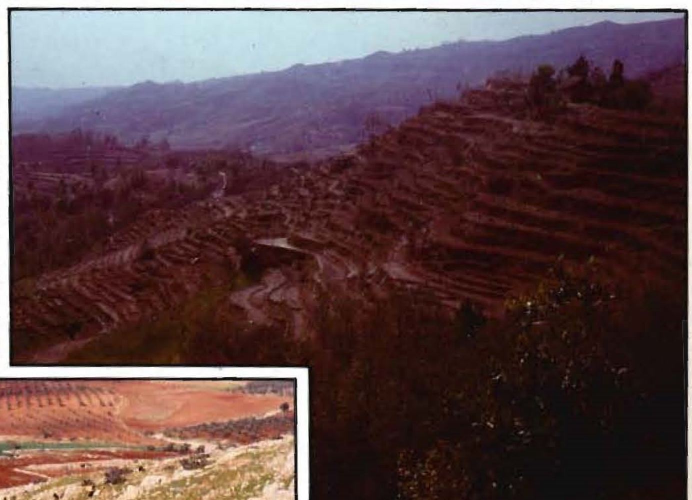
ICARDA Annual Report 1993



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 18 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.

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Cover

ICARDA's mandate covers a variety of farming systems and natural agricultural resources of the West Asia and North Africa (WANA) ecoregion. The lower rainfall and highland areas, though less rewarding because of their low potential, are so extensive in WANA that even small increases in their productivity can add up to substantial improvements in overall production.

Pictures show (clockwise): sheep grazing dry rangeland improved with planted shrubs; ancient terraces to conserve soil and water; cereal-based farming systems that integrate crop and livestock production; and olive/ cereal intercropping in marginal mountain farming.

Foreword

An institution such as ICARDA that aims at maintaining the high standards and dynamism of its work must have a suitable mechanism for monitoring the progress of its performance and evaluating the relevance of its mandate and mission in everchanging circumstances. ICARDA has developed a process of regular internal reviews of both its research activities and managerial performance, which is helping to keep it abreast of developments and enhance its ability to respond in a timely and responsible manner.

In addition, once every five years ICARDA undergoes an External Program and Management Review under the auspices of the Consultative Group on International Agricultural Research with which it is associated. Such a review, the third in the Center's history, took place in 1993, the year covered by this Annual Report. ICARDA was gratified that the Review Panel was generally approving of the Center's research and management. The Center sees in their comments a clear message that ICARDA is engaged in relevant, useful and much needed research, that it is open to new ideas and promising innovations, that it is fiscally and administratively well managed, and that it is a responsible guardian of stakeholder interests. Nothing expresses this positive assessment better than the opening remarks of the Review Report. In the Panel's view,

> "Whatever the contemporary perspective taken:
> - growing food deficits, and demands for self-reliance in the region,
> - environmental degradation, and the pressing need for sustainable agricultural systems,
> - ecoregionality and the quest for enhanced relevance in agricultural research,
> - capacity-building imperatives, and the Center's appraised contribution, ICARDA makes a compelling case for its continued existence and the case will probably grow in strength for years to come. It is one of those cases that, if ICARDA did not exist, it would have to be created."

ICARDA is happy to rest its case on this testimony.

Nasrat R. Fadda
Director General

Enrico Porceddu
Chairman, Board of Trustees

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PART ONE

Major Developments in 1993

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Major Developments in 1993

ICARDA started the year 1993 with an optimistic tone. The Center felt that it could meet the emerging austerity situation without seriously affecting its work plans, staffing levels, or morale. This optimism was based on a fairly healthy financial situation at the start of 1993, and on the hope that the continuing funding stringency had reached its limits and that a change for the better was not far away. The Center saw its main task as one of maintaining the integrity of its research program in the short to medium term to be well placed to take advantage of positive changes when they came.

Medium-term Plan 1994-98

With optimistic funding prospects in mind, ICARDA developed its Medium-term Plan 1994-98 and presented it to TAC (Technical Advisory Committee) in March 1993. The Plan was well received and endorsed by TAC. Later, in May 1993, the Center presented the Plan to the CGIAR (Consultative Group on International Agricultural Research) at the Group's Mid-term Meeting in Puerto Rico. Again, the Plan was commended for its clarity and responsiveness to the new CGIAR thinking on the future orientation of international agricultural research, and to the various likely funding scenarios.

Third External Program and Management Review

During the year, ICARDA went through its third quinquennial External Program and Management Review. The Report of the Review Panel was presented to the Board of Trustees of the Center at its annual meeting in May 1993. Subsequently, both the Report and ICARDA's Response were presented to TAC in June 1993 at its meeting in Sri Lanka, and to the CGIAR at the International Centers Week in October 1993 in Washington D.C. The meeting expressed a strong interest in the role that ICARDA could play as a lead Center both in the Newly Independent Republics of the former USSR, and in the context of the Middle East peace process. Indirectly, ICARDA also derived benefit from the fact that its Director General (DG) was the Chair of the 1993 Center Directors Committee (CDC). He was the Center Directors' spokesman on several public occasions including the World Bank President's dinner, and shouldered the responsibility for drafting and presenting the CDC annual report to the Group and delivering the Group's address at the farewell ceremony in honor of the retiring CGIAR Chair Mr V. Rajagopalan.

On the occasion of the 1993 Board of Trustees (BOT) meeting in Aleppo, His Excellency Mr Minioru Kubota, Ambassador of Japan to the Syrian Arab Republic (left), gifted a set of sophisticated equipment to ICARDA to support its livestock management and nutrition research. Dr Enrico Porceddu, BOT Chairman (standing next to Mr Kubota), Dr Nasrat Fadda, Director General of ICARDA (right), other visiting Ambassadors and senior officials from the embassies/consulates in Syria, BOT members, and several senior ICARDA staff attended the ceremony.

Austerity and Staff

As mentioned above, until the May 1993 meeting of the Board, ICARDA felt confident that it could complete the year within the expected income and the planned deficit authorized by the Board. By August, however, the Center began to receive strong signals of a radical change in the financial prospects for 1993 and beyond, indicating that expected revenues would be substantially below the conservative scenario under which the Center had prepared itself to operate. This was the main concern of the Center for the rest of the year. Several actions were taken to reduce the deficit in 1993 and prepare a balanced or near-balanced budget for 1994.

A comprehensive review of the items of expenditure was conducted and areas for possible savings were identified. These included mainly travel, transportation, overtime, and insurance. The major savings, however, were made through staff reductions. It was decided that the ICARDA-financed contracts of Visiting Scientists and Postdoctoral Fellows were not to be renewed on expiry; advantage was also taken of voluntary resignations to freeze positions and reallocate staff responsibilities; and an incentive scheme to encourage resignations was introduced, of which a substantial number of staff members took advantage. The adjustments were implemented smoothly, with minimal disruption. ICARDA hopes that, with these steps, future adjustments will not be as demanding. The Management and the Board of Trustees of the Center wish to place on record their deep appreciation of the understanding of both regional and international staff in times of financial difficulties.

Research and Training Highlights

Though ICARDA remained preoccupied with implementing the adjustments dictated by funding shortfalls, the research activities of the Center continued fairly uninterrupted. The annual coordination meetings with ICARDA's national partners were held in Algeria, Egypt, Ethiopia, Iran, Iraq, Jordan, Lebanon, Libya, Morocco, Sudan, Syria, Tunisia, Turkey, and the UAE. Over 500 national scientists and several stakeholders participated in the meetings.

The Weather

The 1992/93 season in WANA (West Asia and North Africa) was remarkably similar to 1991/92. In Syria and the eastern Mediterranean countries winter was again much colder than usual. Although precipitation was less plentiful than last year, it was sufficient to ensure a generally good harvest in Turkey, Syria, eastern Libya, and Egypt. In Lebanon and Jordan, a promising crop was reduced to average, partly because of excessive rainfall during harvest time in May. Drought conditions prevailed in eastern Libya, and continued for a second year in Morocco. Cereal production in the Arabian Peninsula, Iran, and Iraq was appreciably above average.

The small spring rains in Ethiopia started erratically, but were exceptionally heavy in April and May. The main summer rains were generally adequate, but yields were markedly below the level of the preceding year. In nearly all parts of Sudan where rainfed cropping is practised, precipitation and crop yields were below average.

Agroecological Characterization

More Roots for Drought Resistance ?

The amount of water stored in the soil in Mediterranean environments is dynamic. At the end of the arid summer the soil is normally dry. Stored water builds up to a maximum during the winter, and then rapidly declines in the spring as it is used by crops. The proportion of the rainfall that is stored depends on its amount and distribution through the season. It has been estimated that it would take at least 415 mm of rain to wet a soil profile that is 75 cm deep, and 500 mm to wet a 180-cm profile. These estimates would vary with soil type and rainfall distribution.

At maximum wetness, the deep clay soil at Tel Hadya can store an amount of plant-extractable water equivalent to about 220 mm of rain in a 180-cm depth of the profile. However, in the last seven years at Tel Hadya, it was only in 1987/88 that almost this much water was stored. When the soil was wet to this depth, wheat and chickpea crops extracted virtually all of the water. If the crops had a root system that could take up more water, the extra water removed would not have been replenished in any of those seven years. Thus, selection for greater root growth may be of value for better rainfall areas but not for those that are most drought-prone.

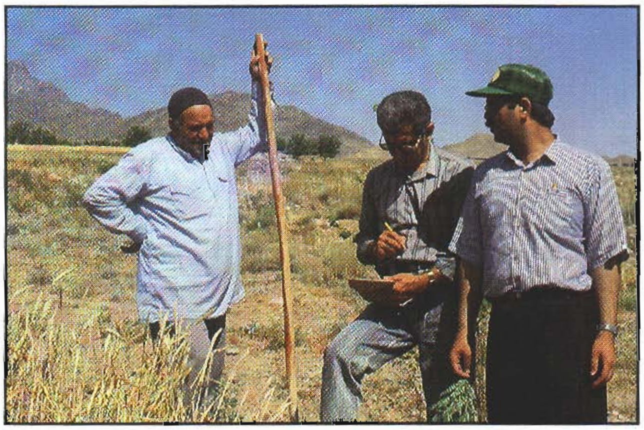
Germplasm Conservation

Collection Missions

In 1993 ICARDA mounted germplasm collection missions jointly with national scientists in Iran, Iraq, and Lebanon, where international teams had not collected for many years. Twenty-six wild and 107 cultivated wheat, 194 *Aegilops* spp., and 34 wild and 47 cultivated barley accessions were collected.

Valuable information was obtained on the extent of genetic erosion in wheat and barley and their wild relatives in West Asia where these two important crops were domesticated some 10,000 years ago. Primitive forms of wheat, compactum and emmer, are still grown in remote areas of northwestern Iran but they may be soon replaced by improved varieties of bread wheat. This has already happened in the more fertile areas with higher input agriculture.

The Jebel Sinjar area in Iraq, the highlands northwest of Mount Hermon in Lebanon, and Sweida province south of Damascus in Syria were identified as sites for *in situ* (on site) conservation because of the presence of large and diverse populations of wild progenitors of wheat.



Members of the germplasm collection team interview a farmer in Iran.

A collection mission to Balochistan focused on food and forage legumes. Owing to ubiquitous overgrazing by small ruminants, only 22 samples of forage legumes (*Vicia* spp., *Trigonella* spp., and *Melilotus* spp.) were collected. The mission also collected 77 samples of landraces of lentil, faba bean, wheat, and barley.

Over 450 accessions of *Vicia* spp. and *Lathyrus* spp. were collected in an extensive survey of forage legumes in Morocco. The survey was conducted in collaboration with Moroccan researchers and CLIMA (Center for Legumes in Mediterranean Agriculture, Perth, Australia). This represents the most comprehensive collection of Vicieae from the North Africa region.

Agreement with the Vavilov All-Russian Institute of Plant Industry

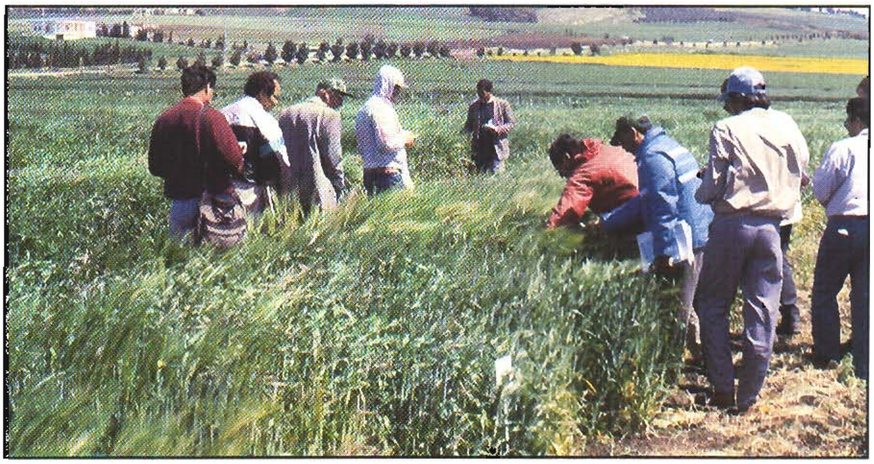
Following the restructuring of the former Soviet Union, a new agreement was signed between ICARDA and the Vavilov All-Russian Institute of Plant Industry, based in St. Petersburg, Russia. The agreement focuses on the efficient conservation and utilization of genetic diversity of ICARDA's mandate crops, many samples of which have been accumulated at both centers through collections, exchanges, and acquisitions. It envisages collaboration in the evaluation of genetic resources, pre-breeding, exchange of germplasm, information and scientific visits, and the long-term storage of collections.

Germplasm Enhancement

Cereal Crops

Release of Cultivars

Several NARS (National Agricultural Research Systems) released improved cereal cultivars in 1993. Egypt released Sahel 1 (wheat) and Giza 125 (barley) for rainfed areas in the northwest coast. Algeria released Haidar, Balikh 2, Om Rabi 9, and Kabir 1; and Libya released Zahra 5 as improved durum cultivars. Four countries released hull-less barley varieties derived from the material from the ICARDA



North African scientists select promising barley lines in Beja, Tunisia.

barley breeding project based at CIMMYT, Mexico: Kaputor and Namoi in Australia; Kolla in Bolivia; Falcon in Canada; and Jau-93 in Pakistan.

New Barley Breeding Approach

Over the last three years the breeding approach of ICARDA in North Africa has been shifting towards exploiting specific adaptation, with greater involvement of national scientists in the work. In this context, the Center has shifted the emphasis of germplasm distribution to early generations of crossing involving a number of North African landraces. Selection is done for adaptation to the different environments of each country. In 1993, almost 5000 plants were selected from populations performing well in one or more locations. Their progenies will be screened for disease resistance, and then distributed for yield testing. This approach allows ICARDA to better respond to local objectives and to maintain diversity within and across countries.

Cold Tolerance and Grain Yield in Barley

Cold tolerance is thought to have a detrimental effect on yield potential. A study of 252 winter barley genotypes to ascertain whether high levels of cold tolerance will also reduce yield in warmer or mild-winter areas and lessen the adaptability of the germplasm suggests that there is no relationship between yield potential in mild climates and cold tolerance. High-yielding, broadly adapted, cold-tolerant material is, therefore, a realistic target.

Screening winter barley genotypes for cold tolerance at a high-elevation site in Turkey.

Screening for Resistance to Root Diseases in Barley

Surveys of root diseases, and their causal organisms, in rainfed barley were carried out during the past two years in Syria, Egypt, Tunisia, and Turkey. Of the pathogens identified, *Cochliobolus sativus* and *Monographella nivalis* were most frequent.

Root rots interfere with the plant's ability to extract nutrients and water from the soil and are especially damaging under drought conditions. The disease can be controlled through rotation and/or use of resistant cultivars. A testing system was developed that allows the screening of a relatively large number of cultivars for resistance to *C. sativus* and *M. nivalis*. The system uses peat-based inoculum and is similar to the one used for inoculating legumes with rhizobia. Using this technique, advanced breeding lines developed for drought stress environments are being tested. Initial results are encouraging and indicate that sources of resistance to *C. sativus* are available.

A conidial suspension of the root rot fungus *C. sativus* is applied in a peat carrier to barley seed. This methodology allows the testing of a large number of genotypes, and of inoculated plots next to check plots.

Hessian Fly Resistance in Durum

Working with the Moroccan National Program, the first durum wheat lines resistant to Hessian fly were developed. The search for more sources of resistance is on, and this involves the use of wild relatives, wide crossing, and embryo rescue techniques. Resistant lines are being advanced for yield testing.

Trace Element Deficiencies and Toxicities

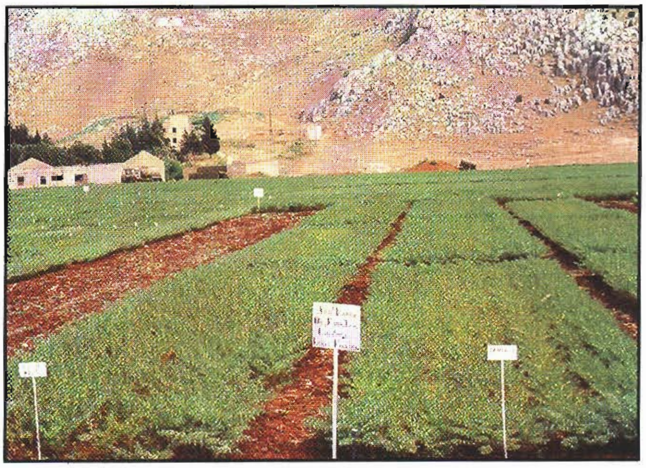
During the past two years ICARDA, in collaboration with its national partners, has been taking an increasing interest in trace element problems affecting the growth and yield of cereals. So far zinc, copper, and iron deficiencies have been identified in the highland areas of Turkey. The Turkish national program has had spectacular yield responses (40%) to applied zinc. ICARDA is alerting other NARS about the possibilities of trace element deficiencies.

ICARDA and NARS have found boron toxicity to be widespread. So far it has been identified in Turkey, Syria, Tunisia, and the dryland areas of Egypt. Its presence is also suspected in Libya and Algeria. The symptom expression is greater on barley than on wheat. Since boron toxicity, as opposed to trace element deficiency, is not easily countered agronomically, research on plant tolerance as a solution is necessary. All of the 1992/93 breeding nurseries were screened, and a range of tolerant material was identified. Large yield increases in the tolerant lines were obtained. In collaboration with NARS, surveys are being carried out to better define the areas with high boron content.

Food Legumes

Release of Cultivars

National programs continued to participate actively in the International Legume Nursery Network. Through this cooperative activity, five countries released seven lines of kabuli chickpea derived from the ICARDA/ICRISAT breeding program: China (FLIP 81-40W and FLIP 81-71C), Egypt (ILC 195), Lebanon (FLIP 85-5C), Libya (ILC 484), and Sudan (ILC 915). Another five countries released eight cultivars of lentil: Australia (FLIP 84-51L, 84-58L, and 84-154 L), Bangladesh (selection from a cross of ILL 4353 and ILL 353), Ethiopia (NEL 2704 and FLIP 84-7L), Libya (78 S 26002), and Sudan (ILL 818). In addition, several NARS evaluated a large number of lines in on-farm trials for eventual release.



Promising kabuli chickpea lines in on-farm trials in Lebanon. FLIP 85-5C was the first cultivar in WANA released in the coastal areas of Lebanon specifically for its green seeds, eaten raw in that country.

Lentils for High-Altitude Regions

Afghanistan, Iran, Pakistan, and Turkey have large areas in the highlands where lentil is grown as a spring-sown crop because the winter is too cold. In 1992/93 Turkey again demonstrated that the yields of winter-sown lentil cultivars at its high-elevation site in Hymana far exceeded that of spring-sown crop, provided there was adequate winter-hardiness in the cultivars. Lines ILL 468, 1918, 465, and 983 were selected for this trait.

Lentil screening for winter-hardiness is carried out in collaboration with Turkey at Hymana Research Station, near Ankara.

Faba Bean Necrotic Yellows Virus in Egypt

A viral epidemic in faba bean caused nearly 90% yield loss in the Middle Egypt in 1991/92. The Egyptian scientists with their ICARDA counterparts, using modern biotechnological tools, identified the main causal agent as the faba bean necrotic yellows virus (FBNYV). This is a newly identified virus of legumes in a number of WANA countries, and is spread by legume aphids. The joint team monitored the development of the disease and the vector during the 1992/93 season. Through timely control of the vector and roguing diseased plants, the disease was brought under control. The study of the ecology and epidemiology of the virus continues with the aim of designing an integrated control strategy that uses a combination of resistant cultivars and appropriate cultural practices.

Faba bean necrotic yellows virus in a farmer's field in the Fayoum Governorate of Egypt. The virus caused nearly 90% yield losses in Egypt in 1991/92.

First DNA Marker for Resistance to Ascochyta Blight in Chickpea

In collaboration with the University of Frankfurt, with a special project grant from BMZ, attempts are being made to develop molecular markers linked to genes for resistance to ascochyta blight in chickpea cultivars. A cross was made between ascochyta blight resistant chickpea cultivar ILC 3279 and the susceptible line ILC 1272. The F_2 population was analyzed for the phenotypical trait expression (resistant or susceptible) on individual plant basis. From all trait-evaluated F_2 plants, DNA was extracted and probed against 15 oligonucleotide probes. A linkage was found between presence and absence of a DNA fingerprint band and the trait expression "resistant versus susceptible."

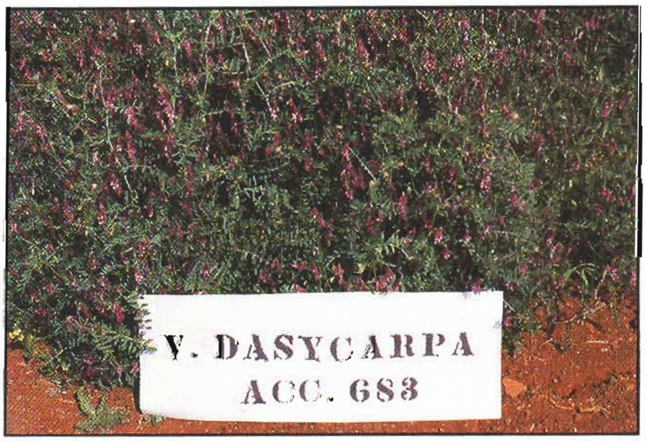
Use of Wild *Cicer* in Kabuli Chickpea Improvement

Up to 50% increase in seed yield of advanced chickpea progenies over the best check cultivar was derived from interspecific hybridization. Considerable progress was made in transferring resistance to cyst nematode and tolerance to cold from wild *Cicer* species to cultivated varieties. Efforts are also under way to perfect embryo-rescue techniques to make use of those wild species that have not been successfully crossed with the cultigen by traditional means.

Forage Legumes

Use of Germplasm by NARS

Vetches (*Vicia* spp.) and chicklings (*Lathyrus* spp.) are important annual forage legumes which can be introduced in the cereal-dominated cropping systems of the dry areas of WANA. In 1992/93 several national programs identified useful material from the Center's International Legume Nursery Network. The Jordanian national program released one cultivar each of woolly-pod vetch (IFLVD 683), common vetch (IFLVS 715), and common chickling (IFLLS 110). In Morocco, one line of narbon vetch (IFLVN 577/2391) and one of common vetch (IFLVS 709/2603) were entered in the national catalog trial. The Turkish national program in the East Anatolian region selected several cold-tolerant lines of *Lathyrus sativus* and *L. ochrus* for winter sowing.



Wolly-pod vetch has been found to be a promising annual forage legume for green grazing and hay making in both low- and high-elevation areas in West Asia.

Rapid Screening for Antinutritional Factor

Use of chicklings as human food and animal feed is constrained because their seeds contain a toxic, free amino acid, ß-N-oxalyl amino-L-alanine (BOAA). In collaboration with the Grain Research Laboratory, Winnipeg, Canada and the University of Deir-Ezzor, Syria, a rapid screening method for BOAA content was developed based on the use of near infrared reflectance spectroscopy. The technique is now routinely used for screening chickling germplasm at the Center.

Seed Production

The regional train-the-trainers programs were initiated in 1992 in close cooperation with GTZ's Jordan Seed Project and the University of Jordan by organizing two courses: one on Seed Testing Techniques, and the other on Seed Health Testing. Altogether 19 trainers from nine countries took part. In 1993, 6 follow-up in-country courses were held in 4 countries in which 64 national staff members were trained: Egypt (22), Ethiopia (12), Jordan (11), and Sudan (19).

The national train-the-trainers program in Egypt, conducted jointly with the Central Administration for Seed, the Agricultural Research Center, GTZ's Egypt Seed Project, and National Agricultural Research Project, was successfully completed in 1993. This training program was initiated in 1990 by training six trainers. From 1991 to 1993 the trainers independently conducted nine courses involving 111 field inspectors.

Resource Management and Conservation

The first phase of a project on Dryland Resource Management ended in 1993 with a workshop at ICARDA. Small interdisciplinary groups of national scientists in each of the six participating WANA countries (Jordan, Lebanon, Libya, Pakistan, Tunisia, and Yemen) developed case studies of natural resources misused in agricultural activities. The studies focused on two objectives: (i) to describe and analyze current resource management practices and local land users' perceptions, for the purpose of developing alternative management practices, and (ii) to help build national capacity to address the problems of land and land users in the drier areas.

The workshop recommended that the next stage is to initiate practical interventions with the resource users, and to monitor their effectiveness as well as social and economic acceptability.

Water Quality in Supplemental Irrigation Systems

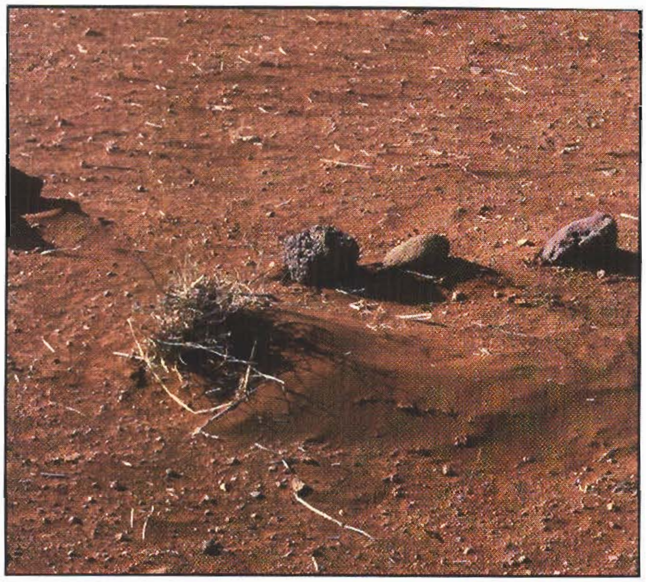
Recent field research in the Djezireh plains in north-eastern Syria has demonstrated that, under semi-arid conditions, supplemental irrigation water even with a low salt concentration can produce a rapid build-up of salt in the soil and hence lead to a decline in crop productivity.

On average, wheat yield declined by 50% after five years of using irrigation water with an electrical conductivity of 3-4 mmhos/cm.

Control of Wind Erosion

With the cooperation of the Syrian Soils Directorate, studies on wind erosion were extended to two provinces in northeast Syria. Aims include the continued quantification of relationships between postharvest erosion and site conditions (weather, soil type, and land management practices), and the evaluation of a simple conservation tillage technique against soil loss by wind.

'Ducksfoot' cultivation of about 20% of the field area, in strips transverse to the predominant direction of the summer winds, proved effective at a vulnerable site reducing a total seasonal loss of about 1 tonne soil/ha to almost zero. However, an opposite effect was observed at the most vulnerable site tested: the loss of soil from a grazed barley field increased from the usual 2.5 t/ha to about 7 t/ha where conservation tillage had been applied.



Soil on harvested barley fields, such as this one in Aleppo, is easily blown away after sheep have grazed off stubble.

The physical condition of the soil appears to be the reason for this stark difference between sites. Whereas at the first site, tillage threw up non-erodible clods, at the second site it exposed loose, erodible material and so promoted loss by wind erosion.

Conservation tillage is, therefore, not a universal solution to the problem of erosion by strong summer winds on fields from which stubble has been grazed and where the surface often is pulverized by sheep and goats. However, conservation tillage may prove suitable for heavier, better-structured soils.

Plantation of Fodder Shrubs in the Syrian Steppe

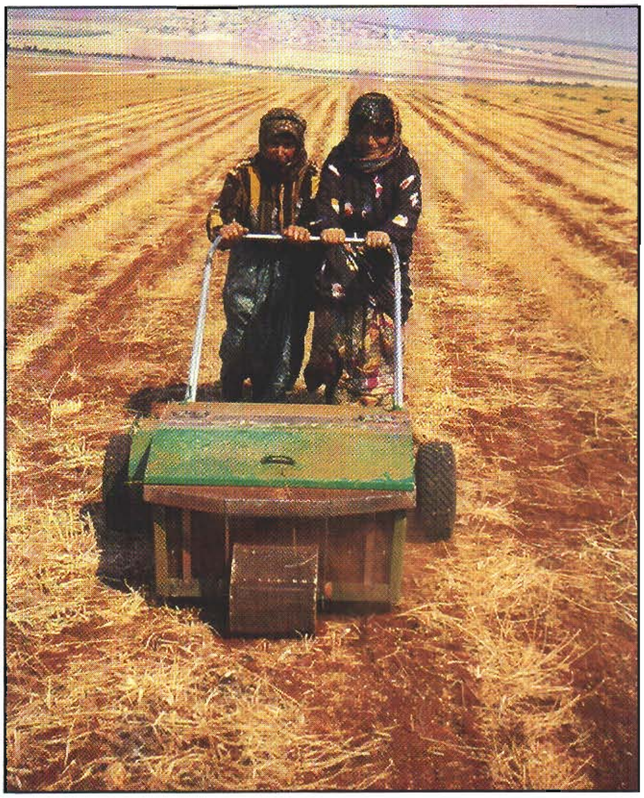
Fodder shrubs such as *Atriplex* spp. can help reverse rangeland degradation, provide feed for livestock, reduce soil erosion by providing windbreaks, and promote regeneration of natural vegetation in a sheltered habitat. In 1983 the Syrian government began a campaign of private shrub plantation in the Syrian steppe to redevelop the rangeland. From that year the law has required that all farmers holding barley cultivation licences in the steppe plant at least 30% of their land to shrubs (*Atriplex* spp. and *Salsola vermiculata*).

A survey was undertaken by ICARDA in northern Syria to study the management practices followed by farmers in shrub plantations. The study indicated that few private plantations exist, largely because most of them were not properly established or maintained.

The cost of plantation establishment by seedling transplants is high and time-consuming. *Atriplex* spp. and *Salsola* spp. can be direct seeded, but protection during the early stages of growth, for about three years, is necessary.

Low-Risk Pasture Establishment Using Medic Pods

Using a hand-driven 'pasture seed sweeper' developed by ICARDA in 1992, several tonnes of medic pods were harvested and used to determine the pod sowing rate necessary to establish a reasonably dense pasture. Prototypes of sweepers, with technical drawings, were sent to Algeria, Morocco, and Lebanon to enable those countries to have the units manufactured locally.



Using the pod sweeper developed by ICARDA, several tonnes of medic pods were collected for pasture establishment experiments.

At Tel Hadya, pods of *Medicago rigidula* and *M. rotata* were broadcast in the autumn of 1992 at the rates of 0, 100, 200, and 300 kg/ha and the field planted to barley. Germinated medic seedlings were counted after the autumn 1993 rains and a linear relationship was observed between the pod sowing rate and the number of germinated seedlings. *Medicago rotata* had significantly higher germination rate than *M. rigidula,* confirming earlier results.

These and earlier studies indicate that successful pastures can be established by sowing 150 kg/ha of medic pods prior to sowing a barley crop in the year before the pasture is desired. Pod sowing rate could be reduced to around 100 kg/ha if older pods are used, as ageing softens seeds in pods and increases germination rate.

Rhizobial Inoculation and Phosphorus and Zinc Nutrition for Annual Medics

The local adaptation of medic species depends on the presence in the soil of compatible *Rhizobium meliloti* bacteria as well as nutrients such as phosphorus and zinc. In a greenhouse experiment with a representative P-deficient clay soil from the Aleppo region, four medic species consistently and significantly ($P \leq 0.05$) responded well to P application. Similarly, a marked response to applied Zn was also common but only with adequate P and N levels. *Medicago rotata* and *M. polymorpha* responded to inoculation more markedly than other species. Thus, in addition to cereal fertilization with N, it may be necessary to apply P and Zn to medic pasture in cereal-pasture rotations.

Potential Fertility of Awassi Ewes

Lambing percentages in flocks of Awassi ewes in the Near East rarely exceed 85 and are often as low as 65. This is attributed to poor nutrition, poor management, disease, and possibly the effects of high temperatures at mating, which generally occurs in mid-summer. At Tel Hadya, eliminating major disease problems, maintaining a minimum ewe weight at mating, and using good rams has resulted in raising lambing percentages close to 100.

Impact Assessment and Enhancement

Wheat Yield and Net Returns in Upper Egypt

Egyptian and ICARDA scientists conducted a survey of wheat production in Upper Egypt. It was found that the recent increase in Egyptian wheat production was derived from an increase both in the area planted and in productivity per unit area.

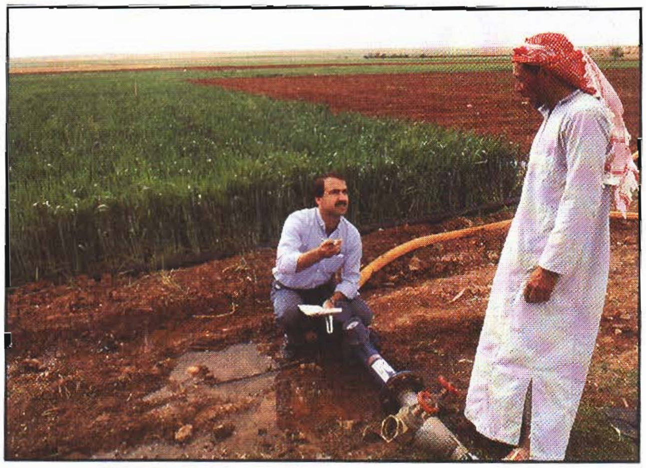
Farmers' awareness of recommended production technologies was high but adoption rates varied. Rates were high for improved variety, date of planting and irrigation regime but low for seed rate, nitrogen fertilizer, and crop establishment practices. Lack of adequate extension information was considered one of the principal reasons for low adoption rates.

Recent changes in agricultural policy, which increased wheat price, have had a dramatic impact on farmers' net returns: the higher the farmer's technical level, the greater was the derived benefit. However, the removal of input subsidies could have a negative effect on farm income and influence farmers' choices of technology adoption.

Supplemental Irrigation and Pricing Policies for Groundwater Depletion Control in Syria

A research and technology transfer project, jointly conducted by ICARDA and the Syrian Ministry of Agriculture and Agrarian Reform, revealed that, with supplemental irrigation, the overall productivity of rainfed wheat-based farming systems dramatically increased by 300 to 900%. This, combined with the lack of knowledge on crop water requirements and correct water management practices, has led farmers to over-exploit some of the aquifers.

Trials on farmers' field over the period 1990-93 indicated the possibility of saving 50% of supplemental irrigation on wheat, sacrificing only 10% of yield in low-rainfall years and none in normal or good rainfalls years. Increasing the water/wheat price ratio to 1.00 may result in considerable water savings (up to 42%) at the expense of only 12% yield decline.



A Syrian farmer being interviewed to collect data on traditional supplemental irrigation practices.

The Syrian Department of Agricultural Extension has developed a plan to transfer and adopt the improved technology of supplemental irrigation on a large scale. Information on supplemental irrigation schedules will be communicated to farmers through personal contacts and, eventually, by radio and television broadcasts. However, it is envisaged that any economy in the use of irrigation water will be adopted effectively only when farmers realize, and pay, the real value of water.

Potential for Wheat Production Improvement in Lebanon

Lebanon currently imports wheat to meet over 80% of its requirements. A farm survey by ICARDA and Lebanese institutions (Agricultural Research Institute, American University of Beirut, and Lebanese University) revealed that wheat was considered an important farm enterprise by the majority of farmers.

A considerable potential for increased wheat production exists through greater use of improved varieties. Average yields reported by farmers under rainfed conditions were 3.5 t/ha for improved varieties compared with 1.5 t/ha for local varieties; and with supplemental irrigation, 4.8 t/ha and 2.8 t/ha for improved and local varieties, respectively.

Local varieties are still grown by 57% of farmers in the Beqa'a, 88% in the North, and 100% in the South. Technology transfer efforts are under way to familiarize farmers with improved varieties.

Small Ruminant Production Systems in Lebanon

A collaborative survey of small ruminant systems in the northern and central Beqa'a Valley was conducted by four Lebanese institutions (Agricultural Research Institute, Ministry of Agriculture, Lebanese University, and American University of Beirut) and ICARDA. Ninety-three flock owners in 28 villages were interviewed.

From December to March, 85% of the animals' diet (109 to 165 kg/head) was hand-fed, and was dominated by wheat bran and barley grain. From April to November, grazing predominated and, to varying degrees, included crop residues, cereal stubble, and unharvested cereal crops.

Animal health problems were ranked first in importance by farmers, followed by inadequate feed supplies, high prices of feed, and problems in marketing livestock products.

Training

In 1993, ICARDA offered training to 659 individuals from 31 countries: 17 in WANA, 6 in the sub-Sahara, 2 in East Asia, and 6 in Europe. About 40% of the trainees attended courses at ICARDA headquarters in Aleppo, and the rest took in-country, subregional and regional training courses. About 12% of the trainees were women.

ICARDA continued its strategy to gradually decentralize its training activities by offering more subregional and regional courses. During the year, the Center offered 13 headquarters courses and 21 in-country, regional, and subregional courses.

Possibilities for conducting joint training in areas of mutual interest are being explored with regional and international centers.

Information Dissemination

Within the framework of AINWANA (Agricultural Information Network in West Asia and North Africa), a three-week training course in library management and the use of modern information technology was organized at the Center's headquarters in Aleppo. Nine information personnel from six WANA countries participated. In addition, three national librarians received individual training in library management and the use of CDS/ISIS and CD-ROMs in preservation, retrieval, and dissemination of agricultural literature. In-house instruction on the use of CSD/ISIS was provided to ICARDA researchers.

