei* and *P. mediterraneus*, found previously in chickpea roots, although the presence of other species cannot be ruled out. The cyst nematode *Heterodera latipons* was found in 21 samples, and another root-lesion nematode belonging to genus *Pratylenchoides*, in 17 samples. The stem and bulb nematodes *Ditylenchus* spp. were found in 10 samples. The root-knot nematode *Meloidogyne artiellia*, known to cause severe damage to chickpea in Syria, was observed in only two root samples of barley, although barley is a common host for this nematode.

Pratylenchus spp., *H. latipons* and *M. artiellia* should be regarded as noxious to barley. Species of *Pratylenchus* have a wide host range and are known to affect cereals in the Mediterranean basin, but no specific information is available for barley. *H. latipons* attacks mainly barley in Mediterranean countries, and is considered a severe pest of barley in Cyprus. *M. artiellia* can damage cereals, legumes and crucifers, and is common on chickpea in Syria.

In general, the numbers of root nematodes were relatively low. Most of the *Pratylenchus* specimens were juveniles. Future surveys should, therefore, be conducted at a later stage of barley growth, and extended to the remaining barley areas, to obtain a better understanding of the role of this nematode in barley production in Syria.

Crop Rotation to Control Ground Pearl in Barley

Ground pearl, *Porphyrophora tritici* (Homoptera: Margarodidae), poses a serious pest problem to wheat and barley in marginal areas. Extensive and severe infestations have been observed in over 100,000 hectares of northern Syria in areas receiving 200 to 250 mm annual rainfall. *P. tritici* infestations vary greatly from location to location and from plant to plant, and may be promoted by such factors as cereal monoculture, stubble left in the field, and plants affected by other stresses. Therefore, the effect of different rotation schemes on *P. tritici* infestations was studied in three long-term barley trials at Breda, a dry environment in northern Syria, where a barley landrace (Arabi Aswad or Tadmor) was grown every year or was alternated with forage legumes or clean fallow. Significant differences were observed between densities of second-instar specimens of ground pearl on plants among the different rotation schemes. Continuous barley was most severely infested, followed by barley rotated with vetch or clean fallow. The number of second-instar specimens per plant was 6.4, 4.4, and 3.9, respectively. Fertilizer applications and tillage schemes employed in the three rotations did not affect *P. tritici* populations. Therefore, *P. tritici* infestations in marginal rainfed environments may be prevented from causing losses by using a forage legume or clean fallow to disrupt barley monocultures. Chemical insecticides, although effective, would not be economical in marginal areas.

Boron-toxicity Tolerance in Barley and Other Cereals

Boron is one of the essential micronutrients for crop growth, but it can be toxic to plants when present in high levels. Boron concentrations in the subsoil are widespread in the dry areas of WANA. Since reducing

Ground pearl in barley: field damage (left) and second instar cysts (right).

the excess of soil boron concentration agronomically is difficult and expensive, research on plant tolerance has been carried out at ICARDA since 1992.

Experiments conducted with many moderately tolerant to tolerant cereal entries in a greenhouse showed that the expression of boron-toxicity symptoms and percentage grain yield reduction were greater for barley than for durum wheat, and least for bread wheat. Boron toxicity also delayed heading in all three crops, and reduced plant height in wheat, except for the most tolerant entries.

In screening advanced lines and germplasm collections for boron-toxicity tolerance, more attention is being paid to winter barley and durum wheat, since such work has not been carried out on these crops in the past. Good sources of tolerance have been found in three Chinese barley accessions. Other promising sources appeared in ICARDA's germplasm collection from Iraq. In durum wheat, an old Syrian cultivar and an Algerian landrace showed the best tolerance.

Introgressive Hybridization between Wild and Cultivated Durum Wheat

Durum recombinant lines with genes introgressed from wild relatives were tested for abiotic stress tolerance, disease resistance, and grain quality traits. Several lines proved promising under dryland conditions with high yield, resistance to leaf rust, tan spot and *Septoria tritici*, and improved grain quality for processing. From the crosses between a high-yielding durum genotype and *Triticum dicoccoides*, plants with high levels of resistance to tan spot, heat, and cold were selected and included in the joint CIMMYT/ICARDA durum international trials. F_6 progenies of some of these crosses, showing best quality traits, contained the *Glu-A1* allele from *T. dicoccoides* and the *Glu-B3* allele (LMW-2) from durum.

Introgression from *T. dicoccum* and *T. polonicum* improved resistance to drought, heat, and leaf and stem rust. Crosses with *T. polonicum* improved resistance to terminal stress (heat and drought), and with *T. carthlicum* to cold. Introgression from *T. monococcum* improved leaf rust resistance and provided early vigor, while introgression from *Aegilops* provided Hessian fly resistance.

Improving Hessian Fly Resistance in Durum Wheat

Hessian fly is a major constraint to wheat productivity in temperate Mediterranean environments. Work on developing host resistance in wheat for this pest is carried out in collaboration with the national program in Morocco, where the insect is endemic and natural infestation is heavy every year. Screening a large number of durum lines resulted in the identification of one accession resistant to Hessian fly. Screening *Aegilops* spp., collected from the areas where Hessian fly is endemic, also provided several accessions resistant to the insect. Crosses of Hessian fly resistant *Triticum* spp. with durum wheat have produced promising durum populations. A backcrossing program has been under way to combine Hessian fly resistance with good adaptation to environment, high productivity, and good technological qualities. Some 46% of the segregating populations with resistance to Hessian fly have also been selected for resistance to leaf and stem rusts. Resistant lines are being multiplied for multilocation testing.

Performance of Double Haploids of Bread Wheat with Hessian Fly Resistance

Performance of a series of double haploids with Hessian fly resistance, developed earlier, was evaluated in the 1993/94 season by the joint CIMMYT/ICARDA bread wheat improvement project in collaboration with the Moroccan national program. The yield trial conducted at Jma't Shaim, Morocco—a hot spot for Hessian fly infestation—under natural infestation revealed that several double-haploid lines had substantially higher yields not only over the Hessian fly susceptible parents (Tsi/Vee's; Vee's'; and Gonam) but also over the Hessian fly resistant parents (Shi #4144/Grow; Saada). Table 7 presents the yield performance of five of the highest yielding double haploids in the trial in contrast to the mean yields of the resistant and susceptible parents. Because these double haploids combine the Hessian fly resistance with other desirable traits, such as resistance to yellow rust and *Septoria tritici* blotch, and drought tolerance derived from Hessian fly susceptible parents, their performance has been nearly 10-20% better than that of the Hessian fly resistant parents. The double-haploid lines are currently under seed multiplication at Tel Hadya.

Table 7. Performance of Hessian fly resistant, double-haploid lines of bread wheat under natural infestation and dry conditions at Jma't Shaim, Morocco, 1993/94.

Line	Grain yield (kg/ha)
Shi#4414/Crow//Gomam	2975
Shi#4414/Crow//Gomam	2933
Shi#4414/Crow//Gomam	2883
Tsi/Vee/Shi#4414/Crow	2775
Vee's/Saada	2650
Mean of resistant parents	2458
Mean of susceptible parents	2080
LSD (P = 0.05)	630
CV (%)	14.0

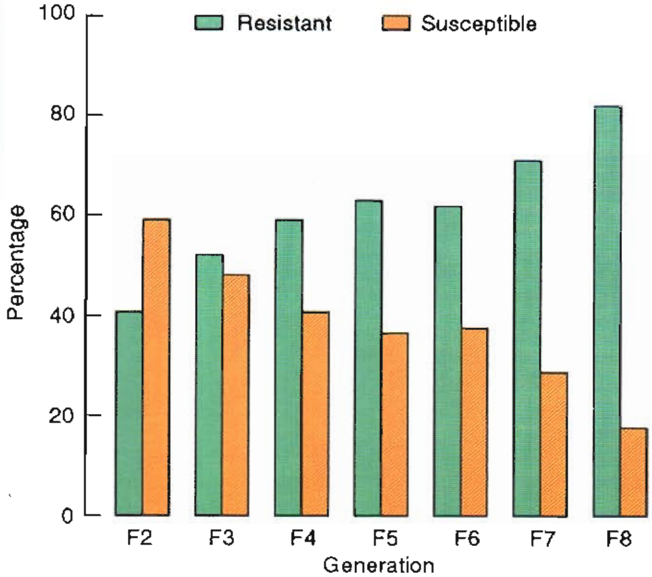


Fig. 8. Percentage of bread wheat families resistant or susceptible to yellow rust at Tel Hadya, 1993/94, under artificial inoculation of mixed field inoculum collected in the 1992/93 season.

Enhancing Yellow Rust Resistance in Bread Wheat Germplasm

Yellow rust, caused by *Puccinia striiformis*, has been responsible for considerable reductions in wheat yields in several countries in West Asia recently. Epiphytotics of the disease developed in parts of Balochistan (Pakistan), Iran, Lebanon, Syria, Turkey, and Yemen in 1993, and caused losses exceeding one million tonnes. The appearance of epiphytotics has been attributed not only to the conducive weather for disease development but also to new virulences in the pathogen against which the resistant *Yr 9* gene in commonly grown cultivars has become ineffective. The joint CIMMYT/ICARDA bread wheat improvement project has been placing increased emphasis on improving the yellow rust resistance level in wheat germplasm (Fig. 8). Investigations on the virulence pattern of the pathogen in different parts of WANA and the identification of sources of resistance in bread wheat germplasm and wild *Triticum* and *Aegilops* species, are receiving priority attention in collaborative work with NARS.

Screening bread wheat germplasm and breeding lines for yellow rust resistance, Tel Amara, Lebanon, 1994.

Enhancement of Winter and Facultative Wheat Germplasm

Winter and facultative bread wheat germplasm was evaluated for cold tolerance in Turkey, and for disease resistance and drought tolerance in Syria in the joint CIMMYT/ICARDA winter and facultative bread wheat improvement program. Disease screening was particularly effective for yellow rust and common bunt (caused by *Tilletia caries* and *T. foetida*) owing to the effective development of artificial epiphytotics at Tel Hadya. From over 4000 entries, a special nursery of genotypes resistant to common bunt was assembled and distributed to the NARS in Iran and Turkey. Accessions combining resistance to both common bunt and yellow rust were also identified and included in special germplasm pools for use by breeders.

Legume Crops

ICARDA encourages and supports national efforts in WANA and other developing countries with similar agroecologies, in improving the productivity and yield stability of lentil, kabuli chickpea, faba bean, dry pea and annual forage legumes (vetches and chicklings), and in enhancing their role in achieving sustainable increases in the productivity of cereal-based farming systems. To pursue these objectives, research was continued on cool-season legumes at Tel Hadya and Breda in Syria, and Kfardan and Terbol in Lebanon. Jointly with national scientists, research sites in several countries were used where conditions for germplasm screening were ideal for developing material with specific resistance to key biotic and abiotic stresses. Summer nurseries of lentil and chickpea were raised at Terbol for generation advancement.

International Legume Testing Program

Lentil, kabuli chickpea, dry pea, chickling, and vetch genetic materials are sent to national programs as international nurseries and trials. The performance data permit the assessment of genotype x environment interaction and help in targeting breeding efforts for specific agroecological conditions. In 1994, two new drought-tolerance nurseries, one each in chickpea and lentil, were developed for the 1994/95 season. ICARDA supplied 1027 sets of 40 different trials and nurseries to cooperating scientists in 48 countries for the 1994/95 season. Requests from several cooperators for large quantities of seed of elite lines identified by them from earlier international nurseries/trials for multilocation yield testing and on-farm verification were also met. The cultivars released by national programs are listed in Appendix 2.

Lentil Adaptation and Results from Decentralized Breeding

Lentil is an under-exploited and under-researched annual legume. From the onset, researchers at ICARDA have been studying the variation in the world germplasm collection to understand factors affecting lentil adaptation to direct the breeding program. Additional information on the specificity of adaptation within the crop has come from collaborative yield trials of common entries selected in different locations. For example, the North African Regional Yield Trial on lentil was established in 1990 to comprise the best lines selected in Algeria, Libya, Morocco, and Tunisia. This trial has revealed that lentils selected in the various countries of North Africa differ substantially in phenology, indicating the need for specific adaptation to a range of environments in the region.

Guided by this understanding, the base breeding program has been designed as a series of separate, but finely targeted, streams linked closely to national breeding programs. The three major target agroecological regions are: (1) South Asia and East Africa, (2) Mediterranean low- to medium-elevation, and (3) high- elevation areas. These correspond to the early, medium, and late maturity groups in lentil. Within each region, there are specific target areas. Thus, for example, within the Mediterranean low to medium elevation region, specific target areas are (i) the major production area of 300-400 mm annual rainfall, (ii) arid areas with <300 mm annual rainfall, (iii) Morocco, where there is the additional problem of rust, and (iv) Egypt, where lentil is irrigated. Each of these target areas has different blends of key traits for recombination (Table 8).

Based on the premise that local selection for adaptation to a specific target area is the most efficient selection method, selection at Tel Hadya is limited to adaptation to the home region—Mediterranean low to medium elevation—and for traits for which the Center has a comparative advantage, such as vascular wilt resistance. As a result, the breeding program has been decentralized to work closely with national programs. For such regions, crosses are agreed with cooperators and made at Tel Hadya; the generations are advanced in the off-season and segregating populations supplied to national cooperators for local selection. Since 1985 when this approach was implemented, ICARDA has made specific crosses for Algeria, Bangladesh, India, Jordan, Morocco, Nepal, Syria, and Turkey. Over 200 crosses are made annually for these countries. Selections made by NARS are fed back into the international trial system for further distribution.

Falguni was recently released as the first rust-resistant lentil cultivar in Bangladesh, as a result of this decentralized approach. It was selected from segregating populations targeted for Bangladesh from crosses

Table 8. Target agroecological regions for lentil production and key breeding aims.

Region	Key traits for recombination
Mediterranean low to medium elevation	
1. 300-400 mm ann. rainfall	Biomass (seed + straw), attributes for mechanical harvest & wilt resistance
2. <300 mm ann. rainfall	Biomass, drought escape through earliness
3. Morocco	Biomass, attributes for mechanical harvest & rust resistance
4. Egypt	Seed yield, response to irrigation, earliness and wilt resistance
High elevation	
1. Anatolian highlands	Biomass & winter hardiness
2. N. African highlands	Seed yield & low level of winter hardiness
South Asia and E. Africa	
1. India, Pakistan, Nepal & Ethiopia	Seed yield, early maturity, resistance to rust, ascochyta and wilt
2. Bangladesh	Seed yield, extra earliness & rust resistance

made of rust-resistant x local cultivar at ICARDA in 1985. Another rust-resistant line, locally selected from the cross of L 15 x FLIP 84-112L, is in the prerelease stage in Bangladesh.

Phenology Model for Highland Winter-sown Lentil

To support the research to identify superior winter-hardy lentils for the highlands, ICARDA has examined the consequences of the change from a spring-sown, highland lentil cropping system to a winter-sown system using a model of flowering. This activity was a part of an ODA-sponsored 'downstreaming' project involving the University of Reading, UK, the Central Research Institute for Field Crops, Turkey, and ICARDA.

The approach was first to develop a simple descriptive model of flowering in lentil by investigating the response of flowering in six genotypes to a wide range of photoperiod and temperature regimes in controlled environments. The flowering response was found to be governed by temperature and photoperiod and well described by the relation:

$$1/f = a + bt + cP$$

where f is the time in days from sowing to first flowering, T and P are the respective values of mean temperature and photoperiod in the same period, and a, b, c are genotypic constants. The model was subsequently validated, with an average r^2 of 0.852, on a wide range of germplasm (231 accessions) grown under two photoperiods (13 and 16 h) and two temperature regimes (24/13°C and 18/9°C) in a glasshouse. Recently, the model was validated in the field with a world germplasm collection of 400 accessions using two environments each in northern Syria and northern Pakistan.

To study the consequences of the change from a spring-sown to a winter-sown system, definitions were required of the window of opportunity for fall germination and emergence. Additional definitions were needed for the spring season of the first 'safe' sowing date and the first and last 'safe' flowering dates, juxtaposed between the threats of late frosts at flowering and the onset of drought. The first date of 'safe' germination in the fall was defined as the receipt of 15 mm of rain within a five-day period after 1 September and the latest fall sowing date was defined as the date on which probability of average air temperature falling below 4°C first exceeds 10%. The definition for the first 'safe' sowing date in spring was the inverse definition of that used to define the end of the season in winter, i.e. the date at which air temperature averaged >4°C in at least nine years out of ten. The first 'safe' flowering date in spring was defined as the date of the last recorded frost in the 40-year data set at the target location. The last 'safe' flowering date was defined as the date on which the weekly probability of rain declines to below 25%.

Meteorological data (40-year runs) at three representative Anatolian sites—Corum (798 m elevation), Sivas (1285 m), and Erzurum (1869 m)—were analyzed to establish the timing and duration of the fall germination window and the spring flowering window at each location. Simulating various sowing dates, the model was able to indicate appropriate periods for each site. This nullified the need for expensive field experiments of date of sowing across a string of sites spanning the highlands of Turkey, providing a major cost saving to the national program.

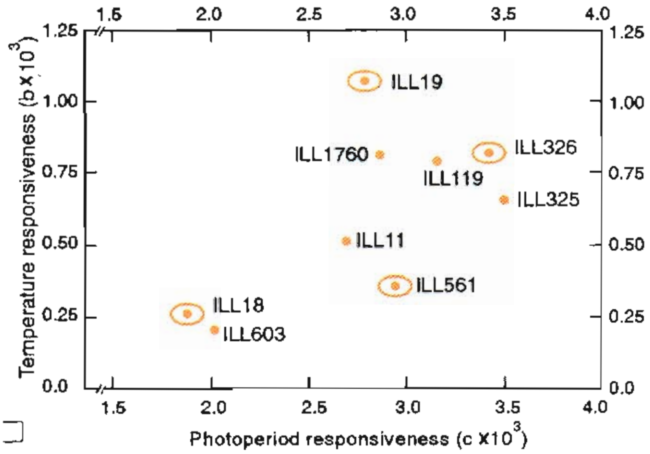


Fig. 9. The temperature- and photoperiod-response constants (b and c, respectively) of nine cold-tolerant lentil genotypes for rate of progress from germination to first flowering.

The flowering model was then used to examine the consequences of sowing a range of cold-tolerant germplasm differing in response to temperature and photoperiod (Fig. 9). Flowering times were calculated at each site for a range of sowing dates and genotypes spanning the variation present in response to temperature and photoperiod among winter-hardy material. For each site these flowering dates were then superimposed on the 'safe' spring flowering windows, defined above. In Fig. 10 the space defined by the two vertical and two horizontal broken lines (representing the 'safe' germination window and 'safe' first flowering date, respectively) indicates that all genotypes at Erzurum, with the exception of very photothermal-sensitive material, such as ILL 326, will flower too early, if germinated within the 'safe' window of opportunity in early winter. In contrast, as a result of the comparatively milder environments at both Sivas and Corum, all genotypes, with the exception of photothermally-insensitive material such as ILL 18, can flower safely if germinated within the 'safe' window of opportunity. Sowing photothermally-insensitive accessions such as ILL 18 would be an extremely risky strategy at all locations and would frequently risk complete crop failure from frost damage, because they were unable to synchronize flowering into the 'safe' spring window, despite their considerable tolerance to winter cold. The most useful photothermal response for a winter-sowing at high elevations was a high photoperiod response, which could synchronize flowering within a particular 'safe' window, almost regardless of sowing date.

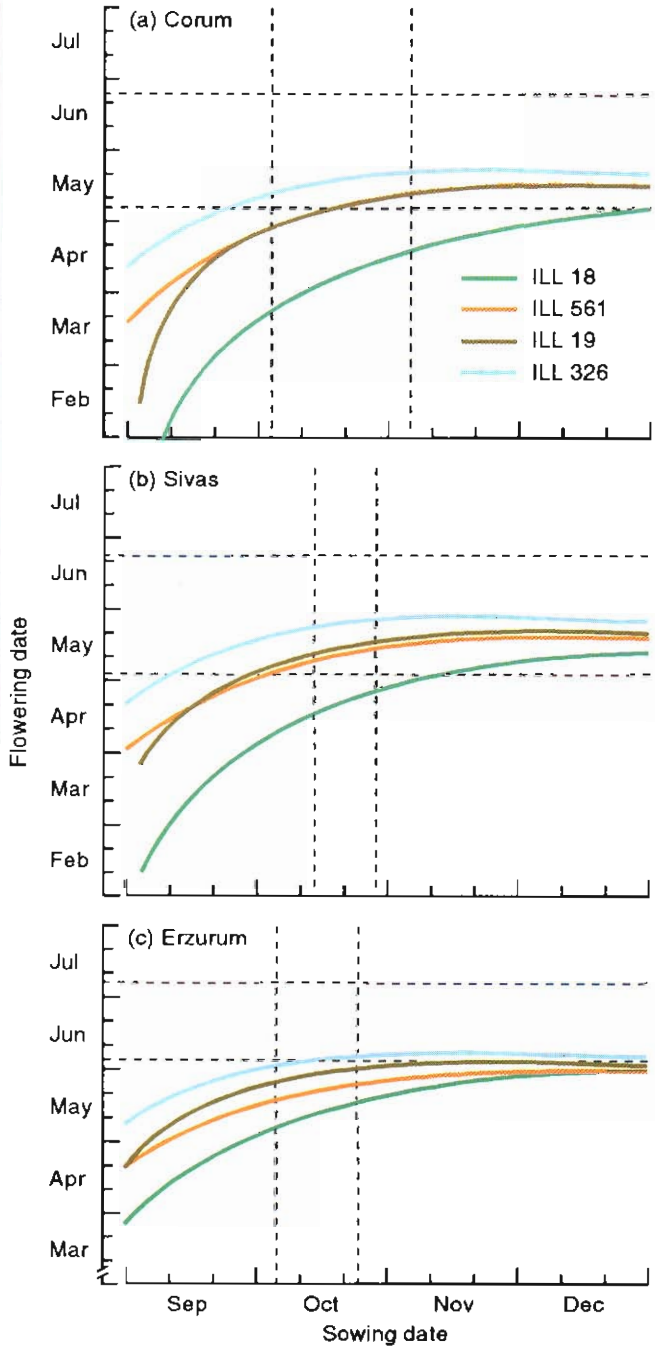
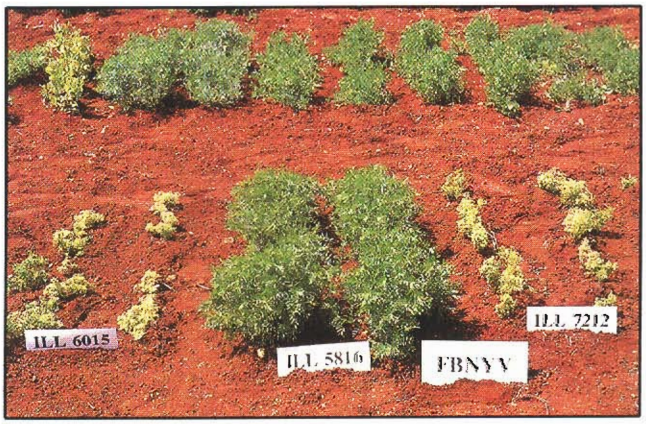


Fig. 10. The mean first flowering date over 40 years predicted for four accessions of lentil with winter-sowing dates from 1 September to 31 December at Corum, Sivas and Erzurum, Turkey. The two broken vertical lines represent the safe window of opportunity for germination for winter sowings and the two broken horizontal lines represent the safe window of opportunity for first flowering in spring.

Screening Lentil Germplasm for Resistance to Faba Bean Necrotic Yellows Virus

Faba bean necrotic yellows virus (FBNYV) was recently reported to have affected cool-season legumes in a number of WANA countries. Therefore, screening for FBNYV resistance was initiated in 1993 at Tel Hadya, where over 100 lentil genotypes were evaluated for their reaction to FBNYV using artificial aphid-inoculation with the virus. A wide variation in response of lentil germplasm to FBNYV infection was observed. A number of genotypes (e.g. ILL 291, 5816, 6198, 6193, 6245) were highly resistant and characterized by low virus incidence (0-5%) on the basis of symptoms and low yield loss due to infection (0-5%), compared with highly susceptible genotypes such as Palouse, Crimson and ILL 5700, 5212, and 6015 which suffered 80-100% yield loss.



Screening lentil germplasm for resistance to faba bean necrotic yellows virus at Tel Hadya, 1994.

Decentralization of Faba Bean Improvement

Following the recommendations of TAC (Technical Advisory Committee), research on faba bean improvement has been decentralized. The Nile Valley countries and China continued to make significant progress in developing high-yielding and disease- and pest-resistant cultivars, adapted to their production environments. Some progress was also made in the North Africa Regional Program where research on faba bean was conducted under a BMZ/GTZ-supported project, REMAFEVE (Réseau Maghrébin de Recherche sur Féve).

Emphasis in Egypt was on developing cultivars with improved resistance to foliar diseases, *Orobanche* and abiotic stresses, and on a crop phenology that would permit incorporation of faba bean into different cropping systems, particularly in rotation with cotton, to increase cropping intensity. Breeding for resistance to foliar diseases (chocolate spot and rust) has resulted in the development of five improved cultivars (Giza 461, 714, 716, 717 and 743) for North Delta with 60-70% reduced disease infestation and 15-30% higher yield than the commercial cultivar Giza 3. Giza 716 matures 15 days earlier and is, thus, suitable for rotation with cotton on nearly 360,000 ha in Egypt. Breeding for *Orobanche* resistance has yielded Giza 674 and Giza 429 which, over the last five years, have given 80% higher yield than the commercial variety Giza 2 in *Orobanche*-infested fields without the use of herbicide.

The Sudanese national program has laid emphasis on developing genotypes with higher and stable yield, good cooking quality, and ability for efficient water use. The program released three cultivars during the 1993/94 season: Basabeer (BB7) and Hudeiba 93 (Bulk 1/2) for the River Nile State and for the new areas south of Khartoum, and Shambat 616 (00616) for central Sudan.

Root rot and wilt diseases cause 20-50% reduction in faba bean yield in Ethiopia. Research conducted at the Plant Protection Center, Ambo, was successful in identifying host resistance to these diseases. Three genotypes (Bichera 86-1, Bichera 86-3, and Eth 86-120-2) combining high yield and resistance to fusarium wilt and black root-rot were identified as disease resistant in the laboratory as well as in multilocation field testing.

In the North Africa Regional Program, evaluation of *Orobanche*-tolerant/resistant faba bean cultivars, developed at ICARDA, was continued. The resistance/tolerance of faba bean lines 18009S, 18025S, 18105S, 8/972, and 8/9/128 to *Orobanche crenata* was confirmed in Algeria and Tunisia. In Tunisia, where *Orobanche foetida* was the major species of the parasite, tolerance of ICARDA pure lines BPL 818, 838, 911, 990, and 1015 was confirmed. Integrated *Orobanche*-control studies revealed that two postemergence applications of 70 g a.i./ha of glyphosate or one postemergence application of imazethapy at 100 g a.i./ha effectively controlled

Through collaborative research with ICARDA, faba bean line H41 was released as 'Li Fang Chan Du' for the Zheijiang province in China.

Orobanche foetida in Tunisia. Application of 60 g/ha of glyphosate twice gave effective control of *Orobanche crenata* in Algeria. The Tunisian national program identified FLIP 84-59FB and POL-3 as superior faba bean cultivars with tolerance to drought.

The Zheijiang Academy of Agricultural Sciences, Hangzhou, China continued to operate the fall-sown faba bean improvement research network in China. Line H41 was released as 'Li Fang Chan Du' for the Zheijiang province. In addition, several high-yielding, large-podded, disease-resistant genotypes, developed in collaboration with ICARDA, are in on-farm evaluation for pure or mixed/relay cropping systems.