The first phase of ICARDA Agricultural Database (ICAD) was completed by downloading 310,000 bibliographic records covering the period 1970-1992 from AGRICOLA and CABI databases.

Eighty publications were produced in-house, and two books were published jointly with a commercial publisher. ICARDA scientists submitted 76 articles to refereed journals, several of them with national scientists as co-authors.

Computing and Biometrics

Computing in ICARDA witnessed a transformation during 1993 from a stand-alone to a networked environment. The introduction of data capture in the field using hand-held computers made a positive impact on research productivity and the accuracy of the captured data. For further automation, a program was developed to link electronic scales to personal computers to enable direct recording of seed weights. Good progress was made in scientific data management through the development of a new Meteorology Database and a Trials Management System using Oracle database management system and SAS statistical package.

A biometric technique to evaluate inter-site transferability of crop varieties was developed. The technique has been applied to select barley and wheat varieties which are transferable over the target environments and possess high yield.

A total of 440 ICARDA staff members were trained in in-house courses. Three courses were organized at headquarters in which 57 trainees from WANA countries participated.

Outreach Activities

Outreach is ICARDA's major mechanism for conducting collaborative research with NARS. Currently, this operates through six regional programs serving the subregions of North Africa, the Nile Valley, West Asia, the Arabian Peninsula, the West Asian Highlands, and Latin America.

Highland Regional Program

The Highland Regional Program continued to develop and strengthen collaborative research in areas where low temperatures in winter severely limit crop growth (usually 750 meters above sea level).

Support for the project activities in Pakistan was provided by USAID (United States Agency for International Development) and for Turkey by the Government of Italy. The activities in Iran are supported by that country.

In Pakistan, the Project entered its eighth year in providing support to the Arid Zone Research Institute (AZRI) in Quetta, and is approaching its termination in 1994. Emphasis has been given to increasing the seed of promising lines of wheat with resistance to yellow rust, barley, lentils and forage legumes, to be submitted for registration as new varieties in 1994. The number of farm sites where fourwing saltbush is being demonstrated increased substantially. A seven-year project on water harvesting was completed and the results indicate that the benefits of this technology over the traditional system are marginal under Quetta conditions.

In Turkey, the Central Research Institute for Field Crops (CRIFC) and ICARDA organized a study of the agricultural systems and constraints to increased cereal productivity in Sivas and Kayseri provinces in Central Anatolia. Some 207 farmers from 10 districts participated over the period 1991 to 1993.

The data point to a semi-subsistence farming system with continued reliance on traditional production methods in both provinces. About 38% of the arable land is fallowed each year, and 63% of the cropped area is devoted to wheat. Other crops of importance are chickpea (12%), barley (11%), rye (7%), and others (totalling 7%). Nearly 42% of the wheat crop is sold and the rest is saved for home consumption and seed. About the same proportion of chickpea production is also sold at harvest. Barley and rye are retained primarily to feed household livestock. Few farmers sell livestock, although it is considered a financial buffer.

Only 37% of the labor represented by household members is engaged in on-farm work, and only a small proportion of the remainder is employed occasionally in off-farm work.

Many farmers have adopted elements of the recommended package. Farmers in Sivas and Kayseri identified their friends and neighbors as the most important sources of information on farming practices and innovations. Overall, however, management and availability of improved technologies continue to limit the progress.

Arabian Peninsula Regional Program

With financial support from the Arab Fund for Economic and Social Development (AFESD), the Arabian Peninsula Regional Program continued to carry out its work on germplasm exchange, evaluation and improvement; and training.

A total of 91 barley, bread wheat and durum wheat, 14 lentil and chickpea, and 14 forage legume trials were distributed to the countries in the Arabian Peninsula. To make up for data lost during the Gulf War, multilocation combined analysis was carried out at ICARDA on wheat and barley joint trials earlier conducted in Kuwait and the results sent to that country. Varietal description and evaluation of the common and improved wheat and barley cultivars grown in Saudi Arabia and Yemen commenced and a varietal description booklet on common wheat and barley cultivars is being prepared.

Nile Valley Regional Program

The Nile Valley Regional Program (NVRP) covers agricultural research, transfer of technology, and human resources development to improve the production of cool-season food legumes and cereals. The Program strategy involves multidisciplinary, multi-institutional, and problem-oriented networks making full use of the expertise, human resources, and the infrastructure available in the participating countries.

The NVRP activities in Ethiopia are now supported by the Royal Netherlands Government. The European Union will support a second five-year phase in Egypt starting 1 January 1994. Besides the commodity programs, Phase II will have a new orientation on resource management and sustainability. The Sudanese component of the NVRP continued to be supported by the Royal Netherlands Government.

The NVRP has had a major impact on wheat production in Egypt resulting in yield increases of up to 25% (see also page 12).

In Sudan, wheat yield increases ranged between 28% and 124% as a result of improved package adoption, with the marginal rate of return (MRR) ranging from 643 to 1236%.

Two improved packages involving two cultivars of barley (HB2 and ARDU 12) were demonstrated in Ethiopia. Yield increases from package adoption ranged between 50% and 161% for HBH2 and ARDU 12, with an average of 323% and 185% MRR, respectively.

Wheat production in Egypt has gone up by 25%. Scientists from the three Nile Valley countries, NVRP Review Team members, donor representatives, and ICARDA scientists visit a wheat field in Upper Egypt to examine the performance of the crop.

In food legumes, the most prominent achievement was the self-sufficiency attained in lentil production in Sudan through a three-fold expansion of the area from 3,000 to 10,000 ha, and the adoption of improved production packages. Yield increases ranged between 20% and 246% with a MRR of 588 to 1447%. In other food legumes, yield increases ranged between 27% and 115% in faba bean (MRR 20 to 213%) and 35% in chickpea (MRR 588%). Similarly, in Ethiopia and Egypt, substantial yield increases and profits were realized from the adoption of improved food legume production packages.

West Asia Regional Program

The West Asia Regional Program (WARP) supports technology transfer activities in Syria, Jordan, Iraq, Lebanon, Cyprus, and lowland areas of Turkey. The Program is supported by UNDP (United Nations Development Programme) and AFESD.

A study tour was conducted for three scientists each from Jordan, Syria, and Iraq to share the Tunisian experience in barley, forage, and sheep production. The tour inspired a reciprocal visit by two scientists from Tunis to the West Asia Regional Program.

Four travelling workshops were organized with the participation of scientists from ICARDA and Mashreq countries (Syria, Jordan, and Iraq).

Scientists from Syria, Jordan, Iraq, and ICARDA discuss constraints to production with Jordanian farmers.

ICARDA, in cooperation with ISNAR (International Service for National Agricultural Research), is assisting the National Center for Agricultural Research and Technology Transfer, Jordan to develop a research strategy and a medium-term plan.

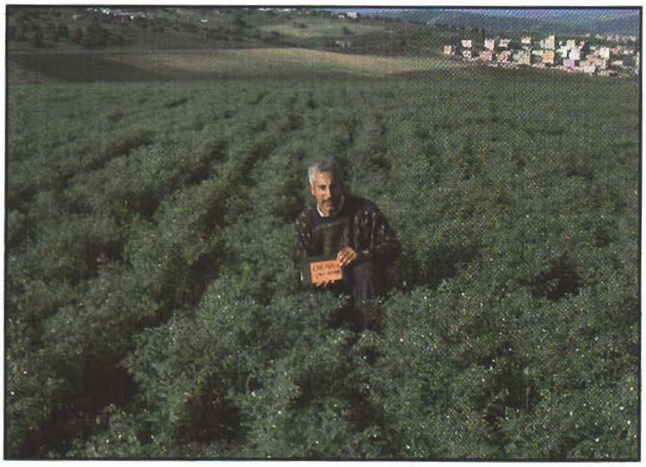
Joint research projects are being implemented in cooperation with NARS. Some examples from Jordan include: tillage and residue management, dryland resource management, monitoring the effectiveness of technology transfer activities in Syria and Jordan, supplementary irrigation and water harvesting, and wind erosion.

North Africa Regional Program

The North Africa Regional Program covering Algeria, Libya, Morocco, and Tunisia executes collaborative research and training activities in those countries. The Program is also responsible for executing a special project supported by IFAD (International Fund for Agricultural Development) on transfer of technology.

The IFAD-funded project to increase cereal, food legume, and livestock production in semi-arid areas in all four of the North African countries achieved good results through testing, verifying, and demonstrating improved technologies in farmers' fields. To continue and complement this work, ICARDA and the four NARS developed a project on "Transfer, Adoption, and Impact of Improved Agricultural Technologies in the Semi-Arid Regions of North Africa" as a second phase to the IFAD project. The Arab Fund for Economic and Social Development has agreed in principle to co-finance the second phase.

ICARDA and IFPRI (International Food Policy Research Institute) have developed a project on "Regional Adaptive Research for the Development of Integrated Crop/Livestock Production in West Asia and North Africa." IFAD has agreed to partially finance the project. ICARDA and IFAD are trying to identify co-financiers to fill a funding gap.



A chickpea demonstration field in Algeria.

In collaboration with the CGIAR Gender Program, ICARDA contracted a consultant to explore concepts, methodologies, and frameworks for gender analysis in agricultural research and provide a base for linking gender issues in agriculture within the WANA region with ICARDA's research activities. The final report of the study is under preparation.

Within the UNDP and IDRC special-funded projects with ICARDA on biotechnology, barley yellow dwarf, and agroecological characterization, ICARDA subcontracted some of the work to NARS scientists with the required expertise.

Latin America Regional Program

In the ICARDA barley breeding project, based in Mexico, several promising lines of hull-less barley have been developed for the Latin American markets. These lines combine high yield with good grain quality and disease resistance and have found good acceptance with housewives. The project has also identified lines with good malting qualities for use by breweries. Five new varieties were released in four countries in 1993 (see pages 5-6).

PART TWO

Research and Training Overview

Contents

Research and Training Overview

ICARDA carries out its research in close collaboration with National Agricultural Research Systems (NARS) within the framework of 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. Multidisciplinary links integrate these activities. 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, and livestock, and the associated farming systems.

At its headquarters at Tel Hadya, about 35 km southwest of Aleppo, Syria, ICARDA carries out its research experiments on a 948-ha farm. The Center operates four additional sites in Syria and two in Lebanon (see Table 28); collaborative research and transfer of technology activities with NARS are summarized in the chapter entitled Outreach Activities. The text here represents only a selection of research results achieved by the Center during the 1992/93 cropping season. A full report of each of the four major programs (Cereal; Legume; Pasture, Forage and Livestock; Farm Resource Management) and of the Genetic Resources Unit is published separately (see Appendix 2).

The Weather in the 1992/93 Season

The 1992/93 season in WANA (West Asia and North Africa) was remarkably similar to 1991/92 as the drought in Morocco continued for a second year, and the winter in the Middle East was again much colder than usual. Precipitation was less plentiful than last year, but sufficient to ensure a generally good harvest.

Seasonal rainfall totals were about 10% below average in the wetter parts of northern Syria and 10% above average in the generally drier areas. Crop yields were, however, uniformly above average due to the favorable intra-seasonal rainfall distribution and its interaction with temperature. The rains at Tel Hadya started in mid-November (Fig. 1), giving crops a good start before temperatures dropped in the second half of December. They remained low until February, but there were no damaging late frosts. The cool weather helped to conserve some of the rain received during this period but slowed down plant development. Yet, the crops suffered moisture stress during a long dry spell lasting from mid-March to early May, when late

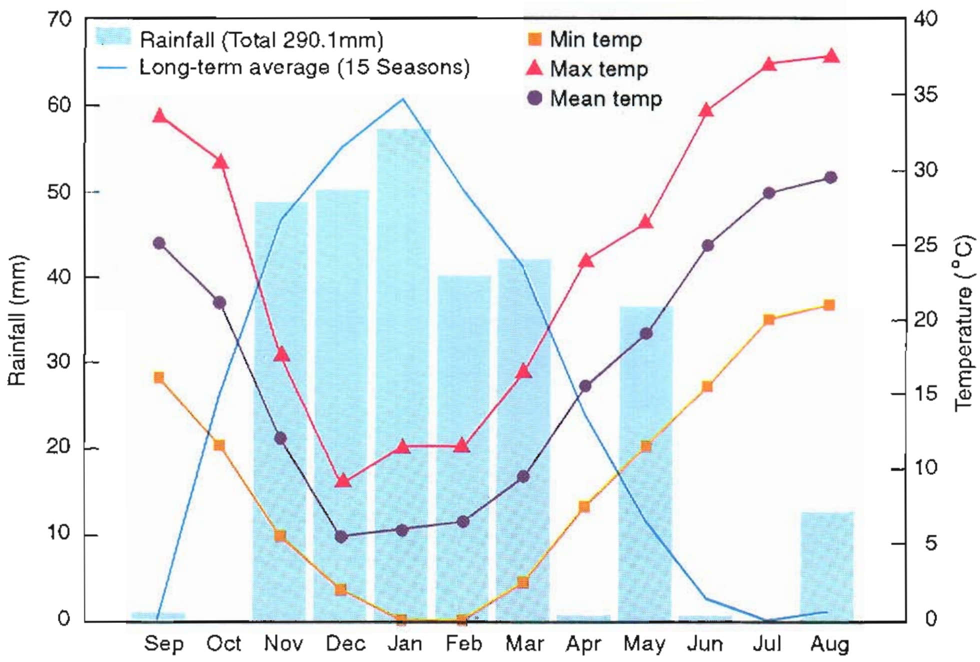


Fig. 1. The weather in 1992/93 at Tel Hadya, ICARDA's main research station near Aleppo, Syria.

rains arrived in time to save the harvest. Both wheat, which had reached the flowering stage, and barley, which had reached grain filling, benefited.

The southern half of Afghanistan, central, eastern and southern Iran, the northeast of Saudi Arabia and the United Arab Emirates received unusually heavy precipitation up to February, causing flooding in several Iranian provinces. From March to May, the rains shifted further west to western Iran, Iraq, and the areas bordering the northwestern end of the Arabian Gulf. Growing conditions were favorable in Iraq, parts of Afghanistan, and especially in Iran where cereal production was distinctly above average. Conditions were less favorable in northern Afghanistan and northwestern Pakistan where precipitation was inadequate and the winter unusually warm.

In North Africa, going eastwards from drought-stricken Morocco, precipitation increased across Algeria, the northeast as well as northern Tunisia being very wet throughout the season. Further east, rainfall decreased again, the western half of Libya being affected by a drought as severe as the one ravaging Morocco. Eastern Libya, however, received above average rainfall from January to March as did northern Egypt. Cereal production was nearly 50 percent below average in Morocco, somewhat below average in western Algeria but above average in the eastern half of the country, and in Tunisia, for the third year in a row.

The small rains in Ethiopia started erratically, but were exceptionally heavy in April and May, and the harvest was somewhat below average. The main rains were close to average across most of the country, but yields were markedly below the level of the previous year. In nearly all parts of Sudan where rainfed cropping is practised, precipitation and crop yields were below average. In Yemen, on the contrary, yields were much higher than last year as a result of a good rainy season.

Agroecological Characterization

More Roots for Drought Resistance ?

Can greater root growth which would allow increased uptake of water from the soil increase the drought resistance of crops? Data on the water balance of rainfed wheat and chickpea crops in a long-term rotation trial at Tel Hadya suggest that this may be possible in wetter areas, but more roots are unlikely to provide against drought in drier zones.

The amount of water stored in the soil in Mediterranean environments is dynamic. At the end of the arid summer the soil is dry. Stored water builds up to a maximum during the winter, when most rain falls and evaporation and crop water use are low, and then rapidly declines in the spring as it is used by crops (Fig. 2). The proportion of the rainfall that is stored depends on its amount and distribution through the season.

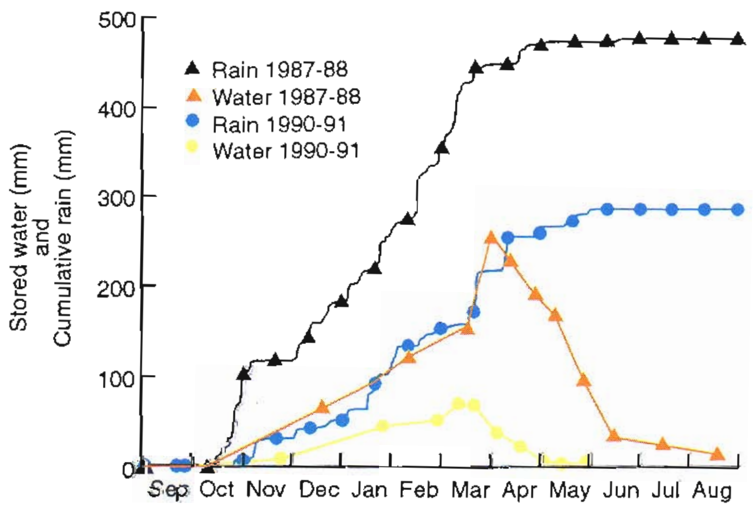


Fig. 2. The time-course of rainfall accumulation, and storage and use of soil water, in contrasting seasons at Tel Hadya.

At maximum wetness, the deep clay soil at Tel Hadya can store an amount of plant-extractable water equivalent to about 220 mm of rain in 180 cm depth of the profile (Fig. 3). However, in the last seven years at Tel Hadya, it was only in 1987/88 (480 mm of rain; estimated as a 1 in 30 years event) that almost this much water was stored, and in most years a much smaller proportion of the soil volume became wet (Fig. 4). When the soil was wet to this depth, wheat and chickpea crops extracted virtually all of the water (Fig. 5). In these seven years, if the crops had a root system that could take up more water, on no occasion would the extra water removed have been replenished in the following season. Thus, in this situation, a larger root system would be of no advantage because the limitation is the supply of water (rainfall) rather than the ability of plants to use it.

Not all soil profiles are as deep as that at Tel Hadya. Using the data for 1987/88 it was estimated that it would take at least 415 mm of rain to wet a soil profile that is 75 cm deep, 460 mm to wet one that is 105 cm deep, and 500 mm to fully wet a 180 cm profile. These estimates would change for a similar soil depending on the distribution of the rain through a season, and would also differ for other soil types. Thus, selection for greater root growth may be of value for better rainfall areas but not for those that are most drought-prone.

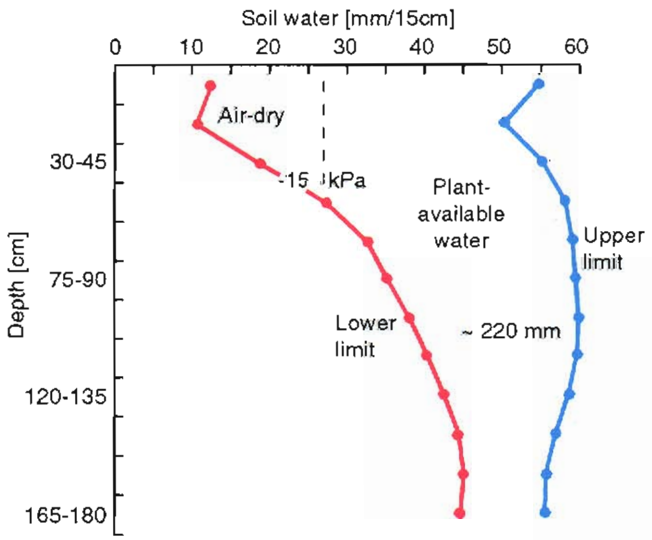


Fig. 3. Plant-extractable water for Tel Hadya soil.

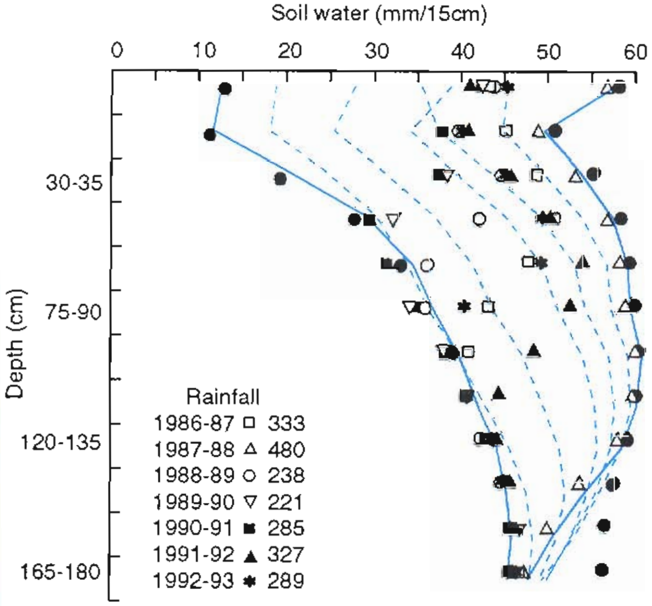


Fig. 4. Maximum soil water profiles measured under wheat and chickpea crops, and total seasonal rainfall, in the past seven years at Tel Hadya.

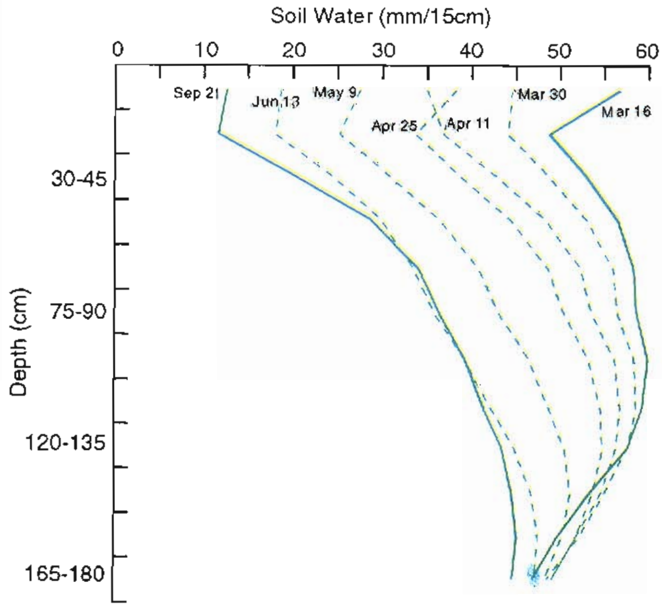


Fig. 5. Pattern of drying of the soil profile by wheat and chickpea crops in 1987/88 when the profile was almost fully wet at maximum water storage.

Germplasm Conservation

In close collaboration with NARS and the International Plant Genetic Resources Institute (IPGRI), ICARDA maintained its strong emphasis on acquiring, characterizing, documenting, conserving, and distributing germplasm of its mandate crops.

Over 1035 new accessions of the mandate crops and/or their relatives were collected, and 1192 were received from other institutions during the year, raising the total number of accessions in the Center's gene bank to 103,750. More than 19,000 seed samples were distributed to users worldwide.

Following the restructuring of the former Soviet Union, the Center signed a new agreement with the Vavilov All-Russian Institute of Plant Industry, based in St. Petersburg, Russia, for efficient conservation and utilization of the genetic diversity available in the region.

Collection Missions

Cereals

Germplasm collections in Iran, Iraq, and Lebanon, where international teams had not been collecting for many years, yielded 26 wild and 107 cultivated wheat, 194 *Aegilops* spp., and 34 wild and 47 cultivated barley accessions.

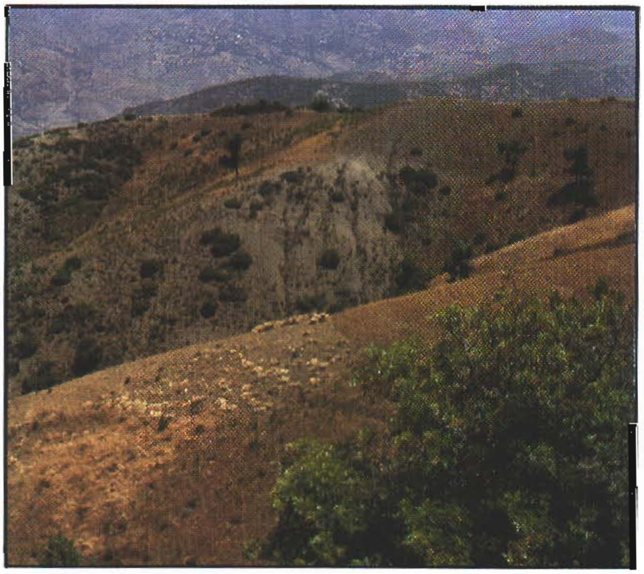
Genetic erosion in wheat and barley and their wild relatives was observed. Improved varieties of bread wheat are increasingly used to replace primitive forms, particularly in the more fertile areas with higher input agriculture. Primitive forms of wheat, compactum and emmer, are still grown in remote areas of northwestern Iran. The greatest surprise was the discovery of a field of *Triticum dicoccum* (emmer wheat), one of the most primitive tetraploid wheats, southwest of Zanjan.

The Jebel Sinjar area in Iraq, the highlands northwest of the Mount Hermon in Lebanon, and the Sweida province south of Damascus in Syria were identified as sites suitable for *in situ* conservation because of the presence of large and diverse populations of wild progenitors of wheat.

In Lebanon, useful sites were identified for *in situ* conservation of the wild *Triticum* and *Hordeum* species, for example, Aiha, near Kfar Kouk, and a site near Yanta where *T. boeoticum*, *dicoccoides* and *urartu* occur jointly. Extensive *T. dicoccoides* populations were discovered with great diversity in spike color and development, and mixed stands of *T. boeoticum* and *T. urartu*. This, for the first time, confirmed the occurrence of *boeoticum* in Lebanon.

Legumes

Over 450 accessions of *Vicia* and *Lathyrus* spp. were collected in an extensive ecogeographical survey of forage legumes in Morocco. The survey was conducted in collaboration with Moroccan researchers and CLIMA (Center for Legumes in Mediterranean Agriculture, Australia). This represents the most comprehensive collection of Vicieae from the North Africa region.



A site in Morocco where germplasm was collected in 1993.

Of 20 species of *Vicia* previously reported from Morocco, only 11 were positively identified. Persistent drought during 1991-93 may have reduced the diversity available. Nevertheless, it is apparent that species such as *Vicia narbonensis*, *V. serratifolia*, *V. cedrotorum*, *V. vicioides*, *V. durandii*, and *V. glauca* are rare in Morocco. With the increasing grazing and cropping pressure in the country, some of these species face the threat of extinction. While other *Vicia* and *Lathyrus* species were dominant in localized environments, the *V. sativa* complex was widely adapted and found in more than 80% of the sites visited. It was apparent from the examination of seeds and pods that the gene pool was broad, and that there has been much introgression, especially between *V. sativa* ssp. *sativa* and *V. sativa* ssp. *nigra*. Seed and pod color and calyx length, for example, represent a continuum between these two. Although *V. sativa* as a species is not generally adapted to cold environments or acid soils, a significant number of ecotypes (up to 14%) were found in such locations.

A striking feature was the "success" of some of the Vicieae in competition with cereals. In crops in the Rif mountains and valleys, *L. articulatus* was a dominant "weed" and on occasions had overgrown the cereal crop. In the colder (and higher) Middle and High Atlas areas, *V. villosa* ssp. *dasycarpa* was a dominant crop contaminant.

Collections in Balochistan, Pakistan, focused on food and forage legumes, but owing to widespread overgrazing by small ruminants, only 22 samples of forage legumes (*Vicia* spp., *Trigonella* spp., and *Melilotus* spp.) could be collected. In addition, 77 samples of landraces of lentil, faba bean, wheat, and barley were collected.

The widespread genetic erosion observed by the NARS/ICARDA collection teams in the region is a matter of serious concern.

Monitoring Wild Wheat and Barley Populations in their Natural Habitat

A mission to southern Syria monitored previously sampled populations of wild progenitors of wheat and barley and explored new ones.

The wild diploid wheat, *Triticum urartu*, was found growing jointly with wild emmer (*T. dicoccoides*) and wild barley (*Hordeum spontaneum*) in the center of the Hauran plain. This population could be a link between the *urartu* populations in the Mount Hermon highlands of Lebanon and the Jebel Al Arab area in Syria—the two sites where this species still grows in massive stands.

In the highlands of Jebel Al Arab, populations of wild progenitors of cereals, growing on stony, non-arable land among the farmers' fields, are relatively well protected during their vegetative period. They are usually not grazed before the harvest of durum wheat and the seed bank is regularly enriched with shattering spikelets. However, in the communal land areas where the Bedouins graze their sheep flocks continuously throughout the vegetative period, only unpalatable, mostly spiny plants are left. In contrast, in the vicinity of the overgrazed land, where grazing is controlled by farmers, dense stands of wild wheat were seen.

In the lowlands of Hauran, all land is cultivated and overgrazing by sheep continues uncontrolled. Wild wheat populations survive only among the fields along the borders and between heaps of stones, especially if these are farther from villages.

In situ Conservation of Wild Progenitors and Relatives of Cereals and Legumes

An experiment has been started at ICARDA's main research station at Tel Hadya to establish and manage populations of indigenous crop wild progenitors and relatives conserved *in situ*, and to monitor and analyze their population dynamics.

Two populations, one local (collected from sites close to Tel Hadya) and one geographically distant (originating from northern Syria or southeastern Turkey) of the following species are used in the experiment: *Hordeum spontaneum*, *Triticum urartu*, *T. boeoticum*, *T. dicoccoides*, *Lens orientalis*, *L. odemensis*, *Cicer reticulatum*, *C. echinospermum*, *Medicago rotata*, and *M. rigidula*. Individual species, two populations of each species, and species mixtures of different complexity have been planted in two environments: uncultivated grazing land and arable land. The main factors affecting survival and competitive ability of the populations will be determined, and the possibility of reintroducing crop wild progenitors and relatives into their original habitat will be tested.

Self-regenerating populations of wild progenitors of cereals and legumes in an experiment at Tel Hadya simulating their *in situ* conservation.

Preliminary results show interesting differences between the two environments: populations on arable land display a much higher reproduction rate and expansion in area than those on uncultivated grazing land.

A large proportion of wild cereal seeds was eaten by rodents, birds, and ants. The damage was more serious in the case of populations on grazing land than on arable land.

In wild barley and wild lentil, the locally adapted germplasm is performing much better than the geographically distant populations.

Germplasm Conservation and Safety Duplication

Conservation of germplasm progressed at accelerated pace during the year. Of 53,038 accessions of cereals, 26,190 of legumes and 24,522 of forages, 37, 376 (70.5%), 12, 397 (47.3%) and 6573 (26.8%), respectively, had been stored in the Center's base collections by the end of 1993. Over 16, 300 accessions of cereals and 9900 of legumes were duplicated for safety, and deposited with research institutes within and outside the region collaborating with ICARDA in this activity.

Revision of *Aegilops*

Aegilops L., a genus of annual grasses (family Poaceae, subfamily Pooideae, tribe Triticeae, subtribe Triticinae), has been revised. The genus forms the largest part of the so-called secondary gene pool of wheat (*Triticum* L.).

Aegilops now comprises 22 species and five non-typical varieties, arranged in five sections (Table 1). These taxa and their names resulted from taxonomic decisions and from a scrutiny of the more than 900 names involved. *Amblyopyrum* now consists of only one species with one non-typical variety, although 39 names are involved. In addition, the intergeneric hybrid genus x *Aegilotriticum* P. Fourn. remains in existence because of the continued separation of the parental genera *Aegilops* and *Triticum*. This hybrid genus accommodates natural and artificial intergeneric hybrids and now consists of seven accepted taxa: one artificially created hybrid and six sterile, natural hybrids. Its eight accepted names remain from no less than 77 names involved.

At an early stage in the evolution of the common ancestral stock, which is thought to have taken place in Transcaucasia, *Amblyopyrum muticum* as well as the wild taxa of *Triticum* have separated from *Aegilops*. Their distribution areas underscore this:

Table 1. Taxa recognized in the genera *Aegilops* (grouped by section), *Amblyopyrum*, x *Aegilotriticum*, and (wild) *Triticum*, and their genome symbols.

Taxon	Genome
Genus *Aegilops* L.	
Sect. *Aegilops*	
1. *Aegilops biuncialis* Vis.	UM
2. *Aegilops columnaris* Zhuk.	UM
3. *Aegilops geniculata* Roth	UM
4. *Aegilops kotschyi* Boiss.	US
5. *Aegilops neglecta* Req. ex Bertol.	UM/UMN
6. *Aegilops peregrina* (Hack. in J. Fraser) Maire & Weiller var. *peregrina* var. *brachyathera* (Boiss.) Eig	US
7. *Aegilops triuncialis* L. var. *triuncialis* var. *persica* (Boiss.) Eig	UC
8. *Aegilops umbellulata* Zhuk.	U
Sect. *Comopyrum* (Jaub. & Spach) Zhuk.	
9. *Aegilops comosa* Sm. in Sibth. & Sm. var. *comosa*, var. *subventricosa* Boiss.	M
10. *Aegilops uniaristata* Vis.	N
Sect. *Cylindropyrum* (Jaub. & Spach) Zhuk.	
11. *Aegilops caudata* L.	C
12. *Aegilops cylindrica* Host	CD
Sect. *Sitopsis* (Jaub. & Spach) Zhuk.	
13. *Aegilops bicornis* (Forssk.) Jaub. & Spach var. *bicornis*, var. *anathera* Eig	S^b
14. *Aegilops longissima* Schweinf. & Muschl.	S^1
15. *Aegilops searsii* Feldman & Kislev ex Hammer	S^s
16. *Aegilops sharonensis* Eig	S^1
17. *Aegilops speltoides* Tausch var. *speltoides* var. *ligustica* (Savign.) Fiori	S
Sect. *Vertebrata* Zhuk. emend. Kihara	
18. *Aegilops crassa* Boiss.	DM/DDM
19. *Aegilops juvenalis* (Thell.) Eig	DMU
20. *Aegilops tauschii* Coss.	D
21. *Aegilops vavilovii* (Zhuk.) Chennav.	DMS
22. *Aegilops ventricosa* Tausch	DN
Genus *Amblyopyrum* (Jaub. & Spach) Eig	
1. *Amblyopyrum muticum* (Boiss.) Eig var. *muticum*, var. *loliaceum* (Jaub. & Spach) Eig	T
Genus x *Aegilotriticum* P. Fourn.	
1. x *Aegilotriticum erebunii* (Gandilyan) van Slageren *comb. nov.*	AD
2. x *Aegilotriticum grenieri* (K. Richt.) P. Fourn.	-
3. x *Aegilotriticum langeanum* (Amo) van Slageren *comb. nov.*	-
4. x *Aegilotriticum rodetii* (Trab.) van Slageren *comb. nov.*	-
5. x *Aegilotriticum sancti-andreae* (Degen) Soò	-
6. x *Aegilotriticum speltaeforme* (Jord.) van Slageren *comb. nov.*	-
7. x *Aegilotriticum triticoides* (Req. ex Bertol.) van Slageren *comb. nov.*	-
Wild taxa of *Triticum* L.	
1. *T. monococcum* L. ssp. *aegilopoides* (Link) Thell.	A
2. *T. turgidum* L. ssp. *dicoccoides* (Körn. ex Asch. & Graebn.) Thell.	AB
3. *T. timopheevii* ssp. *araraticum* (Jakubz.) MacKey	AG
4. *T. urartu* Tumanian ex Gandilyan	A

Amblyopyrum is a western-Asiatic element, confined to Armenia in the Transcaucasus and Asia Minor, and not even reaching the Fertile Crescent arc; the four wild taxa of *Triticum* did spread along the Crescent, while one of them (*T. monococcum* ssp. *aegilopoides*) also reached the Aegaeis, Bulgaria, and Yugoslavia.

Aegilops spread further than the other two genera. It can be described as a Mediterranean-western Asiatic element, occurring all around the Mediterranean Sea and in western and Central Asia, with its spread eastwards being halted by the mountain ranges of the Tian Shan and Himalayas. The extensive distribution of the genus is mainly because of its great capacity for adaptation to moderately disturbed environments. The center of diversity of *Aegilops* follows the Fertile Crescent arc in West Asia (Fig. 6), where the mountains of Turkey, Transcaucasia and western Iran change to the Mesopotamian plains. The 10 diploid taxa are generally less widespread than the 10 tetraploids, with two hexaploid species of limited distribution. *Ae. sharonensis* Eig may be considered endemic, occurring only on the coastal plain of Palestine and in southern Lebanon.

Morphological evidence as well as phylogenetical considerations underlined the location of one species, *Ae. mutica* Boiss., in the monospecific genus *Amblyopyrum* (Jaub. & Spach) Eig. This transfer reestablished an earlier decision by Eig, which had generally not been followed.

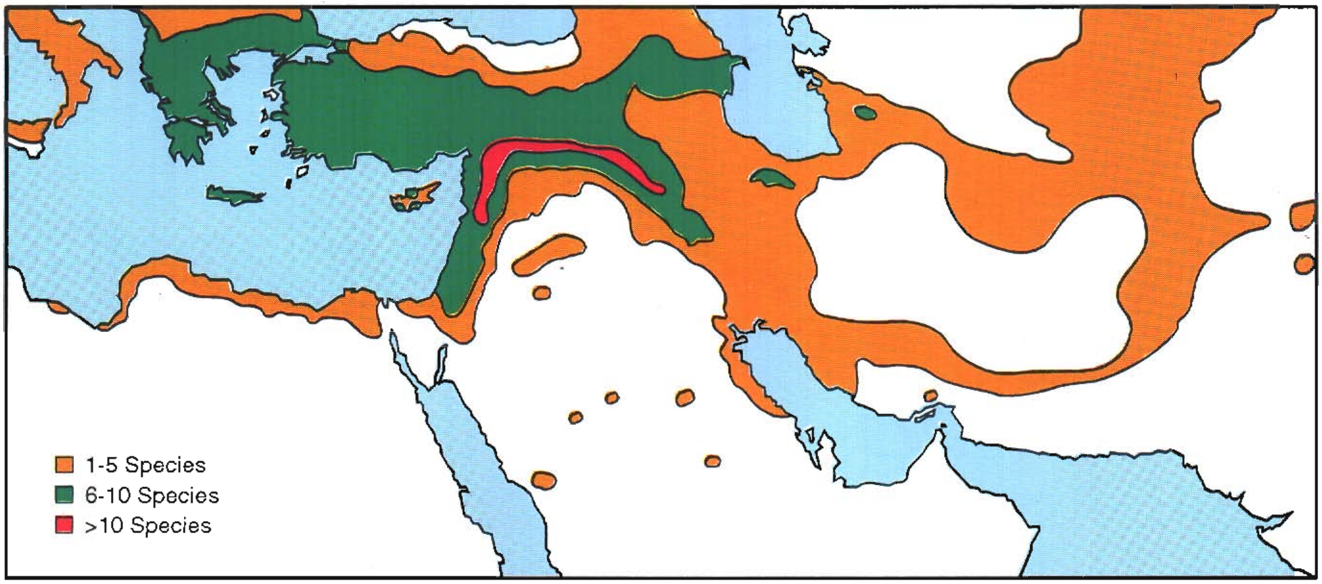


Fig. 6. Distribution ot sympatric *Aegilops* species in western Asia and northern Africa (partially).

Four wild taxa now remain in the genus *Triticum*: *T. monococcum* ssp. *aegilopoides*—wild einkorn; *T. turgidum* ssp. *dicoccoides*—wild emmer; *T. timopheevii* ssp. *araraticum*—wild Timopheevii wheat, and *T. urartu*, a diploid, wild species.

Germplasm Documentation

Availability of, and accessibility to, information on conserved germplasm is important for its efficient utilization. In 1993, a genetic resources database was implemented on the Center-wide PC network. The data on conserved samples can now be accessed from more than 100 PCs on ICARDA's computer network with two VAX 4000/500 machines. The menu-driven system caters for flexible data retrieval, including step-wise selection of accessions, data editing and reporting.

An integral part of the database is a newly developed seed stock control system. It monitors seed movement at two levels: a first warning is generated when "low stock level" is approached; a "stop distribution" flag follows which persists until the stock is replenished.

Germplasm Enhancement

Cereal Crops

Stress Tolerance in Winter and Facultative Barley

Cold-tolerant germplasm of winter and facultative barley was evaluated for its tolerance to drought and heat. Two highly drought- and cold-tolerant lines, CWB117-5-9-5 and Roho/Mazurka, were selected. Their yields of 2833 and 2755 kg/ha, respectively, equalled those of Arabi Abiad and Arabi Aswad check varieties (both spring types, drought tolerant) at Breda, Syria. Under severe cold conditions of Krasnodar, Russia, CWB117-5-9-5 yielded 18% more than the best local cultivar Vavilon.

Emphasis continued to be placed on breeding and selection for tolerance to cold, drought, and multiple diseases (net blotch, leaf rust, and powdery mildew) at appropriate sites and under controlled conditions. A large number of lines tolerant to these stresses, and with good yield potential, were selected from the various breeding nurseries (Table 2).

Table 2. Breeding and selection* of winter and facultative barley lines for abiotic and biotic stress tolerance, 1992/93.

Nursery	Total no. of lines	No. of lines selected for tolerance to			Earliness	High yield
		Cold	Drought	Disease		
Yield trial	24	8	8	7	6	6
Observation nursery	150	85	45	13	47	40
Crossing block	150	119	40	41	35	36
Screening nursery	252	40	43		13	38
Elite lines	2268	304	249		214	342
Germplasm	282	54	33		48	62

* Selection for cold tolerance in Russia and Turkey; for drought at Breda, Syria; and for net blotch, leaf rust and powdery mildew at a wet site in Krasnodar region, Russia.

Performance of Two-Row *versus* Six-Row Winter and Facultative Barley Types

In the winter barley growing areas of WANA and elsewhere both winter and facultative barley types are required. Traditionally, two-row types are dominant in Turkey, and six-row types in North Africa highlands and west and central Asia. A study of 586 two-row and 294 six-row types was carried out at five sites with different agroecological conditions. The two-row types showed a yield advantage of 6 to 22% at sites with severe moisture stress, whereas in the non-stressed environment of Krasnodar, Russia, where sufficient late precipitation was received, six-row types yielded 3-17% more than the two row types.

Breeding Winter Barley for High-Boron Soils

Barley is grown approximately on 3.5 million hectares in Turkey where high-boron soils are reported. For example, boron toxicity symptoms in barley are common in the central Anatolian plateau. A wide range of winter barley germplasm was screened in high-boron fields at Kazan, Turkey, and in a greenhouse at ICARDA.

Four high-yielding, cold-tolerant lines derived from a cross between Zarjou (high-boron tolerant) and No. 80515 (high-boron susceptible) were compared with the high-yielding, cold- and high- boron tolerant local variety Bulbul in a high-boron field at Kazan Research Farm in Turkey, and in normal soils at ICARDA 's farm at Tel Hadya, Syria (Table 3).

Table 3. Performance of winter barley lines derived from the Zarjou/80 5151 cross with differences in sensitivity to high boron in comparison with the check cultivar Bulbul, 1992/93.

Line	Kazan, Turkey				Tel Hadya	
	Boron toxicity reaction	Cold toler. rating	Yield (kg/ha)	% of check	Yield, (kg/ha)	% of check
WBEL-456	Tolerant	5	5800	145	5200	117
WBEL-459	Sensitive	5	3348	83	5250	118
WBEL-462	Sensitive	5	3556	89	5300	120
WBEL-465	Tolerant	5	5044	126	5700	128
Bulbul	Tolerant	5	4000	83	5250	118
	LSD (0.05)		456		663	

The boron toxicity susceptible lines, WBEL-459 and WBEL-462, developed necrotic spots in Kazan whereas the other lines did not. All selections had significantly higher yields than Bulbul at Tel Hadya and there were no significant yield differences between them. However, at Kazan, despite similar cold tolerance and disease resistance, the high-boron susceptible lines (WBEL-462 and WBEL-454) yielded significantly less than the tolerant sister lines. The highest yielding tolerant line, WBEL-456, produced 5800 kg/ha, compared with 3348 and 4000 kg/ha for WBEL-459 and Bulbul, respectively. These studies demonstrate that the development of high-boron tolerant cultivars can significantly increase barley production in areas where boron toxicity limits production.

Hull-less Winter-Type Barley

In the high-elevation areas of WANA countries and Nepal and Tibet, and in South American countries, barley is used for human food. Therefore, research to develop cold-tolerant, winter-type, hull-less (naked) barley was intensified to complement the research conducted for the South American highlands. A number of high-yielding lines have been identified and their quality characteristics as human food will be determined (see also page 66).

Increasing Plant Height of Barley Landraces under Severe Drought

Drought reduces plant height. Since a short crop cannot be harvested by a combine, farmers either leave it for grazing or harvest it by hand. The geographical distribution of the two popular barley landraces in Syria is, to some extent, associated with their plant height under drought: Arabi Abiad (white seed) is mostly grown in slightly wetter environments because in dry environments and/or in dry years its plant height is too short; and Arabi Aswad (black seed) is grown in drier environments because it is taller than Arabi Abiad.

Since its introduction into the barley breeding program in 1985, *Hordeum spontaneum*, the wild progenitor of cultivated barley, has proved promising for its ability to maintain an acceptable plant height even under severe drought. Some of the most promising sources of this desirable trait have been from populations collected in Palestine. Pure lines extracted from these populations were evaluated in Bouider, Syria (long-term average rainfall about 200 mm). Three pure lines were identified, which combined good plant height (46 to 61 cm) under drought and earliness (109 to 115 day to heading), as superior to Arabi Aswad (30 cm plant height, 116 days to heading).

The first crosses between these three *H. spontaneum* pure lines and selected Syrian landraces were made in 1987. The F_1s were grown off-season, and 1765 single plants were selected from F_2s grown in 1987/88. In 1988/89, about 75% of the F_3 families were discarded mostly because they shattered seed like the wild progenitor, and had low tillering and small seed size. The best 74 selections were tested over four cropping seasons at Bouider, and also in Breda and Hassake in 1992/93, in Syria, under severe stress conditions. The grain yield ranged from 340 kg/ha to 755 kg/ha and total biological yield from 1987 kg/ha to 3488 kg/ha.

The five relevant checks to assess the performance of the lines derived from *H. spontaneum* were the two Syrian landraces (Arabi Abiad and Arabi Aswad) and three selections from them. Two of these selections are black-seeded (Tadmor and Zanbaka), and one is white-seeded (Arta). Arta was included because one of the barley lines used in the crosses with *H. spontaneum* is white-seeded (SLB 39-60).

Some of the best lines obtained from crosses with *H. spontaneum* had the same yielding ability as the best cultivated barley both for grain and total biological yield (Table 4). This is particularly important as barley is widely used as animal feed in WANA.

Some lines combined improved plant height under drought with high-tillering ability typical of Syrian landraces (Table 4). The differences between the lines derived from *H. spontaneum* and the checks may not appear large, but considering the difference between Arabi Abiad and Arabi Aswad, they are large enough to affect adoption in dry areas. One family derived from SLB 39-60 is of particular interest because it has white seeds and a plant height under drought which is comparable with the black-seeded lines. In general, the best lines derived from *H. spontaneum* did not exceed the plant height of Zanbaka, a black-seeded pure line selected from Arabi Aswad.

Table 4. Grain yield, total biological yield, plant height, and number of tillers/m² (average of 5 to 6 environments) of three lines derived from crosses with *H. spontaneum* compared with five checks at Bouider (1989-93), and at Breda and Hassake (1992/93), all in Syria.

Cross/Name	Grain yield (kg/ha)	Total biological yield (kg/ha)	Height (cm)	Tiller
SLB 39-60/ *H. spontaneum* 41-1	821	3288	31	327
H. spontaneum 41-1/Tadmor	809	3437	35	359
H. spontaneum 39-2/Tadmor	784	3248	29	290
Checks				
Tadmor	745	2838	28	326
Zanbaka	774	3035	34	303
Arta	810	3154	26	332
Arabi Aswad	776	3189	31	306
Arabi Abiad	721	2656	27	271

This new germplasm, combining desirable traits from both landraces and *H. spontaneum*, is now ready for testing on a large scale. It should enable the farmers to combine-harvest the crop grown in dry environments or dry years.

Improved plant height of a barley line (derived from a cross with *Hordeum spontaneum*) suitable for machine-harvesting in a dry year (left), in contrast with the short-stature local barley (right) that necessitated harvesting by hand.

Histological Studies of Pre-penetration Development of *Rhynchosporium secalis*

Scald, caused by *Rhynchosporium secalis*, is one of the most important barley leaf diseases worldwide. An extensive field screening program is carried out at Tel Hadya and several sources of resistance have been identified.

A histological study was undertaken to examine differences among cultivars in their reaction to the fungus in pre- and post-penetration stage. Seven barley cultivars were selected that showed a differential reaction to three Syrian and two Tunisian monospore *R. secalis* isolates. Spore germination on detached leaves, placed on water agar amended with 80 mg benzimidazole/l, was measured 24, 48 and 72 hr after inoculation. Compared with the susceptible check (WI2291), germination was lower on all other cultivars 24 hr after inoculation (Table 5). Field tests showed that the cultivar Atlas 46 was resistant in Syria, but susceptible in Tunisia. This might be due to differen-ces in spore germination. On detached leaves, germination of Syrian isolates was lower than of Tunisian ones.

Observations on differences in the post-penetration stage were made using fluorescent dyes. Preliminary experiments indicated the presence of subcuticular hyphae with the compatible combination WI2291/8706-B, 14 days after inoculation, while no subcuticular hyphae were present with the incompatible Atlas 46/8706-B variety x isolate combination.

Table 5. Percentage[1] germination of five monospore isolates of *Rhynchosporium secalis* spores on detached leaves of seven barley cultivars, after 24 hr incubation.

Cultivars	Isolates				
	8801A	8703A	8706B	8706A	8713A
Atlas 46	21***	21***	26***	72***	7%***
Tadmor	52**	66***	58***	77**	84
Abyssinian	22***	44***	19***	22***	17***
Arta	30***	63***	52***	55***	63***
La Mesita	36***	57***	72**	59***	67***
Kitchin	59***	71**	66***	61***	82**
WI2291	75	82	81	87	90

[1] Percentages are means of three replications.
Differences between cultivars and susceptible check (WI2291) significant at * 5%, ** 1%, and *** 0.1% level of probability.

Histological studies of plant-pathosystems have concentrated on the post-penetration stage and few reports exist on resistance operating before penetration. The above tests showed that for certain barley genotypes a resistance mechanism against *R. secalis* operates before penetration as well. These tests are a potential tool to examine resistance of adult plants under controlled conditions.

Double Haploid Line Production in Barley Using Anther Culture

Production of double haploid (DH) lines in barley in the past has only been possible using *Hordeum bulbosum*. Because of the problems associated with the use of *H. bulbosum*, use of anther culture in barley, although difficult, should have high potential value for routine DH production. Barley line WI2291 has been shown to be amenable to *in vitro* cultivation, whereas Tadmor is recalcitrant (Dr A. Gland, personal communication). In a first experiment cycle F_1 anthers of the cross WI2291 x Tadmor were cultured *in vitro* using three different regeneration media. Though numerous calli were produced, all regenerated plants were albinos. Using a German barley variety Dissa, known for good *in vitro* response, the culturing conditions were optimized and plants successfully regenerated and chromosomes could be doubled by colchicine treatment. A new Tadmor x WI2299 cycle was started using different media. The initial *in vitro* response of the cross has been improved greatly (Fig. 7).

Fig. 7. Induction of barley embryogenic calli on tissue culture media. Anthers were obtained from F_1 hybrids of the cross Tadmor x WI2291. Induction of calli was observed three weeks after anthers were plated and kept in the dark at 25°C.

Improvement of Durum Wheat Quality

The main objective of the CIMMYT/ICARDA durum project is to develop, in collaboration with WANA durum research programs, productive and stress-resistant lines with high grain quality. Such genotypes have already been released in many countries in the region (see Appendix 2). The newly released cultivars carry valuable traits for making good quality pasta, burghul, couscous, and durum bread. The sedimentation test and the band γ-45 gliadin were found to be the most important selection criteria for high grain quality.

Mediterranean durum landraces, known for their superior grain quality, were analyzed for their quality traits. High sedimentation values and index were found to be associated with the presence of γ-45 gliadin, and low values with the presence of γ-42 gliadin (Table 6). Further, 69% of the landraces examined had only γ-45 gliadin and 11%, only γ-42 gliadin; 20% contained both types of gliadins.

Table 6. Relationship of γ-gliadins with some grain quality traits in Mediterranean durum germplasm (n=136), Tel Hadya, 1992/93.

Traits	γ-45 gliadin (n=117)	γ-42 gliadin (n=19)	Difference
Protein (%)	12.5	12.1	0.4
Vitreousness	94.4	95.3	-1.1
Carotene score	5.5	5.2	0.3
1000-kernel weight	47.0	47.0	0.0
SDS	25.7	18.5	7.2***
SDS index	2.4	1.8	0.6*

Significant at the probability levels of * 5% and *** 0.1%.

Most quality traits were influenced more by genotype than by environment or G x E interactions in dry areas. Protein content and vitreousness were exceptions. Farinograph stability and mixing tolerance were influenced more by G x E interactions than by genotype or environment (Table 7).

Under irrigated conditions, high broad-sense heritability values were recorded for kernel size, test weight, carotene content, sedimentation test, and sedimentation index; medium values for protein content and vitreousness; and low values for farinograph stability and mixing tolerance. In drylands, high heritabilities were found for most grain traits studied (Table 8).

Table 7. Effect of genotype (G), environment (E), and G x E interactions on durum grain quality traits under Mediterranean continental dryland conditions, Syria, 1992/93.

Trait	G		E		G x E	
	SS	%	SS	%	SS	%
Protein content	40.1	5.1	666.3	84.1	79.1	10
Vitreousness	11269.0	11.4	69425.5	70.0	16779.6	16.9
Carotene content	68.7	41.0	44.9	26.8	46.7	27.9
SDS test	9989.8	58.6	4564.3	27.1	2006.2	11.9
SDS index	27.9	51.3	15.4	28.3	7.2	13.2
Kernel size	1965.8	49.6	1102.1	27.8	808.9	20.4
Test weight	491.5	52.8	129.7	14.0	218.2	23.5
Farinograph stability	62.9	32.9	44.4	23.2	81.5	42.6
Farinograph mixing stability	68901.0	24.6	36094.5	12.9	167676.0	59.9

Table 8. Heritabilities of some durum quality traits under irrigated and dry rainfed conditions, Tel Hadya, 1992/93.

Trait	Heritability	
	Irrigated	Rainfed
Protein content	0.49	0.72
Kernel size	0.97	0.94
Test weight	0.97	0.94
Vitreousness	0.95	0.79
Carotene content	0.97	0.90
Sedimentation test (SDS)	0.93	0.94
SDS index	0.93	0.96
Farinograph stability	0.00	0.90
Farinograph mixing tolerance	0.20	0.93

Transfer of Hessian Fly Resistance to Durum Wheat

Hessian fly is a major constraint to durum wheat production in North Africa. Resistance to this insect pest has been identified in many tetraploid *Aegilops* species. To transfer this resistance to durum wheat, a wide-crossing program has been started in collaboration with INRA/INAV, Morocco.

To broaden the genetic base in durum wheat for Hessian fly resistance, 150 accessions of *Aegilops*, mainly *Ae. ovata* and *Ae. triuncialis*, were screened. Individual plants were crossed at Settat, Morocco, with durum and bread wheat. Sixty crosses were made, but seed set was low. From 19 hybrid seeds, embryos were excised and cultured on a MS medium. Eleven hybrid plantlets were regenerated. Root-tip chromosome analysis confirmed that they were hybrids. They will be evaluated for their reaction to Hessian fly. Meanwhile, efforts are being made to increase the seed set in this wide-crossing program.

Sources of Resistance to Wheat Diseases in ICARDA's Germplasm

Use of resistant cultivars is the most practical measure to protect crops from diseases. ICARDA carries out field screening of germplasm developed by it, CIMMYT, regional organizations such as ACSAD, and NARS of the WANA region. Screening is done under disease pressure in hot-spots, under natural infection or artificially created epiphytotics. Wheat wild relatives and progenitors (*Triticum* spp., and *Aegilops* spp.) from ICARDA's germplasm collection are also screened.

Sources of resistance identified are assembled in germplasm pools and distributed to NARS in WANA and to collaborators in other countries. During 1988-93, several germplasm pools for sources of resistance to wheat diseases have been developed (Table 9). The pools include 430 lines: 166 for yellow rust, 74 for common bunt, 83 for *Septoria tritici* blotch, 41 for stem rust, and 66 for leaf rust. Some lines in these pools have multiple disease resistance. These sources are used by ICARDA researchers and those elsewhere in their wheat breeding programs.

Table 9. ICARDA-developed germplasm pools for sources of resistance to diseases, 1988-1993.

Germplasm pool	Disease	No. lines	No. sets distributed	Year of release
Bread wheat				
WYRGP-87	Yellow rust	26	47	1988/89
WYRGP-91	Yellow rust	65	69	1991/92
WYRGP-93	Yellow rust	27	54	1993/94
WSTGP-87	Septoria blotch	16	47	1988/90
WSTGP-91	Septoria blotch	25	49	1991/92
WLRGP-91	Leaf rust	26	70	1991/92
WLRGP-03	Leaf rust	40	57	1993/94
WSRGP-92	Stem rust	24	40	1992/93
WCBYRGP-87	Common bunt and yellow rust	26	29	1988/89
WCBGP-91	Common bunt	13	47	1991/92
Durum wheat				
DYRGP-87	Yellow rust	26	29	1988/89
DYRGP-92	Yellow rust	22	30	1992/93
DSTGP-87	Septoria blotch	19	29	1989/90
DSRGP-92	Stem rust	17	29	1992/93
DCBYRGP-88	Common bunt and yellow rust	19	29	1989/90
DCBGP-92	Common bunt	16	29	1992/93

Screening of *Triticum dicoccoides* and *T. boeoticum* collection at ICARDA has provided sources of resistance to yellow rust, leaf rust, *S. tritici* blotch and common bunt. Several hundred entries of 22 species of *Aegilops* spp. were also screened for yellow rust, *S. tritici* blotch and common bunt resistance, and promising sources identified.

Legume Crops

ICARDA encourages and supports national efforts in West Asia and North Africa 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 this objective, research was continued on these cool-season legumes at the Center's principal research station at Tel Hadya in Syria, but good use was also made of other testing sites in Syria (Breda and Jindiress) and Lebanon (Kfardan and Terbol). Summer nurseries were raised at Terbol for generation advancement of lentil and chickpea. Jointly with national scientists, research sites in several countries were used where conditions for germplasm screening were ideal for developing breeding material with specific resistance to key biotic and abiotic stresses and for narrow local adaptation.

International Legume Testing Program

National programs continued to participate actively in the international legume nursery testing program, which is a vehicle for dissemination of genetic materials in the form of international trials and nurseries. In response to requests from NARS scientists from 52 countries, ICARDA supplied 1176 sets of 37 different types of trials and nurseries for the 1993/94 season. These included 341 sets of lentil, 462 of chickpea, 73 of dry pea, 126 of chicklings, and 174 of vetches. The benefit of this program to NARS is evident from variety releases in various countries (see Appendix 2). In addition, several national programs selected promising lines for multilocation testing, on-farm trials or prerelease multiplication. NARS with strong breeding programs made a large number of selections from segregating populations and identified lines resistant to the local biotic and abiotic stresses for use in their hybridization programs.

Breeding Kabuli Chickpea for Ascochyta Blight Resistance

Ascochyta blight, caused by *Ascochyta rabiei*, continues to be the most important biotic stress limiting the wide-scale adoption of winter sowing of kabuli chickpea in the Mediterranean basin. Since the weather conditions during 1992/93 were extremely favorable for the pathogen, the disease devastated the chickpea crop in the Hassake province of Syria. This reinforced the need for greater attention to the breeding objective of identifying sources of durable resistance to this disease.

Of 1615 breeding lines developed between 1981 and 1990 and evaluated for resistance in 1991/92, 185 were rated as resistant both in the field and greenhouse. In 1992/93, these lines were tested again against individual pathotypes of the blight pathogen as well as their mixtures in the field and greenhouse: 81% of them were rated as resistant to moderately resistant to a mixture of six pathotypes in the greenhouse, and about 43% as resistant to moderately resistant in the field. Twelve of these lines (FLIP 84 92C, 84-93C, 90-73C, 90-77C, 90-109C, S91241, S91292, S91345, S91347, S91348, S91377, and S91400) were rated as resistant to moderately resistant to all pathotypes individually in the greenhouse or to their mixtures both in the greenhouse and field. These lines have broad-based resistance to all pathotypes used in this study and should, therefore, be of great value in developing durable resistance to ascochyta blight in winter chickpea. Screening has been started to identify sources of resistance to the newly identified highly virulent isolates of *A. rabiei.*

Screening Kabuli Chickpea for Drought Tolerance

Drought is the most severe constraint to increased productivity in spring-sown kabuli chickpea in the Mediterranean basin. After five years of research, ICARDA has developed a reliable and easy field screening technique for the evaluation of germplasm and breeding material for drought tolerance. In this technique, sowing is delayed by three weeks in spring, which permits good discrimination between different levels of tolerance to drought, visually rated on a 1 (highly tolerant) to 9 (highly susceptible) scale for earliness and productivity. Earliness alone is not a sufficiently effective criterion, nor is yield potential, as measured with optimum moisture supply through irrigation. Using this technique, chickpea lines were identified that yielded higher than the best standard check variety, Syrian Local Large (ILC 1929) in 1992/93, when the total seasonal precipitation at Tel Hadya was only 286 mm at crop maturity (Table 10).

Field screening for drought tolerance in kabuli chickpea at Tel Hadya, Syria, 1992/93.

Table 10. Performance of some drought-tolerant kabuli chickpea lines in a spring-sown, drought tolerance screening trial at Tel Hadya, 1992/93.

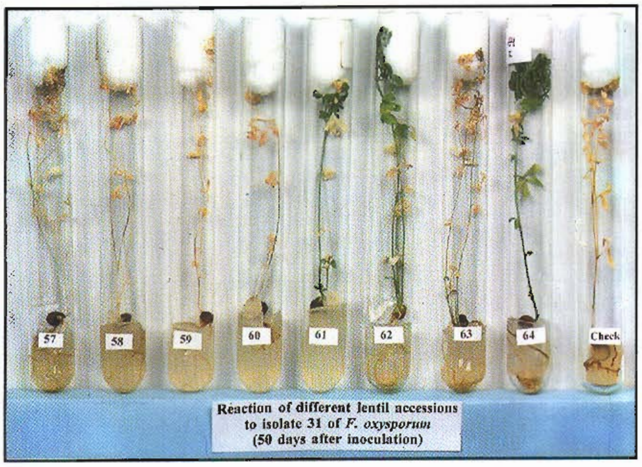
Genotype	Rainfed			Irrigated seed yield (kg/ha)
	DTS[1]	DFLR[2]	Seed yield (kg/ha)	
Selected				
ILC 3550	4	45	1079	3528
ILC 3843	4	46	1166	3468
ICC 4958	4	46	1176	3106
FLIP 87-58C	4	41	1076	3603
FLIP 87-85C	4	46	1026	3674
FLIP 88-42C	4	44	1099	2994
FLIP 87-59C	4	42	1243	3733
Checks				
ILC 1929	6	48	798	3828
ILC 72	9	67	54	2641
LSD (P=0.05)			486.4	

[1] DTS = Drought tolerance score; [2] DFLR = Days to flowering.

Management of Lentil Vascular Wilt

Vascular wilt, caused by *Fusarium oxysporum* f.sp. *lentis,* is worldwide the most important disease of cultivated lentil. In Syria, the overall disease incidence varied between 5 and 12% in 1992/93 but, in some isolated cases, reached up to 72%. It was estimated that a 10% increase in wilt incidence caused a loss of 8.7% in grain yield, and a higher loss in straw yield. Since chemical control of the disease is not feasible, host-plant resistance is the most practical and environment-friendly means of disease management.

The fungus *F. oxysporum* f.sp. *lentis,* previously considered host-specific, caused wilting on *Vicia montbretii* and foot rot on barley and wheat in laboratory and plastic house experiments, indicating that its inoculum potential may increase in a lentil/cereal rotation. The fungus was reisolated from above the collar region of symptomless, artificially-inoculated *Pisum sativum* and *Vicia ervilia.*



Differential reaction of lentil genotypes to an isolate of *Fusarium oxysporum* f. sp. *lentis* in test tubes.

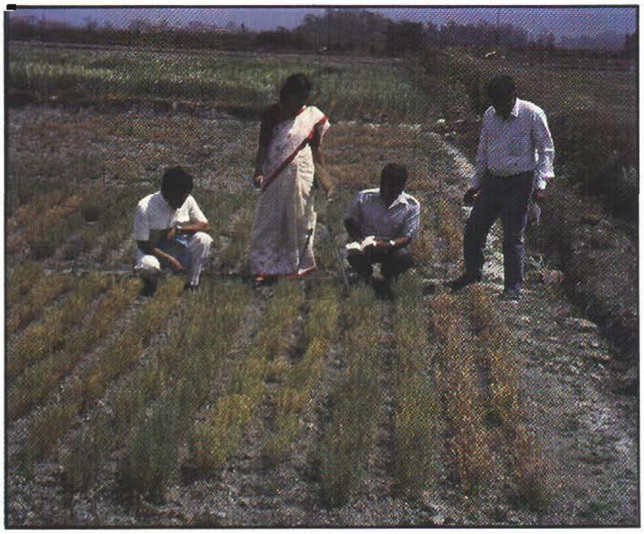
Techniques for wilt resistance screening at the seedling stage have been developed based on liquid culture in the laboratory and on soil culture in trays in the plastic house. Adult plant resistance has been assessed in pots in the plastic house and in a sick-plot in the field. The field-sick plot, developed over a three-year period, has a high inoculum potential with a relatively uniform distribution. This, in conjunction with frequently-repeated susceptible checks (every third row), minimizes disease escape.

Several resistant sources, mostly small-seeded, have been identified and used as parents in the crossing block. Such lines have been shared with national programs through the Lentil International Fusarium Wilt Nursery (LIFWN). Their resistance/tolerance has been confirmed in several countries. An on-farm trial of wilt-resistant lines was jointly conducted in Syria with the Ministry of Agriculture in the 1992/93 cropping season. Results confirmed the combination of resistance to wilt with high yield. The wilt-resistant line ILL 5588 has been released in Lebanon as Talya 2 (see Appendix 2), and the line ILL 5883 will shortly be registered in Syria for farmers' use.

To locate additional sources of resistance, a core collection of 577 germplasm accessions, originating from 34 countries, was screened in the wilt-sick plot. Twenty accessions were found promising with 0-5% wilt damage, compared with the check with 90-100% damage. They will be retested in the next season.

As a result of the extensive screening for vascular wilt resistance at ICARDA, several sources of multiple disease resistance have been identified from the existing breeding material. For example, ILL 6024 has a high level of resistance to both rust and wilt, moderate resistance to ascochyta blight, and tolerance to botrytis blight.

Wild lentils represent another potential source for disease resistance. Crosses between wild and cultivated lentils have resulted in high-yielding selections



Evaluation of resistance to lentil vascular wilt in a sick-plot at Tel Hadya, Syria (left) and at Khumaltar, Nepal (right).

under rainfed conditions. Over 219 accessions of wild *Lens* and two accessions of *V. montbretii* (syn. *Lens montbretii*) were screened for resistance to a Syrian isolate of *F. oxysporum* f.sp. *lentis* under artificial inoculation in a plastic house and in the field. In the wilt-sick plot, only three accessions, ILWL 79 and ILWL 113 of *L. culinaris* ssp. *orientalis* and ILWL 138 of *L. nigricans* ssp. *ervoides*, were resistant. Utilization of these wild sources of resistance is under way.

Preliminary experiments on the biological control of *F. oxysporum* f. sp. *lentis* through soil-borne bacterial antagonists have shown promise and will be pursued.

Phylogenetic Relationships among Cold-tolerant Lentils

Lentil is currently sown in spring in Turkey at elevations above 850 m on about 250,000 hectares. Collaborative research with Turkey has shown that yield may be increased by up to 50% by advanced sowing in late autumn with winter-hardy cultivars. Efforts are under way to develop cultivars with adequate levels of winter-hardiness. As a first step, a field screening method was developed at Hymana (1050 m elevation), Turkey, to differentiate genotypes for their winter-hardiness, using eight contrasting lentil lines. Using the same method, 86 randomly selected accessions of cultivated lentil were evaluated and genotypic differences in cold-hardiness confirmed. The cold-hardy accessions will be used in the breeding program to develop lentil cultivars for late-autumn sowing in the high-altitude areas.

To complement the screening for winter-hardiness, four cold-tolerant lines (ILL 3516, 1406, 1879, and 630), one cold-resistant line (ILL 662), and two cold-susceptible lines (ILL 1189 and 485) were fingerprinted with the $(GGAT)_5$/DraI probe/enzyme combination to study the genetic variation among them (Fig. 8). The data were analyzed using Wagner parsimony method in relation to the geographical origin of the lines. The lines fell into four groups based on their genetic divergence. Cold-tolerant lines from India (ILL 3516) and Iran (ILL 1405) are genetically distant from the cold-tolerant lines from Turkey (ILL 1879 and 630). Use of these divergent sources of cold tolerance in crossing program is likely to provide larger variation for this important trait.

1 2 3 4 5 6 7 M

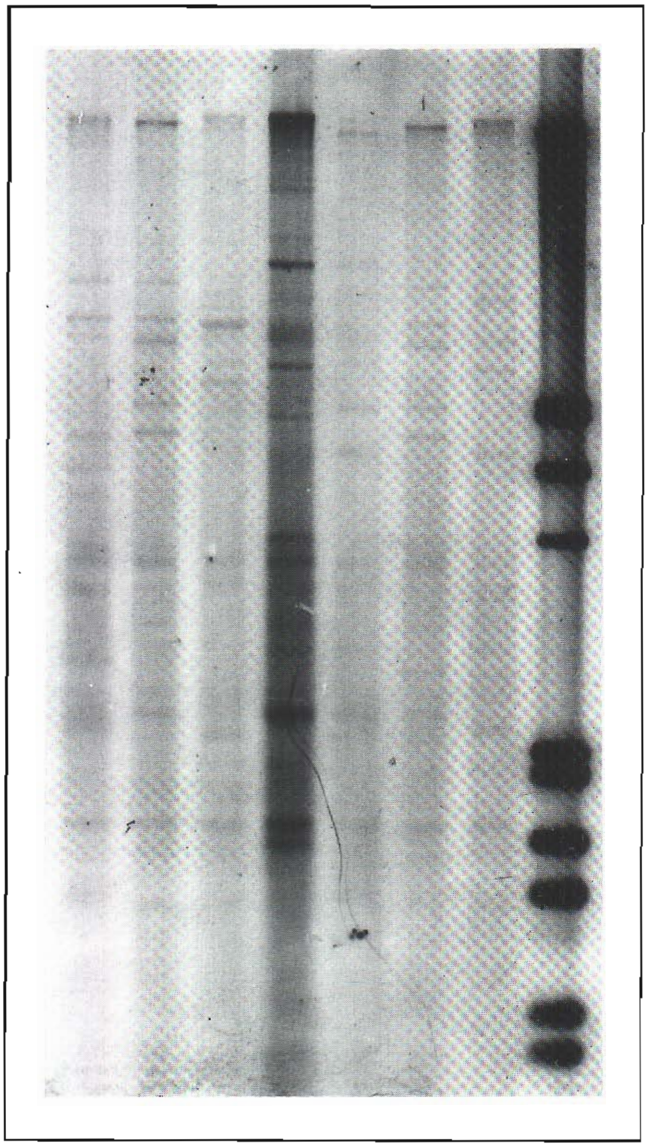


Fig. 8. DNA fingerprinting of seven lentil accessions using $(GGAT)_5$/DraI probe/enzyme combination. Lanes 1 to 7 show fingerprints of ILL 485, 630 662, 1189, 1405, 1878, and 3516, respectively. Lane 8 shows the molecular-weight marker, Lambda Eco RI/Hind III digest.

Faba Bean Viruses in Egypt

Faba bean (*Vicia faba*) is susceptible to a large number of viruses. In Egypt, over the last three decades, nine viruses have been identified to infect this crop. During the growing season of 1991/1992 a viral epiphytotic in Middle Egypt (Minia and Beni Suef governorates) seriously damaged faba bean fields (see also page 8). Plants showed yellowing and necrosis and poor grain filling; many pods remained empty. The epiphytotic caused about 90% yield loss. ICARDA and Egyptian scientists surveyed the infected fields in that area and collected around 20 samples for examination. Most of the samples were found infected with faba bean necrotic yellows virus (FBNYV), a newly identified virus of legumes in a number of WANA countries. Virus particles of FBNYV are small, around 18 nm in diameter and the viral genome is made of ssDNA. This virus is spread by legume aphids.

Faba bean necrotic yellows virus symptoms.

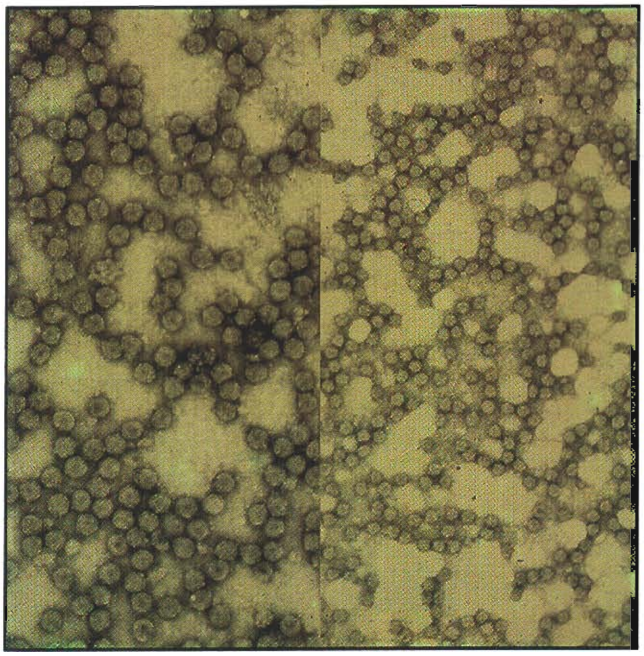
Because the number of samples tested during the spring of 1992 was small, intensive surveys were conducted in 1993, first in early February and then around mid-March. In each survey around 80 fields distributed across the faba bean growing areas in Egypt were visually evaluated. Only 12-13% of fields were found to have a FBNYV incidence level of 21% or higher. More than 2500 infected faba bean samples were collected during both surveys for examination. Laboratory tests were conducted at the Agriculture Genetic Engineering Research Institute and the Plant Pathology Institute in Giza, Egypt. The ELISA kits for the tests were provided by the Virology Laboratory of ICARDA. It was found that about 50% of the samples were infected with FBNYV. Another two viruses, bean yellow mosaic virus (BYMV) and broad bean wilt virus (BBWV) were identified, and these were second in importance to FBNYV (Table 11).

Table 11. Results of laboratory tests on faba bean samples with symptoms suggestive of virus infection collected from different locations in Egypt in surveys conducted during February and March, 1993.