Survey of Faba Bean Viruses in Egypt and Sudan

A survey of faba bean viruses was conducted in Egypt during the spring in 1993 and 1994, in collaboration with national program scientists. Field observations and sample collections were made twice during 1993 (in February and March) and once in 1994 (in February). A total of 69 (February) and 83 (March) fields during 1993 and 64 fields during 1994 were visually inspected. In February 1993, the virus incidence was 5% or less in 70% of the fields inspected, 6 to 20% in 17% fields, and more than 20% in 13% fields. A small increase in virus incidence was noticed in the March 1993 survey. During 1994, virus incidence was 5% or less in 53% of the fields inspected, 6 to 20% in 17% fields, and more than 20% in 30% fields (Fig. 11). Laboratory tests of 1414 samples with symptoms suggestive of virus infection collected during the first survey, and 1069 samples collected in the second 1993 survey showed that faba bean necrotic yellows virus (FBNYV) was the most common (50.6%), followed by bean yellow mosaic potyvirus (BYMV) (24.5%), and broad bean wilt fabavirus (4.6%). During 1994, FBNYV was again the most common, as it was detected in 62.1% of the 1166 samples tested, followed by FYMV (31.2%).

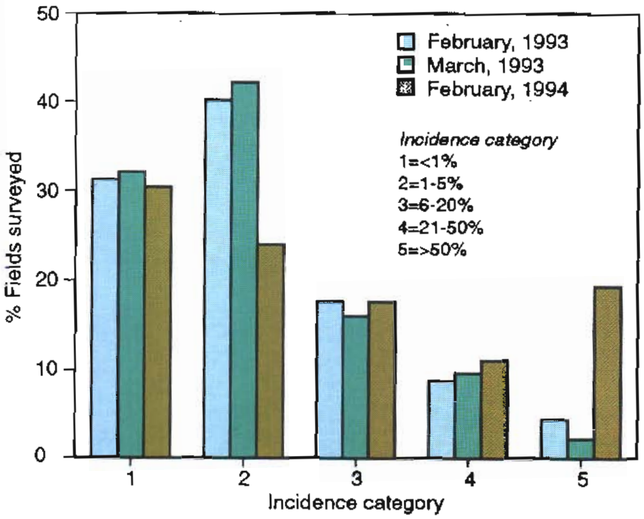


Fig. 11. General distribution of faba bean fields surveyed in Egypt in February and March 1993, and in February 1994, on the basis of virus diseases incidence categories. Number of fields surveyed: 69 (February 1993), 83 (March 1993), and 64 (February 1994).

In collaboration with national scientists, a survey of faba bean viruses was also conducted in Sudan during February 1994. A total of 33 faba bean fields in Khartoum, Gezira and Rahad, and the Northern Region were inspected. Half of the fields had virus disease incidence of 5% or less, 20% fields 6-20%, 18% fields 21-50% and 12% fields 51-100%. In traditional faba bean areas (north of Khartoum), virus diseases inducing mosaic or mottle symptoms were more common, and laboratory tests indicated that 90% of these samples were infected with BYMV. In non-traditional areas (Gezira and Rahad) the most common virus disease symptoms observed were yellowing and rolling of the leaves often with some necrosis and stunted plant growth. FBNYV, which is the main virus causing such symptoms in Egypt, was not detected in the samples from Sudan. However, the leafhopper-transmitted chickpea chlorotic dwarf virus (CCDV) was detected in these samples. CCDV was also detected in chickpea plants in Sudan showing general yellowing. This survey indicated that BYMV was the most common faba bean virus in the traditional areas, and CCDV in non-traditional areas (Gezira and Rahad) in Sudan.

Sources of Resistance to Multiple Stresses in Chickpea

There is a large annual variation in chickpea yield in WANA because of the susceptibility of existing cultivars to different biotic and abiotic stresses. Among biotic stresses, ascochyta blight (*Ascochyta rabiei*) appears to be the most important, followed by fusarium wilt (*Fusarium oxysporum* f.sp. *ciceri*). Root rots are also important in some areas. Among pests, pod borer in certain areas, and leaf miner (*Liriomyza cicerina*) in all Mediterranean environments are important. Drought is the single most important abiotic stress in the region. Cold is important in highlands and also limits productivity of winter-sown chickpea in lowlands of the Mediterranean region.

Field screening techniques have been developed at ICARDA for ascochyta blight, leaf miner, cold, and drought in the joint ICRISAT/ICARDA chickpea-improvement project. Wilt-sick plots in Spain and Tunisia have been used for resistance screening against fusarium wilt. A laboratory technique has been developed for screning for resistance to seed beetle (*Callosobruchus chinensis*), and a greenhouse screening technique for cyst nematode (*Heterodera ciceri*) and fusarium wilt. Using these techniques, chickpea germplasm available at ICARDA has been evaluated and resistance sources identified for all stresses except seed beetle and cyst nematode. Evaluation of eight wild annual *Cicer* species resulted in the identification of resistance to all seven stress factors. Wild species were the only source of resistance for seed beetle and cyst nematode, and they also had higher levels of resistance than the cultivated species for fusarium wilt, leaf miner, and cold. The most useful species for resistance to different stress factors was *C. bijugum*.

Table 9. Sources of resistance to biotic and abiotic stresses in chickpea germplasm developed at ICARDA.

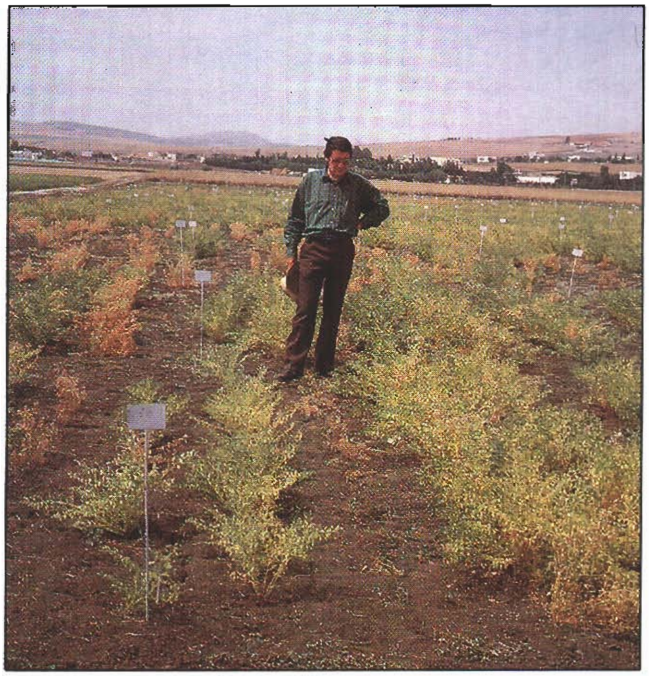
Stresses	Sources of resistance
Single stress	
Ascochyta blight (AB)	ILC 200, ILC 6482, ICC 4475, ICC 6328, ICC, 12004, FLIP 90-98C, FLIP 91-2C, FLIP 91-18C, FLIP 91-22C, FLIP 91-24C, FLIP 91-46C, FLIP 91-50C, FLIP 91-54C
Fusarium wilt (FW)	ILC 267, ILC 1278, ILC 1300, FLIP 86-93C, FLIP 87-33C, FLIP 87-38C
Leaf miner (LM)	ILC 3800, ILC 5901, ILC 7738
Seed beetle (SB)	IWC 39, ILWC 104, ILWC 179, ILWC 181
Cyst nematode (CN)	ILWC 119
Cold (CO)	ILC 8262, ILC 8776
Drought (DR)	FLIP 87-59C, FLIP 88-42C
Multiple stresses	
AB, LM, CO	ILWC 37 (*C. cuneatum*)
FW, LM, SB, CO	ILC 39 (*C. echinospermum*)
AB, FW, SB, CN, CO	ILWC 62, ILWC 70, ILWC 73 (*C. bijugum*)
FW, LM, SB	ILWC 98, ILWC 102 (*C. judaicum*)
FW, CO	ILWC 141 (*C. reticulatum*)
FW, SB, CO	ILWC 112 (*C. reticulatum*)
FW, SB, CO	ILWC 112 (*C. reticulatum*), ILWC 179, ILWC 181 (*C. echinospermum*)

Sources of resistance to biotic and abiotic stresses in chickpea and *Cicer* species, developed at ICARDA and shared with NARS partners, are shown in Table 9.

Distribution and Variability of *Ascochyta rabiei* in Syria and Tunisia

RFLP and RAPD (Random Amplified Polymorphic DNA) analysis was performed to study genetic diversity, genetic structure and distribution of *Ascochyta rabiei*; to monitor migration, mutation and evolution in the pathogen population; and to genetically characterize pathotypes prevailing in different chickpea-growing regions in Syria and Tunisia. The work was done in collaboration with the University of Frankfurt, Germany and the Tunisian national program.

A total of 453 *Ascochyta rabiei* isolates, sampled from all over Syria and Tunisia, were genetically



Dr Habib Halila, National Coordinator for Food Legumes in Tunisia, evaluating chickpea lines in a wilt-sick plot at Beja.

characterized with DNA markers. The analysis classified the isolates into 21 genotypes from Syria and 34 from Tunisia. In both Syria and Tunisia one genotype was found to be most prevalent. The results of pathogenicity tests of the isolates from Syria showed that the genotypes could be classified into three pathotypes based on level of aggressiveness. No change in aggressiveness was observed for any of the pathotypes on a differential set of host plants.

DNA Markers to Estimate Biodiversity in Chickpea and Lentil

DNA markers are useful in detecting biodiversity in germplasm as they target DNA and are not influenced by the environment. Both RFLP and PCR markers were identified and applied in chickpea and lentil biodiversity studies. Using this information, breeders can choose promising new genetic cross-combinations to hasten cultivar development and the genetic resources scientists can target germplasm collection missions.

Breeding Kabuli Chickpea for *Ascochyta* Blight Resistance

The importance of ascochyta blight in WANA has increased after the introduction of winter sowing of chickpea. Without adequate host plant resistance, the crop cannot be grown in winter. The joint ICRISAT/ICARDA chickpea-breeding program has, therefore, laid emphasis on developing ascochyta blight resistant cultivars. In view of the prevalence of a wide variability in the blight fungus in the region, in time and space, broad-based and durable resistance requires pyramiding of resistance genes from different sources. A program of gene pyramiding, started six years ago, has resulted in the development of some promising material (Table 10). Under artificial epiphytotics created in the field using mixed inoculum of ascochyta blight fungus, 234 resistant plants (rating 3 on a 1-9 rating scale, where 1 = no visible damage, 9 = all plants killed) were selected from 60 F_7, 170 F_6, and 298 F_5 progenies. The best parent included in the test had a disease rating of 4. Some of these plants have shown resistance to the most aggressive pathotype under controlled environments.

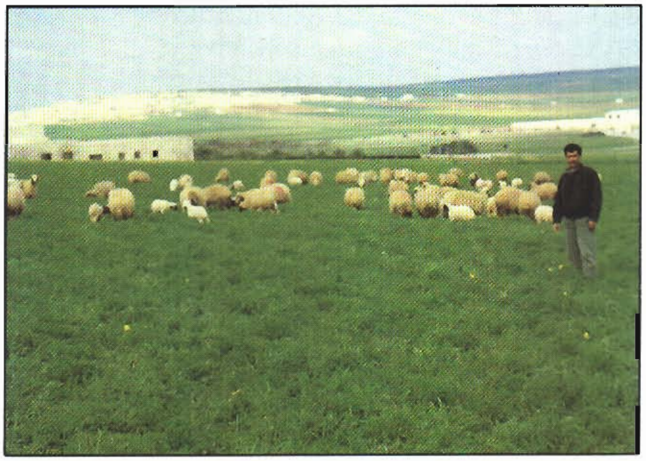
Table 10. Number of progenies in different *Ascochyta* blight rating classes in the advanced generation chickpea material developed in the gene pyramiding project, and number of resistant plants selected at Tel Hadya in 1993/94 under artificial epiphytotics.

Generation	No. of progenies in each blight rating class*						No. of resistant plants selected
	1-2	3	4	5	6	7-9	
F7	0	8	23	14	9	6	22
F6	0	82	81	7	0	0	96
F5	0	110	126	51	11	0	116

* Rating scale: 1= no visible damage; 9 = all plants killed.

Introduction of Vetch in Barley-based Rotations in Mashreq Countries

Genetic resources of vetches (*Vicia* spp.) are abundant in the WANA region. Improving them to enhance their adaptation to dry areas (rainfall <300 mm), eliminating their wild trait of pod shattering, and increasing their productivity and nutritional quality are the major objectives of the forage legume improvement project



Sheep grazing common vetch at a critical stage in the feeding cycle, when alternative feed sources are limited.

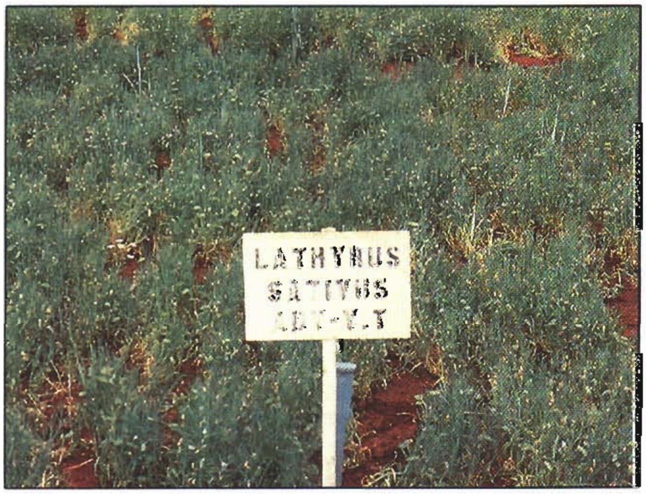
at ICARDA. Using the improved genotypes developed in the project, national programs in Iraq, Jordan, and Syria have been evaluating the introduction of vetches in rotation with barley to replace fallow or to break continuous barley cropping. The results have shown considerable improvement in the productivity of barley as well as increased availability of nutritious fodder either for direct grazing by sheep or for stall feeding in winters. Promising cultivars identified by Syria (*Vicia sativa* line 715 and 800, *Vicia ervilia* line 219, *Vicia narbonensis* line 67, 717 and 800), Jordan (*Vicia sativa* 715, *Vicia villosa* ssp. *dasycarpa* 683, and Iraq (*Vicia sativa* line 715, *Vicia narbonesis* 67, and *Vicia villosa* ssp. *dasycarpa* 683) are under seed multiplication.

During 1993/94, 10 demonstrations were planted in Syria and the crop was used for direct grazing. Participating farmers showed great interest in expanding the cultivation of vetches. In Jordan, 35 demonstrations covering nearly 75 ha were planted with vetches. Farmers used vetch for grazing and left some of it for seed and straw production. With the increased availability of seed the practice is expected to be adopted widely.

Breeding Chickling for Low Neurotoxin Content

Chickling or grasspea (*Lathyrus sativus*) has a great potential as a nutritious fodder crop in low-rainfall, drought-prone areas of WANA. Its seeds contain 25-32% protein and, in several countries of WANA and South Asia, it is consumed as a pulse. However, high consumption of this pulse can cause disorders of the central nervous system leading to leg-paralysis ('Lathyrism' syndrome). This affliction is attributed to the presence of 3-*N*-oxalyl-2-3 diaminopropionic acid (β-ODAP) in chickling. In 1988/89, ICARDA initiated a program to reduce the β-ODAP content in chickling cultivars having good agronomic characters. Initial screening of the available material revealed that, depending on genotype, β-ODAP concentration ranged from 0.1 to 0.9%. A crossing program involving four tester lines with low β-ODAP content and 21 promising lines with various β-ODAP contents was started in 1990/91. This has resulted in the development of progenies with very low neurotoxin content (0.02 to 0.05%), at the F_4 stage, besides having adaptability to adverse environmental conditions.

The chickling lines currently cultivated contain variable β-ODAP levels. Although much progress has been made in lowering the content of this neurotoxin, stable low β-ODAP lines have not been obtained. In collaboration with CLIMA (Centre for Legumes in Mediterranean Agriculture, Australia) and the Ethiopian national program, ICARDA-developed low β-ODAP lines are being tested under different environmental conditions to select stable lines.



Low-neurotoxin lines of chickling, developed in cooperation with the Center for Legumes in Mediterranean Agriculture, Australia, and national programs in West Asia and North Africa, are being tested and selected under different environmental conditions.

Biological Nitrogen Fixation by Food and Forage Legumes

Food and forage legumes are important components of the dryland farming system and they can play a key role in stabilizing the productivity of cereals in rotations. This is, however, dependent largely on their ability to fix atmospheric nitrogen. Studies have, therefore, been conducted to quantify biological nitrogen fixation (BNF) by different annual cool-season food and forage legume under three contrasting rainfed environments: Tel Hadya, Terbol, and Kfardan. Isotopic dilution, using stable isotope of nitrogen and wheat and non-nodulating chickpeas as the standard reference, was used for BNF quantification. Results for 1991-94 from Tel Hadya and Terbol, and from Kfardan for 1993/94, indicated that forage legumes were generally more efficient than grain legumes in BNF, although the actual values are greatly affected by environmental conditions. *Vicia villosa* ssp. *dasycarpa* fixed the highest amount of nitrogen: about 100 kg/ha at Terbol and Kfardan, and nearly 60 kg/ha at Tel Hadya.

Dry Pea Cultivar Testing

Research on dry pea was initiated at ICARDA in 1986/87. As extensive varietal improvement work is being done on dry pea at a number of institutions in both developing and developed countries, ICARDA decided to capitalize on this research instead of conducting its own breeding program and to identify cultivars adapted to the farming systems of WANA. The Center's work is concentrated on collecting enhanced germplasm/cultivars, testing them at ICARDA sites, and distributing the selected cultivars to WANA researchers through the International Legume Testing Program. As a result, several national programs in the region have evaluated the Dry Pea International Adaptation Trial (PIAT) supplied each year and have selected a number of high-yielding lines adapted to their local conditions. The first release of a high-yielding pea line, Karima 1, was in Sudan. Recently two more cultivars, Kontemenos in Cyprus, and 061K-2P-2192 in Ethiopia, have been released for general cultivation. Several other country programs have identified superior lines from PIAT for multilocation and on-farm trials. Sudan has identified Ballot as a potential candidate for release.

Ballot, a high-yielding line of pea adapted to local conditions in Sudan, has been selected for release by Sudanese researchers from ICARDA's Dry Pea International Adaptation Trial.

Seed Production

Adoption of improved varieties is influenced by the availability of seed. To study farmer perceptions of access to seed, a survey was conducted in Ethiopia, Syria, and Jordan. Of the farmers interviewed, 100% had adopted improved wheat varieties in Ethiopia, 90.7% in Syria, and 39.5% in Jordan. However, in Ethiopia, 67.8% of farmers grew older improved varieties which are no longer recommended. One such variety, grown by 33% of farmers, is susceptible to yellow rust.

Non-availability of certified seed at planting time, higher seed prices, unsuitable varieties, and lack of awareness are some of the identified constraints to adoption of modern varieties.

Farmers indicated four sources of seed for planting purposes: government, own-saved, neighbors, and others (markets). The use of own-saved seed is predominant with 95.3% farmers in Ethiopia, 58.3% in Jordan and 55.9% in Syria. Seed from other sources (neighbors, markets) accounted for 25.4% in Syria, 4.5% in Ethiopia, and 7.6% in Jordan. Government-supplied certified seed accounted for 34.1%, 18.6% and 0.2% in Jordan, Syria, and Ethiopia, respectively.

Farm-saved seed, mostly of landraces, is a real competitor of off-farm certified seed. In Ethiopia, some farmers retain seed of local varieties for as long as 50 years or more, and in Syria from 1 to 20 years.

The survey indicated the need for developing appropriate technical guidelines to maintain varietal purity and produce good quality seed by improving farmers' management practices of own-saved seed to supplement the formal seed sector.

Resource Management and Conservation

Long-term Trials

ICARDA has for many years maintained a wide range of long-term trials to determine the effects of different sequences of crops and soil and pest-management treatments on the productivity of specific crops, crop rotations, and crop-animal production systems. This research has continued to highlight, for instance, the inter-seasonal effects of one crop on water availability to the next crop; differences between legume crops in the nitrogen left available to the following cereal; and other important interactions between crop sequence, nitrogen fertilizer rate, rainfall and water-use efficiency. Data from the trials clearly demonstrate that in continuous wheat or barley sequences, replacement in alternate years of cereal with forage legumes increases productivity of both dry matter and feed value. A few interesting leads from these long-term trials are reported below.

Rotation and Crop Management Effects on Soil Structure

An often overlooked factor which affects the productivity of arable land is the physical structure of the soil. An important parameter of soil structure is aggregation (the degree of coherence of sand, silt and clay particles into stable crumbs or peds). When a soil, particularly a clay soil, has a large proportion of its material in the form of stable aggregates, resistance to rainfall impact, surface capping and erosion is greater, water infiltration and permeability are enhanced, and the environment for root growth is generally more favorable. However, aggregation is not a permanent property but varies according to how the soil is managed. Inappropriate management over time tends to degrade soil aggregation, with potentially serious effects on productive capacity.

Samples were taken, prior to planting in November 1992, from the plow layer of field plots at Tel Hadya under both phases of the long-term (seven years) wheat-medic and wheat-fallow rotations. Sampling was designed to take account of the effects both of rotation and of different nitrogen-fertilizer and stubble grazing treatments applied to the wheat. Laboratory analysis of those samples has provided several indices of soil aggregation.

Aggregate stability was generally greater in the rotation of wheat with medic. Aggregates from the wheat-fallow rotation were more likely to swell and disperse in the presence of water (Fig. 12); and the amount of clay dispersed by shaking soil aggregates in water was approximately twice as great in samples from wheat-fallow as in samples from wheat-medic

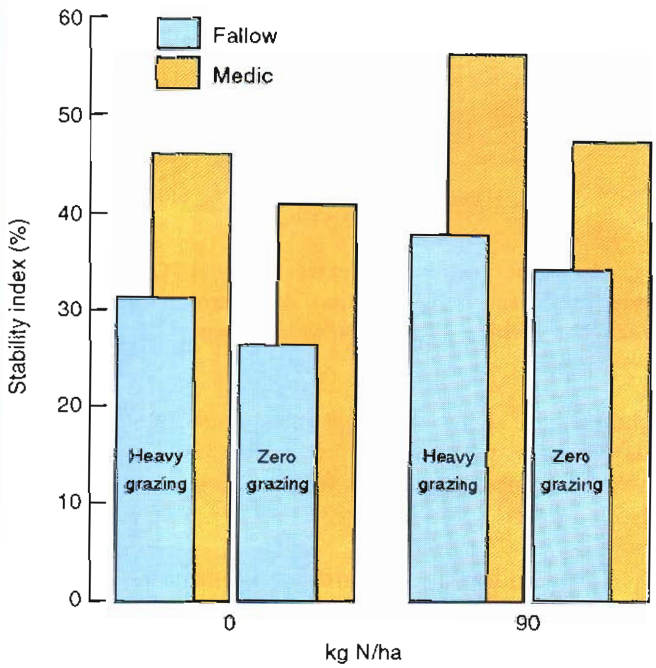


Fig. 12. Stability of wet-sieved aggregates from topsoils under medic and fallow rotation with two levels of stubble grazing and either 0 or 90 kg N/ha applied to wheat.

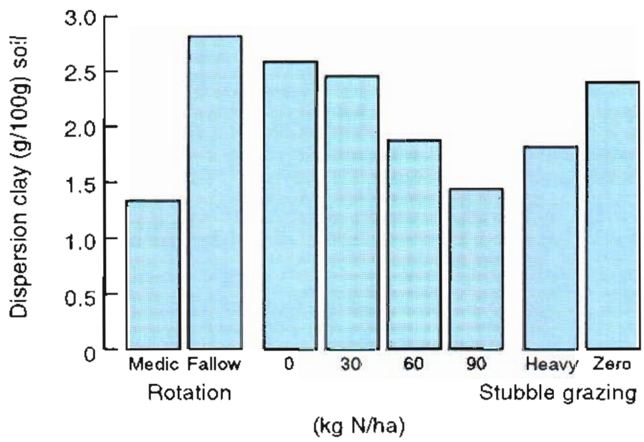


Fig. 13. Overall effect of rotation, nitrogen, and stubble grazing on the coefficient of aggregate dispersion.

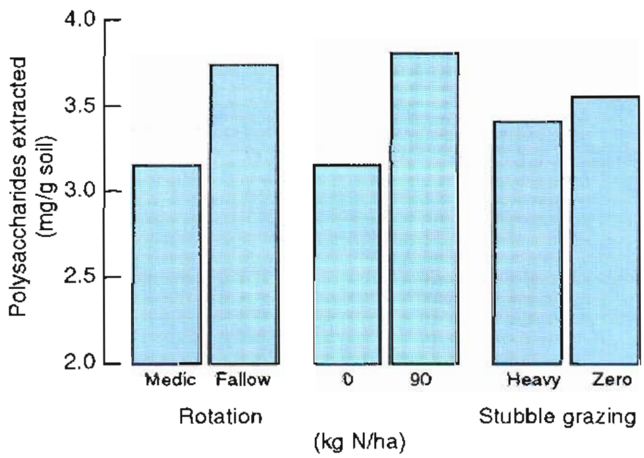


Fig. 14. Soil polysaccharides extracted by H_2SO_4 from soils under medic and fallow rotation, with zero and heavy grazing and with 0 or 90 kg N/ha treatments.

rotation (Fig. 13). Somewhat surprisingly, aggregate stability was apparently improved by heavy grazing of the wheat stubble; nitrogen fertilization of the wheat also increased stability.

The positive effect of nitrogen is attributed to greater growth of the roots which increased the contribution of organic residues to the soil. The better physical condition of the soil under the wheat-medic rotation is attributed to a better organic matter status that is presumed to have come from plowing the medic roots and leaves into the soil, and the feces and urine of the sheep grazing the medic. The mean organic matter content of the wheat-medic plow layer was 1.44% compared with 1.22% under wheat-fallow. Soil organic matter is a complex material, and different components of it contribute differently to soil properties. Aggregate stability is often associated with the soil polysaccharide component. It is therefore significant that the relative amounts of polysaccharide extracted from these soils (Fig. 14) quite closely mirror the pattern of the aggregate stability.

Effect of Tillage and Sowing Date on Yields in a Lentil-Wheat Rotation

A wheat-lentil rotation trial was started at Tel Hadya in 1978/79. Results for the last eight seasons are being analyzed. Some of the main findings are summarized here.

The main treatment comparison in this trial is between three sowing dates using conventional tillage (CT) and two using zero tillage (ZT), that is, direct drilling. The early sowing (CT, ZT) has consistently been in early to mid-October (before rain), the middle sowing (CT, ZT) less consistently in mid- to late November, and the late sowing (CT only) in December or early January, depending on weather.

Under conventional tillage (disking and harrowing), early-sown lentil has been the highest yielding in seven of the eight years, and yield means over all years show an appreciable decline with lateness of sowing (Fig. 15a); under direct drilling, lentil yields tended to be higher but showed little difference between early and middle planting times. The optimum sowing time for wheat varied with season, but with direct drilling the middle sowing time was usually best.