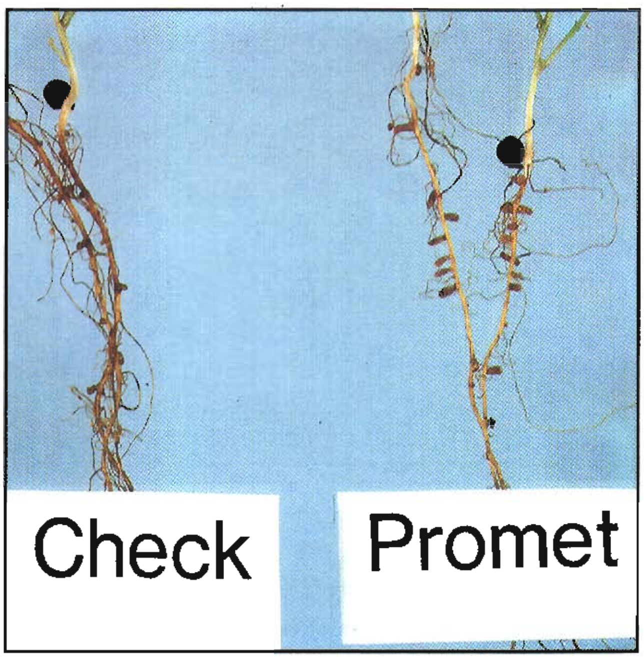
Virus detected	Survey conducted during			
	February 1993		March 1993	
	Total no. of sample tested	Percent infected samples	Total no. of samples tested	Percent infected samples
Faba bean necrotic yellows	1414	41.3	1137	49.3
Bean yellow mosaic	1414	21.0	1137	27.6
Bean leaf roll	1414	0.4	1137	0.0
Broad bean wilt	1414	6.7	1137	1.0
Cucumber mosaic	1414	0.2	1137	0.6
Alfalfa mosaic	1414	0.0	1137	0.6

The survey confirmed that FBNYV is the most important faba bean virus in Egypt. A research plan has been developed to study the ecology and epidemiology of this virus in the Egyptian farming systems and to develop an integrated control strategy through a combination of cultural practices and genetic resistance.

Over the last few years ICARDA has identified seven faba bean genotypes with high levels of resistance to a BYMV isolate in Syria. These lines will be evaluated during the next growing season for BYMV resistance in Egypt and Sudan. Identification of sources of FBNYV resistance in faba bean will also be initiated in Egypt in 1993/94.



Virus particles of faba bean necrotic yellows virus (right) in comparison with those of bean leaf roll virus (x 127,000).



Promet-treated woolly-pod vetch plants maintained healthy nodules in contrast with the untreated plants whose nodules were completely damaged by the larvae of *Sitona crinitus*, at Alkamiye, Syria, 1992/93.

With support from BMZ/GTZ, the Virology Laboratory at ICARDA is collaborating with the Institute of Biochemistry and Plant Virology in Braunschweig, Germany in a three-year project to further characterize FBNYV, develop sensitive procedures for its detection, and study its variability in the WANA region.

Control of Nodule Damage in Woolly-Pod Vetch

Woolly-pod vetch (*Vicia villosa* subsp. *dasycarpa*) has shown promise as an annual forage legume for green grazing and hay making in both low- and high-elevation areas in West Asia. Because of its resistance to broomrape (*Orobanche crenata*), it is a potential cool-season legume to be grown in rotation with cereals in the *Orobanche*-infested areas. However, its productivity and residual effect on subsequent cereal crops can be adversely affected by the damage to its nodules by *Sitona crinitus* larvae. Control measures have been studied on station as well as on farm. A study during 1992/93 conducted at Alkamiye and Jindiress, north Syria, showed that treating the seed of woolly-pod vetch with 12 ml Promet/kg seed before sowing provided good protection to nodules from *Sitona* larvae. The nodule dry matter yields significantly increased because of the seed treatment (Table 12).

Table 12. Effect of seed treatment with Promet (12 ml/kg seed) on the yield and nodule damage in woolly-pod vetch at two locations in Syria, 1992/93.

Location	Treatment	Yield (kg/ha)			Nodule damage (%) on 26 April
		Seed	Total DM	Total N	
Jindiress	Untreated	1750	4440	99.8	79.6
	Treated	1931	5049	117.8	5.5
	LSD (P=0.05)	29.7	101.0	NS	3.4
Alkamiye	Untreated	2334	5851	120.3	68.9
	Treated	2517	6941	139.4	3.0
	LSD (P=0.05)	172.5	196.4	NS	19.5

Table 13. Correlation of total recoverable biomass with different traits in different vetches and common chickling, Tel Hadya, 1992/93.

Forage legumes	Traits					
	Winter growth	Days to flower	Days to maturity	Seed yield	Straw yield	Harvest index
V. sativa	0.465[a]	-0.514[a]	-0.528[b]	0.794[c]	0.932[c]	-0.281
V. ervilia	0.471[a]	-0.725[c]	-0.780[c]	0.796[c]	0.334	0.527[b]
V. narbonensis	0.403[a]	-0.518[a]	-0.455[a]	0.770[c]	0.853[c]	0.073
V. panonica	-0.417[a]	0.414[a]	0.514[a]	0.664[c]	0.865[c]	0.039
V. palaestina	-0.205	-0.263	-0.163	0.757[c]	0.779[c]	0.332
V. hybrida	-0.148	0.166	-0.084	-0.379	0.955[c]	-0.773[b]
L. sativus	-0.211	-0.386	-0.432[a]	0.923[c]	0.953[c]	0.183

a, b, and c denote that the correlation coefficient is significant at P=0.05, 0.01 and 0.001, respectively.

Yield of Annual Forage Legumes in Relation to Winter Growth and Phenology

The need for early winter grazing in the low-rainfall areas makes rapid winter growth and early flowering important selection criteria in the improvement of vetches and chicklings. Relationships of these characters with total harvestable yield were studied in several species of vetches (*Vicia* spp.) and common chickling (*Lathyrus sativus*). Results (Table 13) showed that in *V. sativa, V. ervilia*, and *V. narbonensis*, early winter growth was significantly and positively correlated with total recoverable yield. Days to flowering and days to maturity were negatively correlated; in contrast *V. panonica* showed a positive correlation, mainly because it had low winter growth and late maturity. Thus, there is a clear need to continue the search for early-maturing genotypes of *V. sativa, V. ervilia* and *V. narbonensis*, and genotypes with rapid winter growth and early maturity in *V. panonica*, particularly for the high-elevation areas.

Differences in early winter growth between genotypes of narbon vetch (*Vicia narbonensis*) and common vetch (*V. sativa*), Tel Hadya, 1992/93.

Seed Production

The WANA seed network, established in 1992, became firmly rooted in 1993 with the participation of 17 countries. A number of activities aimed at improving national seed systems in the region were carried out:

- Two issues of the WANA Seed Network Newsletter "SEED INFO" were published and distributed.
- A first draft of the WANA Catalog of Seed Standards was developed (lead country: Syria).
- A report of the WANA Referee Test for Germination and Physical Purity was sent to participating seed testing stations (lead country: Morocco).
- A WANA Directory of Seed Specialists was compiled for publication (lead country: Egypt).

The first meeting of the Steering Committee of the WANA Seed Network Council was held in Cairo at the Central Administration for Seeds.

A project to establish an M.Sc. program in Seed Science and Technology at the University of Jordan was approved by the European Union. The funding will support 10 students. Instructors for the course will be drawn from the University of Jordan, University of Athens, University of Tuscia, and ICARDA. Consultants will also be contracted for lecturing.

ICARDA and the General Organization for Seed Multiplication (GOSM), Syria continued their joint efforts to multiply seed of promising lines at the GOSM farm. Of each promising line one hectare is planted. The prerelease multiplication was particularly successful for the bread wheat promising line Nesser, which was released as Cham 6. Upon its release, an adequate quantity of seed was available for distribution to farmers. Several other promising lines of cereals and legumes are under prerelease multiplication.

As part of institution building, greater emphasis was placed in 1992/93 on train-the-trainer programs at both national and regional levels (Fig. 9). At the national level, the trainers are instructed in their home countries, while in the regional programs trainers receive instruction outside. Because of their multiplying effect, these programs have proved both efficient and cost-effective (see also page 9).

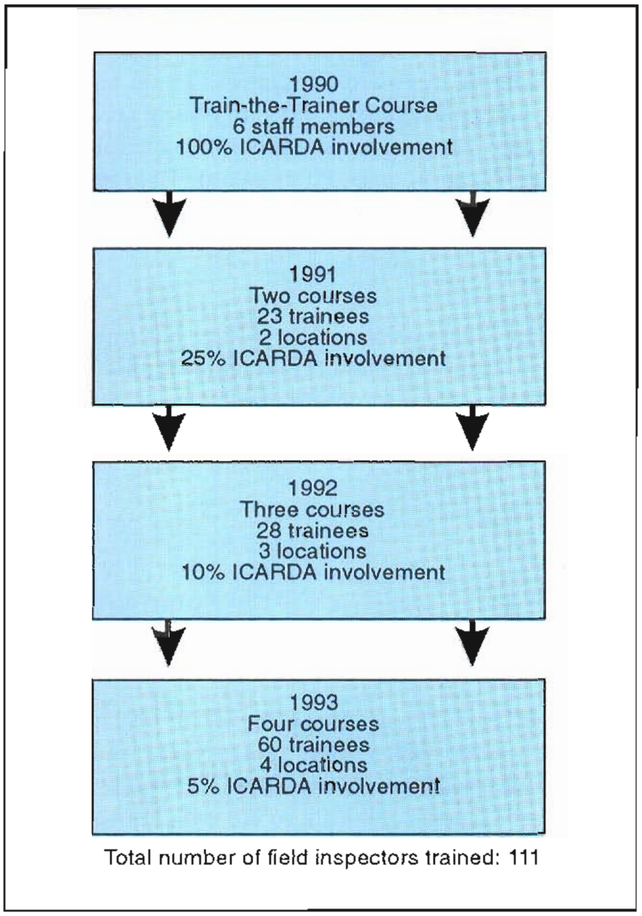


Fig. 9. Multiplying effect and cost-effectiveness of train-the-trainer approach in seed production technology.

Resource Management and Conservation

Water

Water is a precious resource but is extravagantly used in many parts of the world. Its scarcity in the WANA region has become an urgent issue. The allocation of river flows is the subject of international dispute and negotiation, and at the national level many governments are concerned about the overutilization of underground water and the declining levels of aquifers. The rapidly growing populations in the WANA countries are exerting an immense pressure on agriculture to expand, to provide more food and employment. Rainfed farming has already been pushed in most areas to its driest limits, and opportunities for major expansions of irrigated agriculture in the region are few. Indeed, there are difficulties in maintaining production even in the existing agricultural area, against major threats from scarcity of water, soil erosion, salinization, and urbanization. The inescapable trend is toward an intensification of agriculture, and the key to that everywhere is water and its more efficient utilization.

With its dryland mandate, ICARDA has from its inception focused its attention on water. In the mid-1980s, supplemental irrigation was added to the research agenda of the Center to increase and, especially, stabilize the yields of basically rainfed crops.

Farmer Perceptions of Underground Water Supplies

In Syria, around 70% of all supplemental irrigation (260,000 ha) depends on pumped groundwater. Reliable information on the quantity and quality of this resource is scarce; but there are indications that many farmers extract more of it than their crops need, even where falling aquifers require them to deepen their wells, or drill new ones, at frequent intervals. Underground water is a common property resource, and little awareness or incentives exist for its conservation. Thus, even at the village level, the question of water and water-use efficiency is complex, embracing not only agronomic issues but hydrogeology on the one hand and human, economic, and social issues on the other.

During 1993, a study was initiated near Atareb, about 30 km west of Aleppo. A sample of 25 farmers was selected with active irrigation wells within a 22 sq km area. The objective was to elicit communal and individual awareness of the issues of common property management, taking village-level groundwater utilization as a specific case. The longer term objective of such studies is to identify approaches by which communal responsibility for the management of endangered resources might be encouraged by education and by appropriate government support and regulation. A second objective was to obtain and interpret a time sequence of well data from the same farmers (amounts pumped, and depths to water level).

Many farmers in WANA believe that water is a God-given, undepletable resource. They give mythical accounts of its origin and endless supply.

The most interesting finding, from a series of informal interviews, was that farmers do not share researchers' and officials' perceptions of the nature of groundwater and the mechanisms governing its behavior. Many visualize it as a very robust and secure source, originating in distant rain/snow (in Turkey), from the sea (desalinated by passage through the intervening rock) or from a sea-like, undepletable body of water in the Earth's interior! They do not all agree that water levels are falling in their wells or, if they are, that this is a danger. Thirteen of 25 respondents believe the present situation is non-problematic. Eleven believe there is a problem, but only three of them accept the official explanation that the sole cause is overuse. If communities and individuals are to be persuaded to act together to conserve the resource upon which their production depends, their beliefs about the nature of that resource need to be better understood and accommodated.

Attempts to gain a greater technical understanding of the groundwater resource in the study area were hampered by the complexity of the underlying geology and deficiencies in currently available hydrogeological information. A number of significant points emerged:

- Three aquifers apparently underlie the study area at different depths between 200 and 450 meters.
- A relatively small part of the catchment area for the recharge of these aquifers is permeable, justifying fears about their capacity to support continued pumping at current rates.
- The shallowest aquifer appears close to exhaustion.
- Because of the poor quality of the deepest aquifer and the danger of draining the two shallower aquifers downwards into it, deep drilling should be restricted.

Effect of Supplemental Irrigation Water Quality on Soil Conditions and Crop Yield

Previous studies of supplemental irrigation have tended to neglect or underestimate the possible effect of water quality on soil properties and crop yield. This is probably because a large proportion of the crop water requirement under supplemental irrigation is assumed to come from rainfall. But recent field research in the Al-Djezireh plains in northeastern Syria, has shown that on loamy clay soils under semi-arid conditions supplemental irrigation water even with a low salt concentration can produce a rapid build-up of salt in the soil, leading to a decline in crop productivity.

Results from 20 farms, using underground water of different salinity and having different irrigation histories, show that salt started to accumulate from the first year of irrigation. The rate and extent of accumulation were directly proportional to the salinity of the irrigation water (Fig. 10). The high rate of evaporation and the low rainfall (annual average around 300 mm) prevent the through drainage of the soil profile, and salt accumulates progressively in the soil (Fig. 11).

The combined effect of saline irrigation water and the resulting salinity of the topsoil caused a progressive decline in wheat yield (Fig. 12). An average decline of 50% was recorded after five years of using irrigation water with an electrical conductivity of 3-4 mmhos/cm.

This is a problem that can only get worse—as more and more farmers drill wells to augment and stabilize their yields and drill ever deeper to tap

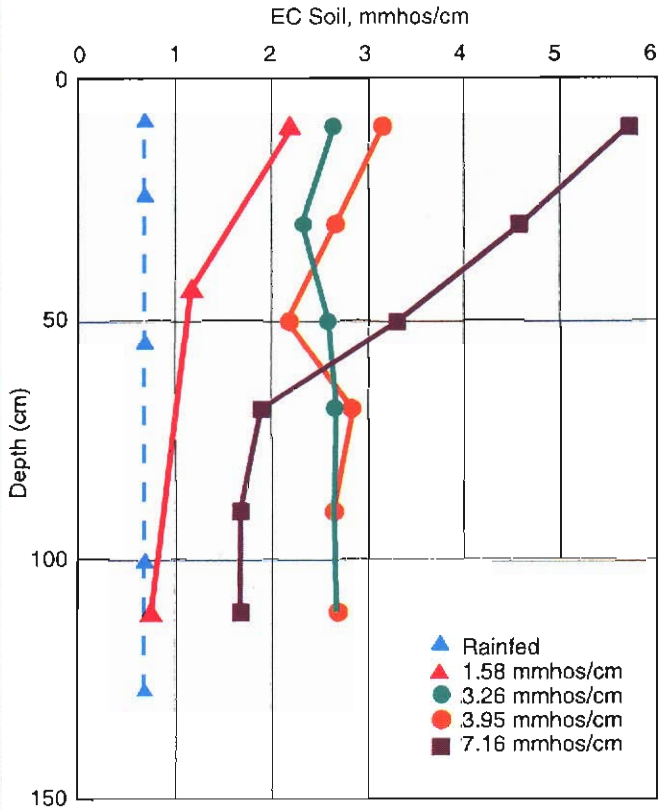


Fig. 10. Effect of irrigation water salinity on soil salinity at various depths within the soil profile after one year of using saline irrigation water in northeastern Syria.

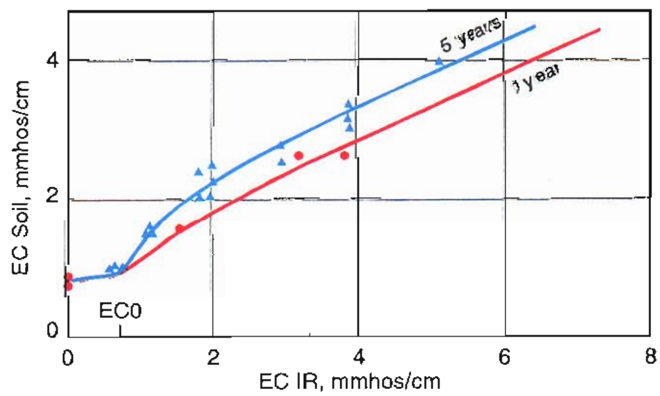


Fig. 11. Relationship between average electrical conductivity of saturation extract of the soil upper layer (0-60 cm) with electrical conductivity of the irrigation water after one year and five years of using saline irrigation water in northeastern Syria.

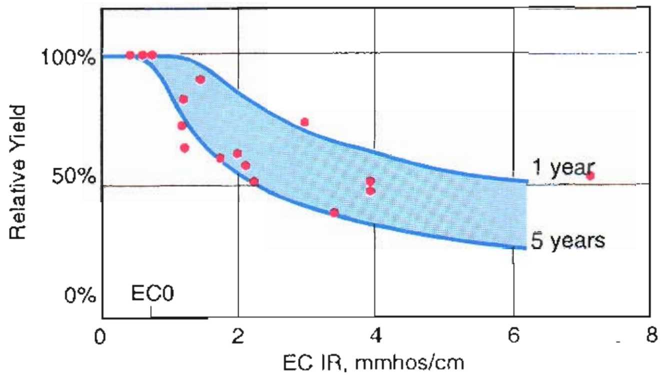


Fig. 12. Relationship between irrigation water salinity and relative wheat yield at the farms sampled in northern Syria.

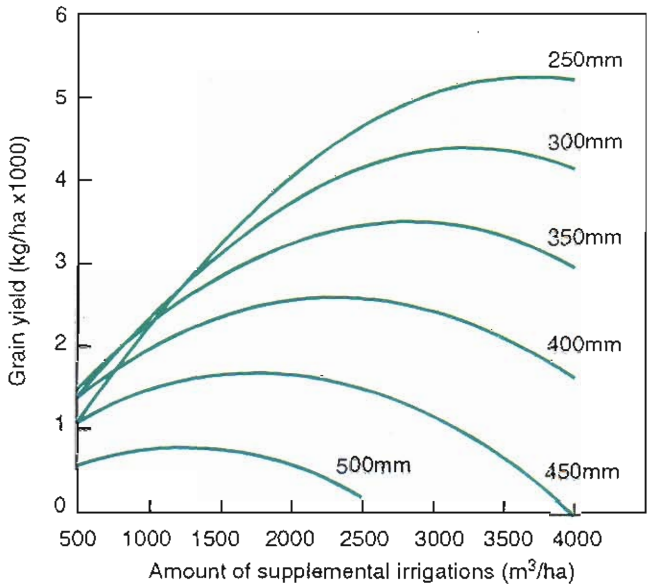


Fig. 13. Production functions of grain yield increase of supplementally irrigated wheat under different seasonal rainfall scenarios. 1000 m³/ha = 100 mm.

poorer quality water as shallower aquifers fail—unless remedial action is taken. Farmers notice salt accumulating in their topsoils and modify their rotations accordingly, avoiding salt sensitive legumes and eliminating high-water-consuming summer crops. None of the areas supplementally irrigated with poor-quality water is provided with a drainage network. Even if such a network existed, it would be necessary to irrigate at higher rates than those currently recommended to ensure through drainage to remove the salt.

Economics of Producing Wheat under Supplemental Irrigation

Supplemental irrigation of wheat has increased dramatically in Syria over the last decade. At the same time, ignorance of crop water requirements, poor water management practices, the low efficiency of many irrigation systems, and the generally low cost of water have all led to overpumping and excessive water use. On the reasonable assumption that most farmers are economically rational operators, it may be anticipated that appropriate manipulation of the relative costs and prices of inputs (especially water) and outputs (wheat grain) could promote greater water-use efficiency.

To this end, production functions (Fig. 13) based on data from earlier supplemental irrigation trials have been used to effect an optimization analysis of supplementally irrigated wheat production under different rainfall and cost/price scenarios. From the derived equations (Fig. 14), the optimal rate of supple-

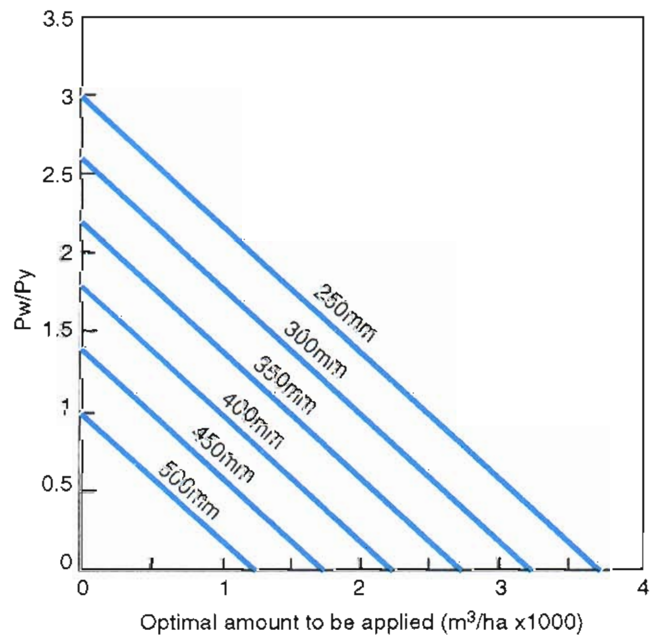


Fig. 14. Optimization chart for supplemental irrigation of wheat in Aleppo, Syria under rainfall scenarios of 250-500 mm. P_w/P_y is the ratio of water cost (SYP/m³) to grain price (SYP/kg).

mental irrigation can be calculated for any rainfall value and ratio of water cost to wheat grain price. It can be seen that improving the wheat price encourages the use of more water unless there is, simultaneously, a greater rate of increase in the water cost. Fig. 15 shows the effect of increasing the cost of water on the size of optimal irrigation assuming a constant wheat price of 10 SYP/kg (SYP 42 = 1 USD). Where pricing and marketing conditions are government controlled, as in Syria, such analyses can be used to help farmers to attain optimal production for the prices offered, and/or policy makers to take decisions to achieve government goals. In the latter case, the goal of reduced pumping of groundwater would be achieved by increasing water costs (through taxation) or reducing wheat prices.

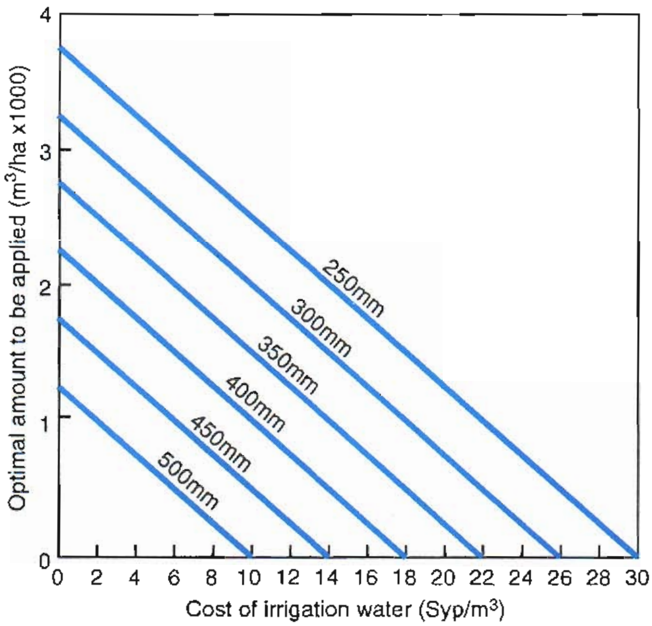


Fig. 15. Effect of increasing the cost of water on the size of optimal irrigation.

Oilseed Crops

Studies on oilseed crops have their rationale in both potential macro- and micro-economic benefits. If oilseeds were to become more widely grown in WANA, macro-economic benefits would accrue from import substitution, since at the present time most countries import a considerable proportion of their edible oils. At the micro level, the potential benefits would be to individual farmers. The range of commodity crops currently available to most rainfed crop farmers is narrow, and the introduction to their systems of an appropriate oilseed could broaden their rotational and commercial options.

The present research task is threefold: to identify those cultivars of rapeseed, mustard, safflower, and sunflower most suited to production under WANA rainfed conditions; to assess the appropriate management practices for those cultivars; and, not least, to identify the most suitable agroecological and rotational niches for these crops within the WANA production systems.

Trial results for 1992/93 were, in summary:

- Rapeseed and mustard yields were disappointing at Tel Hadya, where rains started late and were below average, but they were large enough (around 1.5 t/ha) at Jindiress to be economically interesting.
- Safflower yields were impressive (2-3 t/ha) at Tel Hadya but less so at Jindiress (around 1 t/ha), where insect pests posed a problem.
- Some open-pollinated sunflower varieties performed as well as the best hybrids, indicating that the production of cheap seed for this crop need not be a problem in WANA. At Tel Hadya, the crop required supplemental irrigation, 40 mm at the early flowering stage, to complete its growth cycle and yield around 2 t/ha. Except where bird damage intervened, Jindiress yields tended to be a little higher than this from completely rainfed growth.

Agroecologically, the conclusions from this and previous seasons' work are, provisionally, that safflower is the oilseed most suited to the drier end of the potential oilseed spectrum, that is (in the Syrian situation) approximately between Breda and Tel Hadya environments (270-330 mean annual rainfall). This rainfall is adequate for good yields, and the relative dryness keeps potential pests at bay. Rapeseed and mustard appear to need a somewhat moister environment—good yields are possible at Tel Hadya but not every year—while sunflower, a spring-planted crop, requires the highest rainfall (and good soil moisture storage), unless supplemental irrigation is available. Rainfed, the Tel Hadya environment is usually too dry, but that of Jindiress (annual mean rainfall 450 mm) appears adequate.

Safflower, a potential oilseed crop for low-rainfall areas of Syria.

Clearly, more work is required to define the environmental requirements (and the varietal range) of these crops more precisely. At the same time, we need to consider how best to fit them into crop rotations; both safflower and sunflower are known to exhaust profile moisture severely. As a first step, rapeseed is being included within an ongoing rotation trial at Tel Hadya in the 1993/94 season on an observational basis.

Economics of Nitrogen Use in Wheat-Based Rotations at Tel Hadya

Long-term rotation trials provide a wealth of data that may be analyzed variously and selectively according to topical concerns and research interests. In the ICARDA Annual Report 1992 (pp 55-56), a reference was made to the large-plot, two-course rotation established at Tel Hadya in 1983/84, and treatment effects on water-use efficiency and nitrogen cycling were summarized. Nitrogen remains a subject of interest, particularly the efficiency of use of fertilizer nitrogen; and, here we report on the economics of nitrogen applied to the wheat course of five of this trial's seven rotations.

A new economic analysis of eight seasons' yield data again shows wheat-lentil to be the most profitable rotation, followed by wheat-water melon, with wheat-wheat the least profitable. However, in all rotations, returns to fertilizer nitrogen applied in the wheat course were considerable up to 60 kg N/ha, but declined between 60 and 90 kg N/ha to become low and very risky above 90 kg N/ha. Eight-year means of the economically optimal rate varied from 45 kg N/ha in the wheat-wheat to 86 kg N/ha in the wheat-water melon rotation (Table 14).

The amount of water unused by the preceding crop and available in the soil profile is an important factor determining the wheat fertilizer requirement. The amount stored depends on the nature of the preceding crop and the preceding season's rainfall. Fallow, water melon, and to a lesser extent lentil, leave the most moisture available and tend to be followed by higher yielding wheat with a greater demand for fertilizer nitrogen; and, because the stored moisture buffers the wheat against the variation of the current season's rainfall, the coefficient of variation of the annual nitrogen optimum is lower, too (Table 14).

It follows that rates of N fertilization to wheat should take account not only of last season's crop but also last season's rainfall. Ex-post analysis indicates that 'adaptive management' (adjusting N fertilizer rates annually to take account of preceding rainfall) would have increased gross margins in the present trial by a mean of 13% over the eight-year means of the calculated annual optima (Table 14). Greatest increases (22 and 36%, respectively) were indicated in the wheat-chickpea and wheat-wheat rotations that are most likely to suffer water limitations.

Table 14. Mean optimum nitrogen rates* (kg/ha) for wheat and a comparison of expected gross margins (SYP/ha) derived from adaptive and non-adaptive fertilizer management strategies.

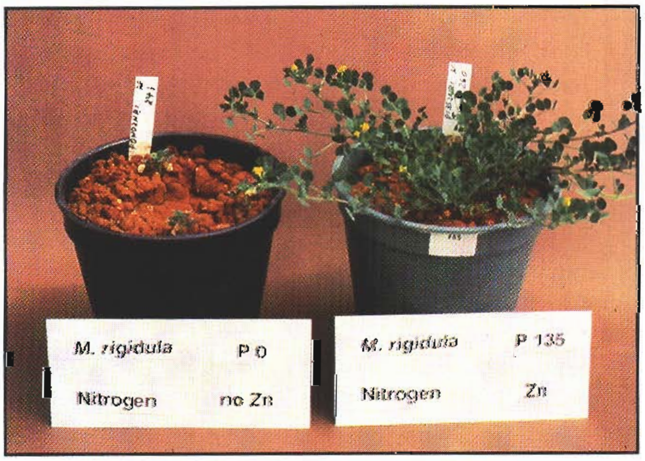
Rotation	N-rate, optimal		Management strategy		
	Mean	CV, %	Non-adaptive	Adaptive	Benefit
Wheat-fallow	75	35	4675	4897	5 %
Wheat-melon	86	12	6697	6898	3 %
Wheat-lentil	60	61	9477	9902	4 %
Wheat-chickpea	49	75	4676	6008	22 %
Wheat-wheat	45	67	1004	1576	36 %
Average	63	—	5304	5856	14 %

* Eight-year means from a long-term rotation trial at Tel Hadya.

Rhizobial Inoculation and Phosphorus and Zinc Nutrition for Annual Medics

Cereal production in the Mediterranean region has traditionally used fallowing in alternate years to conserve soil moisture. With increasing land use pressure, fallowed land, either clean-tilled or with native weeds, is giving way to continuous cropping. The introduction of self-regenerating pasture medics (*Medicago* spp.), instead of leaving the land fallow, provides forage for livestock in alternate years and reduces the nitrogen requirement of the following cereal crop. However, adaptation of medic species depends on compatible *Rhizobium meliloti* bacteria and on climatic conditions. In addition, nutrients such as phosphorus and zinc are potentially limiting factors. Therefore, in a greenhouse experiment with a representative P-deficient clay soil (Calcixerollic Xerochrept) from the Aleppo region, which was treated with P (0, 15, 45, and 135 mg P/kg) and Zn (0, 5 mg/kg), growth characteristics of four annual medic species—*Medicago polymorpha* (L.), *M. rotata* (Boiss), *M. rigidula* (L.) All., and *M. noeana* (Boiss)—were assessed with and without rhizobial inoculation, and in a N treatment at 41 mg N/kg (303.17 mg KNO_3/pot).

All four species consistently and significantly ($P \leq 0.05$) responded well to P application in herbage dry-matter yields. Similarly, a marked response to applied Zn also occurred, but only with adequate P and N levels (or effective inoculation) except for *M. noeana*.



Response of *Medicago rigidula* to zinc application under sufficient P and symbiotic nitrogen supply.

Green pod number and root biomass also increased with P application. *M. rotata* and *M. polymorpha* responded to inoculation more markedly than other species. Thus, when medics are newly introduced, inoculation may be necessary where rhizobia are incompatible.

From these results it appears that, in addition to cereal fertilization with N, it may be necessary to apply P and Zn to medic pasture in crop-pasture rotations. 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 health deserve attention.

Stubble Grazing

A second year of work on supplementation of ewes grazing stubble has confirmed that feeding small amounts of supplements can greatly improve liveweight gains in the mating period. Gains in weight in this period can have an important impact on flock fertility.

Ewes grazing at stocking rates of 20 and 40 ewes/ha were supplemented with 150 or 300 g/day of barley or 160 or 320 g/day of a mixture of barley and cottonseed cake and compared with unsupplemented groups. Supplementation with barley depressed stubble intake in the first week of grazing a new area of stubble. Unsupplemented ewes had liveweight changes of +0.6 and -1.2 kg in a month at the low and high stocking rate. Supplementation with 150 g/day of barley resulted in weight gains per ewe per month of 2.6 and 0.3 kg, and with 300 g/day of 5.0 and 1.0 kg, for 20 and 40 ewes/ha, respectively. The mixture of barley and cottonseed cake, which gave approximately the same amount of energy but with twice the amount of protein compared with barley alone, had a much greater effect. Feeding 160 g/day resulted in gains of 6.2 and 2.0 kg at 20 and 40 ewes/ha and feeding 320 g/day increased the gains to 8.3 and 4.2 kg in a month.

These results indicate that, if small amounts of supplements are fed during stubble grazing, it is possible to combine high levels of utilization of stubble with increases in live weight and body condition in ewes at mating.

Small amounts of feed supplements given to ewes grazing stubble can greatly improve their liveweight gains and body condition during the mating period.

Survey of Small Ruminants in Lebanon's Beqa'a Valley

Following nearly two decades of civil war in Lebanon, a lack of information on the small ruminant production sector makes it difficult to identify the research needs for improving sheep and goat production. Recognizing this, ICARDA and four Lebanese institutions—Agricultural Research Institute of Lebanon, Lebanese Ministry of Agriculture, Lebanese University, and American University of Beirut—conducted a collaborative survey of small ruminant systems in 1993 in the northern and central Beqa'a Valley. Twenty-eight villages were sampled, and village heads (*moukhtars*) of each were interviewed along with a total of 93 flock-owner farmers.

The data were statistically clustered by criteria of flock composition, farm size, and degree of dependence on rangeland resources. Three main clusters were identified, covering 88% of the farmers and 73% of the 37,660 sheep and goats in the sample.

The general characteristics of the three clusters are given in Table 15. Members of each of these clusters are found throughout the Beqa'a Valley study area (Fig. 16).

Table 15. Main clusters of farmers from survey of small ruminant production in the Beqa'a Valley of Lebanon, August 1993.

Cluster	Number of farmers	Farm size (ha)	Adult flock size (head)	Majority species	Use of rangelands
1	27	3.1	198	Sheep	low
2	28	1.1	378	Goats	heavy
3	21	10.8	211	Goats	moderate

The proportions between the numbers of animals weaned (lambs and kids) to numbers of dams (adult female sheep and goats) were lowest for cluster 2, followed by cluster 3. Even cluster 1, though best among the three, reported only mediocre performance (Table 16). This suggested problems with management of animal nutrition and health which are discussed below.

The weaning rates (Table 16) matched with milk production: poorest in cluster 2 and best in cluster 1. The exception was the high goat milk production in cluster 3. Most milk is sold fresh, some is for home use, and smaller amounts are sold as yoghurt, cheese, and ghee (clarified butter).

Table 16. Reproductive, weaning, and milk production performance of sheep and goats, reported by management cluster, from survey of small ruminants in the Beqa'a Valley of Lebanon, August 1993.

Livestock class:	Cluster 1	Cluster 2	Cluster 3
Sheep			
Lambs born per dam	0.89	0.69	0.79
Lambs weaned per dam	0.80	0.60	0.68
Milk (kg/dam/season)	55.2	37.1	44.7
Goats			
Kids born per dam	1.08	0.84	0.76
Kids weaned per dam	0.85	0.58	0.59
Milk (kg/dam/season)	59.0	37.5	72.2

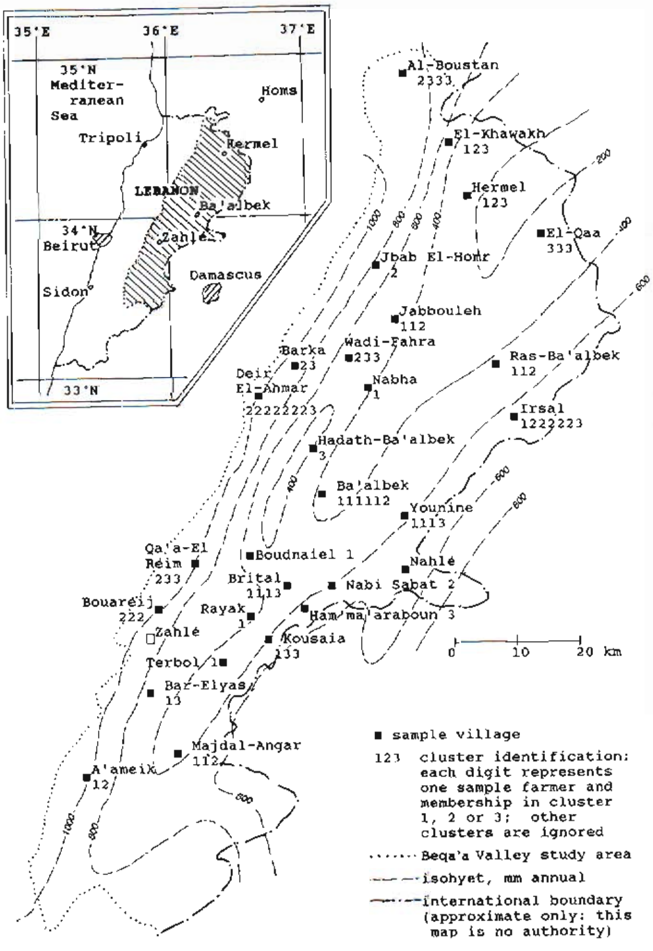


Fig. 16. Location of sample villages in Lebanon's Beqa'a Valley survey of small ruminant production.