This pattern of yields was in many ways reflected in the pattern of water use (Fig. 15b), particularly under conventional tillage. In all seasons, wheat used more water than was received as rainfall, while lentil used less. Storage of water in the soil after each lentil crop increased the supply to the following wheat crop, though amounts varied with the volume and distribution of lentil-season rainfall. This effect was much less clear under zero tillage. With lentils, and also the middle planting of wheat, yield per unit of water use

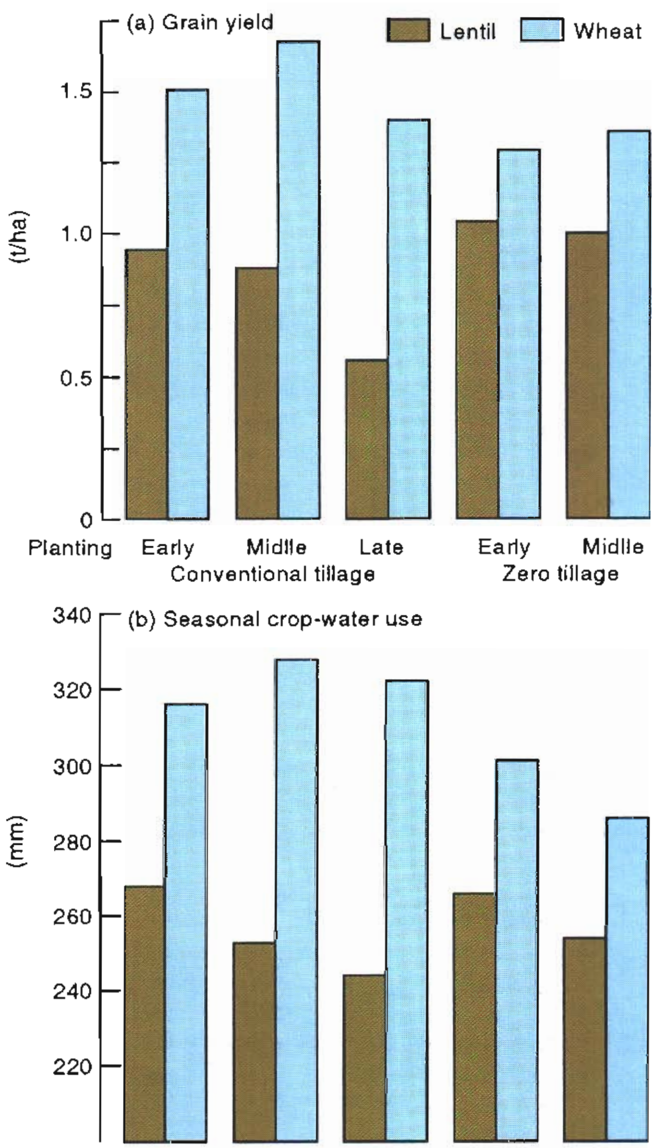


Fig. 15. Effect of tillage type and sowing time on (a) grain yield, and (b) water use in lentil and wheat crops in a long-term trial at Tel Hadya, means of eight years' data.

appeared appreciably higher than under conventional tillage— the lentils gave more yield from the same amount of water, while wheat gave a similar yield from less water. Wheat under zero tillage used less water (averages of 15 and 22 mm) than did wheat under conventional tillage. Actual use was, on average, quite close to the mean rainfall (about 300 mm), suggesting that zero tillage largely negates the water-conserving effect of the lentil crop.

A further finding of this study is relevant here. Practising the same tillage system for many years on the same plot creates large differences in the weed flora. (Differences in soil structure have also been noticed.) In particular, the zero-tillage system brings increased problems in the control of both weeds and rodents. The increased costs these incur need to be weighed carefully against any economies that zero-tillage systems are thought to have.

Statistical Estimation of Time Trends of Yields in Long-term Trials

Long-term trials of different sequences of crops and husbandry practices have two general aims. The first is to identify those sequences of crops and crop-management practices that optimize biological or economic productivity, or both. The second, with a longer perspective, compares sustainability trends in crop productivity and the condition of the land that supports it. The identification and understanding of the mechanism or causes of such trends is central to the issue of sustainable crop production.

However, while it is relatively easy to compare different crop rotation and management treatments for short-term productivity, the identification of trends is more difficult. This is particularly so in environments in which large inter-annual fluctuations in the weather result in large inter-annual fluctuations in production. In WANA rainfed agriculture, the strongest determinant of yield is rainfall whatever the fertilizer rate or tillage practice or antecedent crop might be. To detect emerging trends from long-term data, it is necessary to identify and develop biometric and statistical techniques that reduce the 'background noise' of seasonal effects.

A biometric procedure has been developed at ICARDA that quantifies trends in data sequences from long-term trials. This procedure promises to identify differences in absolute and relative yield among different sequences of crops, inputs, and crop-management treatments from relatively small data sets.

Applied to seven years of data from a trial of continuous barley under different fertilizer regimes, the procedure indicated a generally rising yield trend, greater and more reliable for straw than for grain

(Table 11). For straw, that rising trend was significantly enhanced by annual fertilization. Although the rising trend was somewhat unexpected, the greater clarity in the pattern of the straw values matches agronomic experience of cereal crops; straw yields usually follow rainfall total and fertilizer rate strongly and tend to be less affected by random seasonal factors (e.g. late drought, pest attack) than are grain yields. So, in seeking time-trends in cereal production, we may expect straw to provide the earlier indicator.

Table 11. Estimates of seven-year trends of grain and straw yields of continuously cropped barley under different annual fertilizer regimes, at Breda.

	Time-trend (kg/ha/year)			
N\P	0	45	90	Mean
Grain				
0	22	49	**28**	33
60	**94**	58	**87**	**80**
120	**108**	26	38	**57**
SE		± 37.7		± 21.8
Mean	**75**	**44**	**51**	**57**
SE		± 21.8		
Straw				
	105	**98**	**90**	**97**
	166	**189**	**294**	**216**
	187	**219**	**293**	**233**
		± 37.5		± 21.7
	153	**168**	**225**	**182**
		± 21.7		

Boldfaced figures indicate statistical significance at 5% level.

A seven-year sequence of data is rather short. Longer sequences will permit more degrees of freedom for the analysis across years. In its present form, annual variability is allowed for as a quadratic function of total growth-season rainfall. With longer data sequences, it will be possible to include other single-value parameters representing the seasonal growth environment. Planting date is a candidate for inclusion. Further, the present model estimates only a linear yield trend from the seven-year data set, but over longer periods a curvilinear trend is biologically inevitable, and the procedure will have to be adjusted to allow for this.

Forage Legume-Barley Rotations for Barley-based Farming Systems

Farmers in drier rainfed arable areas increasingly grow barley every year, eliminating the traditional fallow year. This is to support livestock production, which is locally the main agricultural enterprise. Attempts to introduce forage legumes (usually species of *Medicago*, *Vicia* and *Lathyrus*) have, at best, met with only partial success. Reasons include farmer perceptions that the forage legumes currently available produce less forage than does barley, even when the barley is grown continuously. Meanwhile, ICARDA trials at Tel Hadya and Breda continue to show that, under experimental conditions, rotations of barley with forage legumes almost always outperform continuous barley in dry matter production, while overall plant protein yield may be nearly doubled.

In 1990, *Vicia narbonensis* (narbon vetch) was introduced into the Tel Hadya and Breda long-term trials in the expectation that it would be more vigorous and productive than the *Vicia sativa* and *Lathyrus sativus* already used. This indeed proved to be the case. Narbon vetch consistently outyielded the other two legumes at both sites (Fig. 16) by a mean of 30-40% over four years.

Differences among the barley yields in the alternate years of these rotations were relatively small, but the values tended to be slightly lower after *V. narbonensis*, particularly at Tel Hadya. Table 12 shows mean grain yields from the 1991/92 to 1993/94 seasons; straw yields showed a similar pattern.

Table 12. Effect of preceding forage legume on barley grain yield (t/ha) at Tel Hadya and Breda, three-year means, 1991-1994.

Preceding crop	Tel Hadya	Breda
Lathyrus sativus	2.45	1.05
Vicia sativa	2.43	1.22
Vicia narbonensis	2.29	1.23

When barley and legume yields are put together to obtain total rotation production, the advantage from growing *V. narbonensis* is small (Fig. 17). Only at Breda in 1993/4 was there an appreciable difference,

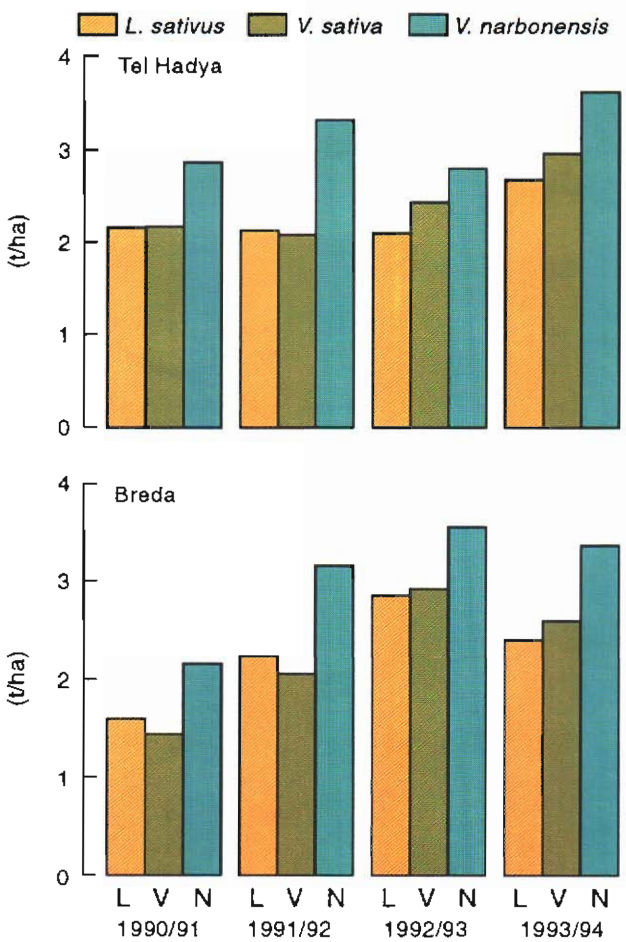


Fig. 16. Total dry-matter yields of three forage legumes in rotation with fertilized barley over four years at Tel Hadya and Breda.

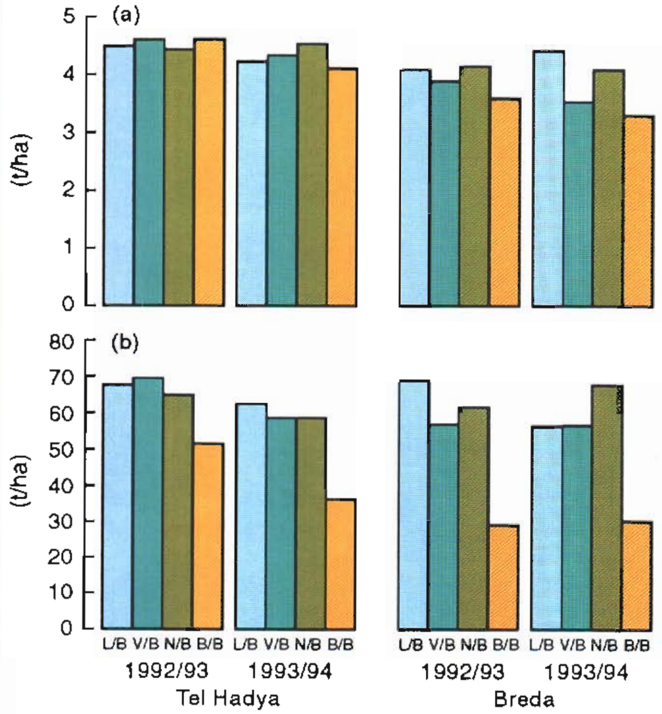


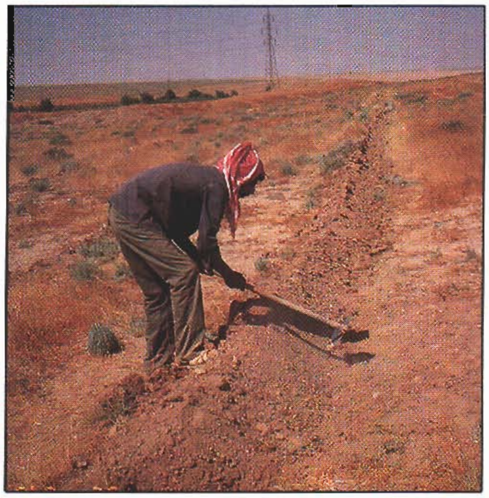
Fig. 17. Total production of rotations of barley with *Lathyrus sativus* (L/B), *Vicia sativa* (V/B), *Vicia narbonensis* (N/B) and barley (B/B) at Tel Hadya and Breda, 1992/93 and 1993/94: (a) total dry matter (t/ha); (b) total N in dry matter (kg/ha).

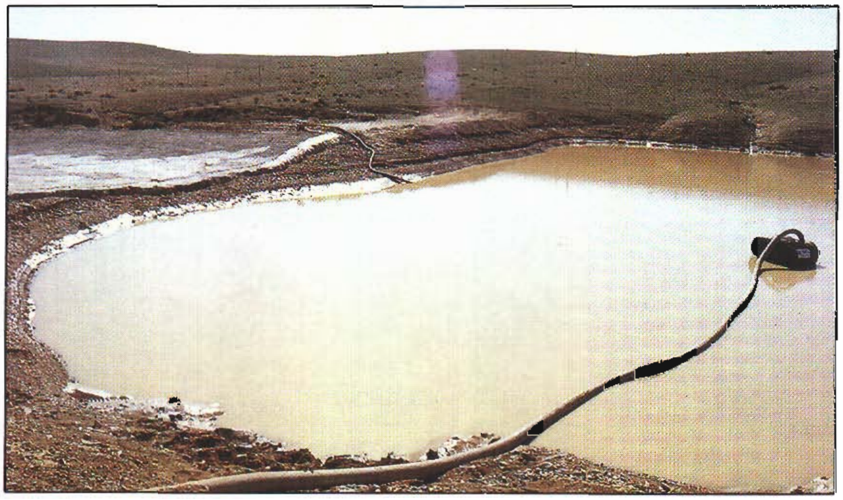
in both dry matter and total nitrogen, over other legume-barley rotations. However, all legume-barley rotations equalled or exceeded the dry-matter production of the continuous barley, and differences in total nitrogen output were large, particularly at Breda. These results need to be transferred to dry-area barley farmers.

Potential of Water Harvesting in Jordan

In partnership with the University of Jordan and the Jordan Ministry of Agriculture, ICARDA studied the crop production activities in the Muwaqqar water catchment, southeast of Amman, to assess the socio-economic potential of applying water-harvesting techniques, developed and tested by University scientists, on local farms. The study covered barley cropping; fruit and nut tree and vegetable production; poultry and livestock enterprises; and rangeland utilization.

The Muwaqqar catchment, with a human population of around 6700, is a parallelogram approximately 15 km x 5 km. It has mean annual rainfall less than 200 mm; gently undulating topography with low hills, crisscrossed with gullies and shallow wadis. Soil surface structure is poor, prone to crusting, erosion, and water runoff. Recent population growth has led to more intensive use of this land, first by increased sheep and goat grazing of natural vegetation, then, as pastures deteriorated, by mechanized barley cultivation, particularly in natural depressions where natural water 'run-on' often occurs. The newest developments, fuelled by the proximity of the large urban market of Amman, include open-air feedlots for small





Water harvesting in Jordan: a farmer prepares contour runoff ridges (left); small earth dams with harvested water being pumped for supplemental irrigation (right).

ruminants, poultry enterprises, and some orchards and vegetable farms.

All of these enterprises depend largely on inputs brought in from outside the catchment. Water is undoubtedly the most limiting factor in productive land use. Traditional cisterns that store runoff are still used to water livestock, but much of the water used agriculturally is brought in by truck from the municipal supply. Meanwhile, the number of drilled wells, particularly for the vegetable farms, is increasing rapidly.

The survey covered 82 land users and represented the various agricultural enterprises found in the catchment. One conclusion was that the capture and storage of flood water using earthen dams was common. The large amounts of water that can be collected provide a major economic incentive, and the supplemental irrigation of barley and tree crops would seem to be the most profitable use for such water in the short term. The main issues identified by the survey were construction costs, technical feasibility, water quality (for animal consumption), and utilization and distribution rights—all of which need further investigation, with local land users participating in the research process.

The use of small runoff basins to enhance tree production also appears appropriate. Some adjustment of current planting densities may be needed, but in situations where neither land nor establishment costs appear to be limiting, investors are expected to be willing to apply the technique. Using trucked water to maintain orchards, as is currently done, is a questionable long-term strategy.

Potential advantages from such measures as contour ridging and building walls across wadis, intended to sustain rangeland shrubs and improve grazing resources, are less certain. As well as problems of controlling access and management, there is the economic question of whether the forage output would justify the effort and cost involved in land preparation and shrub maintenance.

Nevertheless, providing feed to livestock is the major (economic) concern of the largest group of land users in the catchment. At present, their focus is on barley grain and straw production. Improving barley production appears to be the most obvious application of water harvesting. The use of wadi dams poses problems for this group, and it may be more useful to seek ways to improve the traditional natural water-harvesting or run-on system, perhaps by improving runoff efficiency from surrounding slopes. This would necessarily involve barley producers in the research process. The results of the survey indicate that barley farmers with small and medium-sized flocks have the greatest economic incentive to improve their barley production, and that barley improvement would be of greater economic interest to them in the short and medium term than rangeland improvement.

Medic Pasture Establishment in a Barley-Pasture Rotation

Prior to planting barley in the fall of 1992, pods of *Medicago rotata* and *M. rigidula* were broadcast in a 50:50 mixture (by weight) at 0, 100, 200, and 300 kg/ha sowing rates. The barley crop was then sown and harvested in May 1993. Barley stubble was not grazed in the summer of 1993. In the fall and winter of 1993/94, medic seedlings were counted on three occasions. In spring 1994, medic seed added to the soil seed bank was quantified, and the contribution of medic and volunteer barley to the dry matter yield of the pasture was measured.

Mature plants of *Medicago rigidula* that grew from seeds in pods at Tel Hadya, 1993/94, confirming that pasture establishment is possible with pod-sowing.

Volunteer barley was managed as part of the medic pasture system. It was heavily grazed for a few days in January and also in March 1994 to prevent it from competing with the medic seedlings. By the end of the season, the barley recovered sufficiently to contribute about half of the pasture biomass. As part of the medic–barley system, barley provided green grazing in spring and straw at the end of the season.

The total new seed averaged 167, 289, and 182 kg/ha in the 100, 200, and 300 kg/ha pod-sowing treatments; *M. rigidula* contributed about 70% by weight. These results confirm that a sowing rate of 150 kg pods/ha is adequate for pasture establishment at about 250 seedlings/m^2. The 150 kg/ha sowing rate will also leave enough seed in the ground to provide a pasture in a subsequent season if no seed is set in the first pasture year. Most importantly, under the 373 mm rainfall received in 1993/94, a successful seed bank containing, on average, more than 200 kg/ha new seed was obtained.

On-farm Trials with Forage Legume–Barley Rotations

On-farm forage legume trials were conducted for seven cropping seasons in northwest Syria. Trials aimed at involving farmers in studies to quantify the benefits of using common vetch (*Vicia sativa*, V) or chickling (*Lathyrus sativus*, C) to replace the fallow year in a barley-fallow rotation (F) or to introduce forage legumes into barley (B) monoculture. Thus, there were four rotations: BF, BB, BV, and BC, with both phases being represented each year. The trials were replicated on six to eight farms, depending on the year; each site was 4 ha divided equally between the two phases. Each year, 30-60 kg N/ha was applied to half of the barley area. Several farmers chose to graze lambs on the vetch and chickling crops in spring.

Yield of feed from both phases of the rotation was largest from the BV and BC rotations. Mean dry matter (DM) yields for seven years, summed for both phases of each rotation, were: 2.91 (BF), 4.82 (BB), 5.02 (BC), and 5.32 t/ha (BV). Total outputs of crude protein were twice as high for the rotations including legumes as compared with the average output of BF and BB. The BV rotation gave the highest output of metabolizable energy. Application of nitrogen increased barley DM yields by about one tonne for all rotations. There were no nitrogen x rotation interactions.

The farmers considered the high cost of hand labor a serious constraint to growing forage legumes. Therefore, for widespread adoption, development of inexpensive and efficient methods of mechanized harvesting is necessary. Drought and cold tolerance, early maturity, and high harvest index may promote farmers' interest in forage legumes. The grazing option was most attractive because it (1) eliminates the need for expensive weeding and hand-harvesting, and (2) reduces the risks associated with drought during flowering and maturity. However, a part of the forage legume area must be kept to provide seed for future planting.

Residual Phosphate on Marginal Lands

An long-term experiment was started at Tel Hadya in 1984/85 to test the hypothesis that the application of superphosphate to non-arable (marginal) land stimulates the legumes, eliminates the nitrogen deficiency, and so leads to increased herbage production.

Phosphate fertilizer was applied in small quantities (11 and 26 kg P/ha) every year for seven years. At the end of the seventh season (July 1991), Olsen-P values were found raised from approximately 7 mg/kg to about 20 and 40 mg/kg, respectively. No more fertilizer was applied, and the experimental plots were used to study the effects of the residual phosphate on pasture and grazing animals.

In May 1994 (44 months after the last phosphate application), plots which received phosphate fertilizer, retained a significantly higher level of available phosphorus than the control (Table 13).

The legume component (dry matter) in the pasture under the control (P_0) was between 4% (in January) and 16% (in April), while it ranged from 14 to 26% under P_{11} and from 8 to 31% under P_{26} (Fig. 18a).

The total herbage yield of legume (Fig. 18b) showed similar trends to previous seasons: a higher accumulation of biomass at both P_{11} and P_{26} than the control, the difference being significant throughout the season. There were no significant differences between P_{11} and P_{26}.

Table 13. Available phosphorus in the soil (mg/kg) recorded in May in each of four seasons[1] (8, 20, 32 and 44 months after last fertilizer application) at Tel Hadya in northern Syria.

Season	(months flowing last application)	Phosphate rate[2] (kg/ha P) 0	11	26	SEM
1990/91	(8)	6.5	20.8	40.1	1.56
1991/92	(20)	7.3	23.4	38.2	2.07
1992/93	(32)	7.2	12.8	24.8	1.29
1993/94	(44)	9.3	15.2	21.5	1.19

[1] Each value is an average of two stocking rates. There was no significant phosphate x stocking rate interaction.
[2] The last phosphate application was in September 1990.

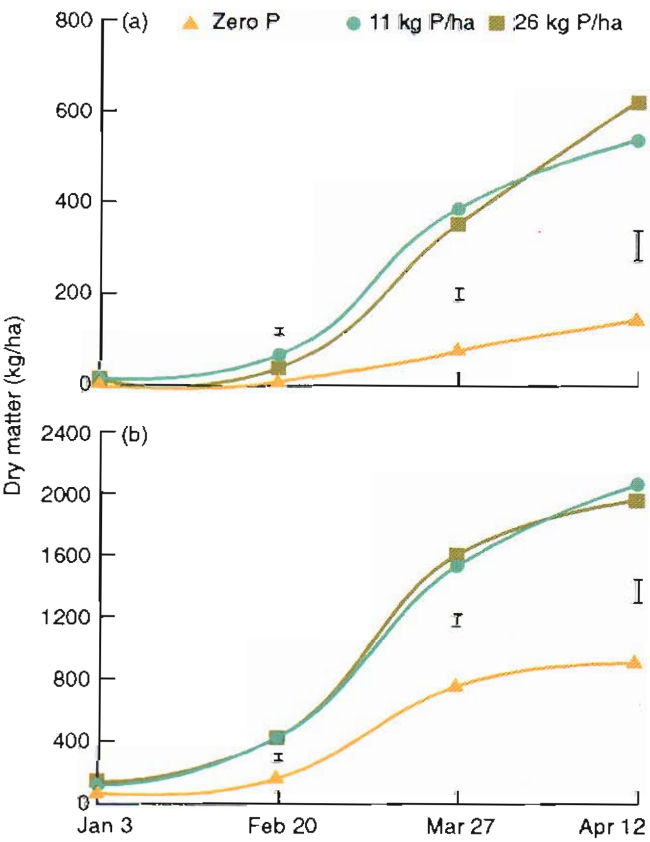


Fig. 18. Cumulative legume (a) and total biomass (b) as affected by residual phosphate on marginal land at Tel Hadya in 1994. Vertical bars represent SEs (DF Error 10).

Table 14. Mass (g/m^2) and number of seeds/m^2 of legume and total seeds (grass, legume and weed) species in the top 1 cm soil as result of residual phosphate from previous phosphate[1] applications under two stocking rates, June 1994, Tel Hadya.

Phosphate rate	Legume		Total	
	mass	number	mass	number
0	1.1	1437	8.9	6683
11	4.3	5281	23.2	15244
26	5.6	7073	20.9	15165
SEM (DF = 10)	0.63	895	3.37	1588

[1] Last phosphate application was in September 1990. Each value for phosphate rate is an average of two stocking rates. The stocking rate and phosphate x stocking rate interaction was not significant.

The number and mass of legume and total seeds are shown for June in Table 14. Seed mass and number of seeds for legumes harvested in June at P_{11} and P_{26} were higher than those at P_0. Total seed mass of all species was, respectively, 2.6 and 2.3 times that of P_0, and the number of seeds was 2.3 and 2.3 times that at P_0.

Reseeding Degraded Grasslands in El Bab, Syria

Mediterranean marginal lands within the cereal zone are used for grazing by livestock. They are communally owned, intensively grazed by sheep and goats, and frequently suffer from soil erosion. One of the previous ICARDA studies in the village of Bueda (70 km south of Aleppo) showed that marginal lands fail to provide adequate feed at various times of the year. During these periods, the sheep must either graze fallow and/or be hand-fed with barley, legume grains and straws. Thus, improving the productivity of marginal land can reduce dependence of farmers on alternative sources of feed.

Several indigenous legume species were assessed for their ability to rehabilitate degraded marginal lands. In 1993, a farmer, who has been cooperating with ICARDA to introduce forage legumes in rotation with barley in the El Bab area (Batajek, 70 km north east of Aleppo; 250 mm annual rainfall), requested help in rehabilitating his marginal land. In November 1993, an experiment was started on a hill of 32 ha which was controlled by the farmer and his two brothers. Plots were marked out in 2-3 ha unfenced paddocks in a randomized complete block design with three replications. Treatments included (1) fertilizing paddocks with 25 kg P_2O_5/ha; (2) oversowing with legume seeds and pods; (3) oversowing and fertilizing, and (4) a control treatment with no seeding or fertilizer.

The following species are included in the experiment; *Trifolium stellatum, T. campestre, T. tomentosum, T. resupinatum, T. purpurium, T. lappacium, T. speciosum, T. angustifolium, T. haussknechtii, T. scabrum, T. pilulare*; two selections of *Medicago rigidula* (1919 and 716); one selection of *M. noeana* (15485), and one selection of *M. rotata, Scorpiurus muricatus,* and *Hippocrepis unsiliquosa.* All species, except medics, were mixed and broadcast at a seed rate of about 10 kg/ha, while the medics were sown at a rate of 100 kg pods/ha (25 kg/ha for each accession).

Distribution of legume plants in March 1994 at Batajek, using 20 quadrats (10 x 100 cm each), indicated that *Trigonella* was the dominant legume in all treatments. In April 1994, herbage production was measured using cylindrical samples. Each sample consisted of four cylinders which were taken from each paddock. The samples were separated into species, and plants were counted, oven dried, and weighed. Legume plant numbers and dry matter were greater on the sown and fertilized plots, while grass dry matter was greater on the native plots whether fertilized or not (Table 15).

A rapid survey was conducted in July 1994 to assess the interest of farmers in neighboring villages in improving their marginal land. Three villages liked the idea, having seen the effect at Batajek. In November 1994, a total area of 56 ha belonging to the villages of Tarhin (19 ha), Tel Jurji (12 ha), and Tel Atia (25 ha) was seeded and fertilized (25 kg P_2O_5/ha). There were only two treatments in the new locations: seeded, fertilized; and native unfertilized (control) without replication. Table 16 shows the species and amounts of seeds and pods used in each location.

Table 15. Plant numbers and dry-matter production in April 1994 from the El Bab marginal land renovation experiment. Treatments are seeded and fertilized with 40 kg/ha phosphate (S+P); seeded without P (S-P); natural and fertilized (N+P); and natural, unfertilized (N-P).

Species	(plants/m²)			
	S+P	S-P	N+P	N-P
Trigonella spp.	216	164	130	115
M. rigidula	12	13	0	1
T. purpureum	21	9	0	0
T. speciosum	3	5	0	0
T. haussknechtii	2	6	0	0
T. pilulare	8	1	0	0
T. tomentosum	2	2	1	2
Dead clovers	16	46	2	1
V. sativa spp. *amphicarpa*	1	3	0	0.48
Other legumes	1	0	0	0.48
Total legumes	269	249	133	119
Total grass	6425	5783	5250	6452
Total weeds	491	343	342	351
Total plants	7197	6374	5725	6922
Dry matter (kg/ha)				
Legumes	223	219	148	135
Grass	697	558	944	813
Weeds	67	87	111	93
Total herbage	986	864	1202	1040

Table 16. Legume species and quantities (kg) of seeds (S) or pods (P) and rate per ha used on marginal lands in four villages at El Bab.