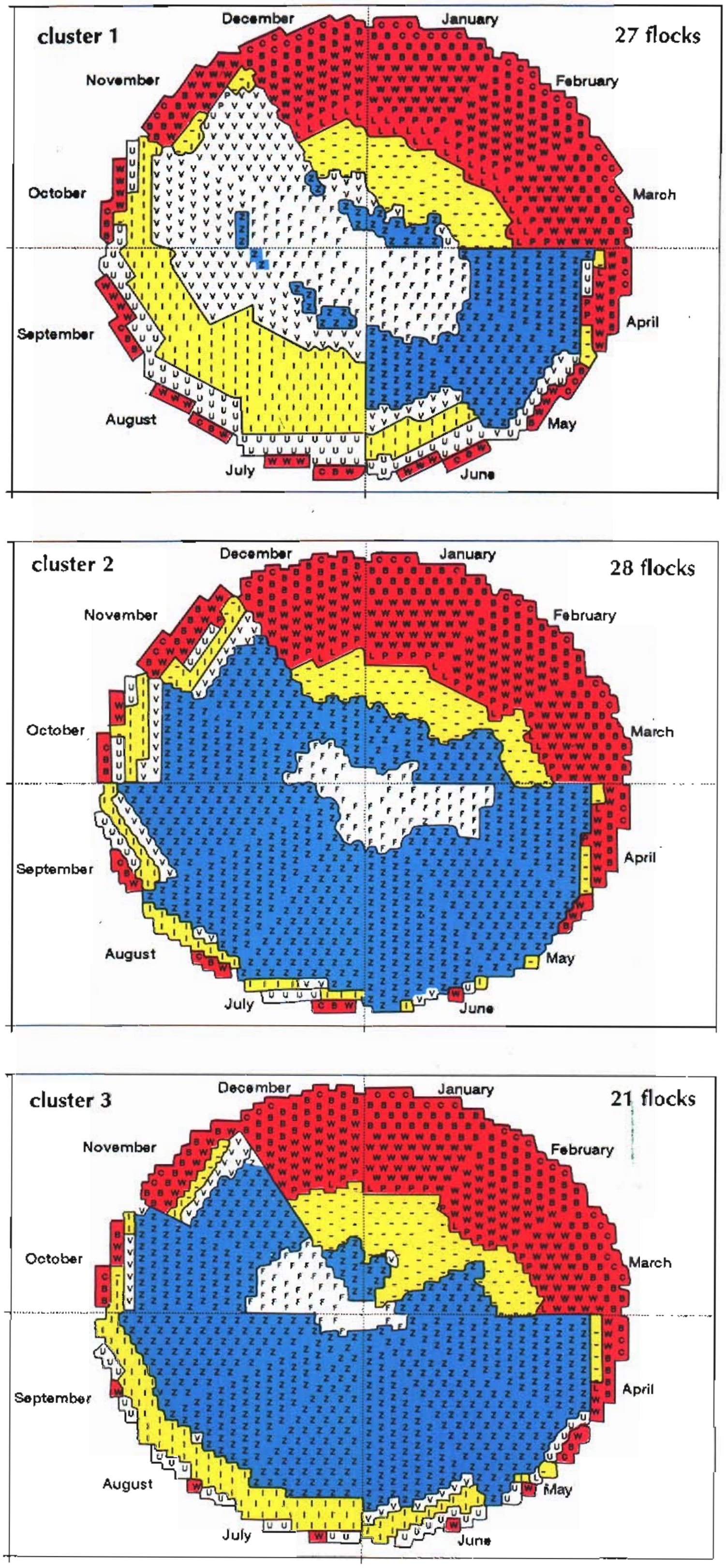
From one-half to one-third of the sampled farmers reported animal diseases in the following order of incidence: enterotoxemia, mastitis, foot & mouth disease, parasites, and brucellosis. The two most damaging among these are foot & mouth disease and brucellosis; these are already receiving veterinary attention. Animal health problems were ranked first in importance by farmers, followed by inadequate feed supplies, high prices of feeds, and problems in marketing livestock products. Interestingly, however, feed subsidies ranked equal to or greater than health care in farmers' suggested solutions to livestock problems.

Mating occurs from June to November but is concentrated in August and September; the average duration within flocks, however, was only 35 days. Lambing/kidding seasons stretched from November to May with an average duration within flocks of 36 days. Lambs and kids were weaned at 2 to 3 months of age, from February to October, over an average within-farm period of 22 days. Milking starts at weaning or before: the average milking period was 110 days for sheep and 139 days for goats.

Feeding/grazing calendars show the smallest differences among clusters in the winter/early spring period of hand-feeding (November-March) which is the main season of lambing and early lactation. Hand-feeding accounted for some 85% of animal diets in the December-March period, according to farmers. Total hand-feeding averaged from 165 kg/head in cluster 1 to 109 kg/head in cluster 3, and was comprised of wheat bran (35-50%), barley grain (18-20%) and other materials such as wheat straw and grain, lentil straw, and sugar beet pulp.

Various grazing sources provided most of the diet from April to November. It is impossible for a flock owner to accurately estimate the composition or quantities of grazing intake, particularly when more than one grazing source is used in the same time period. Nevertheless, farmers readily provide their personal guesses in percentage terms, taking into account amounts of the diet which are hand-fed. These may be summarized in feeding-grazing calendars using methods developed at ICARDA (Fig. 17).

Reported grazing diets showed strong contrasts between the three clusters. For cluster 1, crop residues and local rangelands are grazed from April to June; grazing shifts to unharvested cereal crops, cereal



Hand-fed Materials

(Each symbol is 1% of monthly diet)

- = cereal straw

L = legume straw

W = wheat bran

P = sugar beet pulp

B = barley grain

C = other concentrates

Grazed Materials

U = unharvested crops (cereal + legume)

I = cereal stubble

V = vegetable and sugar beet residues

Z = common grazing (village, road, hill)

F = fallow grazing (weedy and garden)

Fig. 17. Feeding/grazing calendars of three clusters of farmers in Lebanon's Beqa'a Valley survey of small ruminant production.

Table 17. Grazing sources, according to farmers' reports of surface areas used, from survey of small ruminants in the Beqa'a Valley of Lebanon, August 1993.

	Cluster 1 (%)	Cluster 2 (%)	Cluster 3 (%)
Rangeland open for all	68.8	9.9	65.5
Rangeland controlled by village	24.6	54.7	19.0
Farm land rented for grazing	6.1	34.1	13.9
Rangeland owned by farmer	0.0	0.5	0.7
Private farm land	0.5	0.7	0.9
Total	100.0	100.0	100.0

stubbles, and vegetable crop residues from July to November. For cluster 2, rangeland provides the majority of grazing from April to November. Cluster 3 flocks depend on rangeland and cereal stubbles in this period.

There is a great contrast between cluster 2, for which village-controlled rangeland and purchased grazing rights are the most important, and the other two clusters for which free rangeland (open to all) is used more frequently (Table 17 and Fig. 17). Prices are well established for rights to graze crop residues. Unharvested crops go for higher prices as their nutritive value and quantity per hectare are higher than those of cereal stubbles after harvest. Grazing fees associated with use of controlled rangelands were noted in many cases. Highest costs per head were reported by cluster 2 farmers who make greater use of controlled rangelands. Herders or shepherds are mainly drawn from the flock owners' families, though 25% are hired.

These results indicate that studies on winter diets and management could be done on a research station and have wide relevance to all three clusters. Work on summer and autumn diets and management, however, may best be done in the context of on-farm trials with representative flocks, considering the diversity in grazing management systems of the different clusters.

The spread of the lambing/kidding seasons over several months, combined with low levels of fertility (76% and 84% lamb and kid crops, respectively), may be related to nutritive deficiencies in the mid-summer mating season. Reported high mortality of lambs and goats (12.5 and 26.8%) by weaning time is also indicative of problems in the nutrition/health complex.

The four Lebanese institutions and ICARDA will continue to follow up the leads from this survey for further study and research.

Training

In 1993, ICARDA offered training to 659 individuals (Fig. 18). Training participants came from 31 countries including 17 WANA countries, six sub-Saharan countries, two East Asian countries, and six European countries. Of these, about 40% were trained in courses at ICARDA headquarters in Aleppo, and the remaining in in-country, sub-regional and regional training courses. About 12% of the trainees were women.

The Center continued its strategy to gradually decentralize its training activities by offering more subregional and regional courses. In 1992/93, only 13 courses were offered at headquarters but 21 in other countries as regional and subregional courses.

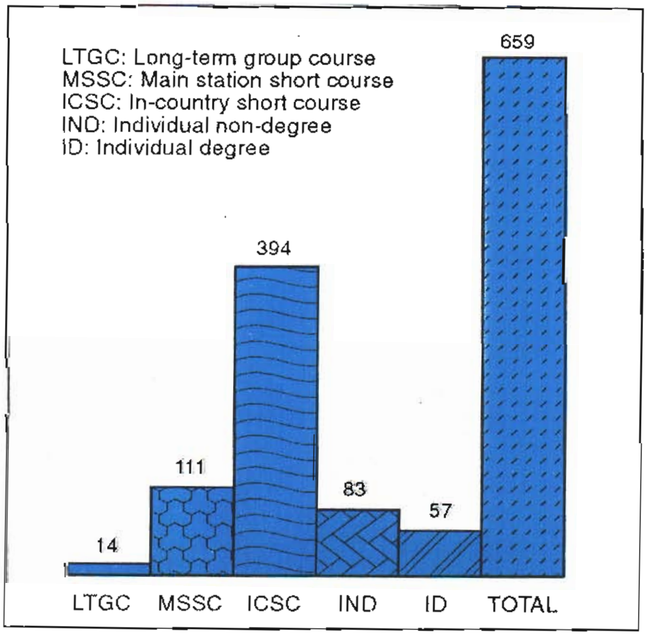


Fig. 18. ICARDA training participants, 1992/93.

Courses were offered in crop improvement research, seed testing, seed processing, seed health, water harvesting techniques, supplemental irrigation, biometrical methods and related computing in crop improvement, mechanical harvest of food and feed legumes, and information management. Emphasis was given to courses of an upstream nature such as DNA molecular marker techniques.

A working draft of a Manual of Training Procedures was published and implemented. Feedback on the draft was obtained to develop a revised version for the 1994 training activities. A training policy on graduate research studies was also developed and implemented.

Work began on a medium-term plan for the Center's training program for the next five years. The plan outlines a training system that has strong components of needs assessment, follow-up communication, and training material development. The plan will be developed into a special project proposal and submitted to a donor for funding.

Contacts were made with sister regional and international centers such as CIHEAM, ACSAD, ILCA, CIMMYT, FAO, and UNDP for conducting joint training activities in areas of mutual interest.

Information Dissemination

The first phase of an in-house ICARDA Agricultural Database (ICAD) was completed by downloading 310,000 bibliographic records, relevant to ICARDA's research interests, covering the period 1970-1992 from AGRICOLA and CABI databases. ICAD was created on the ICARDA VAX system using the CDS/ISIS program and made available on-line to users at headquarters.

Within the framework of AINWANA (Agricultural Information Network in West Asia and North Africa), a three-week training course in library management and the use of modern information technology was organized. Nine information personnel from six WANA countries participated. In addition, three national librarians received individual training in library management and the use of CDS/ISIS and CD-ROMs for information management and retrieval. In-house instruction on the use of CDS/ISIS was provided to 10 ICARDA researchers. A joint project proposal was initiated with CIHEAM for developing a database/bibliography on durum wheat in North Africa.

Participation in AGRIS (International Information System for Agricultural Science and Technology) continued, and reporting to CARIS (Current Agricultural Research Information System) was initiated.

Eighty publications were produced in-house, in addition to two reference books published jointly with a commercial publisher. ICARDA scientists submitted 76 articles to refereed journals, several of them with national scientists as co-authors. A pricing policy was developed in preparation for charging for some of the Center's publications where appropriate. As in past years, the Center again figured prominently in the national and regional media.

Impact Assessment and Enhancement

Adoption of Fertilizer Use on Rainfed Barley

ICARDA and Syrian researchers have jointly worked with barley farmers in northern Syria for more than 10 years. A major diagnostic study in the early 1980s prompted a long-term program of on-farm fertilizer trials, which in turn led to a new government policy allocating fertilizer for the first time to barley growers in dry areas. By early 1993, 86.7% of farmers in Zone 2 (annual rainfall 250 to 350 mm) and 46.7% in the drier Zone 3 (mean annual rainfall 250 mm) were using fertilizer on their barley. We now report preliminary results from a follow-up study which examined: (i) the factors that had influenced farmers' adoption (or non-adoption) of the fertilizer recommendation, and (ii) the extent to which barley farmers have shifted to continuous barley cropping and the underlying reasons for this.

The major reason cited by fertilizer adopters was the belief that fertilizer increases yields, backed up by the availability of credit and the observation that their neighbors were also using fertilizer. However, 61% of non-adopters gave the non-availability of credit as an important reason for not adopting fertilizer recommendations, and 36% believed that fertilizer was risky to use. The study also examined 'psychological (or personality)' factors. The self-image of those who adopted was more progressive, flexible, and scientifically orientated than that of non-adopters; and 34% of adopters said they liked the occupation of rainfed farming very much as against only 12.5% of non-adopters. This indicated that uptake of new technology is a function not only of economic and technical factors but of individual attitudes and lifestyle preferences.

Around 82% of the farmers interviewed now grow barley continuously, compared with 27% recorded in 1980. The reasons most frequently given were the small area of the farm holding and the need for a higher income. Comparisons for the 1991/92 season showed that mean yields from continuously grown barley were 70% of those from barley following fallow or another crop. Differences were particularly large on farms of non-adopters of fertilizer, where the mean yield in continuous barley rotation was just 431 kg/ha, or 36% of that obtained (1180 kg/ha) in other rotations.

Most farmers are aware of the drawbacks of continuous barley growing. Around 50% had noticed decreasing yields, and 41% referred to insect damage, especially from 'ground pearls' (*Porphyrophora tritici*). This insect is a particular problem in the northeast. Nevertheless, 51% of farmers said they would continue to grow barley continuously, 43% that they would continue for a few years, and only 6% that they would stop it next year. For these farmers, and for many other dry-area barley growers elsewhere in WANA, the problem of fallow replacement (or, rather, what is now "continuous-barley replacement") still remains to be solved.

Bread Wheat Germplasm Adoption

To promote the release and adoption of new cultivars, the CIMMYT/ICARDA spring bread wheat breeding program collaborates with NARS in conducting on-farm trials in Syria, Algeria, Sudan, Lebanon, Morocco, Tunisia, and Egypt. A number of bread wheat varieties have been released as a result of this collaboration (see Appendix 2).

Since 1983, the Syrian national program has released six improved bread wheat varieties (Bohouth 2, 4, and 6; and Cham 2, 4, and 6. The amount of seed produced by the General Organization for Seed Multiplication (GOSM) of Syria for these varieties is presented in Table 18. Assuming a seed rate of 150 kg/ha, these varieties occupied approximately 241,000 ha during the 1992/93 season and about 200,000 ha during 1993/94. These figures are rather conservative considering that most farmers in Syria retain their own seed for next year's crop. During the past two years, GOSM has reduced the amount of seed produced of Mexipak 65 (local variety), while Cham 4, an improved CIMMYT/ICARDA bread wheat cultivar, has become the leading variety grown by farmers.

Table 18. Bread wheat varieties and amount of seed produced by the General Organization for Seed Multiplication of Syria, and distributed to farmers during 1992 and 1993.

Variety	Year of release	Seed quantity (tons) 1992	1993	Total	%
Mexipak 65	1969	5500	—	5500	100
Cham 2	1984	—	—	—	—
Cham 4	1986	16500	14400	30900	562
Bohouth 4	1987	10000	9500	19500	355
Cham 6	1991	4000	4600	8600	156
Bohouth 6	1991	175	200	375	7
Total		36175	28700	64875	

In the 1993 joint on-farm verification yield trials in Syria, two new bread wheat lines, Chorizo (ICW 80-0679-2AP-1AP-5AP-OAP) and Ghurab-2 (SWM 11623-9AP-3AP-7AP-2AP-1AP-OAP), were identified as promising. They yielded higher than the local and improved checks, Mexipak 65 and Cham 6, respectively. They are under farmers' field testing and are potential candidates for release in the country.

Constraints to Adoption of New Barley Varieties in Morocco

Research on genetic improvement of barley in Morocco has resulted in the release of 19 varieties (13 of which were released during the period following 1984). However, the adoption of these varieties has remained limited: the certified barley seed sold to farmers in 1991/92 was less than 2% of total barley seed used in Morocco. This is in sharp contrast with 37% for bread wheat and 17% for durum wheat seed.

Studies to identify the main reasons for low adoption rate of new barley varieties in Morocco focused on three key questions: Are new varieties adapted to farmers' production and utilization constraints? Do farmers have access to the seed of new varieties? Are farmers aware of the existence and potential of new varieties?

A collaborative survey by Moroccan and ICARDA researchers covered 173 barley farmers in seven districts in three agroclimatic zones: favorable, semi-arid, and arid. Two categories of farmers were surveyed: (i) a random sample of 113 barley farmers, and (ii) 60 farmers who had already tested some of the new varieties as part of the on-farm trials.

Preliminary results indicate that adoption of the improved barley varieties was limited to about 24% (all semi-arid) of the survey area. Further, only two relatively old varieties (Arig 8 and ACSAD 60) were used by farmers. These varieties are appreciated for their high grain yields and excellent grain quality for human consumption. However, it seems that for other new varieties, particularly the two-row types, low straw yield and unsuitability of grain for animal feeding could offset the benefits from higher grain yield and so reduce the economic incentive for their wider adoption.

Farmers' limited access to certified barley seed is likely to become the key constraint to the adoption of new varieties in the future. This is because seed programs in Morocco plan to concentrate on producing certified wheat seed, which is a more profitable and less risky enterprise than barley seed production. Current prices for barley certified seed are relatively high, which will encourage farmers to rely more on their own production of local varieties to meet their seed needs, particularly following a good season when barley market prices are low.

Farmers appeared to be well informed of the potentials (and of disadvantages) of the two available improved barley varieties, particularly in the semi-arid zone which has been the target of most efforts to promote the new varieties. Future transfer of technology activities (and breeding efforts) ought to focus more on the arid zones, where more than half of barley areas are located.

Outreach Activities

ICARDA's outreach programs in the region constitute the major mechanism for conducting collaborative research with NARS. Currently, six regional programs operate in North Africa, the Nile Valley, West Asia, the Arabian Peninsula, the West Asian Highlands, and Latin America. These programs were established in recognition of the fact that the Syrian "testbed," no matter how suitably located, cannot fully meet the research needs of ICARDA's diverse mandate region. They foster strong partnerships with national research teams, ensure continuity of the cooperative research, and 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 possible, they also play a catalytic role in attracting donor funding to national programs.

Highland Regional Program

ICARDA's collaborative highland research and training activities are conducted in Pakistan, Turkey and Iran, with financial support from USAID (United States Agency for International Development), Italy and Iran, respectively. The areas (usually 750 meters above sea level) are characterized by low temperatures in winter severely limiting crop growth.

In Pakistan, the USAID-supported project entered its eighth year in providing support to the Arid Zone Research Institute (AZRI) in Quetta. The ICARDA scientist based at AZRI gave special attention to advising on the research management of AZRI as the financial support to the project moved closer to its termination in August 1994. Emphasis was also given to increasing seed of promising lines of wheat with resistance to yellow rust, barley, lentils and forage legumes, to be submitted for registration as new varieties in 1994. The number of farm sites, where fourwing saltbush is being demonstrated, increased substantially. A seven-year project on water harvesting was completed; the results indicate that the benefits of the proposed technology over the traditional system are only marginal.

The ICARDA/Turkey highlands project, supported by Italy, is composed of seven mini-projects aimed at strengthening research facilities and activities in the Central Anatolian highlands and Taurus Mountain areas of Turkey. Four of these mini-projects run in

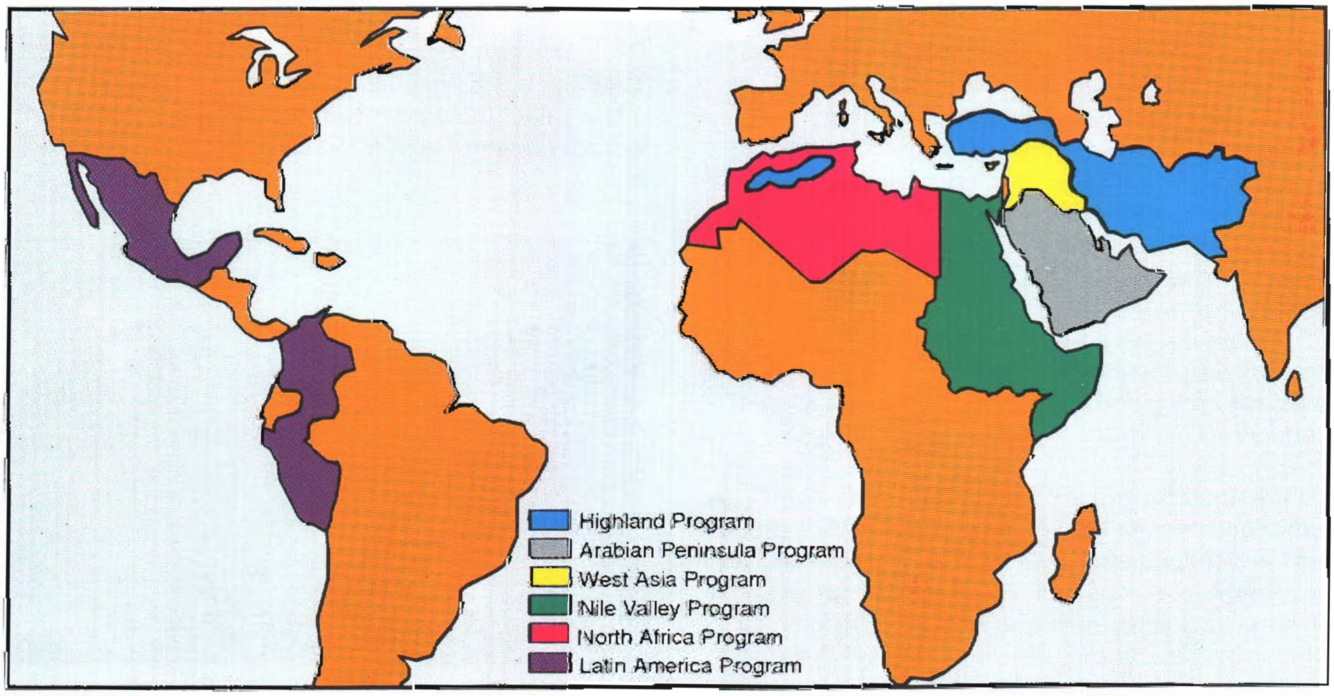


Fig. 19. ICARDA's outreach activities are grouped into six regional programs, based on commonalities of geography, ecology, and constraints to production in each region.

The Turkish Minister of Agriculture and Rural Affairs (third from left) and senior officials and researchers of the country examine the performance of crops at a Turkey/ICARDA project site.

collaboration with the Central Research Institute for Field Crops (CRIFC), and one each with Soil Fertility Research Institute, Ankara, Ankara University, and Cukurova University, Adana.

The mini-project on agricultural structure and constraints to increased production in the eastern margin of Central Anatolia has provided useful information on demographic and economic characteristics of farm households, structure of farms, production problems, and levels of adoption of recommended technologies. A summary of results appears in Part 1 of this Annual Report on page 14.

The mini-project on survey of rhizobium numbers and symbiotic effectiveness in the West Asian highlands was concluded at the end of 1993 and a report is under preparation.

The multidisciplinary village-level work in the mini-project on Taurus Mountains was further intensified through joint efforts with Cukurova University and the Ministry of Agriculture. Farmers in the project area have shown a keen interest in researcher recommendations. In 1992/93 they obtained increased production of wheat, chickpea and fodder crops, and voluntarily shared seeds of improved varieties with their neighbors.

The three mini-projects on improving highland barley and food legumes (chickpea and lentil) and feed legumes (*Vicia* spp. and grasspea) helped in identifying cold-tolerant lines of these crops.

In the mini-project on *Onobrychis* (common sainfoin), a perennial forage legume, single plants with tolerance to insect pests were identified for further evaluation in insect-infected fields on three state farms.

A typical Taurus Mountain Project village in Turkey. Cropping is done on contours to avoid soil erosion and utilize limited soil moisture.

New Activities

Two new activities were initiated during the year: (i) a mini-project on highland durum wheat improvement at CRIFC, and (ii) technical support to cereal and legume pathology research at CRIFC.

Training and Human Resource Development

Six scientists from Turkey participated in four ICARDA short training courses held in Aleppo; two in the International Workshop on Importance and Control of Barley Leaf Blights; one in the International Durum Wheat Workshop, held in Spain; one in WANA Cereal Group Workshop; three in Expert Consultation on Sunn Pest Control in the Near East; and two in Joint Evaluation of Winter Barley Material at ICARDA. A Legume Travelling Workshop was organized in the Central Anatolian highlands from 28 June to 3 July 1993. It provided an excellent opportunity to Turkish legume scientists to interact with one another and with scientists from Iran, Pakistan, and ICARDA.

Coordination Meetings

Two annual coordination meetings were organized in Turkey: the ICARDA/Cukurova University Annual Coordination meeting for the Taurus Mountain mini-project at Adana; and the ICARDA/CRIFC Coordination Meeting to cover the six mini-projects operating in the Central Anatolian highlands.

Arabian Peninsula Regional Program

With financial support from the Arab Fund for Economic and Social Development (AFESD), the Arabian Peninsula Regional Program continued its research and training activities during the 1992/93 season. Cooperation was further strengthened among the participating countries and with ICARDA through reciprocal visits.

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

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

Germplasm Exchange, Evaluation and Improvement

Participating countries, in response to their requests, were provided with 119 different nurseries (Table 19) for evaluation in the 1992/93 season. Each country identified several promising lines.

Table 19. ICARDA's cereal and legume nurseries and germplasm distributed to countries of the Arabian Peninsula, 1992/93.

Country	Barley	Bread wheat	Durum wheat	Special cereal nurs.	Lentil	Chickpea	Forage legume nurs.	Total
Bahrain	—	—	—	—	1	1	—	2
Kuwait	—	—	—	—	1	1	—	2
Oman	3	2	1	2	—	2	6	16
Qatar	1	—	—	—	—	—	2	3
R. of Yemen	3	5	2	7	1	—	—	18
S. Arabia	14	12	10	18	1	6	6	67
UAE	4	4	—	3	—	—	—	11
Total	25	23	13	30	4	10	14	119

The cereal and food and feed legume germplasm, lost by Kuwait during the Gulf war, was fully replaced by ICARDA and will be grown again for testing in Kuwait in the 1993/94 season.

Special wheat and barley germplasm lines developed for drought, heat, and salt tolerance were sent for evaluation to different locations in the United Arab Emirates (two nurseries), Saudi Arabia (two nurseries), the Sultanate of Oman (one nursery), and Yemen (two nurseries). Wheat germplasm with resistance to rusts was also sent to Yemen for evaluation.

A new cereal aphid resistant nursery was distributed for evaluation at selected locations in the Arabian Peninsula.

Wheat and barley regional crossing blocks for the Arabian Peninsula, initiated at ICARDA in 1989/90, made good progress. The main objective of this effort is to cross high-yielding lines and improved cultivars with cultivars adapted to the Arabian Peninsula countries to develop high-yielding cultivars with wide adaptation. Countries participating in this activity are the Republic of Yemen, Saudi Arabia, the Sultanate of Oman, Qatar, and the United Arab Emirates. Results of these regional crosses have been encouraging. The F_3 progenies will be evaluated in 1993/94 at ICARDA and in the participating countries.

Four years data on varietal description and evaluation of the common and improved wheat and barley cultivars grown in the Arabian Peninsula are being compiled and analyzed for publication.

Training and Human Resource Development

Nine participants from the UAE, the Sultanate of Oman, and the Republic of Yemen took short- and long-term training courses at ICARDA. Several reciprocal visits were made between the scientists of ICARDA and the Arabian Peninsula countries. The discussions included cooperation between the Agricultural Research and Extension Authority (AREA)in Yemen and ICARDA in implementing the IDA-supported Agricultural Sector Management Support Project (ASMSP). A draft letter of understanding between AREA and ICARDA for technical assistance was developed for review and implementation.

Coordination Meeting

The third Annual Coordination Meeting of the Program was held in Abu Dhabi, UAE. Senior scientists and officials from participating countries and ICARDA, along with representatives from AFESD, GCC, IDB, and the University of the United Arab Emirates participated. A work plan was developed for the 1993/94 season.

The meeting recommended formulation of a Regional Steering Committee. Nominations have been received from the UAE, Bahrain, Kuwait, the Sultanate of Oman, and the Republic of Yemen. A new project proposal for "Strengthening Agricultural Research and Human Resource Development in the Arabian Peninsula" is under preparation. The proposal will be reviewed by the Regional Steering Committee for submission to potential donors.

West Asia Regional Program

The West Asia Regional Program supports technology transfer activities in Syria, Jordan, Iraq, Lebanon, Cyprus, and lowland areas of Turkey. The Program, supported by UNDP (United Nations Development Programme) and AFESD, seeks to improve the production of barley, forages, and sheep/goats.

Barley

In Syria, in Zone 2 (250-350 mm annual rainfall), improved cultivars Furat 1, Furat 2, and Arta outyielded the local cultivar by 53%, 34%, and 46%, respectively. In Zone 3 (250 mm mean annual rainfall), Tadmor and WI2291 gave a 7% and 11% higher grain yield over the local. The yield of Zanbaka was close to that of the local cultivar. Seed rate of 100 kg/ha was optimum, compared with the conventional rates of 150 and 200 kg/ha. In demonstration trials on farmers' fields in Hama, this seed rate gave a 2% increase in grain yield over the 150 kg/ha rate. In Raqqa and Hassake, it gave a 4% increase over the 200 kg/ha seed rate. Thus, farmers can reduce production costs by decreasing seed rates.

Fertilizer application on barley in Zone 2 produced an average grain yield increase of 43% and

Scientists from Syria, Jordan, Iraq, and ICARDA visit a farmer's field during a traveling workshop in Jordan.

29% with improved cultivars Furat 1 and Furat 2, respectively, and 44% with the local variety. In Zone 3, yield increases ranged from 13 to 79%, with an average of 33%. Furat 1 yielded 38% more than the local cultivar across five locations.

In Jordan, Arta and Harmal, two new promising cultivars, and Rum, a newly released cultivar, yielded 36%, 38% and 35%, respectively, more than the local cultivar. The straw yield was also higher, with that of Rum being the highest.

In north Jordan, the improved barley production package produced 16 to 100% (average of 62%) higher yields than farmers' practices. The straw yield increase ranged from 16 to 100% with a mean of 24%. In central Jordan, grain yield increase with the improved package ranged from 20 to 215% with a mean of 105%. In south Jordan, fields planted in cooperation with the Project gave a satisfactory grain and straw yield, in sharp contrast with farmers' fields which had to be left unharvested for grazing due to crop failure.

In Iraq, Rihane 3 (see Appendix 2) was released as a new barley cultivar for rainfed areas. New dual-purpose barley lines, such as IPA 265, continued to perform well under irrigation. Fertilizer application on barley resulted in a 78% yield increase with the improved cultivar Rihane 3 and 81% with Gezira 1. Using farmer management, Rihane 3 with fertilizer gave 71% more grain yield than the local cultivar and 13% more than Gezira 1.

Forage Legumes

Vetch demonstration trials on farmers' fields were extended in 1992/93 to larger areas in the three countries. Results in Syria indicated that growing barley after *Vicia ervilia* gave a 35% more yield than after barley and equal to the yield of barley after clean fallow. In Jordan, barley following *V. ervilia* gave 32% more grain as compared with barley after barley, but 32% less than that of barley after clean fallow. In Iraq, barley yield after vetch was 10% higher than barley after barley and 12% higher than barley after fallow.

Several forage legume species and accessions were found to have a good potential for dry-matter production and for grain and straw production. In Syria, *V. sativa* 715 and 800, *V. ervilia* 219 and *V. narbonensis* 717 and 683 were found to be promising. In Jordan, *V. sativa* 715 and *V. dasycarpa* 683 and *Lathyrus sativus* 101 were promising and are under consideration for release.

Animal Production

Early Weaning of Lambs

Results in Syria and Jordan further confirmed the previous year's observations that early weaning increases farmer income through greater milk production. In Syria, early weaning increased the income, on average, by 488 SYP/ewe/season (SYP 42 = 1 USD). In Jordan, early weaning resulted in an extra income of 2.3 to 5.65 JD/ewe/season (JD 0.67 = 1 USD).

Feed Supplementation and Hormonal Treatment to Synchronize Oestrum and Increase Ovulation Rate

Results in Syria indicated that the use of sponge-applied PMSG hormone during the mating season gave significant improvement in ewe fertility and prolificacy as compared with control animals and with those on feed supplementation. It also gave 45% more lambs than the other two treatments. In Jordan, PMSG gave 41% more lambs than the control and 12% more than the feed-supplemented animals. In Iraq, the hormone gave 50% more lambs than the control treatment. The economics of the PMSG hormone treatments is well established; however, the technology is targeted to sheep raised under intensive or semi-intensive production systems.

Sheep Feeding on By-products Treated with Urea

Results in Jordan indicated that replacing 20% of barley by olive-seed cake treated with urea gave about the same final lamb weight as the control flock fed on concentrate. The olive-seed cake is a locally available, inexpensive by-product. In Iraq, replacing 25% of the barley grain in the lamb fattening ration by urea-treated straw did not affect the final weight of the animals. The weight gain, when 40% of the concentrate was replaced by urea-treated straw, was 15% lower than of animals feeding on concentrate alone, but 28% higher than those feeding on untreated straw. The economic analysis is in favor of using urea-treated straw, since straw is cheap and is locally available.

Sheep Feeding on By-products Feed Blocks

Studies were conducted to evaluate the potential of feed blocks manufactured from agricultural and industrial by-products. In Iraq, supplementing the feed of ewes grazing stubble by a feed block consisting of wheat and rice bran, poultry waste, and urea resulted in a 56% increase in weight gain. When the feed block was used for fattening lambs, the weight gain was 8% more than when the animals fed on blocks and stubble, as compared with those fed on cottonseed cake and stubble.

Training and Human Resource Development

A training workshop on Seed Science and Technology was organized at the University of Jordan in cooperation with Med-Campus EU program between ICARDA, Jordan, Italy, and Greece. Thirty-nine persons from eight WANA countries, five European countries, and ICARDA participated. ICARDA, the University of Jordan, and the Central Administration for Seeds in Egypt, jointly organized a training course in Jordan on Seed Testing, sponsored by GTZ, setting a good example of complementarity and cooperation between NARS, donors, and ICARDA.

To strengthen linkages between the regional programs of ICARDA, the West Asia Regional Program organized a study tour to Tunisia for scientists from Syria, Jordan, and Iraq.

To link Mashreq and Maghreb activities, a study tour to Tunisia was conducted in which three scientists each from Jordan, Syria, and Iraq participated. Four travelling workshops were organized during 1993 with the participation of scientists from Mashreq countries and ICARDA.

ICARDA, in cooperation with ISNAR, is assisting the National Center for Agricultural Research and Technology Transfer (NCARTT), Jordan, to develop a research strategy and a medium-term plan. Scientists from NCARTT and the two centers met and organized a workshop to develop a first draft of the strategy document.

Coordination Meetings

The 1993 Coordination Meetings with Jordan, Iraq, Syria, and Lebanon were held as scheduled, with enthusiastic participation of national researchers.

Nile Valley Regional Program

The Nile Valley Regional Program (NVRP), started in 1988/89, covers research, transfer of technology, and human resource development to improve the production of cool-season food legumes (faba bean, lentil, and chickpea) and cereals (wheat in cooperation with CIMMYT in Egypt and Sudan, and barley in Egypt and Ethiopia). The program in Ethiopia also includes field pea. The NVRP strategy involves multi-disciplinary, multi-institutional, and problem-oriented networks making full use of the expertise, human resource, and the infrastructure available in the participating countries. Emphasis is on backup research to develop and transfer sustainable improved technology suitable for various agroclimatic regions. As a partner, ICARDA collaborates with the three countries in developing annual work plans; providing germplasm, technical and management backstopping and training opportunities; and coordinating activities at national and regional levels. Funding continued from the European Union (EU) for the Egyptian component, the Netherlands Government for the Sudanese and Ethiopian (barley improvement) components, and the Swedish Agency for Research Cooperation for Developing Countries (SAREC) for the Ethiopian component (food legumes improvement).

Wheat

In Egypt, extensive on-farm demonstrations since the beginning of NVRP have helped increase farmers' awareness of the advantages of improved production packages (Table 20). An adoption study in Upper Egypt revealed high adoption rates of recommended variety (64%), planting date (73%), and irrigation intervals (77%). Adoption rates were low, however, for timing of first irrigation interval (37%), crop establishment practices (12%), seed rate (12%), and fertilizer application (7%). Adoption of improved cultivars by farmers increased considerably in 1992/93 (Table 21). In Middle Egypt, bread wheat yields exceeded durum wheat by about 1 t/ha. Under rainfed conditions, the newly released cultivar Sahel-1 maintained its superiority for the third consecutive season. Cultivars were identified for tolerance to abiotic and biotic stresses.

In Sudan, wheat yield increases ranged between 28 and 124%, with a Marginal Rate of Return (MRR) of 643 to 1236%, in on-farm demonstrations with the improved production package (Table 22). Fifty-three and 31 lines were selected for tolerance to heat and moisture stress, respectively. Studies on water-use efficiency indicated a 45% oversupply of water by farmers than required by the crop. Yield loss caused by leaf and stem rusts was 21 to 83%. In rust resistance screening, 11 entries showed adequate combined resistance to leaf and stem rusts, and 35 were resistant to leaf rust. The outstanding selective effectivity of Gaucho 70WS, as seed dressing, was confirmed in controlling aphids without harming natural enemies.

Table 20. Grain yields obtained by participating (PF) and non-participating (NPF) farmers in wheat demonstrations in the old lands in two governorates in Upper Egypt, 1989-1993.

Governorate/ season	Grain yield			Mean gover. yield (t/ha)	Percent increase over mean yield
	PF t/ha	NPF t/ha	Increase over NPF %		
Sohag					
1989	6.13	3.87	58	4.84	27
1990	7.36	5.21	41	4.93	49
1991	5.68	3.40	67	4.38	30
1992	6.12	4.04	51	5.15	19
1993	6.93	4.45	56	5.19	34
Mean	6.44	4.19	55	4.49	32
Qena					
1989	4.74	3.70	28	3.99	19
1990	8.60	5.28	63	4.68	84
1991	4.72	3.58	32	3.91	21
1992	6.39	4.54	41	5.30	20
1993	6.60	4.71	40	5.32	24
Mean	6.21	4.36	41	4.64	34

Table 21. Certified seed of old and new wheat cultivars distributed to farmers in Egypt during the period 1986-1992.

Season	Old cultivars			New cultivars	
	Giza 155	Giza 157	Sakha 61	Giza 163	Giza 164
1986	2368	8609	1656	—	—
1987	4773	4900	2034	—	—
1988	3364	3486	2024	54	176
1989	2542	3822	2786	726	2324
1990	1914	1788	1831	7836	4688
1991	463	450	372	8820	7226
1992	246	128	210	11930	10712

On-farm wheat improvement demonstration trials in Sudan.

Table 22. Comparison of average seed yield obtained by participating (PF) and non-participating (NPF) farmers in wheat demonstrations in different schemes/provinces in Sudan, 1992/93.

Scheme/ province	Average seed yield (kg/ha)		Standard error (kg/ha)	Increase over NPF %
	PF	NPF		
Managil	2017	1220	47	65
South Gezira	2297	1611	89	43
Rahad	1672	1124	40	49
New Halfa	1630	943	71	73
White Nile	2987	1999	155	49
Dongola	3889	2138	345	28
Hasa	2076	927	249	124
Kaboushia	2814	1782	243	58
Mean	2298	1468	155	61

Barley

In Ethiopia, 50 and 161% yield increases (average MRR of 323 and 185%) were realized with the adoption of new production packages (Table 23). The sowing date of late May was recommended for HB 100, early June for Adet local, and mid-June for HB 99, with seed rates of 175, 100 and 150 kg/ha for the three cultivars, respectively. Nineteen entries were tolerant to the Russian wheat aphid, and 28 to barley fly. Delayed planting to early August increased the damage by barley fly.

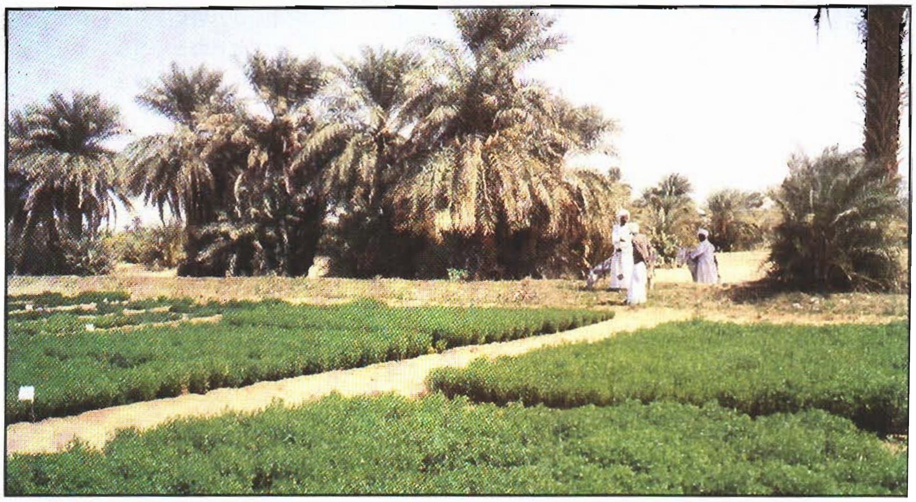
Table 23. Grain yields in demonstration (dem.) trials of barley improvement packages (HB 42 and ARDU 12) compared with local traditional practices in several locations in Ethiopia, 1992/93.

Location	No. of dem.	Mean grain yield (t/ha)			Percent increase over local	
		Local	HB 42	ARDU 12	HB 42	ARDU 12
Chiri	1	1.7	3.1	-	84	-
Debre Libanos	3	1.4	2.3	2.7	62	90
Degem	2	1.9	2.9	2.4	50	26
Guntuta	4	1.4	2.3	2.3	66	65
Meta Berga	4	1.4	2.1	-	61	-
Suba	1	1.8	3.1	-	70	-
Sululta	2	1.0	2.2	1.7	133	74
Telecho	5	1.5	2.4	2.5	61	68
Wolmera	2	1.2	3.0	1.6	161	41
Total/Mean	24	1.5	2.6	2.2	83	61

In the rainfed areas of the North West Coast (NWC) in Egypt, farmers obtained yield increases of 44 and 43% with the improved cultivars, Giza 123 and Giza 124, respectively. In backup research, four lines combined high yield and stability, with yield increases ranging between 5 and 30% over the improved cultivar. One line, selected for release as Giza 126, gave 15% more yield than the check with high yield stability across all tested environments. Screening for aphid resistance provided 20 and 45 resistant/tolerant genotypes under controlled and natural aphid infestation, respectively. Disease surveys revealed that powdery mildew, net blotch, stripe, and covered smut were the major diseases. An improved production package was developed for NWC involving 20-cm row spacing, 50 kg seeds/ha, early sowing in November, and N and P fertilization. Broadcast seeding and low seed rate were recommended for Giza 123 under rainfed conditions, while seed drilling was recommended under irrigation.

Lentil

Sudan achieved self-sufficiency in lentil production through increasing acreage and adopting improved production packages. Government incentives contributed greatly to this achievement through credit



Sudan achieved self-sufficiency in lentil production by increasing acreage and adopting improved production packages.

support, guaranteed lentil prices, and availability of threshing machines and decorticators. Yield increases ranged between 20 and 246% (with MRR of 588 to 1447%) in demonstrations using the recommended package. Lines ILL 813 and ILL 818 (introductions from ICARDA) were released (see Appendix 2). In Rubatab, seed and straw yields increased by 15 and 19%, respectively, by increasing the seed rate to 107 kg/ha, and by 22 and 11% by broadcast/ridge planting.

In Ethiopia, farmers adopting improved production packages increased their yields by 63% with average MRR of 312%. Selections NEL 2704 and FLIP84-78L (from ICARDA) are under consideration for release for the low and high lands, respectively. Ten exotic lines mostly from ICARDA were selected for adaptation to high-altitude areas because of their tolerance to frost.

In Egypt, 65 lentil demonstrations gave an average yield advantages of 19 to 29% in traditional areas and 33% in non-traditional areas in Nubaria (Table 24). Precoz is likely to be released to farmers in the northern areas, and Giza 370 for general use. Surveys indicated that downy mildew, rusts, grey mold, wilt/root rots, and *Sclerotinia* rot were the most important lentil diseases in that order. NPK fertilization in the newly reclaimed areas showed a yield increase of 133% indicating the need for effective rhizobium inoculation and P and K fertilization.

Table 24. Average seed and straw yields obtained by participating (PF) and non-participating (NPF) farmers in lentil demonstrations in various governorates in Egypt, 1992/93.

Governorate	No. of sites	Seed yield (t/ha)			Straw yield (t/ha)		
		PF	NPF	% Over NPF	PF	NPF	% Over NPF
Sharkia	24	2.95	2.37	25	7.12	6.12	16
Kafr El-Sheikh	10	2.16	1.69	28	5.42	4.34	25
Dakahlia	20	2.05	1.72	19	6.24	4.63	35
Assuit	5	2.61	2.02	29	4.99	4.93	1
Nubaria	6	1.11	0.91	33	—	—	—
Total/Mean	65	2.17	1.74	27	5.94	5.01	19

* Increase over traditional practices in:
- Net Returns: 47%.
- Benefit/Cost Ratio: 41%.

Chickpea

In Ethiopia, farmers obtained average yield increases of 117% (MRR of 526%) with the adoption of improved production packages. The desi line ICCL-84227 gave 10% more yield than the improved check, and the kabuli line, ICC-12339, produced 8 and 49% more yield than the improved desi and kabuli checks, respectively. At Adet, three lines outyielded the local check and Mariye by 37 to 42% and 16 to 19%, respectively. Advancing planting date at Alem Tena from August to July increased yield by more than 200%. The advantages of broadbed and furrows for chickpea planting were confirmed by 18-22% more seed yield compared with the ridge and furrow seedbed.

In Egypt, on-farm demonstrations gave yield increases of 24 to 42% in traditional and 26 to 53% in non-traditional production areas with improved production packages. The promising lines, Giza 531 and Giza 195, outyielded farmers' cultivars by 55 and 32%, respectively. Seeds of these two lines were provided to farmers in Upper Egypt, Nubaria, and the North West Coast. Surveys confirmed wilt/root rot as the major chickpea diseases in Egypt. The need for rhizobium inoculation of chickpea was shown in four of six locations and yield increase across locations (Table 25) was 40% with rhizobium inoculation combined with starter N (36 kg N/ha).

In Sudan, farmers adopting improved chickpea production package obtained, on average, 35% higher yields, with 120 to 213% MRR. The introduction ILC 915 was released in Sudan under the name Jebel Mara-1 (see Appendix 2). Twenty-four chickpea lines were identified as resistant to wilt/root rot diseases. Seed dressing with Tecto-TM increased seed yield by 23 to 33% under farmers' conditions through improving seed emergence.

Faba Bean

In Egypt, yield increases of 22 to 36%, with a MRR of 68 to 258%, were obtained in demonstrations of improved production packages in Minia, Beni Suif, and Assuit. The advantages of using a rotavator in sowing were demonstrated to farmers in Minia and Fayoum with yield increases of 33 and 18%, respectively. Yield gains from 6.6 to 26.6% were achieved through integrated control of chocolate spot and rust diseases between 1990/91 and 1992/93. In Upper Egypt and Beheira, control of *Orobanche* by an integrated package of sowing date, resistant/tolerant cultivars, low rate of Glyphosate and foliar fertilizer increased yield by 54 to 88%. Two new faba bean cultivars, Giza 461 and Giza Blanca, were released in the Delta and Nubaria, respectively. Two systematic surveys of legume viruses revealed faba bean necrotic

Table 25. Seed yield for promising chickpea Giza 531 with and without *Rhizobium* inoculation versus high nitrogen dose at six locations in Egypt, 1992/93.

Treatments	Seed yield (kg/ha)*						
	Fayoum	Assuit	Bostan	Alex.	NW coast	Ismailia	Mean
Control	1544d	1858b	1977	660b	1394d	1667	1516d
Inoc. with *Rhizobium*	1867c	1977b	1847	750b	1798c	1929	1695c
120 Kg N/ha split twice	2072b	2290a	2068	1254a	2081b	1857	1937b
36 Kg N/ha + *Rhizobium*	2371a	2340a	2008	1411a	2285a	2321	2126a
Mean	1964	2121	1975	1019	1889	1943	1819
DMRT at 5%	93	196	N.S.	163	127	N.S.	161
CV (%)	3.0	5.8	9.6	10.0	4.2	15.0	8.1

* Values followed by the same letter are not significantly different from each other according to Duncan Multiple Range Test at 5% probability level.

yellows virus (FBNYV) as the most prevalent (49.3%), particularly in Middle Egypt, followed by BYMV (24.3%) in Fayoum. It was apparent that FBYNV was the main reason behind the drastic drop in national faba bean production (40%) in 1991/92.

In Sudan, faba bean yield increases of 27 to 115%, with average MRR of 588%, were obtained by farmers who adopted the improved production packages. Three new faba bean cultivars were released: Shambat 616, Basabeer, and Hudeiba 93 (See Appendix 2). Screening for resistance to aphids is under way using the introduction 'Pakistani' as a source of resistance.

In Ethiopia, yield increases of 85 to 115% were realized with the adoption of improved package with an average MRR of 292%. Five improved faba bean selections for high and mid-altitudes were submitted to the Varietal Release Committee. Three lines with *Botrytis* spp. resistance and one with wilt/root rot resistance were in final stages of release. Yield responses to N and P fertilization in the Adet region indicated the need for inoculation with effective rhizobia and starter N and P fertilization.

Field Pea

In Ethiopia, demonstration of aphid control by Primiphos-methyl 50EC resulted in 18 to 63% increase in yield in two locations with an average MRR of 2807%. Verification trials with three cultivars and improved management practices resulted in 12 to 60% increase in yield with an average MRR of 95%. High seed yields up to 6.87 t/ha were obtained in Sinana.

Regional Cooperation and Networks

Complementarity in research work is used to solve problems of common interest and to avoid duplication of effort. Basic research on each problem is carried out in one of the three countries depending on its comparative advantage in resources and expertise, and the results are verified in the other two countries.

In food legumes, the networks cover the following areas: integrated control of wilt/root rot diseases; aphids and viruses; *Botrytis fabae*; development of autogamous faba bean; and socioeconomic studies. Achievements are apparent in the three countries in the standardization of screening methods, survey methodology, and laboratory diagnosis of virus diseases.

The wheat networks address wheat rusts, aphids and viruses, heat tolerance, water-use efficiency, response to photoperiod and vernalization, and socioeconomic studies. Achievements include the standardization of methodology in studies of wheat rusts, heat tolerance and water-use efficiency. Regional efforts have helped in the identification of physiological races of leaf and stem rusts of wheat throughout the Nile Valley countries. Based on prevailing races in each country, genes for rust resistance have been identified for breeding purposes. Widely-adapted, heat-tolerant wheat genotypes (El-Neilain, Genaro 81, Debeira, Wadi El-Nile, Giza 164, and Anza) were identified under heat stress conditions in both Sudan and Egypt. Commercial cultivars in all three countries were characterized for photoperiod sensitivity and vernalization.

Training and Human Resource Development

During the 1992/93 season, 64 national scientists/technicians from the three Nile Valley countries received non-degree training. A total of 262 scientists participated in professional visits, workshops, coordination meetings, and conferences through the support of NVRP. Eleven graduate students from Sudan and Ethiopia are being supported for M.Sc. degree training in breeding, crop physiology, soil fertility, N_2-fixation, soil-water-plant relationship, and socioeconomic and extension studies.

North Africa Regional Program

The North Africa Regional Program covering Algeria, Libya, Morocco, and Tunisia executes and coordinates ICARDA's core and special-funded collaborative research and training activities in those countries. The Program is also responsible for executing a special project supported by IFAD (International Fund for Agricultural Development) on transfer of technology.

Rapid Rural Appraisal in Algeria

A rapid rural appraisal was used to determine the agricultural problems in eastern Algeria. On-station research was reviewed and off-station socioeconomic research was planned in light of the findings of the survey. Participating organizations included the Institut Technique des Grandes Cultures; Institut Technique des Elevages, Bovins et Ovins; Institut National de la Recherche Agronomique; and ICARDA.

The seven *wilayates* (provinces) surveyed span a range of annual rainfall, from 550 to 250 mm, and temperatures in the Hauts Plateaux (highlands). The following research areas were identified:

1. Evaluation of forage legume and barley genotypes in appropriate representative sites within the area.

2. Tillage practices, especially whether deep tillage is necessary, and the use of simple anti-erosion practices.

3. Management and improvement of weedy fallows to increase the proportion of palatable and nutritious species, including legumes.

4. A drier site might be useful as an extension of the El Khroub trial involving local medic/barley versus weedy fallow/barley, provided local medic seed can be collected, multiplied, and mixed for establishment of the trial in future.

5. Economic optimization of nitrogen and phosphorus fertilizer recommendations according to rainfall zone.

6. A detailed livestock survey on flock management, nutrition and health; including components of population dynamics such as breeding management, lambing percentages, lamb survival and culling strategies.

7. Studies on the interrelationships between resident and transhumant flocks, including possible complementarities.

8. Socioeconomic studies to characterize farming systems, focusing on private farmers until land tenure problems are resolved in other sectors; and studies of markets and costs.

9. Economic modelling of the systems to identify opportunities for implementation.

Rotation Trial

Algerian and ICARDA researchers have established a long-term rotation trial at El Khroub, Algeria. The trial focuses on problems identified in the rapid rural appraisal survey and fits the description of a 'benchmark trial' for North Africa, whereby the work can be extended to other NARS.

Algerian and ICARDA scientists discuss research projects based on the results of a joint rapid rural appraisal.

Other Developments

In 1993, an agreement of cooperation between ICARDA and Algeria was signed. The agreement provides ICARDA the same privileges as to the U.N. organizations. The food legume scientist posted in North Africa for the last three years was transferred to Turkey to assume a new role as a coordinator for ICARDA's collaborative activities in that country.

The IFAD-funded project to increase cereal, food legume and livestock production in semi-arid areas in North Africa achieved encouraging results in all four countries through testing, verifying, and demonstrating improved technologies in farmers' fields. In Algeria, 66 testing sites were used. The improved technologies tested were superior to traditional methods. Yield differences between the improved and local varieties in the farmer-managed trials were significant and varied according to rainfall. Yields of winter chickpea varieties were still below their potential because of weed problems. The results for cereals and legumes from Tunisia and Libya on farmers' fields also confirmed the superiority of the improved technologies. In Morocco, the 1992/93 crop season was characterized by a severe drought (probability of less than 1 in 10 years). All 75 on-farm evaluation trials (each 0.5-1.0 ha) of barley cultivars and forage mixtures failed.

A new decentralized barley breeding strategy was initiated to better target barley germplasm in North Africa. Thus, testing sites have been identified and barley germplasm is being developed for specific adaptation to the various agroecological conditions in the region.

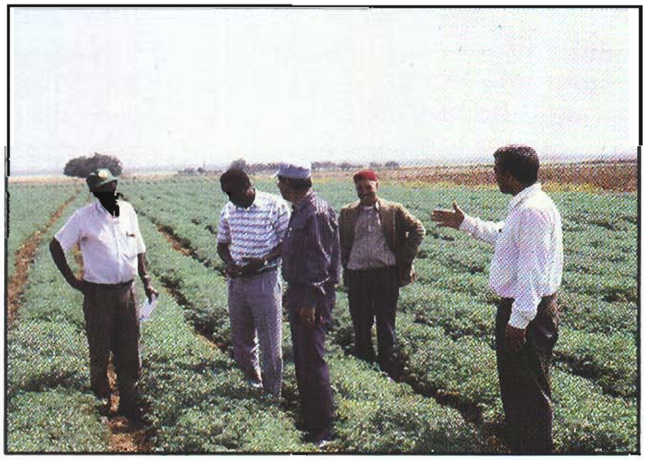
To continue and complement the work started within the Mashreq Project and to build on the progress, the four NARS, assisted by ICARDA, developed a project on "Transfer, Adoption, and Impact of Improved Agricultural Technologies in the Semi-Arid Regions of North Africa" as a second phase to the IFAD project. The Arab Fund for Economic and Social Development has agreed to co-finance the second phase for a period of three years starting in 1994.

To improve the quality and quantity of available feed, reduce dependency on imported feed, and improve livestock productivity, and at the same time protect rangelands from degradation, ICARDA in collaboration with IFPRI (International Food Policy Research Institute) developed a project on "Regional Adaptive Research for the Development of Integrated Crop/Livestock Production in West Asia and North Africa." IFPRI will conduct the research on common property resources and policy options to manage them sustainably.

ICARDA continued its active participation in, and support to, the UNDP-funded project on "Disease Surveillance and Germplasm Enhancement for Cereals and Food Legumes" executed by the concerned governments, and the BMZ-supported "Faba Bean Network in the Maghreb Countries."

Regional Collaboration

Increased collaboration between the four countries in North Africa was evident in germplasm enhancement and disease and insect surveys in cereals and food legumes. Inter-regional collaboration also increased. Scientists from the Nile Valley countries attended the Cereal Travelling Workshop in Tunisia, the Food Legume Travelling Workshop in Algeria, and visited the Tunisian legume program. A team of scientists from West Asia Regional Program visited the technology transfer and crop/livestock systems research in Tunisia. A Tunisian scientist attended the Iraq/ICARDA coordination meeting, and another attended the ICARDA/Jordan coordination meeting. These reciprocal visits helped in promoting the exchange of elite germplasm, information, and expertise.



Inter-regional cooperation: scientists from the Nile Valley countries visit the food legume improvement trials in Tunisia.

Training and Human Resource Development

In 1992/93, a total of 178 North African researchers attended individual or group training courses at ICARDA headquarters in Aleppo or in other WANA countries. The courses included a wide variety of subjects, such as DNA molecular marker techniques, experiment station management, supplemental irrigation, mechanical harvest of food and feed legumes, marginal land improvement, legume disease control, collection and preservation of nitrogen-fixing organisms, and breeding methodology in food and feed legumes.

Coordination Meetings

The North Africa/ICARDA Regional Coordination Meeting was held in Algeria. Attended by about 50 researchers from collaborating institutions in North Africa, in addition to staff members from MIAC (Morocco), IFAD and ICARDA, the meeting focused on inter-country and regional activities. The regional meeting followed individual country/ICARDA coordination and planning meetings with each of the four countries of North Africa.

Latin America Regional Program

For the Latin American countries, ICARDA operates a modest barley breeding program based at CIMMYT in Mexico. Interest in hull-less spring barley is increasing in several countries. Australia, Brazil, Canada, Chile, Ecuador and Bolivia have released hull-less barley cultivars derived from ICARDA's Mexico-based project (see Appendix 2).

Diseases (stripe rust, leaf rust and stem rust, scald, spot blotch and barley yellows dwarf virus) are a major constraint to the production of hull-less spring barley. The environmental conditions in countries where hull-less barley is grown favor disease development. ICARDA's hull-less barley project is attempting to incorporate multiple disease resistance in cultivars with high yield potential. The best hull-less cultivars identified for multiple disease resistance are listed in Table 26. Higo and Lino, although resistant to leaf rust in Mexico, were susceptible to a new race present in Ecuador in 1993. Monitoring virulence changes in target areas is, therefore, essential while breeding for disease resistance.

Table 26. Hull-less barley cultivars with multiple disease resistance to races present in Mexico, 1992/93.

Cultivar	Reaction to					
	Rust			Scald	Spot blotch	BYDV
	Stripe	Leaf	Stem			
Lino	R	R	R	R	R	R
Higo	R	R	R	S	S	R
Atahualpa	R	R	R	MS	MS	R
Viringa	R	R	R	MS	S	S
Nispero	R	R	R	MS	S	S
Ataco	MR	R	R	R	MS	R
Comino	R	R	R	MS	MS	MR

(R=Resistant, MR=Moderately resistant; MS=Moderately susceptible; S= Susceptible).

Resources for Research and Training

Finance

ICARDA's programs are funded by its generous donors (Table 27, see also Appendix 11). In 1993 the Center's grant funding was USD 16.286 million. Combined with other income of USD 1.922 million, the operating revenue was USD 18.208 million. The operating expenses during 1993 totalled USD 21.116 million resulting in a deficit of USD 2.908 million. This deficit was attributed to the global recession which forced the donor community to reduce their support to the CG System. ICARDA was notified in late July 1993 of USD 1.3 million reduction in funding from various donors. This forced the Center to reduce staff and activities to cope with the shortfall in funding.

In addition to cash donations from donors, the Center has, for a number of years, received in-kind contributions from Japan International Cooperation Agency (JICA) and Japan International Research Center for Agricultural Sciences (JIRCAS) in the form of equipment and secondment of Japanese scientists to ICARDA. In 1993, these in-kind contributions translated to US$ 485,000 and US$ 120,000, respectively.

Table 27. Sources of funds for ICARDA's programs and capital requirement (x 1000 USD), 1993 and 1992.

	1993	1992		1993	1992
Arab Fund	720	605a	Italy	1837	1216a
Arab Planning Institute	--	17a	Japan	350	311
Australia	285	296	Mexico	--	10
Austria	100	150	Netherlands	802	732a
CGIAR	4	--a	Norway	287	458
China	50	50	OPEC	28	50a
Denmark	298	348	Spain	125	125
FAO	15	24a	Sweden	527	663
Ford Foundation	32	274a	UNDP	284	298a
France	426	746a	UNEP	44	--a
Germany	1603	2134a	U.K.	753	905
IBRD (World Bank)	3200	3700	USAID	2627	4267a
IDRC	62	87a	Exchange gain/ (loss), net	759	(847)
IFAD	162	81a	Earned income	558	922
India	24	25	Other income	605	1872b
			Total	18,208	20,358

a Part or all of these amounts were provided for specified activities ("restricted core" and "complementary projects").
b Overhead recovery on in-trust projects and sale of farm produce.

Staff

During the year, the following senior staff members separated from ICARDA: Dr Douglas Beck, Food Legume Microbiologist; Dr John Hamblin, Leader, Cereal Improvement Program; and Dr Dyno Keatinge, Regional Coordinator (Highlands).

Dr Victor Shevtsov joined the Cereal Program as a Visiting Scientist.

Dr Habib Ketata, Senior Training Scientist and Dr Khaled Makkouk, Plant Virologist, returned after their sabbatic leave in the USA and Canada, respectively. Dr Mustapha Pala, Wheat-based Systems Agronomist, proceeded to the USA on sabbatical leave.

Computer and Biometric Services

General and Technical Support

Over 148 PCs, 131 terminals, and 40 printers were connected to the network. The VAX computers memory was increased to 128 MBytes each, while disk storage was enhanced to 8500 MBytes. A Policies and Procedures Manual was developed to streamline the use of computer services.

Scientific Computing

Progress was made on the development of a new Trials Management System; especially the modules for Trial Initialization, Randomization and Fieldbook preparation were completed. In addition, data entry/update/query/delete forms were completed. Programs to perform randomization for randomized complete blocks, completely randomized, split-plot, balanced and partially balanced lattice, alpha-lattice and augmented designs were completed.

A Meteorology Database was largely completed with data entry/update/query/delete forms for authorities, basins, districts, data elements, weather stations, and datasets. In addition, the monthly report of user-specified data elements and their headers was completed. A program was developed to convert current ICARDA meteorological data in ICADET format to the new database.

Based on a consultancy study on the implementation of a Geographic Information System at ICARDA, a project proposal entitled "Crops Distribution in West Asia and North Africa using GIS" was developed and submitted to potential donors.

A Palmtop computer was introduced for use as a data logger. To enable researchers to load randomization file and input data in a worksheet a program was developed. A number of macros were developed to facilitate the data entry and transfer between the palmtop and PCs. Also, a program was written to capture digital data from an electronic precision scale directly into a PC.

On VAX/VMS platform, SAS software was upgraded to release 6.08, while on 386 CPU PC platform, GENSTAT was upgraded to version 2.2.

Biometrics

Biometric support was offered in planning of experiments, analysis of data, interpretation and reporting of results, statistical review of research manuscripts, exploration of models to fit data, training and addressing gaps in biometrical methods for specialized applications areas.

Advisory support was offered on more than 150 occasions in various disciplines. About 30% of the consultancies were on planning of experiments. More trials under breeding programs in cereals and legumes have now been planned for their evaluation using α-lattices. A number of diallel and line x tester experiments would also be conducted in α-lattices. Experimental designs were suggested for evaluation of nutrition values of feeds for sheep and effect of feed factors on their body conditions, and to model effects of abiotic stress on emergence in wheat under rain-out shelters. To study spatial variability in boron content of the fields at Bouider, a sampling design was offered.

Assistance on data analysis was offered in some areas: barley rotations at Tel Hadya and Breda; rotations of annual pasture, forage and feed legumes with cereals at Tel Hadya and Kamishly and at farmers' fields at El Bab; seed germination dynamics of amphicarpous legumes; effect of body conditions on lambing variables; modeling of sheep fat on live-weight and body condition scores, modelling of effects of temperature on germination in wheat; plot-type study to evaluate effects of borders and row ends; modeling of viability of wheat genotypes and grouping accessions for similar growth habits, effect of nucleus and cytoplasm on wheat yield, crop loss assessment and weed control in legumes.

Biometric techniques were developed to estimate heritability from varietal trials conducted in incomplete blocks and estimated standard error using data from incomplete blocks at single or several locations; and for inter-site transferability of crop varieties by obtaining a statistic using genotype x environment yield data. The developed statistic was useful in selecting genotypes both for yield and transferability over the target environments represented by the test environments. Critical period of weed interference was estimated as a function of weed-free duration or weed-infested duration.

Management Information Systems

A parallel run of the General Ledger and the Accounts Payable modules of the financial software was made during much of the year. The Purchasing module was successfully implemented, and the Inventory Control parallel run was made in the last quarter. Data loading for the Fixed Assets is proceeding, while the set up for the Personnel module was completed for implementation. The old system was also maintained throughout the year. Requirement specifications for a Project Management and Central Data Registry system were developed.

Training and Visits

A total of 33 courses and sessions were conducted for 440 in-house staff members in diverse areas including PC software packages, statistical packages, network, and VMS. Specialized biometrics sessions covered aspects of G x E interaction study, controlling field variability using α-designs and analysis of a series of split-plot experiments, statistical methods for estima-

In 1993, in-house training courses were offered to 440 staff members in diverse areas including PC software packages, statistical packages, network, and VMS.

tion of means, variances and proportions, test of significance and association between variables.

A training course on "Biometrical Techniques and Related Computing in Agricultural Research" was conducted at Tel Hadya for eight NARS participants. An in-country training course on "Computer Applications in Agricultural Research" was conducted in Iran for 24 researchers. ICARDA cooperated with ILCA in a regional course in Ethiopia on "Scientific Writing and Data Presentation" for 20 researchers. A biometrician from Sudan visited the Center's computer facilities to gain practical experience on analysis of multi-locational data, crop-trait association, intercropping experiments, and long-term trials.

Farms

ICARDA operates five sites in Syria and two in Lebanon (Table 28). These sites represent a variety of agroclimatic conditions, typical of those prevailing in West Asia and North Africa.

Table 28. 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

Appendixes

Contents

Appendix 1

Precipitation (mm) in 1992/93

	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	TOTAL
SYRIA													
Tel Hadya													
1992/93 season	0.3	0.00	49.0	50.1	57.8	40.3	41.7	0.60	36.9	0.6	0.0	12.8	290.1
Long-term average (15 seasons)	0.5	26.0	47.1	55.0	60.8	51.2	41.9	24.7	16.4	2.9	0.0	0.6	327
% of long-term average	63	0	104	91	95	79	100	2	226	21	—	1367	89
Breda													
1992/93 season	11.2	1.0	69.4	32.6	42.7	50.0	36.9	8.0	30.0	1.2	0.0	0.0	283
Long-term average (35 seasons)	1.6	16.5	31.9	52.3	48.1	38.6	74.5	29.9	16.5	15.0	0.21	0.0	325
% of long-term average	713	6	218	62	89	130	50	27	182	8	0	—	87
Boueider													
1992/93 season	0.6	0.0	53.4	28.6	58.0	33.2	27.0	8.6	11.8	24	0.0	0.6	224.2
Long-term average (20 seasons)	0.1	18.7	23.6	37.1	42.0	35.4	72.2	16.5	9.9	1.1	0.1	0.0	257
% of long-term average	1000	0	226	77	138	94	37	52	119	2202	0	2000	87
Ghrerife													
1992/93 season	3.4	0.0	55.0	28.3	59.0	44.8	32.1	1.2	48.8	4.8	0.0	0.0	277.4
Long-term average (8 seasons)	0.4	31.2	27.4	39.5	46.7	41.0	3.3	10.2	18.7	3.1	0.0	0.0	253
% of long-term average	791	0	201	72	127	109	94	12	261	154	—	—	110
Jindiress													
1992/93 season	1.0	0.2	74.8	49.7	57.5	53.8	71.6	23.2	69.8	15.2	0.0	20.2	437
Long-term average (33 seasons)	1.5	30.2	55.5	91.7	84.0	73.2	62.2	41.4	20.1	4.7	0.0	1.5	467
% of long-term average	67	1	135	54	68	74	115	56	347	323	—	1347	94
LEBANON													
Terbol													
1992/93 season	0.0	0.0	140.2	168.0	131.2	51.6	125.2	14.2	31.6	0.0	0.0	0.0	662.0
Long-term average (12 seasons)	0.0	23.2	67.9	98.2	125.4	118.7	99.2	24.6	19.4	3.1	0.3	0.0	580
% of long-term average	—	0	207	171	105	44	126	58	163	0	0	—	114

Note: The long-term average is subject to some fluctuation as each year's new data are averaged in. For location, elevation, etc. of these sites, see Table 28 on page 69.

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
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
	1993	Jau-93
Peru	1987	Una 87, Nana 87

Country	Year of release	Variety
Barley (contd.)		
	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
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
		Stork = ACSAD 75
Lebanon	1987	Belikh 2
	1989	Sebou

Country	Year of release	Variety
Durum Wheat (contd.)		
Libya	1985	Marjawi, Ghuodwa, Zorda, Baraka, Qara, Fazan
	1992	Khiar 92
	1993	Zahra 5
Morocco	1984	Marzak
	1989	Sebou, Om Rabi
	1991	Tensif
	1992	Brachoua, Om Rabi 5
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
	1992	Om Rabi 3, Lahn
Tunisia	1987	Razzak
	1993	Om Rabi 3, Khiar
Turkey	1984	Susf bird
	1985	Balcili
	1988	EGE 88
	1990	Cham 1
	1991	Kizilton
Bread Wheat		
Algeria	1982	Setif 82, HD 1220
	1989	Zidane 89
	1992	Zidane, Nesser, ACSAD 59=40DNA, Cham 4=Sidi Okba, Siete Cerros=Rhumel, Alondra=21AD, DouggaXBJ=Soummam
Egypt	1982	Giza 160
	1988	Sakha 92, Giza 162 Giza 163, Giza 164
	1991	Gammeiza 1, Giza 165
	1993	Sahel 1

Country	Year of release	Variety
Bread Wheat (contd.)		
Ethiopia	1984	Dashen, Batu, Gara
Greece	1983	Louros, Pinios, Arachthos
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,
Tanzania	1983	T-VIRI-Veery 'S' T-DUMA-D6811-Inrat 69/BD Tunisian release
Tunisia	1987	Byrsa, Salambo
	1992	Vaga 92
Turkey	1986	Dogankent-1 (Cham 4)
	1988	Kaklic 88, Kop, Dogu 88
	1989	Es14
	1990	Yuregir, Karasu 90, Katia 1
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

Country	Year of release	Variety
Kabuli Chickpea (contd.)		
	1991	FLIP 84-79C
		FLIP 84-92C
China	1988	ILC 202, ILC 411
	1993	FLIP 81-40W
		FLIP 81-71C
Cyprus	1984	Yialousa (ILC 3279)
	1987	Kyrenia (ILC 464)
Egypt	1993	ILC 195
France	1988	TS 1009 (ILC 482)
		TS 1502 (FLIP 81-293C)
	1992	Roye Rene (FLIP 84-188C)
Iraq	1991	ILC 482, 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)
	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)

Country	Year of release	Variety
Kabuli Chickpea (contd.)		
	1991	Akcin (87AK 11115)
	1992	Aydin 92 (FLIP 82-259C)
		Menemin 92 (FLIP 85-14C)
		Izmir 92 (FLIP 85-60C)
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
Iraq	1992	ILL 8 (78S 26002)
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)

Country	Year of release	Variety
Faba Bean		
Egypt	1991	Reina Blanca, Giza 461
Iran	1986	Barkat (ILB 1269)
Portugal	1989	Favel (80S 43977)
Sudan	1990	Sellaim-ML
	1991	Shambat 75, Shambat 104
	1993	Shambat 616 (00616)
		Basabeer (BB 7)
		Hudeiba 93 ((Bulk 1/3)
Syria	1991	Hama 1 (Selection from Aquadulce)

Country	Year of release	Variety
Peas		
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 1993. Some of the titles published in 1992 but not captured for reporting in the Center's 1992 Annual Report are also included.

Publications

Articles in Journals

Abd El Moneim, A.M. 1993. Agronomic potential of three vetches (*Vicia* spp.) under rainfed conditions. Journal of Agronomy and Crop Science 170(2): 113-120.

Abd El-Moneim, A.M. 1993. Selection for non-shattering common vetch, *Vicia sativa* L. Plant Breeding 110(2): 168-171.

Abd El Moneim, A.M. and M. Bellar. 1993. Response of forage vetches and forage peas to root-knot nematode (*Meloidogyne artiellia*) and cyst nematode (*Heterodera ciceri*). Nematologia Mediterranea 21(1): 67-70.

Abd El-Moneim, A.M. and P.S. Cocks. 1993. Adaptation and yield stability of selected lines of *Lathyrus* spp. under rainfed conditions in West Asia. Euphytica 66(1-2): 89-97.

Aboul-Ata, A.E., J.C. Thouvenel, K.M. Makkouk and M.M. Satour. 1992. Barley yellow dwarf virus in Egypt: natural incidence, transmission and wild hosts. Arab Journal of Plant Protection 10(2): 226-231.

Aletor, V.A. and C.C. Res. 1993. Allelochemicals in plant food and feedingstuffs: 1. nutritional, biochemical and physiopathological aspects in animal production. Veterinary and Human Toxicology 35(1): 57-67.

Arnaud-Santana, E., M.T. Mmbaga, D.P. Coyne and J. Steadman. 1993. Sources of resistance to common bacterial blight and rust in elite *Phaseolus vulgaris* L. germplasm. Hortscience 28(6): 644-646.

Beale, P.E., M. Bounejmate, A. Lahlou, D.B. Marx and S. Christiansen. 1993. Distribution of annual *Trifolium* species in Morocco. Australian Journal of Agricultural Research 44(6): 1303-1310.

Berhe, A., S.P.S. Beniwal, A. Gizaw, A. Telaye, H. Beyene and M.C. Saxena. 1990. On-farm evaluation of four management factors for faba bean production in the Holetta zone of Shewa. Ethiopian Journal of Agricultural Science 12: 17-28.

Bos, L., M. A-M. Mahir and K.M. Makkouk. 1993. Some properties of pea early-browning tobravirus from faba bean (*Vicia faba* L.) in Libya. Phytopathologia Mediterranea 32(1): 7-13.

Cocks, P.S. 1993. Seed and seedling dynamics over four consecutive years from a single seed set of six annual medics (*Medicago* spp.) in North Syria. Experimental Agriculture 29(4): 461-472.

Dakheel, A.J., I. Naji, V. Mahalakshmi and J.M. Peacock. 1993. Morphophysiological traits associated with adaptation of durum wheat to harsh Mediterranean environments. Aspects of Applied Biology 34: 297-307.