Species	Batajek		Tel-Atia		Tarhin		Tel-Jurji	
	S	P	S	P	S	P	S	P
Medicago rigidula 1919		400	60		45		27	
M. rigidula 716		400	57		42		26	
M. rigidula 2792			60		45		27	
M. noeana 15458		400						
M. rotata 2119		400						
M. rotata 2123			349		261		161	
Total		1600	526		393		241	
Total area seeded		16	25		18.7		11.5	
Seed rate kg/ha		100	21		21		21	
Hippocrepis unisilquosa	2							
Scorpiurus muricatus	3							
Trifolium angustifolium	3		27		20		13	
T. campestre	13		27		20		13	
T. haussknechtii	17		41		31		18	
T. lappaceum	17		41		31		18	
T. pilulare	17		59		44		27	
T. purpureum	17		18		14		8	
T. resupinatum	17		18		14		8	
T. scabrum	1.5							
T. speciosum	27		108		81		50	
T. stellatum	1.5							
T. tomentosum	17		41		31		18	
Total	153		380		286		173	
Total area seeded	16		25		18.7		11.5	
Seed rate kg/ha	10		15		15		15	

Role of Sheep in Reseeding Degraded Marginal Lands

The role of sheep in distributing seed via feces is being studied at ICARDA. Eleven *Trifolium* spp., three medics, in addition to *Hippocrepis* spp. and *Scorpiurus* spp., were fed to sheep as a mixture in a single meal. Feces were collected at different intervals to monitor the rate of seed passage. Feces containing seed were then broadcast in a replicated experiment to monitor the subsequent emergence of seedlings in the next season. Results showed that about 60% of the small seed (0.4-1.2 mg) and 25 - 35% of the medium-sized to large seeds (2-10 mg) escaped digestion. Of these, about 80% passed with feces of sheep within 40 hours of ingestion.

Feces collected from the sheep after 6, 12, 24, 36, 48, 72, 96, and 120 hours were gently threshed, seeds were classified, except for *T. scabrum*, *T. purgureum*, *T. campestre*, and *Trifolium speciosum* since they were similar in size and shape. Fig. 19a, b, c show the percentage recovery of the species after grouping them in three categories (Medics, *Trifolium* and others). Later, a germination test was done for the seeds recovered to assess the changes in their hard-seededness and viability after their journey through the rumen. Three replications each of 100 seeds or two replications each of 50 seeds (depending on the availability of the seeds) were tested for germination at 20°C for 10 days. Germinated seeds were counted and removed, and the rest were scarified and tested again for germination to assess their viability (Figs. 20a, b, c).

The recovery of *M. noeana* was more than 50%, while that of *M. rotata* and *M. rigidula*, 20 to 30% (Fig. 19c). Fig. 19b shows the different *Trifolium* spp. which can be grouped into at least two categories: small, where the recovery after ingestion ranged between 58 and 72%, and the relatively large seeds giving between 10 and 40% recovery. Fig. 19a shows the recovery of *Scorpiurus* spp. (39%) and *Hippocrepis* spp. (1%).

The germination percentage and viability for three *Trifolium* species (small seeds) decreased slightly (Fig. 20a), in contrast to the other *Trifolium* spp. whose seeds became harder after ingestion (Fig. 20b). *M. rigidula* and *M. noeana* showed a slight increase in seed softness after ingestion, while *M. rotata* remained unchanged (Fig. 20c). These results indicate that the viability of small legume seeds remains high following ingestion by grazing animals.

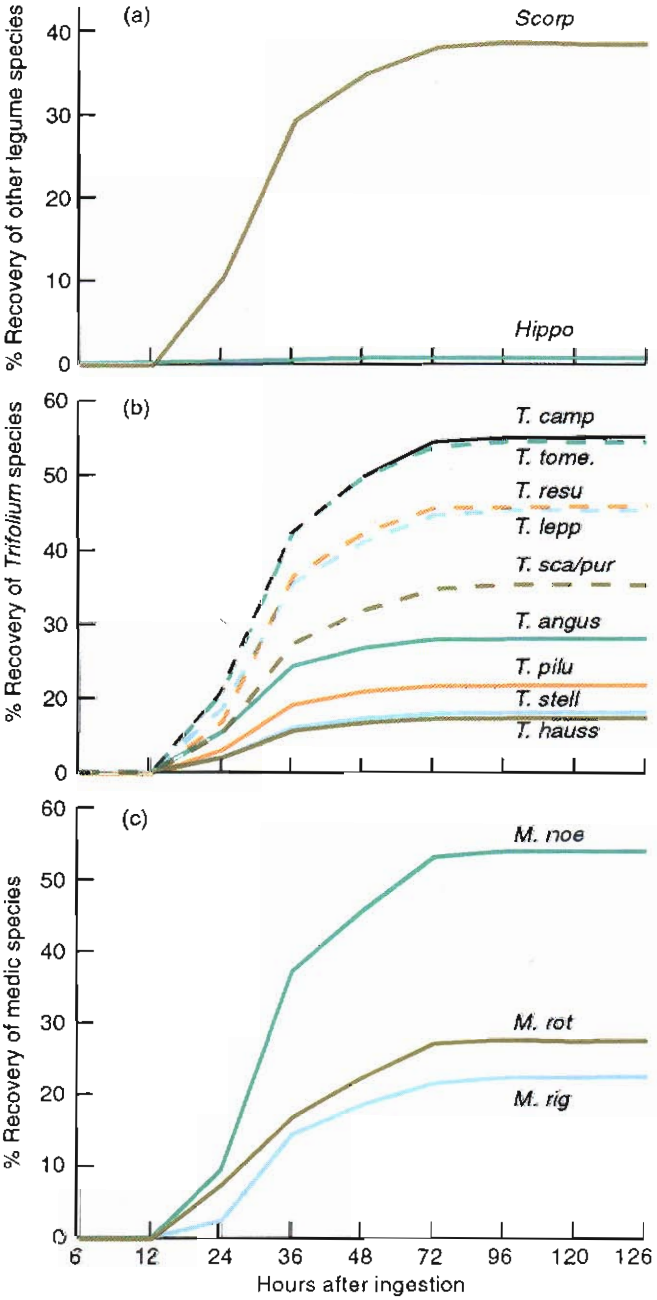


Fig. 19. Percentage recovery of legume seeds from the feces of sheep.

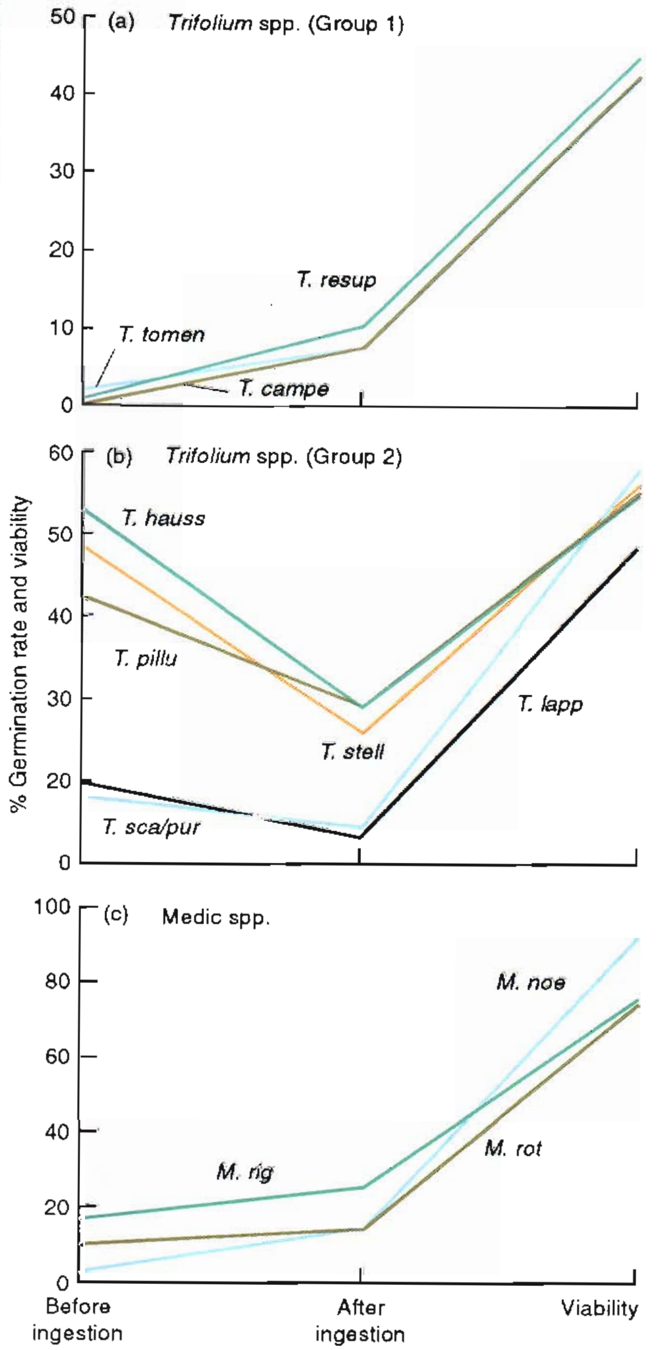
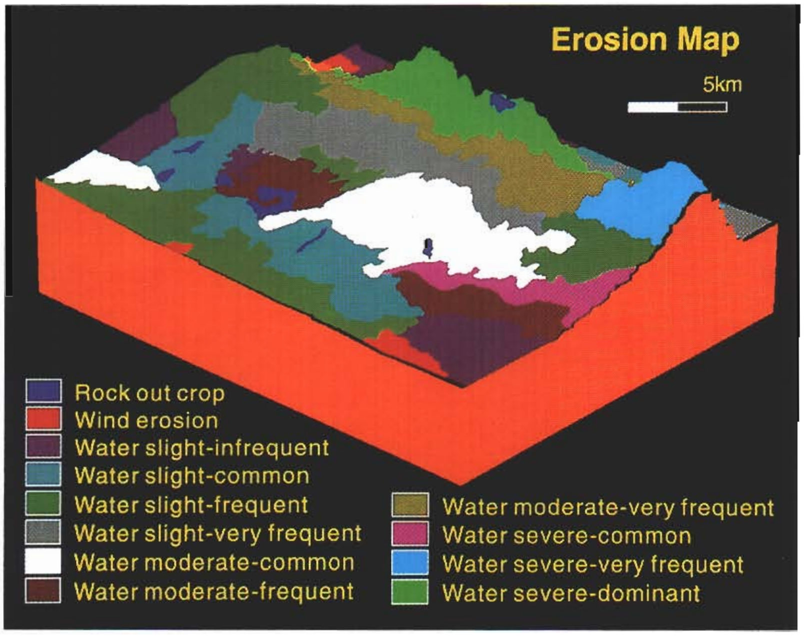
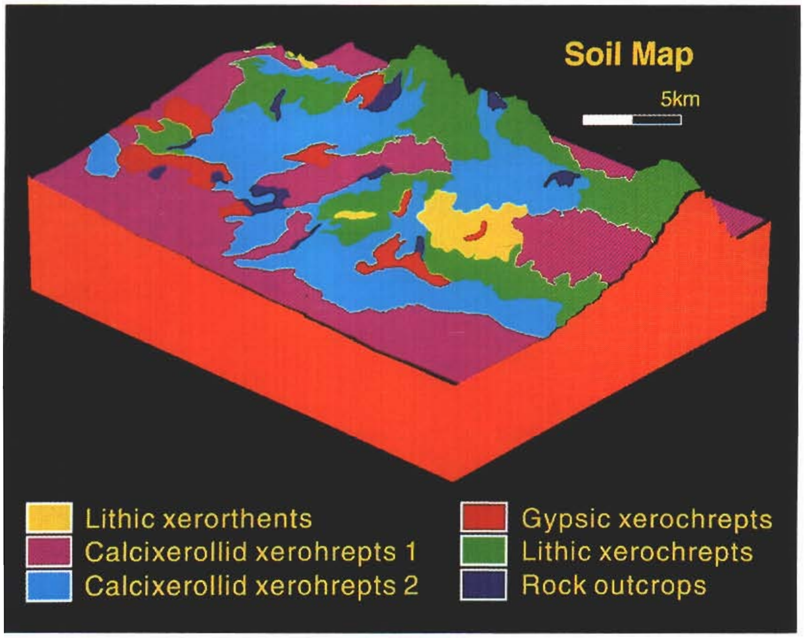


Fig. 20. Germination rate and viability of legume seed recovered from the feces of sheep (average of four intervals: 24, 36, 48, and 72 hours).

Map Database for Resource Management

Remote sensing (satellite data and aerial photograph analyses) is a method for capturing and characterizing the biological and physical resources in spatial formats as they relate to local agricultural systems and land use. GIS (Geographical Information System) is another computer technology to store, retrieve, and analyze multidisciplinary thematic maps obtained by remote sensing, and using other spatial data from extensive field surveys.





Classified erosion (12 classes) and soil (6 classes) maps superimposed on a three-dimension view of the Abd Al Aziz test zone, northeastern Syria. Universal Transverse Mercator (UTM) coordinates of left, front, right, back corners; X 601079 Y 4012329, X 634774 Y 4012786, X 634343 Y 4040520, X 600756 Y 40400622.

A Resource Map Database of Abdal Aziz test zone (40°07'30"-30'00"E, 36°15'00"-30'00"N), northeastern Syria, was created in GIS format, by geographic referencing and digitizing the original hard-copy thematic maps delineated by the aerial photograph interpretation using stereoscopes. The available GIS maps are: (1) Topographic map with extended elevation, slope and aspect maps applying Digital Terrain Model (DTM), (2) vegetation map of 10 representative vegetation types in the region, (3) soil map of six categories of soil types, (4) geomorphological map of land forms and land units, representing geological uniqueness, (5) degradation map of 15 categories of degradation by wind and water, its severity and the magnitude of area affected, and (6) a time series of grazing boundaries of five chosen flocks in the region.

The GIS analyses indicated that the spatial distribution of those severely degraded terrains is highly related to a stony soil type, Lithic Xerothants. However, there is no significant relationship between the degradation and other land features, such as elevation, slope, aspect, vegetation, and geomorphology.

The Resource Map Database will assist in analyzing the interaction between land use, land degradation and productivity on short- and long-term bases. This decision-making tool can help to prioritize land conservation and management interventions at the local and international levels.

Training

Research leads to new knowledge and training promotes good use of that knowledge. ICARDA places emphasis on training as a means of disseminating knowledge and experience with the overall objective of capacity building of NARS and to establish partnerships.

In 1994, ICARDA offered training to 551 individuals (Fig. 21) from 27 countries, comprising 16 WANA, one sub-Saharan, two East Asian, and eight European countries (Table 17). Of these participants, 47% attended courses at ICARDA headquarters in Aleppo while the remaining were trained in in-country, subregional and regional courses outside headquarters. About 17% of the trainees were women.

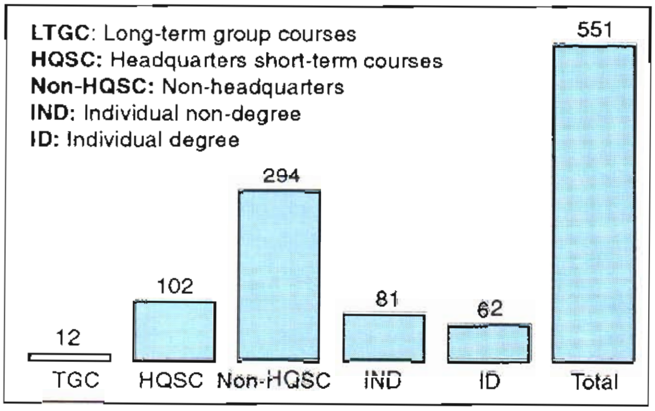


Fig. 21. ICARDA training participants, 1993/94.

Table 17. Participants in the 1993/94 ICARDA training courses.

Country	Long-term group courses	Main station short courses	In-country & sub-regional & regional	Indiv. non-degree	Indiv. degree	Total
Algeria	1	8	3	2	3	17
Australia	—	—	—	—	2	2
Canada	—	—	—	—	1	1
Egypt	1	7	35	1	2	46
Eritera	—	1	—	—	—	1
Ethiopia	1	3	7	1	—	12
France	—	—	—	1	—	1
Germany	—	—	—	—	6	6
Iran	—	6	66	1	1	74
Iraq	1	3	32	—	1	37
Italy	—	—	2	—	2	4
Jordan	—	9	7	6	8	30
Lebanon	—	7	11	6	2	26
Libya	1	6	—	—	—	7
Morocco	—	4	21	2	—	27
Netherlands	—	—	—	—	1	1
Pakistan	1	4	11	—	—	16
Poland	—	1	—	—	—	1
Portugal	—	—	1	—	—	1
Slovak	—	—	—	1	—	1
Spain	—	—	2	—	—	2
S. Oman	1	2	14	5	—	22
Sudan	2	4	15	5	11	37
Syria	2	17	49	48	20	136
Tunisia	—	10	3	—	—	13
Turkey	—	5	1	—	2	8
R. Yemen	1	5	14	2	—	22
	12	102	294	81	62	551

ICARDA continued its strategy of gradually decentralizing its training activities by offering more courses outside of headquarters. In 1993/94, the Center offered 11 headquarters courses and 23 in-country, subregional, and regional courses.

Besides topics in commodity programs, courses were offered in genetic resources conservation, communication and information management, scientific writing and data presentation, computer applications of statistical methods in agricultural research, seed processing and storage, seed processing and quality control, farm survey methodologies, and mechanical harvesting of legumes. Courses of an upstream nature such as DNA molecular marker techniques for crop improvement were also conducted.

Regional and other international research centers including CIHEAM, ACSAD, ILCA, CIMMYT, FAO, and UNDP participated in joint training activities in areas of mutual interest. Two joint group courses were conducted in collaboration with CIHEAM, and one regional group course each was conducted jointly with FAO, UNDP, IPGRI, and ILCA.

In response to a request from the Syrian Ministry of Agriculture and Agrarian Reform (SMAAR) and UNDP, ICARDA signed an agreement with SMAAR in mid-1994 to act as the implementing agent for the human resource development component of a UNDP-assisted project "Technical Assistance to Agricultural Investment in the Southern Region-Phase II." This project is for three years (1994 to 1996). In 1994, ICARDA helped conduct eight training courses in collaboration with the Egyptian International Center for Agriculture (EICA), in Cairo, Egypt. Thirty-nine senior researchers and research managers from this project, including the directors of agriculture in the provinces of Dara'a, Sweida'a, Quneitra, and Rural Damascus, participated in these training courses. These new training activities proved effective in linking national programs in the region with each other and with regional and international organizations.

The *Manual of Training Procedures* was updated. This manual defines categories of ICARDA training, establishes procedures for the selection of training participants, and details the support provisions offered to training participants who receive ICARDA training awards. A policy on the ICARDA Graduate Research Training Program (GRTP) was also developed and implemented.

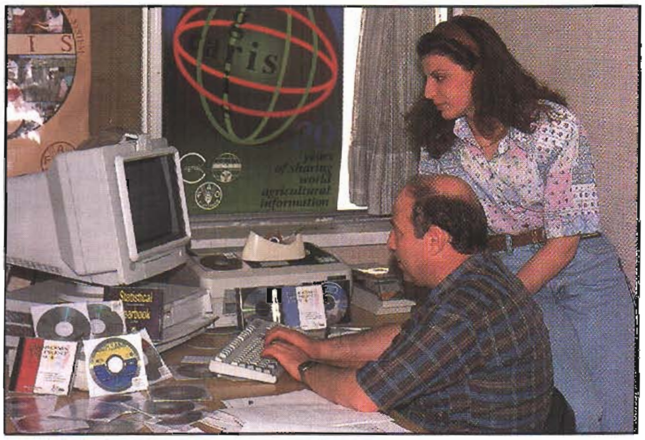
Information Dissemination

ICARDA participated in the inter-center meeting for developing an information strategy for the CGIAR, held at ISNAR in June 1994. As part of increased inter-center cooperation, emphasized by the strategy, an agreement was reached with CIMMYT to jointly provide, in collaboration with ISI-Current Contents and AGRIS, a bibliographic service on barley, wheat, and triticale to the ICARDA and CIMMYT clientele. ICARDA also agreed to participate in the CGIAR initiative on the integrated voice and data network (IVDN).

The in-house database ICAD, on subjects of interest to ICARDA, was further enriched by adding records from CD-ROM databases and other sources. This database now contains over 310,000 records covering the period from 1970 to 1992. A database on durum wheat was also developed.

A training course in information was offered at headquarters in cooperation with FAO. Information professionals from Pakistan, Syria, Tunisia, Turkey, and Yemen participated. Subregional courses on science writing were offered in Amman and Cairo for researchers from Egypt, Iraq, Jordan, Sudan, and Syria.

A work plan was developed with the Syrian national program to cover exchange of publications,



Over the years, ICARDA has built a rich library of CD-ROM databases relevant to its mandate. Each year, several information professionals from West Asia and North Africa receive training in the use of CD-ROM and other information technologies at the Center.

expertise and services, and a traveling workshop within the country to assess the level of available infrastructure and expertise in key institutions.

Over 50 publications were produced, and 80 articles were processed for submission to refereed journals. Posters and other audio-visual material were produced for the CGIAR high-level meeting in Lucerne, Switzerland. Ten press releases were issued. Over 55 stories about ICARDA appeared in the English and Arabic media.

Impact Assessment and Enhancement

ICARDA undertakes four different types of impact assessment: (1) technology adoption and impact studies, (2) institutional impact and development studies, (3) regional and subregional sector studies, and (4) technology evaluation. The first two of these provide *ex-post* assessment, the second two address potential impact (*ex-ante* assessment). The focus of impact assessment is on the sustainability and productivity of ICARDA's mandate crops and farming systems, at regional, national, and farm levels.

Institutional impact and sector studies are undertaken relatively infrequently, usually in response to special project and/or donor needs; but several adoption and impact studies and technology evaluations are conducted each year in partnership with NARS scientists, as an integral part of ICARDA's work in technology generation and transfer. These activities have recently been internally reviewed. The review findings are summarized in Figs. 22, 23, and 24. The general conclusion is that progress has been greatest in assessing the results of wheat research, followed by that of barley. Activities for legumes, including food, feed and pasture crops, have been much fewer; and only modest attention has been given to livestock-feeding practices.

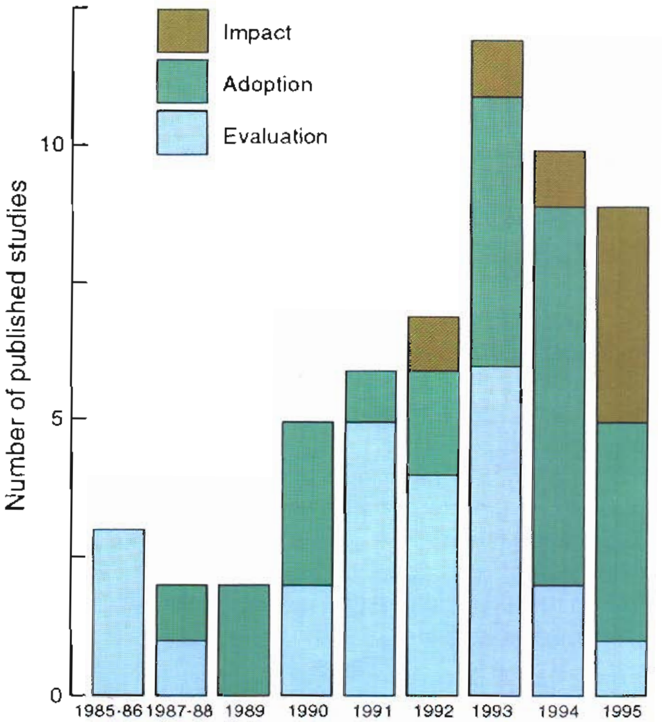


Fig. 22. Technology evaluation, adoption and impact studies at ICARDA.

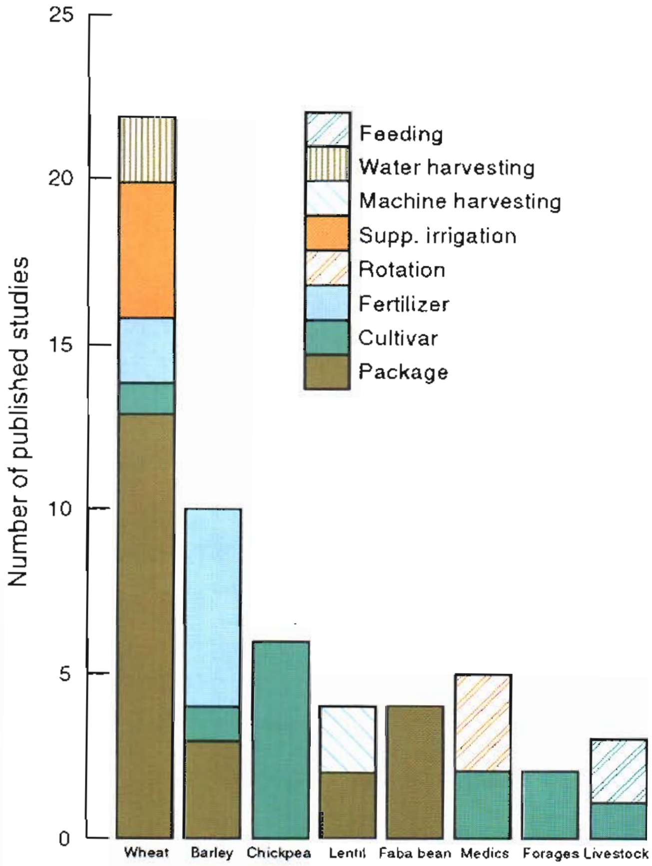


Fig. 23. Technology evaluation, adoption and impact studies at ICARDA: published studies.

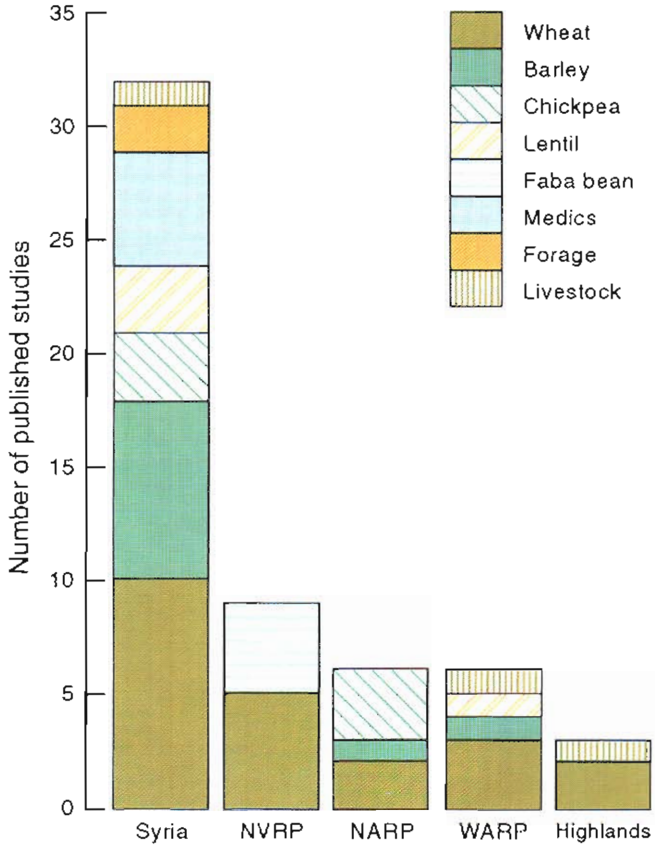


Fig. 24. Technology evaluation, adoption and impact studies at ICARDA: published studies by regional programs. NVRP, Nile Valley Regional Program; NARP, North Africa Regional Program; WARP, West Asia Regional Program.

Little work beyond diagnosis and evaluation was done before 1987 when a formal program on adoption and impact research was started at ICARDA. Since 1989, the number of annual studies has increased considerably. This represents both the maturation of the technology generation process and diversification within ICARDA's socioeconomic staff. Of particular importance has been the reduction in the number of *ex-ante* studies and the corresponding increase in *ex-post* impact analyses in the past three years.

Gender Studies

As part of a new doctoral study on women and agricultural labor in northern Syria, an informal appraisal was undertaken in Aleppo, Idlib, and Azaz Provinces to determine relevant aspects of local agricultural development and identify key resource farmers for subsequent in-depth studies. Interviews were conducted with 22 farmers in 19 villages, and information collected on the division of farm tasks between men and women. Recent agricultural intensification, including the spread of irrigation and increased crop diversification, have important implications for the allocation and organization of female farm labor, both inside and outside the farm household. Agricultural activities where women are the decision-makers include general field labor and specialized activities such as seed selection for next season's planting of maize and potatoes.

The survey identified informal labor exchange among different farms in the same village or between neighboring villages as one important aspect of farm work. Participants in labor exchange receive no monetary wage. More important for large-scale agriculture are the wage labor groups of women, organized and mobilized by female group leaders. This arrangement has not previously been reported in Syria. A tentative hypothesis is that large-holder farmers tend to dominate the labor market. They are able to mobilize large groups of women quickly through the group leaders, even when the women are already working on other farms.

About two-thirds of the women in labor groups are single and in their teens. Married members tend to be over 35 years old, with established families; but younger married women in their first or second pregnancy often work in the field up to their ninth month. Women laborers appear to keep their wages for their own use except when the family is very poor, in which case the money goes to the household head. However, there is a local custom whereby when girls work in the afternoon, they can keep their wages irrespective of parental poverty.

Outreach Activities

Six regional programs of ICARDA serve the subregions of North Africa, the Nile Valley, West Asia, the Arabian Peninsula, the West Asian Highlands, and Latin America (Fig. 25). These programs foster partnerships with national research teams, ensuring continuity of the cooperative research, as well as help identify new research needs and opportunities. In addition they provide a mechanism for decentralizing research and training activities and for the exchange of information. Where appropriate, they also play a catalytic role in attracting donor funding for national programs and establish links with advanced research institutes.

The major technical findings of these collaborative efforts are reported under relevant sections of this Annual Report. Here, a brief overview of the activities directed toward 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 in pursuing the overall goal of the Center.

North Africa Regional Program

The North Africa Regional Program (NARP) focuses on the arid and semi-arid rainfed 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. National research priorities are assessed each year in a planning meeting with each country, while broader cooperative endeavors are reviewed in regional coordination meetings.

Barley

During 1994, decentralization of barley breeding, initiated by ICARDA in 1992, was accelerated as the approach has proved effective. Full participation of national scientists has been achieved in selection of material adapted to local conditions from F_2 popula-

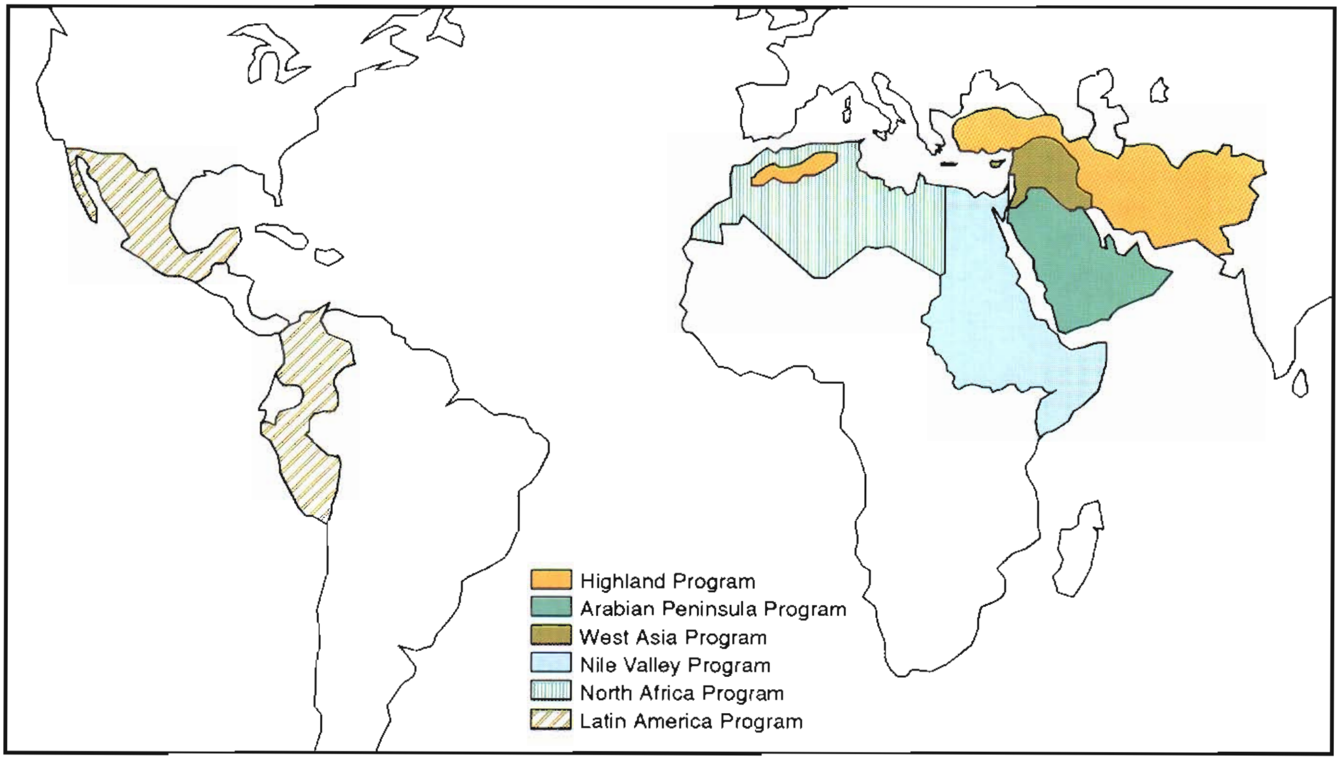


Fig. 25. ICARDA's outreach activities are grouped into six regional programs, based on commonalities of geography, ecology, and constraints to production in each region.

Table 18. Frequency of selection of barley lines (%) in Maghreb countries, in special F_2 segregating populations and F_4 bulked lines during 1992/93 and 1993/94.

	F_2 populations		F_4 populations	
Country	1992/93	1993/94	1992/93	1993/94
Morocco	53.5	62.1	43.7	52.9
Tunisia	69.7	51.8	57.2	43.0
Libya	34.6	44.6	44.3	43.7

tions of crosses designed by national programs. The percentage of segregating populations and F_4 bulk lines selected from observation nurseries has been high during the past two seasons (Table 18). This approach has proved promising and cost-effective.

Durum Wheat

Durum wheat in the Maghreb is grown almost entirely under rainfed conditions in three agroecological zones: drylands with mild winter; moderate rainfall zone; and dry lands with cold winter. Desirable traits for each zone are incorporated into high-yielding germplasm by ICARDA/NARS. For each zone, research tasks are shared by the ICARDA/CIMMYT project based in Aleppo and national programs of Algeria, Morocco, and Tunisia.

Zone I: Dry Lands with Mild Winters

Research is jointly executed with the Moroccan durum breeding program on abiotic stresses (drought and heat), and biotic stresses (Hessian fly, root rots, tan spot, and sawfly). At INRA-Settat, 140 *Aegilops* accessions, provided by ICARDA, were screened for Hessian fly resistance and 19 were identified as resistant. Additional resistant accessions were identified at IAV-Hassan II, Rabat. Embryo-rescue techniques provided a large number of plantlets which are treated with colchicine and crossed with durum wheat at flowering. *Ae. geniculata* x durum gave better results than *Ae. triuncialis* x durum.

Of 1132 accessions from the breeding material, accession No. 829 was found resistant to Hessian fly. This is the first source of Hessian fly resistance in durum wheat in Morocco.

A rapid method of screening for root rot resistance was developed. The same 1132 populations were screened and promising sources identified. The Tunisian cultivars Mahmoudi, BD 1548 and Jenah Khotifa, and several lines from Algerian populations, including Biskri Glabre, were identified as good sources of resistance to powdery mildew. A Tan Spot Resistance Nursery for North Africa was distributed from Morocco.

Zone 2: Moderate Rainfall

The work for this zone is spearheaded by the joint ICARDA/CIMMYT-Tunisian durum breeding program. Major objectives are to develop high-yielding durum cultivars with resistance to septoria blotch and with good grain quality. Resistance to *Septoria tritici* has been identified, and the first generation crosses were made in the spring of 1994 with high-yielding durum varieties. The F_2s derived from these crosses will be distributed as the Regional Maghreb Septoria Nursery.

Zone 3: Dry Lands with Cold Winter

Research for this zone, in collaboration with Algeria, focuses on the development and characterization of germplasm with resistance to cold/frost. It capitalizes on the landraces of high plateau areas and the wheat wild relatives. Preliminary results show that early growth vigor and high tillering capacity at low temperatures are associated with productivity, and the highest yielding lines are obtained from crosses involving durum parents from continental areas of WANA.

Bread Wheat

The collaborative research in bread wheat breeding is most active in Morocco and Tunisia. It emphasizes multilocation testing and selection in the Maghreb. One of the highlights of the season was the identification of a dihaploid Hessian fly resistant line that proved superior to its resistant parents. Another interesting finding was the identification of useful variability for stress-related traits such as seedling vigor, leaf rolling, and frost resistance in local bread wheat landraces.

Chickpea

The lines ILC 482, V.F. a2, 84-92 c, 84-93 c, 85-94c, Amadoun, 84-34, and UC 27 showed good adaptation to low moisture and tolerance to wilt across North Africa. These lines are under multiplication in Algeria and Tunisia.

Lentils

ILL 4400, Balkan 755, and Setif 618 were widely selected for their drought and cold tolerance. FLIP 88-41L and 785-26002 gave a high yield of over 1.5 tonnes yield per hectare under heat and drought (only 173 mm rainfall) conditions.

Collaborative Research on Pasture and Forage Crops

For pasture and forage crops, ICARDA's collaboration with Maghreb NARS focuses on seed production and crop rotation.

Research in Morocco focuses on forage seed production by farmers (Settat/Safi region) using small machinery for seed harvesting, in cooperation with the Directorate of Crop Production and the Extension Services. Field days and farmer surveys were conducted to identify potential seed producers and users.

In Algeria, crop-pasture rotation trials have been established with a view to integrate small ruminants into the farm-production systems. The work is carried out in cooperation with the Institut Technique des Grandes Cultures (ITGC).

Regional Collaborative Activities

Cereal Traveling Workshop

Barley, durum and bread wheat scientists from Morocco, Tunisia, Algeria, Libya, Egypt, and Sudan and ICARDA participated in a Cereal Traveling Workshop in Morocco in early May 1994. They carried out selections from the jointly developed germplasm, Maghreb regional trials, and the Morocco national program nurseries. Discussions focused on accelerating research against drought, and on consolidating the results from the barley shuttle breeding between Aleppo and Maghreb programs.

Regional Coordination Meeting

The Fourth North Africa Regional Coordination Meeting was held in Tripoli, Libya in October 1994. Thirty-two scientists from the Maghreb NARS and eight from ICARDA discussed ongoing activities and salient results, and developed a joint program of activities for the 1994/95 season.

Scientists from North Africa, Nile Valley countries, and ICARDA select barley lines at Annaceur in Morocco.

Regional IFAD/ICARDA/Maghreb Project on Technology Transfer

This project, now in its fourth year, involves the semi-arid regions of Sidi Bel-Abbes in Algeria, Kef in Tunisia, Settat in Morocco, and Derna in Libya. The project aims at verifying technologies in farmers' fields and involves research, teaching and extension institutions thereby strengthening their capacities in on-farm problem solving research.

Nile Valley Regional Program

The Nile Valley Regional Program (NVRP) is based on research cooperation among three NARS (Egypt, Ethiopia, and Sudan) and ICARDA. The Program focuses on technology generation and transfer in addition to human resource development to enhance sustainable productivity of a wide range of major cool-season food legumes (faba bean, chickpea and lentil) and cereals (wheat and barley). Six problem-oriented multi-institutional regional networks have been established to strengthen basic research, while a resource management component has now been established within the Program in Egypt. Funding for the Program continued from the European Union (EU) for the Egyptian component, from the Royal Netherlands Government for the Sudanese component and barley improvement in Ethiopia, and from the Swedish Agency for Research Cooperation with Developing Countries (SAREC) for the food legumes component in Ethiopia. Eritrea is expected to join NVRP in 1995.

Transfer of Technology

Wheat

The impact of wheat technology development and transfer has been tangible in Egypt (Fig. 26). Increased net returns of 42 to 52% were associated with high adoption of recommended irrigation regime (77%), planting date (73%), and cultivar (64%). This has contributed to the rise of wheat production to over 4.5 million tonnes as compared with around 3.0 million tonnes six years ago. Self-sufficiency has increased from 31% in 1989 to 43% in 1994.

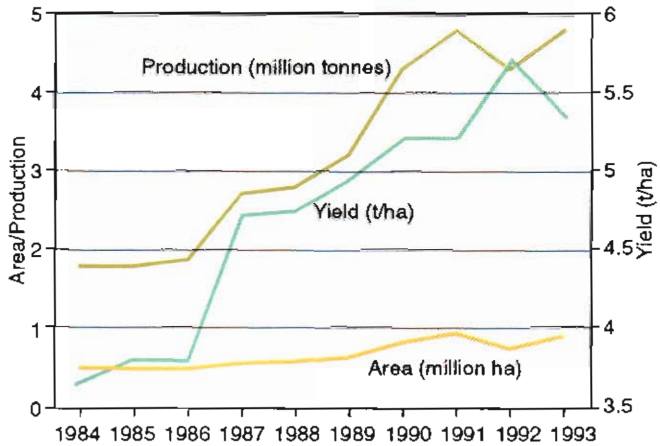


Fig. 26. Area, production, and average yield of wheat in Egypt, 1984-1993.

In Sudan, wide adoption was recorded for improved sowing methods, cultivars, and irrigation interval in 1992/93. In 1993/94, on-farm demonstrations revealed yield increases, with improved location-specific production packages, of 21 to 94% in central Sudan and 32 to 72% in northern Sudan.

Barley

In Ethiopia, improved production packages comprising improved cultivars, fertilizer application, and hand weeding significantly raised grain yields in demonstration plots at six sites (Table 19). A selected landrace (3357-13) yielded 2.5 t/ha, 32% higher than the local check.

Table 19. Yield performance of improved barley production packages and local practices at different locations in Ethiopia, 1993/94.

Location	Seed yield (t/ha)		Yield increase	
	Improved	Local	t/ha	%
Addis Alem	1.60	1.01	0.59	58
Ada Berga	1.52	0.88	0.64	73
Degem	2.47	1.10	1.37	125
Debre Libanos	2.65	1.03	1.62	157
Meta Robi	2.83	1.60	1.23	77
Wolmera	1.18	0.96	0.22	23
Mean	2.04	1.10	0.94	85

In Egypt, improved barley production packages under rainfed conditions increased yields by 0.58 t/ha (109%) averaged over 8 locations in the Northwest Coast and by an average of 0.72 t/ha (81%) at two locations in North Sinai. The newly released drought-tolerant cultivar Giza 126 outyielded farmers' cultivars by 13 to 20%.

Faba Bean

With demonstrations of multifactor production packages, faba bean grain yields improved by 33 to 66% in North Delta, 15 to 29% in Middle Egypt, and 23% in Upper Egypt (Assiut). *Orobanche* infestation was effectively controlled by integrated measures (resistant cultivars, low rate of glyphosate, and 1% NPK fertilization) in demonstrations in North Delta, Middle, and Upper Egypt with yield savings of 0.98 to 1.63 t/ha (49-163%).

In Ethiopia, progress was made in the adoption of improved cultivar (92%), tillage practices (78%), and weed-control methods (72%) in Central Shewa. Ongoing technology development was reflected in high increases in grain yields of 21 to 150% in the Central Highlands and 110 to 165% in northwest Ethiopia.

In Sudan, field monitoring in four areas over three seasons revealed high adoption of early sowing and pest control (69-100%), low to moderate adoption of frequent irrigation (17-50%), and variable adoption of hand weeding. Adoption of weeding and pest control were hampered in 1993/94 by labor and pesticide shortages. The advantages of improved production packages, demonstrated over 34 sites in six production areas, ranged from 114 to 353% higher grain yields.

Chickpea

In Ethiopia, adoption levels were encouraging in the Akaki area (Fig. 27) where an improved cultivar (DZ/16-2) was released. Three advanced desi breeding lines had wide adaptability and high yield, producing over 3 t/ha.

In Egypt, chickpea technology development has been encouraging in the newly reclaimed areas where yield improvements of 16 to 71% were achieved in

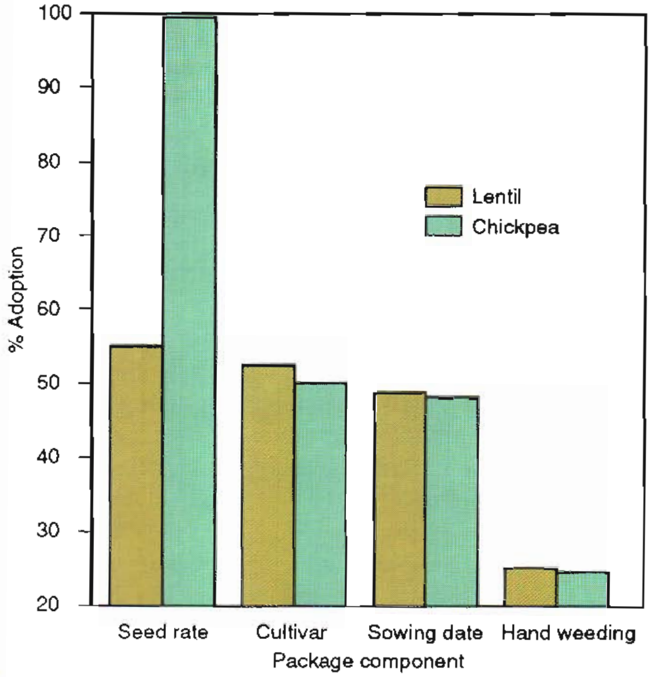


Fig. 27. Adoption levels of components of improved chickpea and lentil production packages in the Akaki area in Ethiopia, 1992.

three out of four demonstrations. Two newly released cultivars, Giza 531 and Giza 195, outyielded farmers' cultivars by 26 to 32% over seven locations in old and newly reclaimed lands.

In Sudan, improved chickpea technology was demonstrated to increase grain yields by 24 to 169% in two major production areas between 1989/90 and 1993/94. The yield increases in 1993/94 were 80% and 169%. For wilt and root rot problems, nine resistant/ tolerant genotypes were identified, of which ICCV-2 is being considered for release.

Lentil

Sudan has made significant strides in lentil production, increasing its area to 10,000 ha. Lentil production now meets domestic needs of the country. Despite very high temperatures in the 1993/94 season, improved production practices in demonstration trials gave 15 to 195% higher yields than traditional practices.

In Ethiopia, substantial technology adoption levels were reported (Fig. 27). Achievements in breeding included the release to farmers of the cultivar NEL 2704 from ICARDA. In Egypt, improved production packages in on-farm demonstrations produced 23% and 95% yield increases in lentil in Old Lands and newly reclaimed areas, respectively.

Resource Management

A resource-management component was initiated in NVRP-Phase II of Egypt to conduct long-term studies on the sustainability of the production systems and natural resources in three agroecological zones: rainfed areas, the New Lands, and the Old Lands (main Nile Valley). Inventory Studies were completed for all three agroecological zones and reports developed. Rapid rural-appraisal studies are under way, to be followed by multidisciplinary surveys in the target areas. Research on long-term resource management will start in 1995/96.

Egyptian and ICARDA scientists with a European Union representative assess the farming systems and resource management practices followed by a small farmer using organic fertilizer in Egypt.

Regional Cooperation and Networks

After several years of regional cooperation, six problem-solving networks were formalized. Because of the agroecological similarities, particularly with Ethiopia, Yemen also joined these networks.

In the Wheat Rust Network, 13 wheat entries were identified as highly resistant to leaf rust in Egypt, Ethiopia, Sudan, and Yemen. In the Wheat Heat Tolerance Network, the yield stability of commercial cultivars Debeira, Condor, Giza 160, and Giza 164 in the heat-stressed environments of Sudan and Egypt was confirmed.

A Regional Traveling Workshop on food legumes and wheat was held in Sudan and another, on barley, in Ethiopia. A Regional Socioeconomics Workshop was held in Egypt to document and standardize adoption and impact studies in the three Nile Valley countries.

Training and Human Resource Development

During the 1993/94 season, a total of 59, 82 and 55 national scientists/technicians received various types of non-degree training through the NVRP projects in Egypt, Ethiopia and Sudan, respectively. A total of 204, 101 and 120 scientists from the three Nile Valley countries (in the same order) participated in professional visits, workshops, coordination meetings and conferences through support from NVRP. In addition, nine graduate students are being supported for M.Sc. degree training.

West Asia Regional Program

The technology transfer activities in Syria, Jordan, Iraq, Lebanon, Cyprus, and lowland areas of Turkey continued to be supported through the Mashreq Project co-financed by UNDP and AFESD. Emphasis continued to be placed on strengthening adaptive research capabilities through implementing large numbers of on-farm trials involving researchers, extensionists, and farmers.

Cooperative Research and Transfer of Technology

Cooperation with Jordan covers tillage and residue management, supplemental irrigation and water

Scientists from Syria, Jordan and Iraq, and ICARDA, visit a site in Morocco.

harvesting, and wind erosion. Cooperation with Lebanon includes improvement of lentil, wheat, barley, and chickpeas, forage crops and marginal land in addition to farm surveys and germplasm collections.

Farmers' adoption of barley production technologies was assessed in Jordan. Three groups of farmers were consulted: farmers who had participated in demonstrations in their fields, farmers neighboring the demonstrations and those who attended field days, and others randomly selected outside these two groups. Farmers tended to favor components of the technology instead of full packages: 65% of them had changed their current cultural practices to the project practices; 62% had adopted fertilizer application, 57% improved cultivar, and 46% chemical weed control. Fifty-nine percent of the farmers surveyed said they adopted the technology as a result of their participation in demonstrations or field days. Constraints to adoption included: lack of credit, drought, inability to invest, and unavailability or lack of access to inputs (Table 20).

Table 20. Constraints limiting farmer adoption of barley production technology in Jordan.

Constraints	Farmer (%)
Credit unavailability	60
Unavailability and high cost of machinery	52
Low rainfall	33
Weak extension services	24
Low quality of improved cultivar for animal feed	20

In order to increase cooperation between Mashreq and Maghreb countries, a study tour was conducted by the Mashreq Project to Morocco in June 1994. Three scientists each from Jordan, Syria and Iraq, in addition to the regional coordinator of the Project, participated. The group shared experience with Moroccan colleagues in barley, forage, and sheep production.

Support to NCARTT

ICARDA, in cooperation with ISNAR, assisted the National Center for Agricultural Research and Technology Transfer in Jordan (NCARTT) to develop a research strategy and medium-term plan. The strategy is now ready for official approval by Jordanian authorities.

Coordination Meetings with NARS

In 1994, the sixth coordination meeting was conducted with Jordan, the fourth with Lebanon, the third with Iraq, and the fourteenth with Syria.

Training and Human Resource Development

Four traveling workshops were organized during 1994 with the participation of 90 researchers from Mashreq countries and ICARDA. Three regional/international workshops were also held on the following topics: development of agriculture in the occupied Palestinian territories, biodiversity and resource management, and fat-tail sheep.

Several training courses were organized in West Asian countries. ICARDA scientists co-supervised 10 MSc students at the Faculty of Agriculture, University of Jordan, six of them either fully or partially financed by ICARDA.

To support the extension workers, six television extension films on Project activities were produced and broadcast in both Syria and Jordan.

Highland Regional Program

ICARDA's collaborative highland research and training activities were conducted in Pakistan, Turkey, and Iran. The highland areas (usually 750 meters above sea level) are characterized by low winter temperatures that severely limit crop growth and productivity.

Turkey

The ICARDA/Turkey Highlands Project, supported by the Government of Italy, is composed of seven small projects and aims at strengthening research activities and facilities in the Central Anatolian Highlands and Taurus Mountain areas. During 1994, five of these projects were conducted in collaboration with the Central Institute of Field Crops (CRIFC), Ankara, and one each with Ankara University and the University of Cukurova, Adana. During the last quarter of the year, three new small projects were initiated.

Barley: Two cold-tolerant barley varieties, TARM-92 and Yesevi-93, were released for farmer cultivation in 1992 and 1993, respectively. Five barley lines, two 6-row and three 2-row ones, have been identified for variety registration trials for very cold areas in Sivas province of the Central Anatolian Plateau.

Durum wheat: As a result of ICARDA's collaborative work on durum wheat with the Southeastern Anatolian Agricultural Research Institute, Diyarbakir, two facultative durum wheat varieties, Aydin-93 (Omrabi "s") and Firat-93 (Korifla), were registered for farmer cultivation.

A joint disease survey, conducted during 1992-94 by the Turkish/ICARDA/CIMMYT scientists, has provided useful information on the importance and prevalence of wheat and barley diseases in the Central Anatolian highlands. During the survey period, diseases that were assessed as important were: foot and root rots, leaf spot and blotch in wheat; leaf stripe and foot and root rots in barley; and loose smut in wheat and barley.

Lentil: Two lentil lines (ILL 662 and 1879) showed cold tolerance at Haymana and Konya locations. Among wild lentils, accessions of *Lens culinaris* ssp. *orientalis* exhibited the highest level of winter hardiness, whereas accessions of *L. nigricans* ssp. *ervoides* were most susceptible to cold.

Vetches: Among vetches, the narbon vetch (*Vicia narbonensis*) produced the highest seed and biological yields with the highest harvest index. It also matured 10-13 days earlier than other species.

The multilocation and multidisciplinary work in the small and hilly villages of the Taurus Mountains was further intensified by the joint efforts of Cukurova University, Ministry of Agriculture and Rural Affairs, and ICARDA. In these villages, triticale performed well and attracted the attention of farmers as a potential animal-feed crop. Also, the intensified work on honeybee rearing attracted farmers' attention and convinced many of them to adopt it to increase their income.

New Activities

A three-year, EU-funded, project was initiated for the Mediterranean highlands of Tunisia, Algeria, Morocco, and Turkey. The project aims at creating a scientific and information network to enhance and sustain crop production in the highlands of those countries. In addition, two other research activities were initiated: tolerance of boron toxicity in barley, and rehabilitation and management of common village pastures.

Training and Human Resource Development

Six scientists from CRIFC and one each from Ankara University and the University of Cukurova participated in five short training courses organized by ICARDA. Twenty-one scientists participated in regional and international workshops. In addition, three senior scientists from Turkey attended the ICARDA/Maghreb Regional Coordination Meeting to jointly develop a workplan for the Mediterranean Highlands Project.

A two-day international workshop on 'Toward Improved Winter-sown Lentil Production in the Highlands of West Asia and North Africa' was organized by Turkey/University of Reading/ICARDA in Antalya, 12-13 December 1994. Scientists from Algeria, Iran, Morocco, Tunisia, Turkey, the UK and USA, and from ICARDA participated.

Coordination Meeting

The Turkey/ICARDA Highland Project Annual Coordination Meeting was organized at CRIFC, Ankara in October 1994. Over 70 scientists from different agricultural research institutes (Ankara, Adana, Diyarbakir, Erzurum, Eskisehir, Izmir and Konya), universities (Ankara and Cukurova), and ICARDA attended the meeting.

Iran

The Iran/ICARDA collaborative project encompasses all the programs, disciplines, commodities and activities of ICARDA's mandate. Therefore, the project is not only multidisciplinary but multidimensional in nature.

The collaborative research with Iranian agricultural research institutions were intensified under this Project financed by the Government of Iran. At the joint Iran/ICARDA coordination and planning meeting, a detailed research and training program for the dryland areas of Iran was developed. Activities implemented during the period under report focused on resource management and cereal improvement.

Training and Human Resource Development

Three Iranian researchers went to Australia, one to USA and one to the UK for PhD studies. The arrangements to send another 23 candidates are being made with various universities around the world.

Three in-country training courses were organized to develop national technical staff. Additionally, many trainees from Iran participated in training courses at ICARDA, and a Regional Travelling Workshop on Winter Cereals was organized in Iran during May/June. Scientists from Azerbaijan, Kazakhstan, Pakistan, Afghanistan, Turkey and Japan, and ICARDA, CIMMYT and IPGRI, also participated.