El-Naimi, M. and O.F. Mamluk. 1992. Pathogenicity of *Septoria tritici* blotch, *Mycosphaerella graminicola*, with inoculum from different origins on wheat. Arab Journal of Plant Protection 10(2): 161-165.

Elings, A. 1993. Durum wheat landraces from Syria. III. Agronomic performance in relation to collection regions and landrace groups. Euphytica 70(1): 85-96.

Elings, A. and M.M. Nachit. 1993. Field evaluation and simulation of frost tolerance in Syrian durum wheat landraces. Netherlands Journal of Agricultural Science 41(1): 1-11.

Erskine, W. and F. Ashkar. 1993. Rainfall and temperature effects on lentil seed yield in Mediterranean environments. Journal of Agricultural Science, Cambridge 121(3): 347-354.

Erskine, W., N.P. Saxena and M.C. Saxena. 1993. Iron deficiency in lentil: yield loss and geographic distribution in a germplasm collection. Plant and Soil 151(2): 249-254.

Fortass, M. and L. Bos. 1992. Broad bean mottle virus in Morocco; variability, interaction with food legume species, and seed transmission in faba bean, pea, and chickpea. Netherlands Journal of Plant Pathology 98(6): 329-342.

Fujita, M., N. Kawada and M. Tahir. 1992. Relationship between cold resistance, heading traits and ear primordia development of wheat cultivars. Euphytica 64(1-2): 123-130.

Giangaspero, M., L. Gruner, H. Nishikawa, D. Tabbaa and G. Vacirca. 1993. Lungworms, *Visna maedi* and mixed infections with respiratory viruses in Syrian Awassi sheep. Veterinary Research Communications 17: 371-374.

Giangaspero, M., E. Vanopdenbosch and H. Nishikawa. 1992. Lentiviral arthritis and encephalitis in goats in north-west Syria. Revue d' Elevage et de Medecine Veterinaire des Pays Tropicaux 45(3-4): 241.

Greco, N., M. Di Vito, K.B. Singh and M.C. Saxena. 1993. Effect of *Heterodera ciceri* on the growth of selected lines of *Cicer* species. Nematologia Mediterranea 21(1): 111-116.

Ibrahim, M., W. Erskine, G. Hanti and A. Fares. 1993. Lodging in lentil as affected by plant population, soil moisture and genotype. Experimental Agriculture 29(2): 201-206.

Jana, S. and K.B. Singh. 1993. Evidence of geographic divergence in kabuli chickpea from germplasm evaluation data. Crop Science 33(4): 626-632.

Janssen, W.G. 1993. Economic and agricultural development in West Asia and North Africa, the need for agricultural research. Food Policy (December): 507-522.

Katul, L., H.J. Vatten, E. Maiss, K.M. Makkouk, D-E. Lesemann and R. Casper. 1993. Characterization and serology of virus-like particles associated with faba bean necrotic yellows. Annals of Applied Biology 123(3): 629-647.

Keatinge, J.D.H. and K. Somel. 1993. Guidelines for improved agronomic management and economic evaluation of crop rotation trials in Mediterranean environments. Experimental Agriculture 29(4): 437-447.

Kittlitz, E.V., K.I.M. Ibrahim, P. Ruckenbauer and L.D. Robertson. 1993. Analysis and use of interpool-crosses (Mediterranean x Central European) in faba beans (*Vicia faba* L.). I. Performance of Mediterranean and Central European faba beans in Syria and Germany. Plant Breeding 110(4): 307-314.

Kumari, S.G., K.M. Makkouk and I.D. Ismail. 1993. Survey of seed-borne viruses in lentil in Syria and their effects on lentil yield. Arab Journal of Plant Protection 11(1): 28-32.

Linke. K.-H., A.M. Abd El-Moneim and M.C. Saxena. 1993. Variation in resistance of some forage legumes species to *Orobanche crenata* Forsk. Field Crops Research 32(3-4): 277-285.

Mahmood, K. and A. Rodriguez. 1993. Marketing and processing of small ruminants in highland Balochistan, Pakistan. Small Ruminant Research 10(2): 93-102.

Makkouk, K.M., H.T. Hsu and S.G. Kumari. 1993. Detection of three plant viruses by dot-blot and tissue-blot immunoassays using chemiluminescent and chromogenic substrates. Journal of Phytopathology 139(2): 97-102.

Makkouk, K.M., S.G. Kumari and R. Al-Daoud. 1992. Survey of viruses affecting lentil (*Lens culinaris* L.) in Syria. Phytopathologia Mediterranea 31(3): 188-190.

Makkouk, K.M., S.G. Kumari and L. Bos. 1993. Pea seed-borne mosaic virus: occurrence in faba bean (*Vicia faba* L.) and lentil (*Lens culinaris* Med.) in West Asia and North Africa, and further information on host range, transmission characteristics, and purification. Netherlands Journal of Plant Pathology 99(3): 115-124.

Makkouk, K.M., S.G. Kumari and A. Shehadeh. 1992. Seed transmission of pea seed-borne mosaic virus in *Lathyrus* and *Vicia* forage legume species. Journal of Plant Disease and Protection 99: 561-563.

Mamluk, O.F. and M.W. Van Slageren. 1993. Resistance to common bunt, yellow rust, leaf rust and *Septoria tritici* blotch in wild einkorn and wild emmer wheat. Phytopathologia Mediterranea 32(1): 14-19.

Mamluk, O.F. and A. Zahour. 1993. Differential distribution and prevalence of *Tilletia foetida* (Wallr.) Liro and *T. caries* (DC) Tul. on bread wheat and durum wheat. Phytopathologia Mediterranea 32(1): 25-32.

Mamluk, O.F., O. Tahhan, R.H. Miller, B. Bayaa, K.M. Makkouk and S.B. Hanounik. 1992. A checklist of cereal, food legume and pasture and forage crop diseases and insects in Syria. Arab Journal of Plant Protection 10(2): 166-225.

Miller, R.H., S. El Masri and K. Al Jundi. 1993. Plant density and wheat stem sawfly (*Hymenoptera: Cephidae*) resistance in Syrian wheats. Bulletin of Entomological Research 83(1): 95-102.

Miller, R.H., K.S. Pike, L.K. Tanigoshi, L.L. Buschman and S. Kornosor. 1993. Distribution and ecology of the Russian wheat aphid, *Diuraphis noxia* Mordvilko (Homoptera: Aphididae) in western Asia and northern Africa. Arab Journal of Plant Protection 11(1): 45-52.

Ocampo, B., G. Venora, A. Errico, K.B. Singh and F. Saccardo. 1992. Karyotype analysis in the genus *Cicer*. Journal of Genetics and Breeding 46(3): 229-240.

Pecetti, L. and M.M. Nachit. 1993. Phenotypic variation of durum wheat landraces for Morocco and influence of some features of the collecting site. Agricultura Mediterranea 123: 243-251.

Reddy, M.V. and K.B. Singh. 1993. Rate-reducing resistance to ascochyta blight in chickpeas. Plant Disease 77(3): 231-233.

Rihawi, S., E. Owen, A.V. Goodchild, A. Termanini and T.T. Treacher. 1993. Grazing of barley stubble by sheep in Syria: effect of stocking rate on selective intake of stubble fractions. Animal Production 56(3): 455.

Robertson, L.D., S.B. Hanounik, Z.A. Fatemi, R. Kallida, S.P.S. Beniwal and M.C. Saxena. 1992. Development and highlights of faba bean research in Morocco under INRA/ICARDA collaborative program. Al Awamia (78): 83-112.

Rodriguez, A., I. Ali, M. Afzal and N.A. Shah. 1993. Marketing of goat and sheep skins in highland Balochistan, Pakistan. Small Ruminant Research 12: 259-270.

Silim, S.N. and M.C. Saxena. 1993. Yield and water use efficiency of faba bean sown at two row spacings and seed densities. Experimental Agriculture 29(2): 173-181.

Silim, S.N. and M.C. Saxena. 1993. Adaptation of spring-sown chickpea to the Mediterranean basin. I. Response to moisture supply. Field Crops Research 34(2): 121-136.

Silim, S.N. and M.C. Saxena. 1993. Adaptation of spring-sown chickpea to the Mediterranean basin. II. Factors influencing yield under drought. Field Crops Research 34(2): 137-146.

Silim, S.N., M.C. Saxena and W. Erskine. 1993. Adaptation of lentil to the Mediterranean environment. I. Factors affecting yield under drought conditions. Experimental Agriculture 29(1): 9-19.

Silim, S.N., M.C. Saxena and W. Erskine. 1993. Adaptation of lentil to the Mediterranean environment. II. Response to moisture supply. Experimental Agriculture 29(1): 21-28.

Simane, B., J.M. Peacock and P.C. Struik. 1993. Differences in developmental plasticity and growth rate among drought-resistant and susceptible cultivars of durum wheat. Plant and Soil 157: 155-166.

Singh, K.B., G. Bejiga and R.S. Malhotra. 1993. Genotype-environment interactions for protein content in chickpea. Journal of the Science of Food and Agriculture 63(1): 87-90.

Singh, K.B. and S. Jana. 1993. Diversity for responses to some biotic and abiotic stresses and multivariate associations in kabuli chickpea (*Cicer arietinum* L.). Euphytica 68(1-2): 1-10.

Singh, K.B., R.S. Malhotra and M.C. Saxena. 1993. Relationship between cold severity and yield loss in chickpea (*Cicer arietinum* L.). Journal of Agronomy and Crop Science 170(2): 121-127.

Singh, K.B., R.S. Malhotra and M.C. Saxena. 1993. Registration of 'ILC 72' chickpea. Crop Science 33(6): 1409.

Singh, K.B., R.S. Malhotra and M.C. Saxena. 1993. Registration of 'ILC 195' chickpea. Crop Science 33(6): 1409-1410.

Singh, K.B. and B. Ocampo. 1993. Interspecific hybridization in annual *Cicer* species. Journal of Genetics and Breeding 47: 199-204.

Singh, K.B. and M.V. Reddy. 1993. Resistance to six races of *Ascochyta rabiei* in the world germplasm collection of chickpea. Crop Science 33(1): 186-189.

Singh, K.B. and M.V. Reddy. 1993. Sources of resistance to ascochyta blight in wild *Cicer* species. Netherlands Journal of Plant Pathology 99(3): 163-167.

Singh, K.B. and M.V. Reddy. 1993. Susceptibility of the chickpea plant to ascochyta blight at different stages of crop growth. Phytopathologia Mediterranea 32(2): 153-155.

Singh, M. 1993. Behaviour of sample coefficient of variation drawn from several distributions. Sankhya: The Indian Journal of Statistics, Series B, 55(1): 65-76.

Singh, M. and K. Hinkelmann. 1992. Distribution of genotypic correlation coefficient and its transforms for non-normal populations. Sankhya: The Indian Journal of Statistics, Series B, 54(1): 42-66.

Singh, M., S. Ceccarelli and J. Hamblin. 1993. Estimation of heritability from varietal trials data. Theoretical and Applied Genetics 86(4): 437-441.

Somel, K., A. Mazid and K. El-Hajj. 1992. Risk implications of fertilizer use on rainfed barley. METU Studies in Development 19(3): 413-448.

Tahir, M. and M. Singh. 1993. Assessment of screening techniques for heat tolerance in wheat. Crop Science 33(4): 740-744.

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

Thomson, E.F., F. Herbert and S. Rihawi. 1993. Effects of genotype and simulated rainfall on the morphological characteristics, chemical composition and rumen degradation of the straw fractions of barley plants. Animal Feed Science and Technology 44: 191-208.

Van Oosterom, E.J. and E. Acevedo. 1993. Leaf area and crop growth in relation to phenology of barley

in Mediterranean environments. Plant and Soil 148(2): 223-237.
Van Oosterom, E.J., S. Ceccarelli and J.M. Peacock. 1993. Yield response of barley to rainfall and temperature in Mediterranean environments. Journal of Agricultural Science, Cambridge 121(3): 307-314.
Van Oosterom, E.J., D. Kleijn, S. Ceccarelli and M.M. Nachit. 1993. Genotype-by-environment interactions of barley in the Mediterranean region. Crop Science 33(4): 669-674.
Van Oosterom, E.J. and J.M. Peacock. 1993. Apex development patterns: the physiological basis to adaptation of barley to harsh Mediterranean environments. Aspects of Applied Biology 34(1): 289-295.
Wahbi, A., A.E. Matar and M.J. Jones. 1993. Responses of a forage hay crop to the residual effects of nitrogen and phosphorus fertilizers in on-farm trials in northern Syria. Experimental Agriculture 29(4): 429-435.
Weber, E., M.C. Saxena, E. George and H. Marschner. 1993. Effect of vesicular-arbuscular mycorrhiza on vegetative growth and harvest index of chickpea grown in northern Syria. Field Crops Research 32(1-2): 115-128.

Scientific Reports and Manuals

Annual report for the international barley nurseries 1990-91. 237 pp.
Annual report for CIMMYT/ICARDA regional bread wheat nurseries 1990/91. 250 pp.
Annual report for CIMMYT/ICARDA regional durum wheat nurseries 1990/91. 216 pp.
International nursery report No. 14. Food legume nurseries 1989-90. 311 pp.
Legume program: research and training plans, 1992/93 season. 102 pp.
Board of trustees presentation, 1992. 80 pp.
Cereal improvement program, annual report 1992. 197 pp.
Legume program, annual report 1992. 363 pp.
Farm resource management program, annual report 1992. 211 pp.
Pasture, forage and livestock program, annual report 1992. 277 pp.
Genetic resources unit, annual report 1992. 170 pp.
Seed unit, annual report 1992. 25 pp.
ICARDA annual report 1992. 142 pp.
Meteorological reports for ICARDA experiment stations in Syria and Lebanon 1991/92. 426 pp.
Beck, D.P., L.A. Materon and F. Afandi. 1993. Practical Rhizobium-legume technology manual. Technical Manual No. 19. 389 pp.
Beniwal, S.P.S., B. Baya'a, S. Weigand, Kh. Makkouk and M.C. Saxena. 1993. Field guide to lentil diseases and insect pests. 107 pp. ISBN 92-9127-009-1.
Diekmann, M. 1993. Seed-borne diseases in seed production. 81 pp. ISBN 92-9127-012-1.
Li-juan, L., Y. Zhao-hai, Z. Zhao-jie, X. Ming-shi and Y. Han-qing. 1993. Faba bean in China: state-of-the-art review. 144 pp.
Naji, I. 1993. Agronomy and on-farm trials: an advanced technique for technology transfer. Technical Manual No. 18. (in Arabic). 33 pp.
Weigand, F., M. Baum and S. Udupa. 1993. DNA molecular marker techniques. Technical Manual No. 20. 51 pp.

Reference Books and Conference Proceedings

Bascur B., G. 1993. La lenteja y el haba en America Latina: su importancia, factores limitantes e investigacion. Rapporte de estudio especial (E. Galvez E., ed.). 154 pp. ISBN 92-9127-007-5.
Bascur B., G. 1993. Lentil and faba bean in Latin America: their importance, limiting factors and research. Special study report (T. Brekelbaum, translator and G.E. Galvez E., ed.). 156 pp. ISBN 92-9127-008-3.
Christiansen, S., L. Materon, M. Falcinelli and P. Cocks (editors). 1993. Introducing ley farming to the Mediterranean basin: proceedings of an international workshop on introducing the ley farming system in the Mediterranean basin, 26-30 June 1989, Perugia Italy. 299 pp. ICARDA, Aleppo, Syria. ISBN 92-9127-004-0.
Damania, A.B. (editor). 1993. Biodiversity and wheat improvement: proceedings of the workshop on evaluation and utilization of biodiversity in wild relatives and primitive forms for wheat improvement, 12-15 October 1992, Aleppo, Syria. 434 pp. Published for ICARDA by John Wiley and Sons, Chichester, UK. ISBN 0-471-94137-9.
Erskine, W. and M.C. Saxena (editors). 1993. Lentil in

South Asia: proceedings of a seminar on lentil in South Asia, 11-15 Mar 1991, New Delhi, India. 236 pp. ICARDA, Aleppo, Syria. ISBN 92-9127-003-2.

Jones, M., G. Mathys and D. Rijks (editors). 1993. The agrometeorology of rainfed barley-based farming systems: proceedings of an international symposium, 6-10 March 1989, Tunis, Tunisia. 368 pp. ICARDA, Aleppo, Syria. ISBN 92-9127-002-4.

Miller, R., M. Taher and S. Barbosa (editors). 1993. Report of the expert consultation on sunn pest problem and its control in the Near East region. FAO/ICARDA Expert Consultation on Sunn Pest, 16-20 May 1993, Aleppo, Syria. 28 pp. FAO, Cairo, Egypt.

Monneveux, P. and B. Salem (editors). 1993. Tolerance a la secheresse des cereals en zone mediterraneenne: diversite genetique et amelioration varietale, 15-17 December 1992, Montpellier, France. Coll. les Colloques, No. 64. Fr. 436 pp. INRA, Montpellier, France. ISBN 2-7380-0512-8.

Saxena, M.C., S. Weigand and L. Li-Juan (editors). 1993. Faba bean production and research in China: proceedings of an international symposium, 24-26 May 1989, Hangzhou, China. 179 pp. ICARDA, Aleppo, Syria. ISBN 92-9127-018-0.

Singh, K.B. and M.C. Saxena (editors). 1993. Breeding for stress tolerance in cool-season food legumes: proceedings of an international conference on breeding for stress tolerance in cool-season food legumes, 10-12 September 1990, Ravello, Italy. 473 pp. Published for ICARDA by John Wiley and Sons, Chichester, UK. ISBN 0-471-94212-X.

Periodicals/Newsletters

FABIS Newsletter. 1992, No. 31, 56 pp.; Supplement 1992, Faba bean bibliography, 106 pp.

LENS Newsletter. 1992, Vol. 19, No. 2, 91 pp.; 1993, Vol. 20, No. 1, 68 pp.; Supplement 1992, Lentil bibliography, 44 pp.

RACHIS Newsletter. 1992, Vol. 10, No. 2, 44 pp.

Seed Info. 1993, No. 4, En, 12 pp.; No. 5, En, 13 pp.

Other Publications

Hawtin, L. and L. Sears. 1993. Legume cookbook: cooking with chickpeas, faba beans and lentils. 119 pp.

ICARDA and the Arab world. 4 pp.

ICARDA in the news 1992 (A compilation of media stories on ICARDA). 82 pp.

ICARDA publications catalog, 1991 supplement. 31 pp.

ICARDA's preliminary response to the 1993 external programme and management review: document presented to the Technical Advisory Committee of the CGIAR at its 61st Meeting at IIMI, Sri Lanka, 28 June-6 July, 1993. 15 pp.

Medium-term plan 1994-1998. 208 pp. ISBN 92-9127-005-9.

Ties that bind, No. 4. The Netherlands and ICARDA. 9 pp.

Regional Program Publications

Highland Regional Program

Pakistan

(Available from: ICARDA, c/o Arid Zone Research Institute, PARC, P.O. Box 362, Quetta, Pakistan)

Highland regional program: the MART/AZRI project annual report 1992. 54 pp.

Khan, M.A., I. Begum, S. Ahmad, S.A. Jalil and E.F. Thomson. 1993. Germplasm evaluation in the arid highlands of Balochistan: annual report of the AZRI Germplasm Research Group. 56 pp.

Rodriguez, A., N.A. Shah, M. Afzal, U. Mustafa and I. Ali. 1993. Economics of water-harvesting trials with cereal crops in highland Balochistan. 37 pp.

Turkey

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

Bayaner, A., V. Uzunlu, J.D.H. Keatinge and R. Tutwiler. 1993. Agricultural structures and constraints to increased production in the eastern margin of central Anatolia: the TARM/ICARDA SIVAS-KAYSERI Collaborative Project. 68 pp.

Erkan, O., V. Tansi, T. Tukel, N. Uygun, U. Dinc, O. Bicer, O. Kaftanoglu, H. Baspinar, O. Guney, M. Jones, D. Keatinge, M. Pala, T. Treacher, A. Mazid, F. Bahhady, T. Goodchild and P. Cocks. 1993. Development of small-scale farmers of Taurus mountains of Turkey. Highland Regional

Program: Cukurova University/ICARDA Taurus Mountains Collaborative Project Annual Report 1990/91. 35 pp.

Nile Valley Regional Program

(Available from: ICARDA, P.O. Box 2116, Cairo, Egypt)

Nile Valley regional program on cool-season food legumes and wheat-Sudan: bread wheat report, annual national coordination meeting, 29 August - 2 September 1993, Agricultural Research Corporation, Wad Medani, Sudan. 304 pp.

Nile Valley regional program on cool-season food legumes and wheat, annual report 1991/92, Sudan. 128 pp.

Nile Valley regional program on cool-season food legumes and wheat, workplan and budget 1993/94, Sudan. 95 pp.

Nile Valley regional program on cool-season food legumes and cereals. Workplan and budget 1992/93, Egypt. 147 pp.

Nile Valley regional program on cool-season food legumes and cereals, annual report 1991/92, Egypt. 136 pp.

Nile Valley regional program on cool-season food legumes, annual report 1991/92, Ethiopia. 134 pp.

Nile Valley regional program on cool-season food legumes, workplan and budget 1993/94, Ethiopia. 105 pp.

North Africa Regional Program

(Available from: ICARDA, Immeuble STB Dalia 6, 1st Floor, Apt. 1, Tunis, Tunisia)

North Africa/ICARDA regional coordination meeting: research highlights and workplans 1992/1993, in collaboration with the Algerian, Libyan, Moroccan and Tunisian agricultural research programs. 190 pp.

West Asia Regional Program

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

Ahmed, D. and B. Mohammed. 1992. Economic assessment of Mashreq project technology transfer (1989-1992). 43 pp.

West Asia regional program on increased productivity of barley, pasture and sheep, annual report 1991/92. 177 pp.

West Asia regional program on increased productivity of barley, pasture and sheep, workplan for Syria, 1993/1994. 117 pp.

West Asia regional program on increased productivity of barley, pasture and sheep, workplan for Jordan 1993/1994. 112 pp.

West Asia regional program on increased productivity of barley, pasture and sheep, workplan for Iraq 1993/1994. 140 pp.

Mashreq Project Newsletter. 1993. No. 3, 18 pp.; No. 4, 20 pp.

Syria/ICARDA Collaborative Program

ICARDA/Syria collaborative research and training program: annual report 1991/92. 265 pp. ICARDA, Aleppo, Syria.

ICARDA/Syria collaborative research and training program: ten years' achievements 1981-1991. 32 pp. ICARDA, Aleppo, Syria.

Book Chapters and Papers in Conference Proceedings

Ceccarelli, S. 1993. Plant breeding technologies relevant to developing countries. Pages 37-46 *in* Animal Production in Developing Countries (M. Gill, E. Owen, G.E. Pollot and T.L.H. Lawrence, eds.). Occasional Publication No. 16. British Society of Animal Production, Penicuik, United Kingdom.

Ceccarelli, S. and S. Grando. 1993. From conventional plant breeding to molecular biology. Pages 533-537 *in* International Crop Science I: Proceedings of the First International Crop Science Congress, 14-22 July 1992, Iowa State Center, Iowa State University, Ames, Iowa, USA (D.R. Buxton, R. Shibles, R.A. Forsberg, B.L. Blad, K.H. Asay, G.M. Paulsen and R.F. Wilson, eds.). Crop Science Society of America, Madison, USA.

Christiansen, S. 1993. A medic sweeper and a thresher help farmers produce pasture seed. Pages 111-114 *in* World Agriculture 1994 (A. Cartwright, ed.). Sterling Publications Limited, London, United Kingdom.

Christiansen, S. and B. Boulanouar. 1993. Progress of ley farming in Morocco. Pages 112-126 *in* Introducing Ley Farming to the Mediterranean Basin: Proceedings of an International Workshop, 26-30 June 1989, Perugia, Italy (S. Christiansen, L. Materon, M. Falcinelli and P. Cocks, eds.). ICARDA, Aleppo, Syria.

Cocks, P.S., B. Mawlawi and H. Sawmy-Edo. 1993. Introduction of ley farming system in Syrian villages. Pages 52-64 *in* Introducing Ley Farming to the Mediterranean Basin: Proceedings of an International Workshop, 26-30 June 1989, Perugia, Italy (S. Christiansen, L. Materon, M. Falcinelli and P. Cocks, eds.). ICARDA, Aleppo, Syria.

Damania, A.B. and M. Tahir. Heat and cold tolerance in wild relatives and primitive forms of wheat. Pages 217-224 *in* Biodiversity and Wheat Improvement: Proceedings of the Evaluation and Utilization of Biodiversity in Wild Relatives and Primitive Forms for Wheat Improvement Workshop, 12-15 Nov 1992, Aleppo, Syria (A.B. Damania, ed.). ICARDA/John Wiley and Sons, Chichester, UK.

Eardly, B.D., L.A. Materon and R.K. Selander. 1993. The chromosomal genetic structure of *Rhizobium meliloti* populations in southwest Asia. Pages 244-251 *in* Introducing Ley Farming to the Mediterranean Basin: Proceedings of an International Workshop, 26-30 June 1989, Perugia, Italy (S. Christiansen, L. Materon, M. Falcinelli and P. Cocks, eds.). ICARDA, Aleppo, Syria.

Erskine, W. and M.C. Saxena. 1993. Problems and prospects of stress resistance breeding in lentil. Pages 51-62 *in* Breeding for Stress Tolerance in Cool-season Food Legumes: Proceedings of an International Conference on Breeding for Stress Tolerance in Cool-season Food Legumes, 10-12 Sep 1990, Ravello, Italy (K.B. Singh and M.C. Saxena, eds.). ICARDA/John Wiley and Sons, Chichester, UK.

Erskine, W. and M.C. Saxena. 1993. Breeding lentil at ICARDA for southern latitudes. Pages 207-219 *in* Lentil in South Asia: Proceedings of the Seminar on Lentils in South Asia, 11-15 Mar 1991, New Delhi, India (W. Erskine and M.C. Saxena, eds.). ICARDA, Aleppo, Syria.

Hakim, S., A.B. Damania, M.Y. Moualla and H. Altunji. 1993. Variation of storage proteins in *Triticum dicoccum*. Pages 325-328 *in* Biodiversity and Wheat Improvement: Proceedings of the Evaluation and Utilization of Biodiversity in Wild Relatives and Primitive Forms for Wheat Improvement Workshop, 12-15 Nov 1992, Aleppo, Syria (A.B. Damania, ed.). ICARDA/John Wiley and Sons, Chichester, UK.

Hanounik, S.B., G.J. Jellis and M.M. Hussein. 1993. Screening for disease resistance in faba bean. Pages 97-106 *in* Breeding for Stress Tolerance in Cool-season Food Legumes: Proceedings of an International Conference on Breeding for Stress Tolerance in Cool-season Food Legumes, 10-12 Sep 1990, Ravello, Italy (K.B. Singh and M.C. Saxena, eds.). ICARDA/John Wiley and Sons, Chichester, UK.

Jana, S. and K.B. Singh. 1993. Utilization of germplasm resources of cool-season food legumes in breeding for stress tolerance. Pages 373-390 *in* Breeding for Stress Tolerance in Cool-season Food Legumes: Proceedings of an International Conference on Breeding for Stress Tolerance in Cool-season Food Legumes, 10-12 Sep 1990, Ravello, Italy (K.B. Singh and M.C. Saxena, eds.). ICARDA/John Wiley and Sons, Chichester, UK.

Jaradat, A.A. 1993. Ecogeographical races in natural populations of Triticum dicoccoides. Pages 397-408 *in* Biodiversity and Wheat Improvement: Proceedings of the Evaluation and Utilization of Biodiversity in Wild Relatives and Primitive Forms for Wheat Improvement Workshop, 12-15 Nov 1992, Aleppo, Syria (A.B. Damania, ed.). ICARDA/John Wiley and Sons, Chichester, UK.

Jones, M. 1993. Recherche agronomique et strategies d'amelioration des zones cultivees en Syrie. Pages 279-293 *in* Steppes d'Arabies, Etats, Pasteurs, Agriculteurs et Commercant: le Devenir des Zones Seches (R. Bocco, R. Jaubert and F. Metral, eds.). Presses Universitaires de France - Paris and Cahiers de l'Institut Universitaire d'Etudes du Developpement - Geneve.

Jones, M.J. 1993. Barley-based farming systems of the Mediterranean. Pages 129-144 *in* The Agrometeorology of Rainfed Barley-Based Farming Systems: Proceedings of an International Symposium, 6-10 Mar 1989, Tunis, Tunisia (M. Jones, G. Mathys and D. Rijks, eds.). ICARDA, Aleppo, Syria.

Jones, M.J. 1993. Sustainable agriculture: an explanation of a concept. Pages 30-47 *in* Crop Protection and Sustainable Agriculture: Proceedings of a Symposium on World Food Production by means of Sustainable Agriculture: the Role of Crop

Protection, CIBA Foundation Symposium 177, 30 Nov - 2 Dec 1992, Madras, India (D.J. Chadwick and J. Marsh, eds.). ICARDA/John Wiley and Sons, Chichester, UK.

Jones, M.J. 1993. Cereal production and relationship to livestock: the point of view of the agronomist. Pages 14-19 *in* Livestock in the Mediterranean Cereal Production Systems: Proceedings of the Joint ANPA-EAAP-ICAMAS Symposium, 7-10 Oct 1990, Rabat, Morocco (F. Guessous, A. Kabbali and H. Narjisse, comp.). EAAP publication No. 49. PUDOC Scientific Publishers, Wageningen, the Netherlands.

Keatinge, J.D.H. 1993. The role of ICARDA and CIMMYT in supporting agricultural research and training in West and Central Asia. Pages 35-46 *in* Proceedings of the Symposium on Agriculture in the Turkic Republics, Ankara University, 24-28 June 1992, Ankara, Turkey (Y.S. Agaoglu and O. Kavuncu, eds.). Ankara University Press, Ankara, Turkey.

Khare, M.N., B. Bayaa and S.P.S. Beniwal. 1993. Selection methods for disease resistance in lentil. Pages 107-121 *in* Breeding for Stress Tolerance in Cool-season Food Legumes: Proceedings of an International Conference on Breeding for Stress Tolerance in Cool-season Food Legumes, 10-12 Sep 1990, Ravello, Italy (K.B. Singh and M.C. Saxena, eds.). ICARDA/John Wiley and Sons, Chichester, UK.

Makkouk, K.M., L. Bos, N.M. Horn and B. Srinivasa Rao. 1993. Screening for virus resistance in cool-season food legumes. Pages 179-192 *in* Breeding for Stress Tolerance in Cool-season Food Legumes: Proceedings of an International Conference on Breeding for Stress Tolerance in Cool-season Food Legumes, 10-12 Sep 1990, Ravello, Italy (K.B. Singh and M.C. Saxena, eds.). ICARDA/John Wiley and Sons, Chichester, UK.

Malhotra, R.S. and M.C. Saxena. 1993. Screening for cold and heat tolerance in cool-season food legumes. Pages 227-244 *in* Breeding for Stress Tolerance in Cool-season Food Legumes: Proceedings of an International Conference on Breeding for Stress Tolerance in Cool-season Food Legumes, 10-12 Sep 1990, Ravello, Italy (K.B. Singh and M.C. Saxena, eds.). ICARDA/John Wiley and Sons, Chichester, UK.

Mamluk, O.F. and M. W. van Slageren. Diversity for important wheat diseases in the WANA region in an *Aegilops* collection. Page 173 *in* Abstracts of the 6th International Congress of Plant Pathology, 28 July-6 Aug 1993, Montreal, Canada. International Society for Plant Protection, Minnesota, USA.

Materon, L.A. 1993. Constraints to nodulation of annual medics by indigenous populations of *Rhizobium meliloti* in West Asian soils. Pages 192-202 *in* Introducing Ley Farming to the Mediterranean Basin: Proceedings of an International Workshop, 26-30 June 1989, Perugia, Italy (S. Christiansen, L. Materon, M. Falcinelli and P. Cocks, eds.). ICARDA, Aleppo, Syria.

Nachit, M.M., M. Baum, E. Autrique, M.E. Sorrells, T. A. Dib and P. Monneveux. 1993. Association of morphophysiological traits with RFLP markers in durum wheat. Pages 429-433 *in* Tolerance a la Secheresse des Cereals en Zone Mediterraneenne: Diversite Genetique et Amelioration Varietale. 15-17 Dec 1992, Montpellier, France (P. Monneveux and B. Salem, eds.). Coll. les Colloques, No. 64. INRA, Montpellier, France.

Nachit, M.M., G. Nachit and H. Ketata. 1993. Analyse des effets additifs et multiplicatifs des interactions genetype x environnement chez le ble dur dans le bassin Mediterraneen. Pages 159-169 *in* Tolerance a la Secheresse des Cereals en Zone Mediterraneenne: Diversite Genetique et Amelioration Varietale. 15-17 December 1992, Montpellier, France (P. Monneveux and B. Salem, eds.). Coll. les Colloques, No. 64. Fr. INRA, Montpellier, France.

Nachit, M., N. Nsarellah, M. Mergoum and J. Ryan. 1993. Durum wheat performance under early and mid-season drought stress. Page 96 *in* Agronomy Abstracts. 1993 Annual Meetings of the American Society of Agronomy, 7-12 Nov 1993, Cincinnati, Ohio. American Society of Agronomy, Madison, WI, USA.

Nordblom, T.L. 1993. Ley farming in the Mediterranean from an economic point of view. Pages 144-164 *in* Introducing Ley Farming to the Mediterranean Basin: Proceedings of an International Workshop, 26-30 June 1989, Perugia, Italy (S. Christiansen, L. Materon, M. Falcinelli and P. Cocks, eds.). ICARDA, Aleppo, Syria.

Nordblom, T.L. and F. Shomo. 1993. Livestock and feed trends in West Asia and North Africa: past, present and future. Pages 15-30 *in* The Situation of Agriculture in Mediterranean Countries. Agricultural Research and Food Security, 28-29 June 1993, Istanbul, Turkey. Cahiers Options

Mediterraneennes Vol. 1, No. 5. CIHEAM, Montpellier, France.

Nordblom, T.L. and F. Shomo. 1993. Livestock and feed in WANA: past, present and future. Pages 35-59 *in* Board of Trustees Presentation, 11-12 May 1993, Aleppo, Syria. ICARDA, Aleppo, Syria.

Oweis, T., H. Zeidan and A. Taimeh. 1992. Modelling approach for optimizing supplemental irrigation management. Pages S1-14.1-19 *in* the International Conference on "Supplementary Irrigation and Drought Water Management", Vol. 1. International Conference on Supplementary Irrigation and Drought Management, 27 Sep - 2 Oct 1992, Bari, Italy. CIHEAM, Istituto Agronomico Mediterraneo, Valenzano, Bari, Italy.

Pagnotta, M.A., O.A. Tanzarella, R.D'Ovidio and E. Porceddu. 1993. Use of molecular markers to assess genetic variability in Triticum dicoccoides. Pages 235-245 *in* Biodiversity and Wheat Improvement: Proceedings of the Evaluation and Utilization of Biodiversity in Wild Relatives and Primitive Forms for Wheat Improvement Workshop, 12-15 Nov 1992, Aleppo, Syria (A.B. Damania, ed.). ICARDA/John Wiley and Sons, Chichester, UK.

Pala, M., A. Matar and J. Ryan. 1993. On-farm trials for technology transfer and economic assessment in northwestern Syria's wheat belt. Page 59 *in* Agronomy Abstracts. 1993 Annual Meetings of the American Society of Agronomy, 7-12 Nov 1993, Cincinnati, Ohio. American Society of Agronomy, Madison, WI, USA.

Peacock, J.M., P. Soman and C.J. Howarth. 1993. High temperature effects on seedling survival in tropical cereals. Pages 106-121 *in* Adaptation of Food Crops to temperature and water stress: Proceedings of an International Symposium, 13-18 Aug 1992, Taiwan (C.G. Kuo, ed.). Publication No. 93-410. Asian Vegetable Research and Development Center, Taiwan.

Porta-Puglia, A., K.B. Singh and A. Infantino. 1993. Strategies for multiple-stress resistance breeding in cool-season food legumes. Pages 411-427 *in* Breeding for Stress Tolerance in Cool-season Food Legumes: Proceedings of an International Conference on Breeding for Stress Tolerance in Cool-season Food Legumes, 10-12 Sep 1990, Ravello, Italy (K.B. Singh and M.C. Saxena, eds.). ICARDA/John Wiley and Sons, Chichester, UK.

Rees, D.J., J.G. Nagy and J.D.H. Keatinge. 1993. Barley production under suboptimal conditions in upland Baluchistan: agronomic and socio-economic considerations. Pages 193-215 *in* The Agrometeorology of Rainfed Barley-Based Farming Systems: Proceedings of an International Symposium, 6-10 Mar 1989, Tunis, Tunisia (M. Jones, G. Mathys and D. Rijks, eds.). ICARDA, Aleppo, Syria.

Reid, R., E. Bettencourt and J. Konopka. 1993. Genetic resources of Lathyrus and Vicia, and associated quarantine problems. Pages 10-19 *in* Potential for *Vicia* and *Lathyrus* Species as New Grain and Fodder Legumes for Southern Australia: Proceedings of the Vicia/Lathyrus Workshop, 22 Aug-23 Sep, Perth, Australia (J.R. Garlinge and M.W. Perry, eds.). Occasional Publication No. 1. Cooperative Research Centre for Legumes in Mediterranean Agriculture, Nedlands, Australia.

Robertson, L.D. and M.C. Saxena. 1993. Problems and prospects of stress resistance breeding in faba bean. Pages 37-50 *in* Breeding for Stress Tolerance in Cool-season Food Legumes: Proceedings of an International Conference on Breeding for Stress Tolerance in Cool-season Food Legumes, 10-12 Sep 1990, Ravello, Italy (K.B. Singh and M.C. Saxena, eds.). ICARDA/John Wiley and Sons, Chichester, UK.

Russi, L. 1993. Preliminary observations on seed coat and hardseededness in six pasture legumes. Pages 289-293 *in* Introducing Ley Farming to the Mediterranean Basin: Proceedings of an International Workshop, 26-30 June 1989, Perugia, Italy (S. Christiansen, L. Materon, M. Falcinelli and P. Cocks, eds.). ICARDA, Aleppo, Syria.