Pakistan

The USAID-funded project at the Arid Zone Research Institute (AZRI) in Quetta, Pakistan ended in mid-1994. The project aimed to strengthen the research and research-management capabilities of AZRI. This was achieved by posting resident advisers from ICARDA and Colorado State University and through long-term training of AZRI staff at universities in the USA. The goals of the project were reached in most important subjects: demonstrating the genetic potential of the two main sheep breeds, on-farm testing of fourwing saltbush (*Atriplex* spp.) as a forage shrub and fuelwood supplier, assessing the technical and economic potential of water-harvesting, and the identification and multiplication of seed from several lines of wheat, barley, forages and lentils. A research management system using protocols was established that made it possible to monitor research progress. The project ended with AZRI having a steadily increasing number of staff with foreign MS and PhD degrees and a solid base of scientific knowledge that is needed to drive the on-farm research activities.

Even though the project ended in August 1994 and ICARDA closed its project office in Quetta, linkages were forged for a durable collaboration between ICARDA and AZRI.

Arabian Peninsula Regional Program

This program continued with financial support from the Arab Fund for Economic and Social Development (AFESD). While routine work on germplasm exchange, evaluation and improvement; technical backstopping of national resource management activities; and training continued, major emphasis has been placed on formulating new collaborative activities which better respond to the priority needs of the small agricultural sector of the region.

Latin America Regional Program

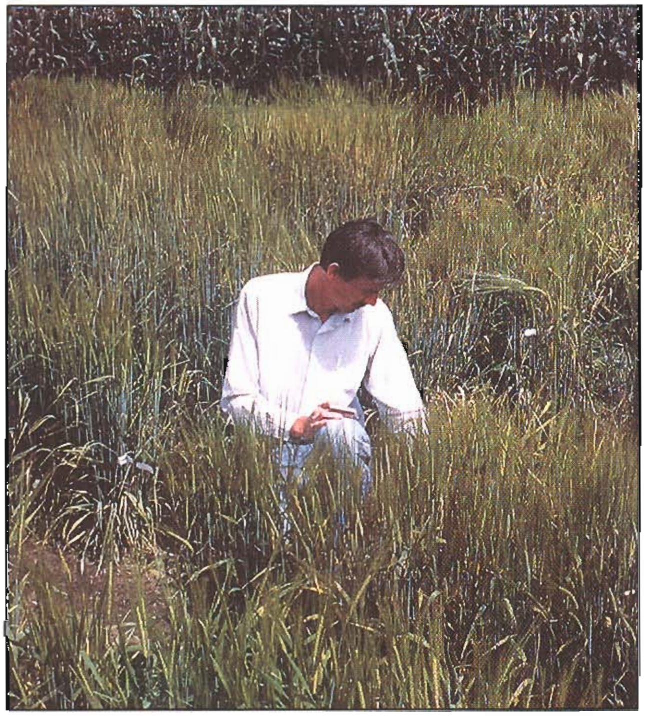
The Latin America Regional Program of ICARDA is based at CIMMYT in Mexico. It focuses on the improvement of barley and barley-based cropping systems in the subregion.

During 1994, Ecuador identified several advanced barley lines with partial resistance to leaf rust. In Peru, at Agrarian University La Molina, a barley line yielded 10 t/ha, a record that contrasts significantly with the national average of 1 t/ha over the last decade. Adoption of these cultivars may, however, be delayed because of their bluish aleurone color. In both Ecuador and Peru, white grain color is preferred by small industries that use barley in commercial products, such as breakfast cereals.

In three Mexican states, in cooperation with different institutions, farmers are exploring barley for uses other than malt. Grazing early-maturing barley as a companion crop to ryegrass and medic (*Medicago polymorpha*) has proved promising in several verification trials carried out in farmers' fields. Ranchers, who are exploring the new system, find that the total number of grazing days for their livestock increase with early-maturing barley.

Outside the subregion, Kenya released Ngao, a two-row barley with early maturity as well as resistance to Barley Yellow Dwarf Virus, the most prevalent disease in the country. A rapid increase in area sown under hull-less barley is being observed in Alberta, Canada, which coincides with the release of hull-less barley varieties suitable for animal feed. Falcon, a six-row hull-less barley with stiff straw and better protein and energy digestibility, was released to Canadian farmers. Falcon was selected from an F_2 population obtained from Mexico. Tukwa and Seebe, two covered barley varieties of the same origin, were also released in Canada.

In collaboration with Oregon State University, a catalog of genes, which provide resistance to race 24 of *Puccinia striiformis* f. sp. *hordei* (stripe rust), is being developed. Resistant genotypes developed by the Program and double haploids produced in Oregon are field-screened for stripe rust resistance in Mexico. This is followed by work on molecular markers (RFLPs) at Oregon State University. Results showed that a sister line of varieties Calicuchima (Ecuador) and Kolla (Bolivia) has two resistance genes located on chromosomes 4 and 7. Double haploids of the variety Shyri (Ecuador), a resistant progenitor, were field-screened in 1994 in Toluca, Mexico.



Robert Loughman from Australia scores stripe rust in Australian cultivars in Toluca, Mexico.

Sources of resistance to scab were provided to breeders in Minnesota and North Dakota, including the cultivar Gobernadora which has been found resistant to scab in China.

Several national program scientists from Latin American countries visited the Program to collect germplasm of their interest. The Program Coordinator was nominated to the advisory committe of a PhD student who will work on stripe rust in barley.

Resources for Research and Training

Finance

ICARDA's programs are funded by its generous donors (Table 21, see also Appendix 11). In 1994, the Center's grant funding was USD 15.388 million. Combined with other income of USD 3.185 million, the operating revenue was USD 18.573 million. The operating expenses during 1994 totalled USD 19.055 million resulting in a deficit of USD 0.482 million. The reduced deficit in 1994 of USD 0.482 million as compared to the 1993 deficit of USD 2.903 million, was attributed to fund raising activities of the CGIAR, which improved the Center revenues in 1994. The staff reductions and cost cutting activities introduced in 1993 also had a bearing on the reduced deficit in 1994.

Furthermore, the Center receives in-kind contributions from Japan International Cooperation Agency (JICA) and Japan International Research Center for Agricultural Sciences (JIRCAS) in the form of equipment and operational research costs. In 1994, these in-kind contributions translated to US$ 170,000.

Table 21. Sources of funds for ICARDA's programs and capital requirement (x 1000 USD), 1994 and 1993.

	1994	1993		1994	1993
Arab Fund	765	720	IFAD	32	162
Arab Planning Institute			India	25	24
			Italy	935	1,837
Australia	276	285	Japan	373	350
Austria	90	100	Mexico		
Canada	580	641	Netherlands	1,169	802
CGIAR		4	Norway	266	287
China	30	50	OPEC	75	28
Denmark	312	298	Spain	125	125
European Eco. Commission	6		Sweden	460	527
			UNDP	355	284
FAO		15	UNEP		44
Ford Foundation	14	32	U.K.	850	753
			USAID	2,000	3,627
France	355	426	Exchange gain/(loss), net	1,700	759
Germany	1,125	1,603			
IBRD (World Bank)	5,105	3,200	Earned income	566	558
			Other income	919	605
IDRC	65	62	Total	18,573	18,208

Staff

During 1994, the following senior staff members sparated from ICARDA: Mr James McMahon, Deputy Director General (Operations); Dr Hassan Seoud, Assistant Director General (Government Liaison); Dr Ahmed Kamel, Regional Coordinator for North Africa; Dr Hazel Harris, Soil Water Conservation Specialist; Dr Ardeshir B. Damania, Cereal Germplasm Curator; Dr Ross Miller, Cereal Entomologist; Dr Timothy Treacher, Visiting Scientist (Livestock); Dr Peter Smith, Visiting Senior Economist; Dr Walid Sarraj, Training Officer; Dr Michael van Slageren, Genetic Resources Scientist; Dr Margaret Mmbaga, Legume Pathologist; and Dr Victor Shevtsov, Visiting Scientist (Cereals).

Dr James Bonnell joined as Principal of the International School of Aleppo.

Dr Mustafa Pala, Wheat-based Systems Agronomist, returned from sabbatical leave.

Computing and Biometrics

General and Technical Support

The VAX 4500 computer cluster provided a stable environment for VMS applications. The number of users doubled during the year. The VMS operating system, SAS, Genstat, and Oracle were upgraded, and the old VAX 750 was switched off.

Most of the staff are now connected to the local area network, and the use of electronic mail has increased significantly. Several new printers and 10 DOS/Windows applications were added to the network. Two anti-virus applications were installed on the server and upgraded; virus problems were rare during the year. PC backups to the tape, through the network, were carried out regularly. New uninterrupted power supply dual systems were installed.

Scientific Computing

Further progress was made on TMS, ICARDA's Trials Management System. The individual modules of TMS are now integrated into the TMS menu system, using ORACLE for user-friendly access. A test system, TESTTMS, was employed in the development and testing of modules. A secure but flexible access authorization system was implemented.

Additional modules were developed for printing labels in plot order or treatment order in user-specified format, printing or displaying the randomization plan layout, and others. A number of modules were modified for improved efficiency and security.

The Meteorological Database (METDB), containing meteorological records from ICARDA and Syrian stations, was further improved with data query, summarization, reporting and updating functions.

Support was provided to users on data management, statistical analysis and preparation of graphics and maps, and on the use of palm-top computers for data logging, and of digital scales for data capturing.

Biometrics

Biometrics support was provided to researchers on planning experiments and data analysis, interpretation and presentation. Many experimental designs were offered, including evaluation of integrated disease management trials in chickpea, effects of temperature and moisture on a faba bean cultivar, and crop-loss assessment in wheat.

Data exploration was carried out using statistical techniques in a number of different areas, for example, two-course barley rotational trials using an autoregressive-moving average error structure, evaluation of effects of fertilizers under continuous barley and its rotation with fallow, by analyzing cumulative yields per year, and on-farm rotation trials at El Bab.

A technical manual, *Estimation of Heritability of Crop Traits From Variety Trials Data*, was prepared in collaboration with the Germplasm Program.

A biometric technique was developed for the estimation of time-trends and the number of years required to detect statistically-significant time-trends in yield variables of a seasonal annual crop under continuous cropping. This was illustrated on a series of seven years grain and yield data comparing continuous annual barley cropping and its rotation with fallow. A method for obtaining robust estimates of the parameters was developed to model germination of durum wheat in terms of time and temperature.

Management Information Systems

Implementation of the Oracle financial/administrative systems continued. Emphasis was placed on providing new or modified reports for the various modules--especially the Purchasing and Inventory Control. In total, 26 new reports were developed, and five reports and two forms were modified. A new medical insurance system was developed, and work began on the new payroll system.

Project Management and Data Registry System

Data entry and query forms were developed. The system is being tested. Standard forms were developed to initiate project management implementation.

Training and Visits

A total of 113 ICARDA staff participated in computer training courses (MS DOS, Pathworks for DOS and internal E-Mail, Microsoft Windows, Lotus 123 for Windows, Lotus Macros, WP for Windows, dBase IV, Basics on VAX/VMS and DOS Usage, and Harvard Graphics). An in-house short training course was also given to 28 ICARDA staff members in techniques for the assessment of trial data.

Three in-country training courses and one at headquarters were offered to NARS personnel in key areas of relevance to their research. A visitor from NCAART, Jordan spent one week at headquarters getting acquainted with the Center's computing activities.

Farms

ICARDA operates five sites in Syria (including its main research station at Tel Hadya) and two in Lebanon (Table 22). These sites represent a variety of agro-climatic conditions, typical of those prevailing in the WANA region.

Table 22. 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°10E	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

Straw Burning and Alternatives

In areas with surplus straw, not required for sheep feeding, straw burning is a widespread practice, particularly where irrigation is available. Burning is forbidden in many countries, because of its negative side effects: release of CO_2 into atmosphere; run-down of organic matter in the soil; risk of accidentally burning other fields; risk of human injuries (clouds of thick smoke reducing visibility on roads).

At its main research farm at Tel Hadya, ICARDA has been using two alternatives to burning straw:

1. Use straw for sheep feeding (direct grazing or baling of straw).

2. Chop and incorporate the straw into the soil.

A moldboard plow with skimmers or similar devices is used to incorporate the chopped straw into the soil. If suitable planters are available, even a ducksfoot cultivator, working 12-15 cm deep, can be used.

Foreground: Straw incorporated by moldboard plow; middle: straw bales for animal feed; inset: a farmer burning his field.

Appendixes

Contents

Appendix 1

Precipitation (mm) in 1993/94

	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	TOTAL
SYRIA													
Tel Hadya													
1993/94 season	0.0	13.1	45.7	18.9	112.6	139.8	14.6	13.0	15.6	0.0	0.0	0.0	373.3
Long-term average (16 seasons)	0.4	25.4	47.0	52.7	64.1	56.8	40.2	24.0	16.3	2.7	0.0	0.6	330.2
% of long-term average	0	52	97	36	176	246	36	54	96	0	-	0	113
Breda													
1993/94 season	0.0	3.2	27.8	14.6	88.0	126.2	9.8	15.2	6.4	0.0	0.0	0.0	291.2
Long-term average (36 seasons)	1.5	16.1	31.8	51.2	49.4	41.0	33.8	29.5	16.2	1.5	0.2	0.0	272.2
% of long-term average	0	20	87	29	178	308	29	52	40	0	0	-	107
Bouider													
1993/94 season	0.0	14.0	52.2	9.4	60.7	74.1	12.2	11.6	11.4	0.0	0.0	0.0	245.6
Long-term average (21 seasons)	0.1	18.4	24.6	35.8	42.9	37.2	26.9	16.3	10.0	1.0	0.1	0.0	213.3
% of long-term average	-	76	212	26	141	199	45	71	114	0	0	-	115
Ghrerife													
1993/94 season	0.0	4.0	33.5	18.6	60.0	89.3	20.0	8.6	11.8	0.0	0.0	0.0	246.4
Long-term average (9 seasons)	0.4	28.2	28.1	37.2	48.2	46.4	32.7	10.0	17.9	2.8	0.0	0.0	251.9
% of long-term average	0	14	119	50	126	192	61	86	66	0	-	-	98
Jindiress													
1993/94 season	0.0	8.2	76.2	27.6	143.8	175.4	49.8	15.6	36.9	0.0	0.0	0.0	533.5
Long-term average (34 seasons)	1.5	29.6	55.9	89.8	85.8	76.1	61.9	40.7	20.6	4.5	0.0	1.4	467.8
% of long-term average	0	28	136	31	168	230	80	38	179	0	-	0	114
LEBANON													
Terbol													
1993/94 season	0.0	15.6	79.8	34.6	159.0	103.0	59.8	20.2	5.6	0.0	0.0	0.0	477.6
Long-term average (13 seasons)	0.0	22.4	68.8	93.3	128.0	117.4	96.1	24.3	18.4	2.9	0.3	0.0	571.9
% of long-term average	-	70	116	37	124	88	62	83	30	0.0	0.0	-	84

Note: For location, area, and elevation of these sites, see Table 22 on page 73.

Appendix 2

Cereal and Legume Varieties Released by National Programs

Country	Year of release	Variety
Barley		
Algeria	1987	Harmal
	1992	Badia
Australia	1989	Yagan
	1991	High
	1993	Kaputor
		Namoi
Bolivia	1991	Kantuta
	1993	Kolla
Brazil	1989	Acumai
Canada	1993	Falcon
Chile	1989	Leo/Inia/Ccu
		Centauro
China	1986	Gobernadora
	1988	Shenmai 1
	1989	V-24
Cyprus	1980	Kantara
	1989	(Mari/Aths*)
Ecuador	1989	Shyri
	1992	Calicuchima-92
		Atahualpa-92
Egypt	1993	Giza 125
Ethiopia	1981	BSH 15
	1984	BSH 42
	1985	Ardu
Iran	1986	Aras
	1990	Kavir, Star
Iraq		Rihane-03
		IPA 7
Jordan	1984	Rum (6-row)
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

Country	Year of release	Variety
Barley (contd.)		
	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	Rihane
Syria	1987	Furat 1113
	1991	Furat 2
		Improved Arabi Abiad
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
Vietnam	1989	Api/CM67//B1
Yemen AR	1986	Arafat, Beecher
Durum Wheat		
Algeria	1982	ZB S FG'S'/LUKS GO
	1984	Timgad
	1986	Sahl, Waha
	1991	Korifla
	1992	Om Rabi 6
	1993	Haidar, Belikh 2, Om Rabi 9, Kabir 1
Cyprus	1982	Mesoaria
	1984	Karpasia
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

Country	Year of release	Variety
Durum Wheat (contd.)		
		Stork = ACSAD 75
Lebanon	1987	Belikh 2
	1989	Sebou
	1994	Waha
Libya	1985	Marjawi, Ghuodwa, Zorda,
		Baraka, Qara, Fazan
	1992	Khiar 92
	1993	Zahra 5 = Korifla
Morocco	1984	Marzak
	1989	Sebou, Om Rabi
	1991	Tensif
	1994	Anouar, Jawhar
Pakistan	1985	Wadhanak
Portugal	1983	Celta, Timpanas
	1984	Castico
	1985	Heluio
Saudi Arabia	1987	Cham 1
Spain	1983	Mexa
	1985	Nuna
	1989	Jabato
	1991	Anton, Roqueno
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
	1991	Kizilton
	1993	Omrabi = Aydin 93
Iran	1994	Omrabi 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,

Country	Year of release	Variety
Bread Wheat (contd.)		
		DouggaXBJ=Soummam
	1994	Mimouni, Ain Abid
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
Ethiopia	1984	Dashen, Batu, Gara
Greece	1983	Louros, Pinios, Arachthos
Iraq	1994	Adnanya, Hamra, Abu Ghraib
Iran	1986	Golestan, Azadi
	1988	Sabalan, Darab, Quds
	1990	Falat
Jordan	1988	Nasma = Jubeiha
		L88 = Rabba
Lebanon	1990	Seri
	1991	Nesser = Cham 6
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

Country	Year of release	Variety
Bread Wheat (contd.)		
	1990	Yuregir, Karasu 90, Katia 1
Yemen AR	1983	Marib 1
	1988	Mukhtar, Aziz, Dhumran
Yemen PDR	1983	Ahgaf
	1988	SW/83/2
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
Ethiopia	1994	DZ 10-16-2
France	1988	TS 1009 (ILC 482)
		TS 1502 (FLIP 81-293C)
	1992	Roye Rene (FLIP 84-188C)
Iraq	1991	Rafidain (ILC 482), Dijla (ILC 3279)
Italy	1987	Califfo (ILC 72)
		Sultano (ILC 3279)
Jordan	1990	Jubeiha-2 (ILC 482)
		Jubeiha-3 (ILC 3279)
Lebanon	1989	Janta 2 (ILC 482)
	1993	FLIP 85-5C
Libya	1993	ILC 484
Morocco	1987	ILC 195, ILC 482
	1992	Rizki (FLIP 83-48C)
		Douyet (FLIP 84-92C)
Oman	1988	ILC 237
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)
Sudan	1987	Shendi (ILC 1335)

Country	Year of release	Variety
Kabuli Chickpea (contd.)		
	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)
	1990	Damla 89 (FLIP 85-7C)
		Tasova 89 (FLIP 85-135C)
	1991	Akcin (87AK 11115)
	1992	Aydin 92 (FLIP 82-259C)
		Menemin 92 (FLIP 85-14C)
		Izmir 92 (FLIP 85-60C)
	1994	Aziziye (FLIP 84-15C)
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)
		Cobber (FLIP84-58L)
		Matilda (FLIP84-154L)
Bangladesh	1993	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	NEL2704
Iraq	1992	Baraka (ILL 5582)

Country	Year of release	Variety
Lentil (contd.)		
Jordan	1990	Jordan 3 (78S 26002)
Lebanon	1988	Talya 2 (78S 26013)
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)
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)

Country	Year of release	Variety
Faba Bean (contd.)		
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
Sudan	1989	Karima-1
Forage Legumes		
Jordan	1993	*Vicia villosa* ssp *dasycarpa* (IFLVD 683)
		Vicia sativa (IFLVS 715)
		L. ochrus (IFLLO 101/185)
Morocco	1990	*Vicia sativa* (ILF-V-1812)

Appendix 3

The following list covers, as of the time of going to press, the publications produced at ICARDA as well as for ICARDA by other publishers in 1994. Some of the titles published in 1993 but not captured for reporting in the Center's 1993 Annual Report are also included.

Publications

Articles in Journals

Ahsan-ul-Haq, M., K.B. Singh, Z. Abidin, and M.S. Ahmad. 1994. Mutation studies in chickpea (*Cicer arietinum* L.). III. Selection of mutants in M2 generation. Pakistan Journal of Agricultural Sciences 31(1): 13-22.

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Aletor, V.A., A. Abd El-Moneim and A.V. Goodchild. 1994. Evaluation of the seeds of selected lines of three *Lathyrus* spp. for B-*N*-oxalylamino-l-alanine (BOAA), tannins, trypsin inhibitor activity and certain *in-vitro* characteristics. Journal of the Science of Food and Agriculture 65(2): 143-151.

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Ali, Z.I., V. Mahalakshmi, M. Singh, G. Ortiz-Ferrara and J.M. Peacock. 1994. Variation in cardinal temperatures for germination among wheat (*Triticum aestivum*) genotypes. Annals of Applied Biology 125: 367-375.

Ali Dib, T., P. Monneveux, E. Acevedo and M.M. Nachit. 1994. Evaluation of proline analysis and chlorophyll fluorescence quenching measurements as drought tolerance indicators in durum wheat (*Triticum turgidum* L. var. *durum*). Euphytica 79(1-2): 65-73.

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Clement, S.L., N. El-Din Sharaf El-Din, S. Weigand and S.S. Lateef. 1994. Research achievements in plant resistance to insect pests of cool-season food legumes. Euphytica 73(1-2): 41-50.

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Kumari, S.G. and K.M. Makkouk. 1994. Evaluation of different ELISA procedures for the detection of pea seed-borne mosaic potyvirus and broad bean stain comovirus in lentil leaf extracts. Arab Journal of Plant Protection: 11(2): 86-91.

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Vivar, H.E. 1994. Mejoramiento de Cebada contra enfermedades. Pages 26-29 in Memorias Sobre el Taller Sobre Resistencia Duradera en Cultivos Alto-Andinos de Bolivia, Colombia, Ecuador y Peru, 30 May-3 Jun 1994, Quito, Ecuador (L.H. Broers, ed.).

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Zoghlami, A.,H. Hassan and L.D. Robertson. 1994. Collecte etude eco-geographique des especes spontanees de legumineuses fourrageres et pastorales en Tunisie. [Collect and eco-geographic survey of farage and pasture legumes in Tunisia]. Pages 29-30 in the Seventh Arab Scientific Conference of Biological Sciences: Biodiversity and Environment, Abstracts, 4-7 Nov 1994, Hammam-Sousse, Tunisia (A. Raies, ed.). Ste des Sciences Naturelles de Tunisia, Tunis, Tunisia. (In French.)

Contributions to Conferences 1994

(Note: Published contributions to conferences are covered under "Book Chapters and Papers in Conference Proceedings" in this Appendix)

February

Logan US Society of Range Management Meeting

Tiedemann, J., J. Ryan and M. Derkaoui. Effect of nitrogen and phosphorus fertilizer on a native plant community in central Morocco.

Washington, D.C. US Roundtable on Population and Food in the Early 21st Century: Meeting Future Food Needs of an Increasing World Population

Nordblom, T. and F. Shomo. Disaggregated food and feed trends to 2010 in the West Asia/North Africa region.

March

Damascus SY Regional Cooperative Project for Research, Development and training on Agricultural Residues Utilization in the Near East

Diekmann, J., M. Nachit, M.C. Saxena and J. Ryan. The utilization of straw for soil improvement and evaporation control.

April

Montpellier FR Facteurs Limitant la Fixation Symbiotique de l'Azote en Zones Mediterraneennes: Influence des Contraintes Osmotiques et des Temperatures Extremes

Materon, L.A. ICARDA's international inoculation network (INONET): a model for technological transfer.

New Delhi IN International Symposium on Pulses Research

Singh, K.B. and M.M. Verma. Wild *Cicer* species: problems and prospects.

Singh, K.B. and O. Singh. Prospects of creating higher yield potential in chickpea.

May

Damascus SY First Cham International Conference

Abdul-Hadi, Z. Information systems in an agricultural research center catering for developing countries.

Rabat MA Acquis et Perspectives de la Recherche Agronomique dans les Zones Arides et Semi-arid du Maroc

Mergoum, M., J. Ryan and N. Nsarellah. Performance of triticale in the drought-prone Moroccan regions.

Rabat MA INRA/MIAC Conference on Dryland Agriculture

Christiansen, S. Poster presentation on on-farm trials with forage legume/barley compared to fallow/barley rotations and continuous barley in north-west Syria.

June

Lisbon PT Third International Triticale Symposium

Yau, S.K. and M.M. Nachit. Performance of 'Drira out-cross 7' triticale in West Asia, North Africa and Mediterranean Europe.

Logan US Second International Triticeae Symposium

Damania, A.B. and J. Valkoun. Evaluation and utilization of genetic resources of Triticeae for crop improvement.

Valkoun, J., A.B. Damania and M. Van Slageren. Geographical distribution, ecology and diversity of *Triticum urartu* populations in Jordan, Lebanon andSyria.

July

Acapulco MX International Soil Science Congress

Ryan, J., S. Masri, L. Habib and M. Pala. Long-term phosphorus fertilization over a rainfall gradient in dryland farming systems of north-western Syria.

Copenhagen DK European Association for Grain Legume Research

Erskine, W. Plant morphology in lentil: genetic variation and its exploitation.

Eujayl, I., M. Baum, W. Erskine, E. Pehu and F.J. Muehlbauer. Development of genetic linkage map for lentil based on RAPD: markers.

Keatinge, J.D.H., Q. Aiming, I. Kusmenoglu, R.H. Ellis, R.j. Summerfield and W. Erskine. Selecting lentil genotypes for winter-sowing in the Turkish highlands.

Summerfield, R.J., W. Erskine, R.H. Ellis, and J.D.H. Keatinge. Prediction of photothermal flowering responses in a world lentil (*Lens culinaris*) collection.

Davis US Fifth International Symposium on Genetics and Molecular Biology of Plant Nutrition

Damania, A.B., L. Pecetti and J. Gorham. Tolerance to salinity in two wild *Triticum* species.

Reading UK Conference on Efficiency of Water Use in Crop Systems

Mahalakshmi, V., S. Grando, I. Jani, S. Ceccarelli and J.M. Peacock. Improving water use efficiency of cultivated barley by introgression with *Hordeum vulgare* ssp. spontaneum. What promise does it hold?

September

Aberdeen UK 3rd International Livestock Farming Systems Symposium

Goodchild, A., T. Nordblom, F. Shomo, S. Hamadeh and R. Wachholtz. Using feed calendars to interface feeds with needs in Syria and Labanon.

Aguas Calientes MX

Vivar, H.E. Uso de una pradera mixta de alfalfa silvestre en asociacion con cebada bajo condiciones de temporal.

Kusadasi-Aydin TR Ninth Congress of the Mediterranean Phytopathological Union (MPU)

Franz, A., H.J. Vetten and K.M. Makkouk. Development and application of monoclonal antibodies for the detection of faba bean necrotic yellow virus.

Makkouk, K.M., S.G. Kumari and W. Ghulam. Tissue-blot immunoassay, a sensitive, quick and economical test for the detection of plant viruses.

Mamluk, O.F. and M.W. van Slageren. Sources of resistance to wheat diseases in *Aegilops* and *Amblyopyrum* spp.

Mmbaga, M.T., S. Kabbabeh and K.B. Singh. Pathogenic variability and resistance to ascochyta blight in chickpea.

Mmbaga, M.T., W. Khedy and S. Kabbabeh. Acochyta blight (*Ascochyta rabiei* Pass.) of chickpea (*Cicer arietinum* L.) in Syria: primary infection and disease spread.

Harare ZW Sixth Conference on African Association for Biological Nitrogen Fixation

Materon, L.A. Role in biological nitrogen fixation research in North Africa: INONET, the International Inoculation Network for Pasture and Forage Legumes.

Materon, L.A., R.S. Smith and G. Gintzburger. Increasing yield of annual medics by seed inoculation with various formulations of peat inoculants in semi-dry environments.

Obaton, M. Practical aspects of the researches on nitrogen fixation by legumes.

Rabat MA Ressources Phytogenetiques et Developpement Durable

Mamluk, O.F. and M.W. van Slageren. *Aegilops* spp. as sources of resistance to wheat diseases.

November

Addis Ababa ET Rockefeller Foundation/ILCA Social Science Conference

Tutwiler, R.N. The great chickpea mystery: introducing winter sowing in the Mediterranean region.

Airlie US Ecoregions of the Developing World - a Lens for Assessing Food, Agriculture and the Environment to the Year 2020

Nordblom, T.L. and F. Shomo. Food and feed prospects to 2020 in the West Asia - North Africa region.

Aleppo SY Expert Consultation on Management and Sustainable Dryland Development of the Arab World

Gintzburger, G., T. Nordblom and A.E. Osman. Agro-pastoral systems, feed calendars and feed resources in the Arab countries of the Mediterranean region.

Aleppo SY International Seminar on Organization and Management of National Seed Programs

Samir El-Sebae, A. Training at ICARDA: philosophy, approaches and major achievements.

Amman JO The Regional Seminar on Optimization of Water in Agriculture

Oweis, T. Supplemental irrigation: an option for improving water use efficiency.

Cochabamba BO Reunion Internacional de Cebada Maltera

Vivar, H.E. Investigacion en Cebada en America: un panorama.

Doha QA AOAD Regional Conference on Conservation of Arab Environmental Resources

Salkini, A.B. and T. Oweis. Rationalization of ground water use for supplemental irrigation in Syria: environmental and socioeconomic consid-erations.

Fez MA Fifth Arab Congress of Plant Protection

Kumari, S.G., K.M. Makkouk and I.D. Ismail. Seed-borne viruses of lentils in Syria: distribution, economic losses, detection, seed transmission rate and thermal treatment of seed as a control measure.

Makkouk, K.M., S.G. Kumari and W. Ghulam. Detection of plant viruses by the tissue-blot immunoassay.

Makkouk, K.M., S.G. Kumari and W. Ghulam. Detection of barley stripe mosaic hordeivirus and barley yellow dwarf luteovirus in cereals and faba bean mosaic potyvirus in legumes by tissue-blot immunoassay.

Hyderabad IN Workshop on G x E Interaction

Ceccarelli, S. Positive interpretation of genotype by environment interaction in relation to sustainability and biodiversity.

Montpellier FR Agricultural Policy Workshop, International Symposium on Systems-Oriented Research in Agriculture and Rural Development

Nordblom, T., F. Shomo, W. Goebel, H. Harris, M. El Mourid, M. Boughlala, A. Ambri, M. El Oumri, H. Farihane, A. El Ouali and A. Jmiy. Farmer interview methods and crop-growth simulation for yield-gap estimation in Morocco.

Rodriguez, A. and W. Gobel. Impact of fertilizer pricing policies on barley-livestock production systems in Northwest Syria.

Safawi JO Workshop on Biotech Application

Sayed, H. and M. Baum. RFLP-analysis in barley using a chemiluminescence and colorimetric system.

Tawkaz, S., A. Comeau and M. Baum. Development of anther protocols for the production of double Haploids in barley (*Hordeum vulgare* L.).

Seattle US ASA-CSSA-SSSA Annual Meeting

Damania, A.B., C.O. Qualset and J. Valkoun. Collection and evaluation of bread wheat and barley from Iran and their tolerance to salinity.

Washington, D.C. US Sustainable Agricultural Growth in the Major Ecoregions of the Developing World: Prospects to 2020

Nordblom, T.L. and F. Shomo. Food and feed prospects to 2020 in the West Asia and North Africa region.

Zaragoza ES International Seminar on Durum Wheat Quality

Tutwiler, R.N. Discovering the quality incentive for increasing durum production in West Asia and North Africa.

December

Antalya TR International Workshop Toward Improved Winter-Sown Lentil Production in the Highlands of West Asia and North Africa

Beniwal, S.P.S., W.J. Kaiser H. and H. Dalkiran. Biotic constraints to the production of lentils and their management in the highlands of West Asia and North Africa.

Erskine, W. and F.J. Muehlbauer. Lentil adaptation to highland winter sown environments in West Asia.

Media Coverage

Wheat: Omlahn-4. Ceres No. 149, Sept-Oct 1994.

Strengthening cooperation among Maghreb countries: It is easier to grow chickpea in winter. Sicili Agricola, 26 Nov 1994. (In Italian).

Agriculture: Advances in cereals research. Le Temps, Oct 1994 (In French).

Durum wheat survives heat. International Agricultural Development, No. 2, 1994.

Palestine "master plan" offers hope. International Agricultural Development, No. 3/4, 1994.

Rehabilitating pasture. International Agricultural Development, No. 5/6, 1994. (In Italian).

Barley in the dry areas. Sicili Agricola, No. 7, July 1994.

Easier culture of chickpea during winter. Sicili Agricola, July 1994. (In Italian).

Scientists reap wheat crop at the end of dry arid summer in northern Syria. Arab World Agribusiness, 9 (9), 1994.

Work on zinc deficiency. Arab World Agribusiness, 10 (5), 1994.

Rehabilitating pasture. Arab World Agribusiness, 10 (5), 1994.

Biodiversity without borders. Middle East Times, Jan 1994.

Master Plan drafted for Palestinian agriculture. Middle East Times, 24-30 Jan 1994.

Reviving old farming methods. Middle East Times, 18-24 Sept 1994.

Protecting pasture. African Farming. July/Aug 1994.

Improvement of faba beans in China and Australia through germplasm evaluation, exchange and utilisation. ACIAR Food Legume Newsletter.

Increase livestock production while rehabilitating marginal land. CGIAR News, Oct 1994.

ICARDA forum focuses on "master plan" for agriculture in territories. The Star (Jordan), 13-19 Jan 1994.

ICARDA to start 2-day workshop on natural resources management. Jordan Times, 15 June 1994.

Experts to gear research to farmers' needs. Jordan Times, 30 Jan 1994.

Report faults decision makers, bureaucracy for extensive agricultural research problems. Jordan Times, 31 Jan 1994.

Scientific writing course opens. Jordan Times, 18 March 1994.
ICARDA meeting to set parameters for safeguarding environment. Jordan Times, 19 June 1994.

Chickpea *Ascochyta* blight control; *Orobanche* weed control research; Germplasm collection; Impact of new technology on women. CGIAR Annual Report 1993.

Increasing grassland productivity: scientific breakthrough. Arab Agriculture Yearbook 1993.

Minister of Agriculture opens workshop on biodiversity. Bin Tarif calls for the preservation of native genetic materials. Al Aswak (Jordan) 16-17 June 1994. (In Arabic).

ICARDA: an important institution for advancement in agricultural research. Al Aswak (Jordan), 8 Jan 1994.

Nasrat Fadda: The environment on our planet is threatened. Al Ayam Arabia. (IN Arabic).

ICARDA's achievements in training Arab farmers. Alam Attijarat, Feb 1994. (In Arabic).

Syria: Positive orientations in the agricultural sector. Arab Agriculture. (In Arabic).

Dr Haddad: Focusing research efforts on areas with dry summers to improve cereal crops and farming systems. Al Shaeb, 8 Jan 1994. (In Arabic).

Course on sheep grazing concludes. Al Shaeb. (In Arabic).

Dr Duyweri: Maintaining germplasm means maintaining our resources and environment. Al Dastoor, 3 Aug 1994. (In Arabic).

Bin Tarif, Minister of Agriculture says: "We place all our potentialities and expertise to support sustainable agricultural production in the fertile Crescent region." Al Dastoor, 16 June 1994. (In Arabic).

Dr Farham inaugurates workshop on agricultural research. Al Dastoor, 30 Jan 1994. (In Arabic).

Workshop on resource management for sustainable agricultural production concludes. Al dastoor, 19 June 1994. (In Arabic).

Inauguration of training course in science writing. Al Dastoor, 17 March 1994. (In Arabic).

Training course in scientific writing in the regional Office of ICARDA. Al Ra'i, 24 April 1994. (In Arabic).

Annual Meeting of the Mashreq project. Al Dastoor, 19 July 1994. (In Arabic).

Conclusion of the annual technical meeting of the Mashreq project. Al Dastoor, 21 July 1994. (In Arabic).

Meeting on the activities of ICARDA. Al Dastoor. 8 Jan 1994. (In Arabic).

Discussion of the Mashreq project continues. Al Ra'i, 20 July 1994.

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 and 1993, 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.)

* See Appendix 15 for country codes.

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.)

Doctoral

1994

EG Alexandria University

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

FR Universite 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.

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.

8 June 1976 Amendment to the CHARTER (En, Fr).

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 Governments in West Asia and North Africa (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.

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

ALGERIA

Country

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

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

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).

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)

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).

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).

IRAQ

6 Sept 1986 with the Government of IRAQ (Ar, 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 (Ar, En) to permit operations on Lebanese territory.

Other

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

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).

PAKISTAN

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

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

SPAIN

Other

18 Feb 1994 Cooperative Agreement between the National Institute of Agricultural Research (INIA) of Spain and 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.

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 in 1991. Incorporates ratification dates.

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

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.

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

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).

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

18 January 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).

YEMEN ARAB REPUBLIC

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

Agreements of cooperation with other countries (not including agreements for specific work plans).

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).

CHINA

20 Aug 1987 with the Chinese Academy of Agricultural Sciences, CAAS, CHINA (Ch, 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 Cooperation International pour le Developpement CIRAD, et l'Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, ORSTOM, FRANCE (En, Fr).

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

INDIA

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

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).

NEPAL

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

RUSSIA

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

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).

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).

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 with the UN Economic and Social Commission for West Asia (ESCWA) (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).

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).

IMPHOS

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

IRRI

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

UNEP

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

WINROCK

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

Appendix 6

Special Projects

During 1994, the following Special Projects were operational utilizing financial support provided as Restricted Core, Complementary and In-Trust funding, separately from ICARDA's unrestricted core budget. The financial contribution by the respective donors for these Special Projects is reported in Appendix 11.

AFESD (Arab Fund for Economic and Social Development)

Regional Project for Strengthening Barley and Wheat Research and Training in the Arabian Peninsula.

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

Transfer, Adoption and Impact of Improved Agricultural Technologies in the Rainfed Semi-Arid Regions of North Africa.

CGIAR Gender Program

Support for Consultant in Gender Research and Analysis.

EU (European Union)

Nile Valley Regional Program - Egypt Phase I.

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.

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.'

Amelioration de l'integration de l'elevage ovin dans les systemes cerealiers et patures de l'Afrique du Nord (Improved integration of sheep, cereal and pasture in rainfed farming systems of North Africa).

Germany

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.

Grains Research and Development Corporation (GRDC), Australia

Improved ICARDA Germplasm for Australia through Regional Adaptation Analysis.

Coordinated Improvement Program for Australian Lentils.

Faba Bean Germplasm Multiplication.

IDRC (International Development Research Centre), Canada

Agroecological Characterization.

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

Water Harvesting.

Integrated Watershed Development.

IFAD (International Fund for Agricultural Development)

Collaborative Research and Technology Transfer Program to Increase Barley, Food Legumes and Livestock Production in North Africa.

IMPHOS (Institut Mondial de Phosphate), Morocco

Study of Soil Test Calibration in Limited Rainfall Areas.

Iran

ICARDA/Iran - Scientific and Technical Cooperation.

Netherlands

Collection and Characterization of Germplasm of Wild Relatives of Wheat.

Development of National Seed Production Organizations in WANA.

Collaborative Project with Utrecht University on Efficiency of Water Use in Wheat and Barley.

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.

National Committee for International Science and Education (NCISE), USA

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

ODA (Overseas Development Administration), United Kingdom

Measurement of Biodiversity within the Genus *Lens*.

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

OPEC Fund for International Development

Barley Development Program: Devolution of Barley Breeding to Maghreb.

Assessment of Wind Erosion in West Asia-North Africa.

Rockefeller Foundation

Support for Social Science Postdoctoral Research Fellow: Impact of Nile Valley Regional Project.

Sweden

Nile Valley Regional Program - Ethiopia Phase II: Strengthening Research and Transfer of Technology for Improved Production of Cool-Season Food Legumes.

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.

USAID (United States Agency for International Development)

Determination of C^{13} Discrimination as an Indirect Selection Criterion for Barley in Dry Environments.

MART/AZR Project - Arid Zone Research Institute, Quetta, Balochistan.

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

Appendix 7

Collaboration in Advanced Research

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

International Centers and Agencies

International Plant Genetic Resources Institute (IPGRI), Rome:
- ICARDA hosts and services the IPGRI Office for West Asia and North Africa.

International Center for the Improvement of Maize and Wheat (CIMMYT), Mexico:
- Wheat and barley improvement: CIMMYT has seconded three wheat breeders to ICARDA, and ICARDA has seconded a barley breeder to CIMMYT.

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad, India:
- Chickpea improvement: ICRISAT has seconded a chickpea breeder to ICARDA.
- ICARDA and ICRISAT maintain the Global Grain Legume Drought Research Network.

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

Australia

University of Western Australia:
- Whole-farm modelling of pasture, cereals and livestock.

University of Western Australia; Grains Research and Development Corporation (GRDC):
- Subterranean vetch.
- *Vicia narbonensis.*

Western Australia Department of Agriculture, Perth:
- Adaptation of dry peas for WANA.

CSIRO, Western Australia:
- Micronutrient deficiencies in small ruminants.

University of Sydney, I.A. Watson Wheat Research Centre:
- Improved ICARDA germplasm for Australia through regional adaptation analysis.

Centre for Legumes in Mediterranean Agriculture (CLIMA) and Grains Research and Development Corporation (GRDC):
- Lentil breeding/adaptation.
- Lathyrus breeding and quality.
- Vetch breeding and adaptation.
- Faba bean germplasm multiplication.
- Genetic resources of grain and forage legumes.

Plant Breeding Institute, Cobbity, NSW:
- Yellow rust virulence studies.

Agricultural Research Institute, Wagga Wagga, NSW and Grains Research and Development Corporation (GRDC):
- Adaptation of bread wheat for the Mediterranean environment.

Waite Agricultural Research Institute for Dryland Agriculture, University of Adelaide:
- Studies on β-Cyano-alanin in vetches.

Victorian Institute for Dryland Agriculture and Grains Research and Development Corporation (GRDC):
- Lentil breeding and adaptation.

Canada

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.

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) and Ecole Nationale Superieure d'Agronomie (ENSA), Montpellier:
- Association of molecular markers with morphophysiological traits associated with constraints of Mediterranean dryland conditions in durum wheat.
- Inoculation of medics in southern France.
- Medic growth as affected by nitrogen fixation and cold conditions.
- Molecular markers for the identification of strains of *Rhizobium.*
- *Rhizobium*-legume ecology.

Institut National de la Recherche Agronomique (INRA), Nouzilly:
- Surveys and monitoring of parasitic and viral diseases.

University of Lyon, Laboratoire d'Ecologie Microbiènne:
- Genetic diversity of *Rhizobium* spp. for chickpea.

Germany

Institute for Biochemistry and Plant Virology, Braunschweig:
- Characterization of the causal agent of an apparently new viral disease of faba bean, lentil and chickpea in WANA.

University of Bonn:
- Cereal nematodes.

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:
- Multiple disease resistance in wheat.

University of Hannover:
- Development of transformation protocols for chickpea.

University of Hohenheim:
- Physiological factors as determinants of yield in durum wheat.
- Straw quality: breeding and evaluation methods (near-infrared reflectance and histochemistry).
- Effect of legume crop residues on productivity of wheat.
- Socioeconomics in Bedouin farming systems in the marginal areas of northern Syria.
- Stability of crop/range/livestock systems in the Al Bab area in northern Syria.

University of Karlsruhe:
- Identification of water harvesting sites and methods using remote sensing and GIS.

Weinstephans Institute, Munich:
- Molecular markers for QTL's.

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

Italy

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.

University of Tuscia, Viterbo; University of Athens; University of Jordan:
- Establishment of MSc program in Seed Science Technology.

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.
- Stress tolerance in wheat.

Netherlands

Centre for Genetic Resources of the Netherlands:
- Collection and characterization of germplasm of wild relatives of wheat.

International Agricultural Centre, Wageningen:
- Seed technology training.

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:
- Cold tolerance in winter and facultative barley.

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

Spain

University of Cordoba:
- Developing wilt resistance in chickpea.
- Genetic studies on wild *Cicer* spp.
- Genetic studies in durum wheat.

University of Cordoba and INIA:
- Barley stress physiology.

University of Granada:
- Isolation of VA-Mycorrhiza from pasture and forage legumes.
- *Rhizobium*-legume ecology.

Centre UdI-IRTA, Lleida:
- Durum breeding for abiotic stress tolerance.

United Kingdom

University of Birmingham:
- Measurement of biodiversity within the genus *Lens*.

Institute for Grassland and Environmental Research (IGER), Aberystwyth:
- Fermentation kinetics and gas production of tropical feeds.

University of Nottingham:
- Factors influencing the adoption of fertilizer on barley in Syria.

University of Reading:
- Investigation of seed dormancy in plant populations on grazed marginal land.
- Utilization of cereal stubble.
- Fixation and cycling of nitrogen in dryland legume/ cereal production systems.
- Gender analysis in the agricultural systems of WANA.
- Adaptation of lentils for highlands.

SAC, Edinburgh:
- Isozyme variability in barley landraces.

United States of America

Department of Breeding and Biometrics, Cornell University, Ithaca:

- Association of molecular markers with morphophysiological traits associated with constraints of Mediterranean dryland conditions in durum wheat.

Department of Plant Pathology, Montana State University, Bozeman:

- Improvement of barley yields and yield stability for subsistence farmers in arid and semi-arid areas of WANA.

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.

University of Nebraska-Lincoln, Department of Biometry:

- Cooperative development of statistical methods useful for agricultural research in dry areas.

Pennsylvania State University:

- Genetic structure of indigenous rhizobial populations.

US Department of Agriculture (USDA), Kansas State University:

- Screening bread wheat germplasm for Hessian fly resistance under dryland conditions in WANA.

Washington State University:

- Lentil gene mapping.
- 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
Inoculation of Pasture and Forage Legumes (INONET)	Identify need for inoculation of pasture and forage legumes. Evaluate response to inoculation with introduced and native strains of *Rhizobium* spp. Biological nitrogen fixation studies. Training of NARS.
Durum Germplasm Evaluation	A set of 200 selected accessions from GRU have been sent to national programs in 11 countries. They will be scored for economically important agronomic and disease resistance characters. The pooled information will be provided to interested scientists.
Wild Wheat Evaluation	A set of 80 *Aegilops* pure lines selected for drought, frost and yellow rust resistance were sent to seven countries who volunteered to evaluate these lines under their environment for agronomic characters and disease resis tance. The pooled information will be provided to scientists.
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 agro-ecological characteristics of major cereal production areas.
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 NARSs and ICARDA and helps in developing better understanding of genotype x environment interaction as well as agroecological characteriza-tion of legume production areas. Includes lentil, chickpea, dry pea, vetches and chickling.
North African Legume Research Network (NALRN)	Network has developed regional screening nurseries and yield trials of cool-season legumes which are tested at various sites in participating countries; joint evaluation and selection done through regional travelling workshops and visits. It complements the efforts of ILTN.
West Asian Legume Research Network (WALRN)	Network complements the efforts of ILTN, provides for regional travelling workshop to jointly evaluate the breeding material.
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.

Coordinator	Scale[1]	Countries/Institutions involved	Donor	Type[2]
L. Materon (PFLP)	INT	11 in WANA, 5 non-WANA	ICARDA Core funds	CO-OP INFO MATERIAL
J. Valkoun (GRU)	INT	6 in WANA	Italy	INFO MATERIAL
J. Valkoun (GRU) C. Ceoloni (Italy)	INT	1 in WANA, 6 non-WANA	Italy	INFO MATERIAL
S.K. Yau (GP)	INT	50 countries worldwide, CIMMYT	ICARDA Core funds	MATERIAL
R.S. Malhotra (GP)	INT	52 countries worldwide, ICRISAT	ICARDA Core funds	MATERIAL
M. Mekni (NARP/GP)	SUBREG	Algeria, Libya, Morocco, Tunisia	ICARDA BMZ/GTZ	MATERIAL
M.C. Saxena (GP) N. Haddad (WARP)	SUBREG	Syria, Jordan, Lebanon, Turkey, Iraq, Cyprus, Iran, Pakistan	ICARDA BMZ/GTZ	MATERIAL
GTZ/INRA, Morocco	SUBREG	North Africa	BMZ/GTZ	CO-OP

Title	Objectives/Activities
SEWANA Durum Wheat Research Network	Durum breeders and crop improvement scientists from South 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.
Screening Wheat and Barley for Resistance to Hessian Fly	Differential nurseries containing the known resistance genes for Hessian fly are planted in six countries. Annual surveys are performed in the Maghreb countries. Training workshop (sponsored by ICARDA, MIAC, INRA, INRAT) for North Africa. Germplasm exchanged.
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.
Dryland Pasture and Forage Legume Network	Communication linkages among pasture, forage and livestock scientists in WANA.
WANA Plant Genetic Resources Network (WANANET)	Working groups will specify priorities in plant genetic resources; identify and implement collaborative projects; implement regional activities.
Faba Bean Information Services (FABIS)	Collection and dissemination of worldwide information on faba bean, chickling and vetch to facilitate communication among research workers. FABIS newsletter; specialized bibliographic supplements; directory of research workers.
Lentil Experimental News Services (LENS)	Collection and dissemination of worldwide information on lentils to facilitate communication between research workers. LENS newsletter; specialized bibliographic supplements; directory of research workers.
RACHIS	Collection and dissemination of worldwide information on wheat and barley to facilitate communication among research workers. Rachis newsletter; specialized bibliographic supplements; directory of research workers.
WANA Seed Network	Encourages (1) stronger regional seed sector cooperation, (2) exchange of information, (3) regional consultations, and (4) inter-country seed trade.
Agricultural Information Network for WANA (AINWANA)	Improve national and regional capacities in information management, preservation and dissemination.
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.

Coordinator	Scale[1]	Countries/Institutions involved	Donor	Type[2]
M. Nachit (GP)	INT	Algeria, Jordan, Lebanon, Morocco, Tunisia, Turkey, Syria, Canada, France, Greece, Italy, Spain, USA	ICARDA Core funds	CO-OP INFO MATERIAL
S. Weigand (GP) M. Mekni (NARP)	SUBREG	Algeria, Morocco, Tunisia	ICARDA MIAC	MATERIAL
J. Ryan (FRMP)	REG	Algeria, Libya, Morocco, Tunisia, Syria, Jordan, Iraq, Cyprus, Turkey, Pakistan, Yemen	ICARDA UNDP IMPHOS	CO-OP INFO
S. Christiansen (PFLP)	INT	WANA, Europe, USA, Australia	ICARDA IBPGR	INFO
IBPGR Regional office for WANA	REG	WANA countries IBPGR, FAO, ACSAD		CO-OP INFO
N. Maliha (CODIS) and M.C. Saxena (GP)	INT	Worldwide	ICARDA	INFO Core funds
N. Maliha (CODIS) and W. Erskine (GP)	INT	Worldwide	ICARDA Core funds	INFO
H. Ketata (GP)	INT	Worldwide	ICARDA	INFO
Initially T. van Gastel (Seed Unit)	REG	Algeria, Morocco, Iraq, Cyprus, Turkey, Jordan, Syria, Egypt, Sudan, Libya, Yemen	to be determined	CO-OP INFO
S. Varma (CODIS)	REG	WANA countries, CIHEAM, ISNAR	to be determined	INFO MATERIALS
M.C. Saxena (GP) ICRISAT/ICARDA	INT	Worldwide, ICRISAT, FAO	ICARDA; ICRISAT FAO	INFO CO-OP MATERIAL

Title	Objectives/Activities
DNA Fingerprinting of Chickpea Ascochyta Blight Fungus	Quantify and characterize variability in *Ascochyta rabiei* and map geographical distribution of different pathotypes

Networks operating under the Nile Valley Regional Program (NVRP)

1. Integrated Management of Wilt and Root Rots of 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 multiple disease-resistant cultivars. Identify races in *Fusarium* wilt pathogens. Develop integrated disease management program.
2. Sources of Primary Inoculum of Stem and Leaf Rusts of Wheat: Their Pathways and Sources of Resistance	Determine dates of first spore and disease incidence of rusts in relation to weather data. Identify prevailing races of the pathogens causing stem and leaf rusts and the effective resistance genes. Identify primary sources of inoculum other than wind-borne spores.
3. Integrated Control of Aphids and Major Virus Diseases in Cool-Season Food Legumes and Cereals	Screening for resistance to develop resistant/tolerant cultivars. Study the feasibility of biological control of aphids through the enhancement of natural enemy populations.
4. 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 of irrigated wheat. Describe the physical environment of each site for the development of computer simulations of crop growth. Characterize photothermal and vernalization responses of selected commercial lines.
5. Water-Use Efficiency of Cereals and Food Legumes	Determine effects of water stress at different phenological stages in wheat growth and yield. Determine the effect of water stress on water-use efficiency of three leading cultivars. Develop cultivars with high water-use efficiency adapted to different agroclimatic conditions.
6. Integrated Management of Chocolate Spot (*Botrytis fabae*) of Faba Bean	Identify sources of resistance to chocolate spot. Incorporate resistance into germplasm with suitable agronomic characteristics for the Nile Valley countries. Provide segregating populations to national scientists to select under their own conditions (Ethiopia and Egypt). Develop integrated disease management program.
7. Socioeconomic Studies on Adoption and Impact of Improved Technologies	Quantification of beneficial impacts of the NVRP at farm, national and regional levels. Development of suitable socioeconomic research methodologies. Development of human resources of the participating countries in the areas of adoption, impact, and research monitoring and evaluation.

Coordinator	Scale[1]	Countries/Institutions involved	Donor	Type[2]
F. Weigand (GP) and University of Frankfurt	REG	Algeria, Pakistan Syria, Tunisia, Turkey, Univ. Frankfurt	GTZ ICARDA	INFO CO-OP MATERIAL
G. Bejiga (Ethiopia)	SUBREG	Egypt, Ethiopia Sudan, ICRISAT	EEC, SAREC Netherlands	CO-OP MATERIAL
Y. El-Daoudi (Egypt)	SUBREG	Egypt, Ethiopia Sudan	EEC, SAREC Netherlands	CO-OP
G.S. Youssef (Egypt) N.E.S. Eddine (Sudan) L. Rizkallah (Egypt)	SUBREG	Egypt, Ethiopia Sudan	EEC, SAREC Netherlands	CO-OP MATERIAL
H.M. Ishag (Sudan)	SUBREG	Egypt, Ethiopia Sudan, CIMMYT	EEC, SAREC Netherlands	CO-OP
M. Abdul Ghani (Egypt)	SUBREG	Egypt, Sudan	EEC, Netherlands	CO-OP
S.A. Khalil (Egypt)	SUBREG	Egypt, Ethiopia	EEC, SAREC	CO-OP MATERIAL
M. Abdul Moneim (Sudan)	SUBREG	Egypt, Ethiopia Sudan	EEC, SAREC Netherlands	CO-OP

Title	Objectives/Activities
8. Development of Autogamous Faba Bean	To develop autogamous faba bean cultivars that are high yielding, stable in seed yield and adapted to local conditions in the Nile Valley countries.

Barley Networks Operating under the Latin America Regional Program

Title	Objectives/Activities
1. 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.
2. Development of Hull-less Barleys	Develop high-yielding hull-less cultivars and improve their nutritional value, producing cultivars with high energy and low fiber.
3. 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.
4. Development of Germplasm Resistant to Scab and Barley Yellow Mosaic Virus (BYM)	Development of scab resistant barley with tolerance to BYM for China.
5. 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.
6. Development of Leaf Rust Resistant Barleys	Network of researchers investigating leaf rust resistance.

Coordinator	Scale[1]	Countries/Institutions involved	Donor	Type[2]
M. El-Sherbeeny (Egypt)	SUBREG	Egypt, Ethiopia, Sudan	EEC, SAREC Netherlands	CO-OP
H. Vivar (LARP)	REG	Oregon State University, Latin American NARS, CIMMYT	ICARDA-CIMMYT Core funds	MATERIAL
H. Vivar	INT	CIMMYT, Canada, Australia, Colombia	"	MATERIAL
H. Vivar	INT	CIMMYT, Chile, Ecuador, Kenya	"	MATERIAL
H. Vivar	INT	CIMMYT, China	"	INFO MATERIAL
H. Vivar	INT	CIMMYT, Vietnam, Uganda, Thailand	"	MATERIAL
H. Vivar	INT	Virginia Tech., North Dakota State Univ, CIMMYT, Latin American NARS	"	INFO

Notes

[1] Scale: NAT (National); SUBREG (Sub-regional); REG (Regional); INT (International).

[2] Type: INFO (Information exchange); PERSON (Personnel exchange); MATERIAL (Material exchange); CO-OP (Cooperative research).

Appendix 9

The International School of Aleppo

The International School of Aleppo (ISA) continued to offer a high school diploma program as well as a full diploma in the International Baccalaureate. ISA is accredited by the Elementary Committee of the Middle State Association of Colleges and Schools.

The number of courses offered in the International General Certificate of Secondary Education (IGCSE) program increased. Curriculum in the elementary school continued to draw upon curricula from many different countries. A whole-language approach is emphasized in teaching language arts.

Seventeen students graduated in 1994. ISA graduates continue to be accepted at major universities around the world, including McGill University, Aleppo University, University of California at Los Angeles, Clemson University, Texas A&M, American University of Paris, American University of Beirut, Concordia University, and Queens University.

ISA enrollment in 1994 was 276 students. Nearly 30 countries were represented in the school student body during the 1993/94 school year.

The whole-child development educational philosophy continued to receive high priority; academic, physical, social, and emotional well-being of the student is emphasized at every step.

Appendix 10

Visitors to ICARDA

The Visitors' Services section celebrated its 15th anniversary in 1994. During this period, the flow of visitors to ICARDA increased steadily from 500 in 1980 to 2254 in 1994 (Fig. 28), reflecting a fast growing interest in the Center.

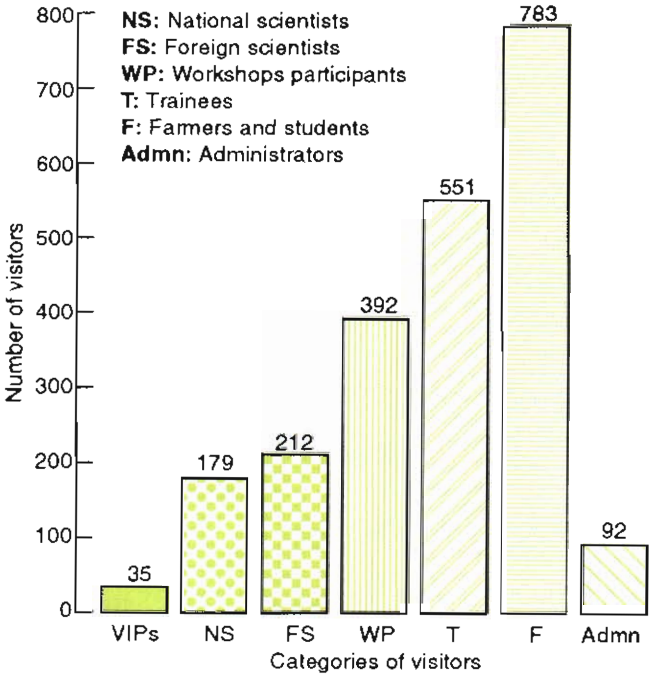


Fig. 28. Visitors to ICARDA, 1994.

Of the visitors, 52% came from Syria, 27% from other WANA countries, 16% from Europe, America and Australia, and 5% from Asia and Africa.

The visitors included national and foreign scientists, consultants, members of the CGIAR System, diplomats, senior government officials, workshop and training participants, farmers, students, media representatives, and others.

Among the many distinguished visitors during the year, ICARDA was honored by a visit of Dr Ismail Serageldine, Chair of the CGIAR.

Appendix 11

Statement of Activity
For the Year Ended 31 December 1994
(x 1000 USD)

	1994	1993
REVENUE		
Grants	15,388	16,286
Exchange gains/(loss), net	1,700	759
Interest income	566	558
Other income, net	919	605
Total revenue	18,573	18,208
EXPENSES		
Research		
Farm Resource Management	1,813	2,015
Germplasm Program	4,510	5,184
Pasture, Forage, and Livestock	1,694	2,044
Genetics Resources Unit	1,254	1,531
Total research	9,271	10,774
Research support	3,355	3,609
Cooperative programs	1,124	1,395
Training	581	568
Information	855	696
General administration	2,317	2,503
General operation	1,552	1,571
Subtotal	9,784	10,342
Total operating expenses	19,055	21,116
(DEFICIT) EXCESS OF REVENUE OVER EXPENSES	(482)	(2,908)
ALLOCATED TO		
Capital invested in property, plant and equipment	94	57
Operating fund	(576)	(2,965)
(Deficit) / Surplus	(482)	(2,908)

Statement of Grant Revenue
For the Year Ended 31 December 1994
(x 1000 USD)

	Funds received	Receivable 31 Dec 1994	(Advance) 31 Dec 1994	Current year grants	Previous year grants
CORE UNRESTRICTED					
Australia	(177)	-	-	177	285
Austria	(90)	-	-	90	100
Canada	(580)	-	-	580	641
China	(30)	-	-	30	50
Denmark	(312)	-	-	312	298
France	(285)	-	-	285	252
Germany	(731)	-	-	731	722
India		25	-	25	24
International Bank for Reconstruction and Development (World Bank)	(5,305)	-	-	5,105	3,200
Italy	(1,200)	-	-	500	700
Japan	(373)	-	-	373	350
Netherlands	(549)	-	-	549	520
Norway	(266)	-	-	266	287
Spain	(125)	-	-	125	125
Sweden	(460)	-	-	460	527
United Kingdom	(734)	-	-	734	753
United States Agency for International Development	(2,000)	-	-	2,000	3,500
	(13,217)	25	-	12,342	12,334
CORE RESTRICTED					
Arab Fund	(251)	759	(14)	765	720
Australia	(191)	-	(92)	99	-
European Economic Commission	(64)	-	(58)	6	-
Ford Foundation	(107)	-	(57)	-	32
France	-	-	(167)	70	174
German Agency for Technical Co-operation	(670)	26	(378)	394	859
International Development Research Centre	(19)	4	(19)	58	58
International Fund for Agricultural Development	(99)	-	22	32	162

	Funds received	Receivable 31 Dec 1994	(Advance) 31 Dec 1994	Current year grants	Previous year grants
CORE RESTRICTED (contd.)					
Italy	-	-	(290)	435	1,137
The Netherlands	(522)	-	(589)	620	320
Spain	(30)	-	(30)	-	-
ODA - United Kingdom	(112)	-	(17)	116	217
OPEC Fund for International Development	(87)	-	(12)	75	28
United Nations Development Programme	(380)	-	(89)	355	284
United Nations Environment Programme	-	-	-	-	44
United States Agency for International Development	(50)	-	-	-	127
	(2,582)	**789**	**(1,834)**	**3,025**	**4,162**
COMPLEMENTARY PROJECTS					
CGIAR	-	-	(11)	-	4
Food and Agricultural Organisation/ IPGRI	-	-	-	-	15
Ford Foundation	(25)	-	(11)	14	-
German Agency for Technical Co-operation	-	-	-	-	22
International Development Research Centre	-	-	(2)	7	4
The Netherlands	-		-	-	5
Closed projects	(1)	-	-	-	-
	(26)	-	(24)	21	50
TOTAL	**15,825**	**814**	**1,858**	**15,388**	**16,546**

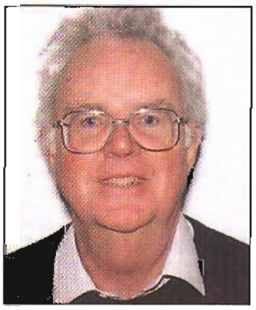
Appendix 12

Board of Trustees

Three new members joined the Board of Trustees in 1994: Dr John Davies, Professor Assia Bensalah Alaoui, and Dr Ali Ahoonmanesh.

The following Board members completed their tenure: Dr Enrico Porceddu (Chairman of the Board and its Executive Committee), Dr Norman Halse (Chairman, Program Committee), Dr Winfried von Urff (Chairman, Audit Committee), Dr Gerard Ouellette, and Dr Hussein Faraj.

Dr John Cecil Davies



Dr John C. Davies is Head of the Natural Resources Research Department and Principal Agricultural and Environment Adviser and Deputy Chief Natural Resources Adviser (Research) to the Overseas Development Administration (ODA), the development arm of the British government.

Dr Davies, who is British, brings to the Board of Trustees enormous experience in staff management, research administration and planning. He is an entomologist whose specialities include pre- and post-harvest insect pests, and field crop research with emphasis on pest control. Previous posts held by Dr Davies included Senior Principal Scientific Officer at the Centre for Overseas Pest Research and Tropical Development Research Institute, in England; and Senior Entomologist, Leader of the Cereal Improvement Program, and then Director of International Cooperation and Training at ICRISAT in India.

Professor Assia Bensalah Alaoui

Dr Assia Bensalah Alaoui, of Morocco, is Professor of Public Law at Université Mohammed V in Rabat. A specialist in food security and strategy in the Mediterranean region, she is also Director of Research at the Centre d'Etudes Stratégiques in Rabat; and is former Professor of Brittanic Literature and Civilization.

She has produced over 30 scholarly articles including, for example, *North-South dialogue: the future role of universities*, for the conference on Environmental Challenges and the Global South, at the American University in Washington DC in 1992; the emerging European Union, past policies and future implications for the Middle East and the Mediterranean, a discussion paper for the Mediterranean Study Commission (1994); and *The role of the Arab Maghreb Union*, for a conference organized by the Foreign Office in Britain in 1991. Other work has covered a broad field including food security, the role of women, population, and environment.

Professor Alaoui plays an important role in a number of national and international bodies. She is a member of the International Consultative Group on the Middle East, created in 1992 by the Center for Strategic and International Studies in Washington; and Vice-President of the Fondation Connaissance de Maroc and of the Permanent Secretariat of the group Charte Mediterranéenne, based in Madrid.

Professor Alaoui brings to the Board of Trustees a broad understanding, and immense experience, of the strategic and economic context in which ICARDA works.

Dr Ali Ahoonmanesh

Dr Ali Ahoonmanesh, from Iran, is a Plant Pathologist with nearly 20 years of experience. He is Director General of the Extension Organization, and of the Agricultural Education Center, Ministry of Agriculture; and Deputy Minister of Agriculture, Iran. He is also the Dean, College of Agriculture, Isfahan.

Dr Ahoonmanesh graduated in agriculture from the University of Tabriz in 1972. He obtained his MSc and PhD degrees in Plant Pathology from the University of California, Davis. He has produced a number of scholarly publications in plant pathology, including Cauliflower Mosaic Virus, Cucurbit Virus, and Tomato Mosaic Virus.

Dr Ahhonmanseh brings to the Board rich experience in research and research management and first-hand knowledge of agriculture in WANA.

Board Members, 1994

On 31 December 1994 the membership of ICARDA's Board of Trustees was as follows:

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LEBANON

Board Meetings, 1994

The Board held the following meetings during 1994:

23 Jan	30th Meeting of the Executive Committee, Beirut
23 and 26 Jan	Extra-ordinary Meeting of the Board of Trustees, Beirut
24-25 Jan	23rd Meeting of the Program Committee, Beirut
25 Apr	31st Meeting of the Executive Committee, Aleppo
26-28 Apr	28th Meeting of the Board of Trustees, Aleppo
31 Oct-1 Nov	32nd Meeting of the Executive Committee, Washington, D.C.

Appendix 13

Senior Staff
(as of 31 December 1994)

SYRIA

Aleppo: Headquarters

Director General's Office

Dr Nasrat R. Fadda, Director General
Dr Aart van Schoonhoven, Deputy Director General (Research)
Dr Robert Booth, Assistant Director General (International Cooperation)
Mr Terence N. Duplock, Director of Administration
Dr Elizabeth Bailey, Project Officer
Mr V.J. Sridharan, Internal Auditor
Ms Afaf Rashed, Administrative Assistant to the Board of Trustees

Government Liaison and Public Relations

Mr Ahmed Mousa El Ali, Public Relations Officer

International Cooperation

Dr Samir El-Sebae Ahmed, Regional Program Coordinator for the Arabian Peninsula
Dr A.J.G. van Gastel, Seed Production Specialist
Mr Zewdie Bishaw, Assistant Seed Production Specialist

Finance

Mr John E. Noisette, Director of Finance
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 Rodriguez, Agricultural Economist
Mr Wolfgang Goebel, 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/Agronomist-Physiologist
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
Dr John Peacock, Cereal Physiologist
Dr Franz Weigand, Biotechnologist
Dr Khaled Makkouk, Plant Virologist
Dr William Erskine, Lentil Breeder
Dr K.B. Singh, Chickpea Breeder (seconded from ICRISAT)
Dr Ali M. Abd El Moneim, Forage Legume Breeder
Dr Michael Baum, Biotechnologist
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Dr Bassam Bayaa, Lentil Pathologist
Dr Abdullah Dakheell, Physiologist
Dr Nour Eddine Mona, Syrian National Coordinator
Dr Haru Nishikawa, JICA Representative/Parasitologist
Dr Akhtar Beg, Oilseeds Specialist

Appendix 14

ICARDA Calendar 1994

January

10 - 11 *Amman.* Workshop on Future Cooperation with West Bank and Gaza
15 - 16 *Amman.* 5th Mashreq Project Steering Committee Meeting
23 - 24 *Beirut.* 23rd Program Committee Meeting
25 *Beirut.* Nomination Committee/Audit Committee Meetings
25 *Beirut.* Extraordinary Board of Trustees Meeting
26 *Beirut.* Board of Trustees Meeting
28 - 14 Feb. *Sudan.* Review Mission - NVRP Sudan

February

05 - 09 *Sudan.* Regional Traveling Workshop-Food Legumes/Cereals
05 - 10 *Sudan.* Course on Seed Certification
28 - 3 Mar. *Egypt.* Workshop on NVRP-Phase II

March

01 - 30 June Long-term Course on Cereal Breeding
20 - 24 *Aleppo.* Course on Practical Diagnosis of Sheep Parasites
16 - 24 *Amman.* Scientific Writing and Data Presentation Course
18 - 07 Apr. *Oman.* In-country Course on Farm Survey Methodology
26 - 30 *Sudan.* In-country Train-the-Trainer Course on Field Inspection Methodology for Seed Production
20 - 23 *Egypt.* NVRP National Traveling Workshop-Food Legumes
21 - 24 *Morocco.* Course on Forage and Pasture Improvement
21 - 27 *Rome.* 63rd TAC Meeting
20 - 22 *Aleppo.* Meeting on Safe Movement of Cereal Germplasm (ICARDA/IPGRI)
26 - 30 *Egypt.* Course on Seed Health Testing for Legumes (NVRP)
20 - 30 *Egypt.* In-country Train-the-Trainers Course on Field Inspection for Food Legumes Seed Production (Egypt/GTZ)
28 - 31 *Egypt.* NVRP National Traveling Workshop - Cereals

April

02 - 06 *New Delhi.* International Pulse Workshop
02 - 14 *Dhamar.* In-Country Course on Experimental Station Operation Management
05 - 14 *Pakistan.* Course on Legume Seed Production
09 - 10 *Amman.* Workshop on Recording and Selection of Awassi Sheep
10 - 17 *Aleppo.* Symposium on "Application of DNA Fingerprinting to Crop Improvement: Molecular Marker-assisted Breeding and Chickpeas for Sustainable Agriculture in the Dry Areas"
10 - 21 *Aleppo.* Course on Legume Diseases and their Control
10 - 21 *Amman.* Course on Sheep Production and Management
17 - 28 *Aleppo.* International Course on Variety Testing
18 - 28 *Aleppo.* Course on Insect Control in Legumes and Cereals (ICARDA/UNEP)
18 - 05 May. Computer Applications of Statistical Methods in Agricultural Research
19 - 22 *Aleppo.* Workshop on Agroecological Characterization (ICARDA/IDRC)
23 - 28 *Syria.* Traveling Workshop-Mashreq Project
25 - 28 *Aleppo.* 28th Board of Trustees Meeting
30 - 12 May *Iran.* Course on Farm Survey Methodology

May

02 - 12 *Aleppo.* Course on Breeding Methodology in Legumes
02 - 12 *Aleppo.* Course on Genetic Resources Conservation (IPGRI/ICARDA)
04 - 07 *Ethiopia.* NVRP National Coordination Meeting
07 - 16 *Iran.* In-Country Course on Cereal Breeding Disease Methodology
08 - 12 *Jordan.* Traveling Workshop-Mashreq Project
09 - 14 *Morocco.* North Africa Traveling Workshop-Cereals (NARP, INRA)
15 - 18 *Quetta.* AZRI/ICARDA Saltbush Workshop
16 - 17 *Lebanon.* Traveling Workshop
23 - 27 *New Delhi.* CGIAR Mid-Term Meeting
28 - 09 June *Karaj.* Regional Traveling Workshop in Iran
29 - 2 June *Cairo.* Regional Workshop on the Adoption and Impact of Improved Agricultural Technologies in the Nile Valley Countries

June

01 - 02 *ICARDA.* Biotechnology Steering Committee
04 - 10 *Iraq.* Traveling Workshop-Mashreq Project
04 - 23 *Cairo.* Data Analysis and Scientific Writing
05 - 09 *Aleppo.* IPGRI's Program Planning and Review Committee

07 *Aleppo*. ICARDA/IPGRI Seminar on *In-situ* Conservation
07 *Aleppo*. Workshop on Steppe Consultancy (PFLP)
08 - 13 *Aleppo*. In-house Planning Meetings
15 - 16 *Amman*. NARS Consultation for the Development of a Consortium on Biodiversity
19 - 27 *Amman*. Course on Farm Survey Techniques
20 - 26 *Cote d'Ivoire*. 64th TAC Meeting
21 - 30 *Turkey*. Regional Traveling Workshop for Highlands
29 *Quetta*. MART/AZR Wrap-up Seminar

August

27 - 05 Sept. *Karaj*. In-country Course on Biometric and Computer Applications in Agricultural Research
28 - 01 Sept. *Sudan*. NVRP National Coordination Meeting.
28 - 08 Sept. *FAO/BMZ/ICARDA*. Joint Course on Plant Viruses Diagnosis

September

05 - 07 *Amman*. Mashreq Project Regional Technical Meeting
10 - 11 *Tripoli/Libya*. Libya/ICARDA Coordination Meeting
10 - 10 Oct. Aleppo. Training Course on Communication Techniques and Information Management
11 - 15 *Egypt*. NVRP National Coordination Meeting
12 - 13 *Amman*. 6th Jordan/ICARDA Coordination Meeting
13 - 14 *Tunis*. Tunisia/ICARDA Coordination Meeting
18 - 19 *Algiers*. Algeria/ICARDA Coordination Meeting
18 - 29 *Aleppo*. Course on DNA Molecular Marker Techniques
18 - 29 *Sidi Bel Abbes*. In-country Course on Seed Processing and Storage
21 - 22 *Settat*. Morocco/ICARDA Coordination Meeting
24 - 25 *Aleppo*. 13th Syria/ICARDA Coordination Meeting
26 - 28 *Baghdad*. 3rd ICARDA/IRAQ Coordination Meeting

October

01 - 05 *Iran*. Iran/ICARDA Coordination Meeting
01 - 04 *Egypt*. NVRP Regional Coordination Meeting
08 - 12 *Tripoli/Libya*. North Africa/ICARDA Regional Coordination Meeting
11 *Beirut*. 4th Lebanon/ICARDA Coordination Meeting
15 - 28 *Iraq*. Design of Experiments and Data Analysis in Agricultural Research
17 - 20 *Ankara*. ICARDA/Turkey Highlands Coordination Meeting
17 - 22 *Ethiopia*. NVRP National Traveling Workshop-Barley
17 - 22 *Washington*. 65th TAC Meeting
24 - 28 *Washington*. International Centers Week

November

01 - 02 *Washington*. Executive Committee Meeting
06 - 17 *Aleppo*. Course on Water Harvesting Concepts and Techniques.
07 - 08 *Amman*. Mashreq Project Steering Committee Meeting
10 - 13 *Aleppo*. 5th IATF Meeting
13 - 23 *Aleppo*. Seminar on Organization and Management of National Seed Program
19 - 21 *Montpellier*. Seminaire sur le Projet de Recherche; Developpement des Systems Cereales, Legumes-Secs et Fourrages dans la region de Sidi-Bel-Abbes
21 - 25 *Ethiopia*. NVRP Steering Committee Meeting
28 - 03 Dec. *Beirut*. Course on Sampling Methods in Agriculture and the Agro-food Industry

December

12 - 13 *Turkey*. Highland Winter Lentil Workshop
12 - 16 *Amsterdam*. Ecoregional Approaches for Sustainable Land Use and Food Production (ERA) Symposium
12 - 23 *Ethiopia*. In-country Course on Seed Processing and Quality Control

Appendix 15

Acronyms and Abbreviations

ACSAD	Arab Center for Studies of the Arid Zones and Dry Lands (Syria)
AFESD	Arab Fund for Economic and Social Development (Kuwait)
AGRIS	International Information System for Agricultural Science and Technology (FAO, Italy)
AOAD	Arab Organization for Agricultural Development (Sudan)
AZRI	Arid Zone Research Institute (Pakistan)
BOT	Board of Trustees (ICARDA)
CG	Consultative Group (USA)
CGIAR	Consultative Group on International Agricultural Research (USA)
CIHEAM	Centre International de Hautes Etudes Agronomiques Mediterraneenes (France)
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo (Mexico)
CLIMA	Centre for Legumes in Mediterranean Agriculture (Australia)
CSIRO	Commonwealth Scientific and Industrial Research Organization (Australia)
ENEA	Ente Nazionale per l'Energia Alternativa
EU	European Union
ENSA	Ecole Superieure d'Agronomie (France)
FAO	Food and Agriculture Organization of the United Nations (Italy)
FABIS	Faba Bean Information Service (ICARDA)
GRDC	Grain Research and Development Corporation (Australia)
GTZ	Deutsche Gesellschaft fur Technische Zusammenarbeit (German Agency for Technical Cooperation)
IBRD	International Bank for Reconstruction and Development (World Bank, USA)
IBPGR	International Board for Plant Genetic Resources (Italy)
IPGRI	International Plant Genetic Resources Institute (Italy), formerly IBPGR
ICAR	Indian Council of Agricultural Research
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 Centre (Canada)
IFAD	International Fund for Agricultural Development (Italy)
IGER	Institute for Grassland and Environmental Research (UK)
ILCA	International Livestock Centre for Africa (Ethiopia)
IMPHOS	Institut Mondial de Phosphate (Morocco)
INRAT	Institut National de le Recherche Agronomique de Tunisie (Tunisia)
INRA	Institut National de la Recherche Agronomique (Morocco)
ISNAR	International Service for National Agricultural Research (The Netherlands)
JICA	Japan International Cooperation Agency (Japan)
JIRCAS	Japan International Research Center for Agricultural Sciences (Japan)

LENS	Lentil News Service (ICARDA and the University of Saskatchewan)
MART/AZR	Management of Agricultural Research and Technology/Arid Zone Research Project (Pakistan)
MIAC	Midamerica International Agricultural Consortium
NARP	North African Regional Program
NARS	National Agricultural Research System(s)
NCISE	National Committee for International Science and Education (USA)
NVRP	Nile Valley Regional Program
OPEC	Organization of Petroleum-Exporting Countries (Austria)
ODA	Overseas Development Administration (UK)
SAREC	Swedish Agency for Research Cooperation with Developing Countries (Sweden)
SMAAR	Syrian Ministry of Agriculture and Agrarian Reform
TAC	Technical Advisory Committee (FAO, Italy)
UNDP	United Nations Development Programme (USA)
UNEP	United Nations Environment Programme (USA)
USDA	United States Department of Agriculture (USA)
USAID	United States Agency for International Development
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 16

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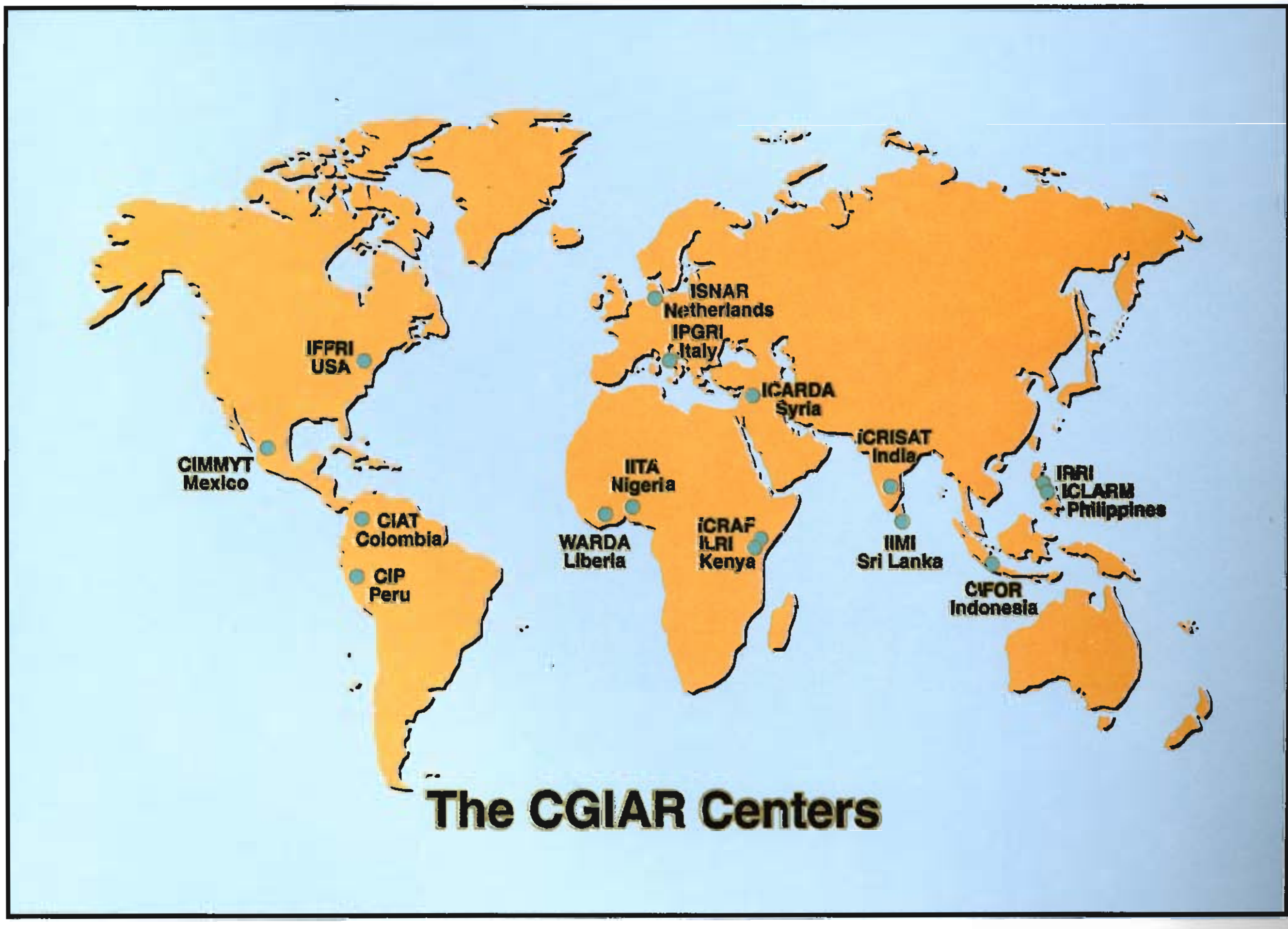
The CGIAR

ICARDA is one of 16 international centers supported by the Consultative Group on International Agricultural Research (CGIAR). Established in 1971, the CGIAR is an international group of representatives of donor agencies, eminent agricultural scientists, and institutional administrators from developed and developing countries who guide and support its work.



Cosponsored by the World Bank, the Food and Agriculture Organisation of the United Nations (FAO), and the United Nations Development Programme (UNDP), the CGIAR operates without a formal character, relying on a consensus deriving from a sense of common purpose.

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The CGIAR is serviced by an executive secretariat, provided by the World Bank and located in Washington. A Technical Advisory Committee (TAC), with its headquarters at FAO in Rome, guides the research programs and priorities of the Group.

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