Ryan, J., S. Masri, S. Garabet, K. Harmsen and H. Habib. 1993. Soil classification and nutrient status at ICARDA's research stations under varying rainfall conditions. Page 60 *in* Agronomy Abstracts. 1993 Annual Meetings of the American Society of Agronomy, 7-12 Nov 1993, Cincinnati, Ohio. American Society of Agronomy, Madison, WI, USA.

Ryan, J., A. Matar, M. Pala and P.N. Soltanpour. 1993. A soil fertility network for the dryland West Asia-North Africa region. Page 60 *in* Agronomy Abstracts. 1993 Annual Meetings of the American Society of Agronomy, 7-12 Nov 1993, Cincinnati, Ohio. American Society of Agronomy, Madison, WI, USA.

Saccardo, F., A. Errico, P. Crino, B. Ocampo and G. Venora. 1993. Mutagenesis and chromosome manipulation for stress tolerance in cool-season food legumes. Pages 343-358 *in* Breeding for Stress Tolerance in Cool-season Food Legumes: Proceedings of an International Conference on Breeding for Stress Tolerance in Cool-season Food Legumes, 10-12 Sep 1990, Ravello, Italy (K.B. Singh and M.C. Saxena, eds.). ICARDA/John Wiley and Sons, Chichester, UK.

Salkini, A.B. and D. Ansell. 1992. Agro-economic impact of supplemental irrigation on rainfed wheat production under the Mediterranean environment of Syria. Pages S2-3.1-10 *in* the International Conference on "Supplementary Irrigation and Drought Water Management", Vol. 1. International Conference on Supplementary Irrigation and Drought Management, 27 Sep - 2 Oct 1992, Bari, Italy. CIHEAM, Istituto Agronomico Mediterraneo, Valenzano, Bari, Italy.

Samir El-Sebae, Ahmed. 1993. Technology transfer and adoption: ICARDA's experience. Pages 107-115 *in* The Situation of Agriculture in Mediterranean Countries. Agricultural Research and Food Security, 28-29 June 1993, Istanbul, Turkey. Cahiers Options Mediterraneennes Vol. 1, No. 5. CIHEAM, Montpellier, France.

Samir El-Sebae, A. and R.H. Booth. 1993. Current and potential role of agricultural universities in strengthening national agricultural research systems in West Asia and North Africa. Pages 239-267 *in* the Role of Universities in National Agricultural Research Systems: Report of the FAO Expert Consultation on the Role of Universities in National Agricultural Research Systems, 10-22 Mar 1991, Rome, Italy. FAO, Rome, Italy.

Saxena, M.C. 1993. The challenge of developing biotic and abiotic stress resistance in cool-season food legumes. Pages 3-14 *in* Breeding for Stress Tolerance in Cool-season Food Legumes: Proceedings of an International Conference on Breeding for Stress Tolerance in Cool-season Food Legumes, 10-12 Sep 1990, Ravello, Italy (K.B. Singh and M.C. Saxena, eds.). ICARDA/John Wiley and Sons, Chichester, UK.

Saxena, M.C. and A.M. Abd El-Moneim. 1993. Place and role of legumes in livestock production in West Asia and North Africa. Pages 60-72 *in* Board of Trustees Presentation, 11-12 May 1993, Aleppo, Syria. ICARDA, Aleppo, Syria.

Saxena, M.C., A.M. Abd El Moneim and M. Ratinam. 1993. Vetches (*Vicia* spp.) and chicklings (*Lathyrus* spp.) in the farming systems in West Asia and North Africa and improvement of these crops at ICARDA. Pages 2-9 *in* Potential for Vicia and Lathyrus Species as New Grain and Fodder Legumes for Southern Australia: Proceedings of the Vicia/Lathyrus Workshop, 22 Aug-23 Sep, Perth, Australia (J.R. Garlinge and M.W. Perry, eds.). Occasional Publication No. 1. Cooperative Research Centre for Legumes in Mediterranean Agriculture, Nedlands, Australia.

Saxena, N.P., C. Johansen, M.C. Saxena and S.N. Silim. 1993. Selection for drought and salinity tolerance in cool-season food legumes. Pages 245-270 *in* Breeding for Stress Tolerance in Cool-season Food Legumes: Proceedings of an International Conference on Breeding for Stress Tolerance in Cool-season Food Legumes, 10-12 Sep 1990, Ravello, Italy (K.B. Singh and M.C. Saxena, eds.). ICARDA/John Wiley and Sons, Chichester, UK.

Singh, K.B. 1993. Experiences, difficulties and prospects of disease resistance breeding in chickpea. Pages 241-248 *in* Durability of Disease Resistance (Th. Jacobs and J.E. Parlevliet, eds.). Kluwer Academic Publishers, Dordrecht, Netherlands.

Singh, K.B. 1993. Problems and prospects of stress resistance breeding in chickpea. Pages 17-35 *in* Breeding for Stress Tolerance in Cool-season Food Legumes: Proceedings of an International Conference on Breeding for Stress Tolerance in Cool-season Food Legumes, 10-12 Sep 1990, Ravello, Italy (K.B. Singh and M.C. Saxena, eds.). ICARDA/John Wiley and Sons, Chichester, UK.

Tahir, M. 1993. Breeding for *Hordeum vulgare* L. for continental Mediterranean environments. Page 62 *in* the First Iranian Congress on Crop Production and Breeding, 6-9 Sep 1993, Karaj, Iran. Ministry of Agriculture, Tehran, Iran. (Abstract in Persian).

Tahir, M. and H. Ketata. 1993. Use of landraces, primitive forms and wild species for the development of winter and facultative durum wheat germplasm. Pages 341-351 *in* Biodiversity and Wheat Improvement: Proceedings of the Evaluation and Utilization of Biodiversity in Wild Relatives and Primitive Forms for Wheat Improvement Workshop, 12-15 Nov 1992, Aleppo, Syria (A.B. Damania, ed.). ICARDA/John Wiley and Sons, Chichester, UK.

Tahir, M. and H. Pashayani. 1993. Effect of alien cytoplasm on wheat for stress tolerance and anther culturability. Page 62 *in* the First Iranian Congress on Crop Production and Breeding, 6-9 Sep 1993, Karaj, Iran. Ministry of Agriculture, Tehran, Iran. (Abstract in Persian).

Treacher, T. 1993. Gestion des systemes d'elevage en Syrie: complementarites entre la steppe et les zones cultivees. Pages 294-305 *in* Steppes d'Arabies, Etats, Pasteurs, Agriculteurs et Commercant: le Devenir des Zones Seches (R. Bocco, R. Jaubert and F. Metral, eds.). Presses Universitaires de France - Paris and Cahiers de l'Institut Universitaire d'Etudes du Developpement - Geneve. l'Institut Universitaire d'Etudes du Developpement, Geneve, Switzerland.

Treacher, T. and A.V. Goodchild. 1993. Small ruminant management in West Asia and North Africa: present and future. Pages 73-75 in Board of Trustees Presentation, 11-12 May 1993, Aleppo, Syria. ICARDA, Aleppo, Syria.

Valkoun, J. and O.F. Mamluk. 1993. Disease resistance and agronomic performance of durum and bread wheat lines derived from crosses with *Triticum monococcum*. Pages 141-146 *in* Biodiversity and Wheat Improvement: Proceedings of the Evaluation and Utilization of Biodiversity in Wild Relatives and Primitive Forms for Wheat Improvement Workshop, 12-15 Nov 1992, Aleppo, Syria (A.B. Damania, ed.). ICARDA/John Wiley and Sons, Chichester, UK.

Van Slageren, M. Taxonomy and distribution of *Aegilops*. Pages 67-79 *in* Biodiversity and Wheat Improvement: Proceedings of the Evaluation and Utilization of Biodiversity in Wild Relatives and Primitive Forms for Wheat Improvement Workshop, 12-15 Nov 1992, Aleppo, Syria (A.B. Damania, ed.). ICARDA/John Wiley and Sons, Chichester, UK.

Wahbi, A., M.J. Jones, E. Jabbour, K. El Hajj and A. Safee. 1993. Fertilizer trials on barley in Northern Syria. Pages 268-272 *in* The Agrometeorology of Rainfed Barley-Based Farming Systems: Proceedings of an International Symposium, 6-10 Mar 1989, Tunis, Tunisia (M. Jones, G. Mathys and D. Rijks, eds.). ICARDA, Aleppo, Syria.

Weigand, S. and M.P. Pimbert. 1993. Screening and selection criteria for insect resistance in cool-season food legumes. Pages 145-156 *in* Breeding for Stress Tolerance in Cool-season Food Legumes: Proceedings of an International Conference on Breeding for Stress Tolerance in Cool-season Food Legumes, 10-12 Sep 1990, Ravello, Italy (K.B. Singh and M.C. Saxena, eds.). ICARDA/John Wiley and Sons, Chichester, UK.

Contributions to Conferences

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

February

Wad Medani SD CIMMYT-International Conference on Wheat in Hot Dry Irrigated Environments

Miller, R.H. Cereal aphid IPM in the Nile Valley: problems and potential.

Mosaad, M.G., G. Ortiz Ferrara and M.M. Nachit. Role of photoperiod and vernalization response in the adaptation of wheat under heat and moisture stress.

Ortiz Ferrara, G., S. Rajaram and M.G. Mosaad. Breeding strategies for improving wheat in heat stressed environments.

Peacock, J.M., V. Mahalakshmi, G. Ortiz-Ferrara, M. Nachit, C.J. Howarth and J. Hamblin. An approach to improving adaptation of wheat under high temperature conditions: the Indian experience.

March

Scarborough GB BSAP Winter Meeting

Rihawi, S., E. Owen, A.V. Goodchild, A. Termanini and T.T. Treacher. Grazing of barley stubble by sheep in Syria: effect of stocking rate on selective intake of stubble fractions.

Termanini, A., A. Goodchild, T. Treacher, S. Rihawi and E. Owen. The effects of urea treatment, urea supplementation and coarse milling on the nutrient intake of sheep fed barley straw.

April

Nottingham GB Physiology of Varieties

Dakheel, A.J., I. Naji, V. Mahalakshmi and J.M.

Peacock. Morphophysiological traits associated with adaptation of durum wheat to harsh Mediterranean environments.

Van Oosterom, E.J. and J.M. Peacock. Apex development patterns: the physiological basis to adaptation of barley to harsh Mediterranean environments.

May

Damascus SY Regional Seminar on the Role of Supplementary Irrigation on Cereal Production

Mikhail, A., A.E. Matar, Z. Abbasi and J. Ryan. Supplementary irrigation in relation to durum wheat quality.

Oweis, T. Evaluation of a drip irrigation system for supplemental irrigation trials of field crops.

Oweis, T. and A.B. Salkini. Socioeconomic aspects of supplemental irrigation.

Salkini, A.B. Impact of supplemental irrigation on the economics of wheat production systems.

Adana TR Second International Meeting on "Red Mediterranean Soils"

Ryan, J. and H. Harris. Observations on nitrogen and phosphorus in rainfed systems of the Mediterranean area.

June

Rabat MA Journees sur la Recherche dans le Developpement Agricole et Rural

Mekni, M.S. Role de l'ICARDA dans le renforcement des programmes nationaux (NARS) et le Developpement agricole: un modele de partenariat.

July

Beijing CH 8th International Wheat Genetics Symposium

Banisadr, N. and M. Tahir. Heat and cold tolerance in *Triticum aestivum* L. and *T. turgidum* var. durum from Iran.

Damania, A.B., L. Pecetti and G. Kashour. Salinity tolerance in genetic resources of wild *Triticum* species.

Tahir, M. and H. Ketata. Rate and duration of grain filling in *Triticum* species and its breeding implications.

Montreal CA 6th International Congress of Plant Pathology

Mamluk, O.F. and M.W. Van Slageren. Diversity for important wheat diseases in the WANA region in an *Aegilops* collection.

Van Leur, J.A.G., K. Bailey and R. Sikora. Survey for barley root diseases in Northern Syria.

August

Loen NO 18th Eucarpia Fodder Crop Section Meeting

Ceccarelli, S. Specific adaptation and breeding for marginal conditions.

Olympia US International Symposium on Soil Testing and Plant Analysis: Precision Nutrient Management

Ryan, J. and S. Garabet. Soil test standardization in West Asia-North Africa.

Tsukuba JP International Symposium on Plant Genetic Resources Management in the Tropics

Valkoun, J. and A.B. Damania. Methodologies for *in situ* conservation of plant genetic resources.

September

Beirut. LB Seminar on Losses of Agricultural Products in the Arab World

Bayaa, B. and O.F. Mamluk. Losses due to important cereal and food legume diseases in the Arab countries.

Cordoba ES IV Reunion Cientifica sobr Nuevas Fuentes de Alimentos para la Producction Animal, Universidad de Cordoba

Goodchild, A.T. and T.T. Treacher. The use of NIRS to predict the intake of varieties of barley straw.

Treacher, T.T., A.V. Goodchild, S. Rihawi and A. Termanini. Systems of feeding small ruminant flocks in the arid zones of West Asia and North Africa.

October

Andhra Pradesh IN CIAN Country Coordinators Consultative Meeting

Erskine, W. and M.C. Saxena. Opportunities for collaboration between ICARDA and CIAN in legume research and training.

Izmir TR Research on Biodiversity and *In Situ* Conservation

Valkoun, J., L.D. Robertson, A.B. Damania and M. van Slageren. Research on biodiversity and *in situ* conservation at ICARDA.

November

Addis Ababa ET International Conference on Livestock and Sustainable Nutrient Cycles in Mixed-Farming Systems of Sub-Saharan Africa

Harris, H.C., J. Ryan, T.T. Treacher and A. Matar. Nitrogen in dryland farming systems common in northwestern Syria.

White, P., A.V. Goodchild, A. Termanini, T.T. Treacher and J. Ryan. Nitrogen intake and losses by sheep on *Medicago* spp. and barley pastures in Northern Syria.

Aleppo SY ICARDA/FAO Winter Chickpea Technology Transfer Workshop

Saxena, M.C. Identification on inter-country commonalities and presentation of networking arrangements.

Singh, K.B. and M.C. Saxena. Historical perspective of winter chickpea.

Tutwiler, R. Options for promotion of winter chickpea.

Aleppo SY Workshop on Management of Gypsiferous Soils

Matar, A. Effect of gypsum contents of soils on growth, nutrient uptake and productivity of major field crops in Syria.

Mardoud, T. and A. Matar. Changes of some chemical properties of gypsiferous soils in the Syrian Euphrates Basin after 20 years of irrigation.

Ryan, J. and S. Garabet. Cation exchange capacity determination in gypsiferous soils: problems and possible solutions.

Amsterdam NL Workshop on Parasitic Weeds at the Royal Tropical Institute

Kharrat, M., M.H. Halila and S.P.S. Beniwal. Parasitism of two faba bean varieties as affected by different seed inoculum levels of *Orobanche crenata* and *O. foetida*.

Saxena, M.C. K.-H. Linke and J. Sauerborn. Integrated control of *Orobanche* in cool-season food legumes.

Ankara TR Symposium on Durum Wheat and its Products

Jaby El Haramein, F., M.M. Nachit and A. Impiglia. Evaluation of durum grain quality at ICARDA.

Cairo EG FAO Expert Consultation on Water Harvesting for Improved Crop Production

Oweis, T. and D. Prinz. Proposal for a regional project on identifying potential water harvesting areas and techniques using remote sensing and GIS.

The Hague NL Workshop on Opportunities for Use of Systems Research Methods in Agriculture in Developing Countries

Harris, H.C., T.L. Nordblom, A. Rodriguez and P. Smith. Experience of the use of systems analysis in ICARDA.

Zaragoza ES Seminar on Durum Wheat Quality in the Mediterranean Region

Impiglia, A., M.M. Nachit, D. Lafiandra and E. Porceddu. Relationship among 81 genotypes based on RFLPs, gliadin and glutenin components effect on gluten strength in durum wheat.

Kayyal, H., H. Abu Hamze, M. Jarrah and M.M. Nachit. Durum wheat production and quality in Syria.

Nachit, M.M., M. Baum, A. Impiglia and H. Ketata. Studies on some quality traits in durum wheat grown in Mediterranean environments.

Osman, O.S., R.J. Pena, E. Autrique and M.M. Nachit. Durum wheat breeding and quality improvement at CIMMYT-Mexico.

Sorrells, M.E., M.M. Nachit, J. Barbosa, E. Autrique and H. Ketata. Relationship among 81 genotypes based on RFLPs, gliadins, parentage, and quality traits.

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

December

Cairo EG Roundtable on Land and Water Management: a Meeting of IDRC-Supported Projects in the MERO Region

Gobel, W. Agro-ecological characterization (IDRC/ICARDA): the experience of the first four years.

Rome IT FAO Expert Consultation on the Coordination and Harmonization of Databases and Software for Agroclimatic Applications

Gobel, W. Stochastic regional models: adding time to GIS.

Media Coverage

Researchers develop practical method to rescue marginal lands, Arab World Agribusiness.

ICARDA hosts wheat biodiversity workshop to celebrate decade of service, Diversity.

Rescuing marginal lands, International Agricultural Development.

Legumes, a food as old as civilization itself, Cooperazione.

Dryland farming challenging the environment, Cooperazione.

Environment and international agricultural development (in Arabic), Al Nawras.

Fund delegation visits ICARDA headquarters, OPEC Fund Newsletter.

We want to push agriculture on all fronts, Arab Water World.

More than a bag of seeds, Arab World Agribusiness.

Planning to re-arrange the agricultural research in Jordan in accordance with the production systems (in German), Laenderspiege.

The regional project coordinator highlights Al Mashreq project for boosting barley, forage, sheep production in the low-rainfall areas by Jordanian scientists (in Arabic), Al-Rai.

Director of the National Center for Agricultural Research: "An annual workplan for scientific research at the level of the Kingdom". Dr Dweri urges farmers to show an interest in barley production (in Arabic), Al-Rai.

Al Mashreq project for forage production contributing to solving the problem of forage shortage, and to increasing the production of red meat in the low-rainfall areas, (in Arabic), Sout Al Chaeb.

The Ministry of Agriculture jointly organizes with FAO an international training course on weed control management to be held on 26 September in Amman (in Arabic), Al-Rai.

The Minister of Agriculture opens a workshop on agricultural research at Al Mashqar, Madaba. Marwan (Minister of Agriculture) calls for a focus on water management and the development of pastures and livestock in the coming years (in Arabic), Al-Rai.

A specialized workshop on the diagnosis of the agricultural system at Mafraq (in Arabic), Al-Rai.

At the opening of the workshop of agricultural research at Madaba, the Minister of Agriculture calls for a focus on water management and the development of pastures and livestock (in Arabic), Al-Dustoor.

In his opening speech of the workshop of assessing agricultural research, the Minister of Agriculture calls for an intensification of research efforts in cereals and forages, (in Arabic), Sout Al Chaeb.

Al Mashreq agricultural project continues its meetings reviewing the results of the field demonstrations (in Arabic), Al-Rai.

Al Mashreq project continues its meetings (in Arabic), Sout Al Chaeb.

Conclusion of the annual meetings of ICARDA, participants review the services of Al Mashreq project in Jordan, Syria and Iraq (in Arabic), Al-Dustoor.

"Impact of the environment" in the Rio Summit (in Italian), Protecta.

ICARDA tries harder, African Farming.

Grazing management workshop begins Sunday, Jordan Times.

Regional workshop on grazing management will be held next Sunday (in Arabic), Al- Rai.

Training course on seed technology in the Jordanian University (in Arabic), Al-Dustoor.

Beginning of the regional workshop on grazing management (in Arabic), Al-Dustoor.

Recommendations of the grazing management workshop (in Arabic), Al-Dustoor.

ICARDA's promising work in biotechnology, Biolink.

ICARDA scientists visit the mountainous villages (in Turkish), Cumhuriyet.

ICARDA scientists visit the mountainous villages (in Turkish), Ekstra.

Prof. Dr Onur Erkan says:"Research has been good and fruitful". Agriculture has advanced in Taurus (in Turkish), Cumhuriyet.

Appendix 4

Graduate Theses Produced with ICARDA's Assistance

1992

Master's

GB University of Reading

Angaw Tsigie Syoum (ET). The effectiveness of Ethiopian strains of *Rhizobium leguminosarum* Biovar *Viciae* under controlled conditions. 119 pp.

Doctoral

DE University of Hohenheim

Peter Stefany (US). Daylength and temperature response in durum wheat. 155 pp.

NL Landbouwuniversiteit te Wageningen

A. Elings. The use of crop growth simulation in evaluation of large germplasm collections: distribution, variation and evaluation of Syrian durum wheat landraces. 183 pp.

1993

Master's

FR L'Institut Universitaire d'Etudes du Developpement

Marina Leybourne (Fr). Links between the steppe and cultivated areas through migration: the socio-economic organization of production of the semi-nomadic agro-pastoral society of the Syrian steppe. 172 pp.

JO University of Jordan, Amman

Ahmad Hammad Yousef Abu-Hammad (JO). Effect of different crop rotations, tillage-residue management on soil moisture storage, soil physical properties, and yields in rainfed areas. 125 pp. (Arabic summary).

* See Appendix 15 for country codes

MA Ecole National d'Agriculture de Meknes

Rachidi Mohamed (MA). Mise au point de techniques de culture du pois-chiche dans deux localites et effet du stress hydrique sur la germination. 110 pp. (In French, Arabic and English summaries).

NL Landbouwuniversiteit te Wageningen

Erik van Oosterom (NL). Adaptation of barley to harsh Mediterranean environments. 141 pp. (Dutch summary).

TR University of Cukurova

Mazen Jarrah (SY). Variability of morphophysiological and quality traits of Mediterranean durum wheat land races. 111 pp. (Turkish summary).

Doctoral

DE Eberhard-Karls-Universitaet, Tuebingen

Christiane Weigner (DE). Resistenzfaktoren von *Cicer arietinum* L. gegenuber *Liriomyza cicerina* und *Helicoverpa armigera* unter verschiedenen agroklimatischen Bedingungen und Anbaujahren. [Mechanisms of resistance in *Cicer arietinum* to *Liriomyza cicerina* and *Helicoverpa armigera* under different agroclimatic conditions]. 91 pp. (In German, English summary).

DE University of Hohenheim

Eckhard George (DE). Growth and phosphate efficiency of grain legumes and barley under dryland conditions in Northwest Syria. 257 pp. (German summary).

FR Ecole Nationale Superieure Agronomique de Montpellier

Tarek Ali Dib (SY). Contribution a l'etude de la tolerance a la secheresse chez le ble dur (*Triticum durum* desf.). Etude de la diversite des caracteres phenologiques et morphophysiologiques d'adaptation. [Contribution to study of tolerance to drought in durum wheat (*Triticum durum* Desf.). Studies of diversity of phenological and morphophysiological characters of adaptation. 226 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).

ETHIOPIA

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

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).

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).

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 Superieur 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).

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).

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 Winrock International Institute for Agricultural Development (En).

Appendix 6

Special Projects

During 1993, the following activities (special projects and projects 'in-trust' for national programs) were operational utilizing funds provided separately from ICARDA's core budget. The financial contribution by the respective donors are reported in Appendix 11. The reports on the activities listed are encompassed in the appropriate sections of the body of this Annual Report and are not repeated here.

AFESD (Arab Fund for Economic and Social Development)

Arabian Peninsula Regional Program.

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.

EEC

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.

FAO (Food and Agriculture Organization of the United Nations)

Joint support for Expert Consultancy in Sunn Pest.

Support for Regional Workshop on Winter Chickpea Promotion in North Africa and West Asia.

Support for Small Grain Germplasm.

Support for Recording the Performance of Awassi Sheep.

Ford Foundation

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

France

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

Amélioration de l'intégration de l'élevage ovin dans les systèmes céréaliers et pâturés 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.

Land Use Management for Marginal Lands in the Barley/Livestock Zones of Jordan and Syria (in collaboration with Hohenheim University).

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 (in collaboration with Biologische Bundesanstalt für Land und Forstwirtschaft).

Use of DNA-Markers in Selection for Disease Resistance Genes in Barley (in collaboration with Technical University, Munich).

IDRC (International Development Research Center), Canada

Barley Yellow Dwarf Virus (in collaboration with Agriculture Canada; Laval University, Quebec).

Marginal Areas.

Agroecological Characterization.

Dryland Resource Management - Yemen.

Water Harvesting (in collaboration with the University of Jordan; Concordia University, Montreal, Canada; Moncton University, Moncton, Canada).

Integrated Watershed Development (Syria).

IFAD (International Fund for Agricultural Development)

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

IMPHOS (Institut Mondial de Phosphate)

Soil Test Calibration in Limited Rainfall Areas.

Iran

ICARDA/Iran - Scientific and Technical Cooperation.

Italy

Support for Activities in Mountainous Areas - Highlands Regional Program, Turkey.

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.

ODA (Overseas Development Administration), United Kingdom

Measurement of Biodiversity within the Genus *Lens* (in collaboration with the University of Birmingham, UK).

Fixation and Cycling of Nitrogen in a Dryland Legume/Cereal Production System (in collaboration with the University of Reading, UK).

OPEC Fund for International Development

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

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 Improved Cereal Varieties in North Africa.

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.

UNEP (United Nations Environment Programme)

Support for Regional Workshop on Dryland Resource Management in WANA.

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

ICARDA received Special Project funding in 1993 for some of its collaborative activities with advanced institutions in industrialized countries. Such items are detailed in Appendix 6. ICARDA's participation in the following activities was, however, financed out of core or restricted-core funds.

International Centers and Agencies

International Board for Plant Genetic Resources (IBPGR), Rome
- ICARDA hosts and services the IBPGR 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.
- Joint support for Rockefeller Social Science Postdoctoral Research Fellow: Impact of Improved Cereal Varieties in North Africa.

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.

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.

Canada

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

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.

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.
- Study of biological nitrogen fixation and nitrogen assimilation in food legumes as a function of genotype.
- Study of chickpea rhizobia and drought and cold tolerance.
- Inoculation of medics in southern France.

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

Germany

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 Hohenheim
- Physiological factors as determinants of yield in durum wheat.
- Better straw quality: breeding and evaluation methods.
- Effect of legume crop residues on productivity of wheat.

Max Planck Institute for Biochemistry, Munich
- Resistance mechanisms in chickpea to leafminer.

Italy

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

Istituto di Miglioramento Genetico Vegetale (University of Perugia); Istituto Sperimentale per la Cerealcoltura, Catania
- Improving yield and yield stability of barley in stress environments.

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

Istituto di Miglioramento Genetico Vegetale, University of Perugia
- Adaptation and seed production of pasture species for marginal land rehabilitation in semi-arid environments.

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

Japan

Japanese International Cooperation Agency (JICA)
- Animal health

Tropical Agricultural Research Center (TARC)
- Land resource evaluation

Netherlands

Royal Tropical Institute, Amsterdam
- *Orobanche* control

Portugal

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

Spain

Polytechnical University, Madrid
- Improvement of the energy efficiency of medic rhizobia.

University of Cordoba
- Developing Orobanche resistance in faba bean.
- Developing wilt resistance in chickpea.

University of Cordoba and INIA
- Barley stress physiology.

University of Granada
- Isolation of VA-Mycorrhiza from forage legumes.

United Kingdom

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

Overseas Development Natural Resources Institute (NRI), London
- Evaluating the nutritive value of straws for small ruminants.

Plant Breeding Institute, Cambridge
- Characterization of barley genotypes.

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.

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.

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

- Statistical analysis of rotation trials.

US Department of Agriculture (USDA), Kansas State University

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

Washington State University; Texas A&M University; European Parasite Laboratory (USDA-ARS)

- Survey of Russian Wheat Aphid and its natural enemies in West Asia and North Africa.

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 to NARS scientists.
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 7 countries who volunteered to evaluate these lines under their environment for agronomic characters and disease resistance. 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 agroecological characteristics of major cereal production areas.
International Legume Testing Network (ILTN)	Dissemination of genetic material and improved production and plant protection practices to NARS for evaluation and use under their own conditions. Permits multilocation testing of material developed by NARS and ICARDA and helps in developing better understanding of genotype x environment interaction as well as agroecological characterization of legume production areas. Includes lentil, chickpea, dry pea, vetches and chickling.
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
A.B. Damania (GRU)	INT	6, in WANA	Italy	INFO MATERIAL
A.B. Damania (GRU) C. Ceoloni (Italy)	INT	1 in WANA 6, non-WANA	Italy	INFO MATERIAL
S.K. Yau (CP)	INT	50 countries worldwide; CIMMYT	ICARDA Core funds	MATERIAL
R.S. Malhotra (LP)	INT	52 countries worldwide	ICARDA Core funds	MATERIAL
S.P.S. Beniwal (NARP/LP)	SUBREG	Algeria, Libya, Morocco, Tunisia	ICARDA BMZ/GTZ	MATERIAL
M.C. Saxena (LP) 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
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 exchange.
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 to facilitate communication between research workers. FABIS newsletter; specialized bibliographic journals; research workers directory.
Lentil Experimental News Services (LENS)	Collection and dissemination of worldwide information on lentils to facilitate communication between research workers. LENS newsletter; specialized bibliographic journals; research workers directory.
RACHIS	Collection and dissemination of worldwide information on wheat and barley to facilitate communication between research workers. RACHIS newsletter; specialized bibliographic journals; research workers directory.
WANA Seed Network	Referee testing including seed health. Regional Seed Newsletter, Seed Directory, and Variety Catalogue. Develop uniform national seed policies and standardized seed certification procedures. Initiate WANA centre for undergraduate and postgraduate study in seed science and technology.
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.
DNA Fingerprinting of Chickpea Ascochyta Blight Fungus	Quantify and characterize variability in *Ascochyta rabiei* and map geographical distribution of different pathotypes.

Coordinator	Scale[1]	Countries/Institutions involved	Donor	Type[2]
R. Miller (CP) M. Mekini (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 (LP)	INT	Worldwide	ICARDA Core funds	INFO
N. Maliha (CODIS) and W. Erskine (LP)	INT	Worldwide	ICARDA Core funds	INFO
H. Ketata (CP)	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. Hamzaoui (CODIS)	REG	WANA countries, CIHEAM, ISNAR	to be determined	INFO MATERIALS
N.P. Saxena ICRISAT/ICARDA	INT	Worldwide, ICRISAT, FAO	ICARDA; ICRISAT FAO	INFO CO-OP MATERIAL
F. Weigand (LP) & Univ. of Frankfurt	REG	Algeria, Pakistan, Syria, Tunisia, Turkey, Univ. Frankfurt	GTZ ICARDA	INFO CO-OP MATERIAL

Title	Objectives/Activities
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 rootrots. 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.
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.

Coordinator	Scale[1]	Countries/Institutions involved	Donor	Type[2]
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, ASAREC 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
H. Faki (Sudan)	SUBREG	Egypt, Ethiopia Sudan	EEC, SAREC Netherlands	CO-OP
M. El-Sherbeeny (Egypt)	SUBREG	Egypt, Ethiopia Sudan	EEC, SAREC Netherlands	CO-OP

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 their nutritional value, producing cultivars with high energy and low fibre.
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]
H. Vivar (LARP)	REG	Oregon State University, Latin American NARS, CIMMYT	ICARDA-CIMMYT Core funds	MATERIAL
H. Vivar	INT	CIMMYT, Canada, Australia, Colombia	ICARDA-CIMMYT Core funds	MATERIAL
H. Vivar	INT	CIMMYT, Chile, Ecuador, Kenya	ICARDA-CIMMYT Core funds	MATERIAL
H. Vivar	INT	CIMMYT, China	ICARDA-CIMMYT Core funds	INFO MATERIAL
H. Vivar	INT	CIMMYT, Vietnam, Uganda, Thailand	ICARDA-CIMMYT Core funds	MATERIAL
H. Vivar	INT	Virginia Tech., North Dakota State Univ., CIMMYT, Latin American NARS	ICARDA-CIMMYT Core funds	INFO

[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

In 1993 the International School of Aleppo (ISA) integrated a full diploma program in the International Baccalaureate (IB). ISA has now completed full accreditation in KG-Grade 10 with the Middle State Association of Colleges and Schools, as well as of academic programs in Grades 11 and 12 with the International Baccalaureate Organization.

The academic programs at ISA continue to expand with an ever-increasing number of IB courses offered in addition to the expansion in the number of courses offered in the general curriculum of the secondary school. The number of courses offered in International General Certificate of Secondary Education (in Grades 9 and 10) also increased. In summary, the curriculum of the secondary school continued to provide quality education to the ISA student body.

Curriculum in the elementary school continued to draw upon curricula from many different countries.

Seventeen students graduated in 1993. ISA graduates continue to be accepted at major universities around the world, including McGill University, Aleppo University, Washington State University, University of California at Los Angeles, Clemson University, and other well known universities.

Enrollment at ISA stood at 296 students in 1993. Nearly 30 countries were represented in the ISA student body during the 1992/93 school year.

The whole child development approach continued to be a high priority for the school, with faculty and staff centering their instructional expertise on the academic, physical, social, and emotional well-being of every student.

Appendix 10

Visitors to ICARDA

During 1993, ICARDA received 2053 visitors from all over the world. They included scientists, consultants, members of the CGIAR System, diplomats, donor representatives, media representatives, senior government officials, Board of Trustees members, conference participants, outreach staff, auditors, farmers, students, job interviewees, and trainees.

Appendix 11

Statement of Activity
For the Year Ended 31 December 1993
(x 1000 USD)

	1993	1992
REVENUE		
Grants	16,286	18,411
Exchange gains/(loss), net	759	(847)
Interest income	558	922
Other income, net	605	1,872
Total revenue	18,208	20,358
EXPENSES		
Research		
Farm resource management	2,015	2,070
Cereal improvement	3,232	2,700
Legume improvement	1,952	2,017
Pasture, forage, and livestock	2,044	1,763
Total research	9,243	8,550
Research support	5,140	4,861
Cooperative programs	1,395	1,498
Training	568	720
Information	696	840
General administration	2,503	2,062
General operation	1,571	1,750
Subtotal	11,873	11,731
Total operating expenses	21,116	20,281
(DEFICIT) EXCESS OF REVENUE OVER EXPENSES	(2,908)	77
ALLOCATED TO		
Capital invested in property, plant and equipment	57	69
Operating fund	(2,965)	8
(Deficit) / Surplus	(2,908)	77

Statement of Grant Revenue
For the Year Ended 31 December 1993
(x 1000 USD)

	Funds received	Receivable 31 Dec 1993	(Advance) 31 Dec 1993	Current year grants	Previous year grants
CORE UNRESTRICTED					
Australia	(285)	-	-	285	296
Austria	(100)	-	-	100	150
Canada	(641)	-	-	641	839
China	(50)	-	-	50	50
Denmark	(298)	-	-	298	348
Ford Foundation	-	-	-	-	150
France	(252)	-	-	252	-
Germany	(722)	-	-	722	836
India	(38)	-	-	24	25
International Bank for Reconstruction and Development (World Bank)	-	200	-	3,200	3,700
Italy	(140)	700	-	700	174
Japan	(350)	-	-	350	311
Mexico	-	-	-	-	10
Netherlands	(520)	-	-	520	423
Norway	(287)	-	-	287	458
Spain	(125)	-	-	125	125
Sweden	(527)	-	-	527	663
United Kingdom	(753)	-	-	753	905
United States Agency for International Development	(3,500)	-	-	3,500	4,250
	(8,588)	900	-	12,334	13,713
CORE RESTRICTED					
Arab Fund	(496)	502	(270)	720	604
Ford Foundation	-	50	-	32	124
France	(180)	-	(203)	174	747
German Agency for Technical Co-operation	(855)	96	(172)	859	1,268
International Development Research Centre	(60)	-	(55)	58	87
International Fund for Agricultural Development	(100)	45	-	162	81

	Funds received	Receivable 31 Dec 1993	(Advance) 31 Dec 1993	Current year grants	Previous year grants
CORE RESTRICTED (contd.)					
Italy	(1,000)	9	(725)	1,137	1,043
The Netherlands	(334)	29	(372)	277	293
OPEC Fund for International Development	(31)	9	(8)	28	50
United Nations Development Programme	(250)	-	(64)	284	298
United Nations Environment Programme	(45)	-	-	44	-
United States Agency for International Development	(34)	72	-	127	17
Arab Planning Institute	-	-	-	-	17
	(3,385)	**812**	**(1,869)**	**3,902**	**4,629**
COMPLEMENTARY PROJECTS					
CGIAR	(15)	-	(11)	4	-
Food and Agricultural Organisation/ IBPGR	-	-	-	15	24
German Agency for Technical Co-operation	-	-	-	22	29
International Development Research Centre	(13)	-	(9)	4	-
The Netherlands	(5)		-	5	16
Closed projects	-	1	-	-	-
	(33)	1	(20)	50	69
TOTAL	**12,006**	**1,713**	**(1,889)**	**16,286**	**18,411**

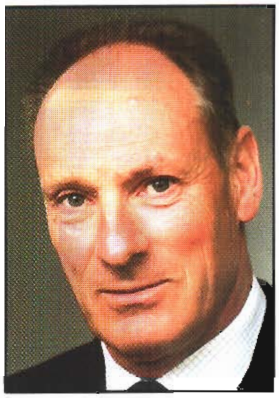
Appendix 12

Board of Trustees

Four new members joined the Board of Trustees in 1993: Drs Alfred Bronnimann, William Roonie Coffman, Toufik Ismail, and Tomio Yoshida.

Dr Roelof Rabbinge and Sir Ralph Riley completed their terms as Board members.

Dr Alfred Bronnimann

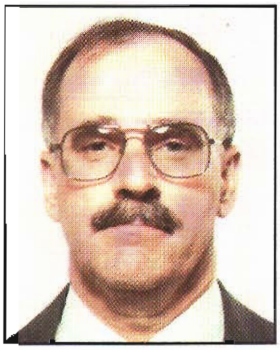


Dr Alfred Bronnimann, a Swiss national, is currently the Director of the Swiss Federal Research Station for Agronomy. He obtained his higher academic degrees, including Ph.D., from the Swiss Federal Institute of Technology, Zurich. He brings with him a wealth of experience in plant pathology and resistance 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.

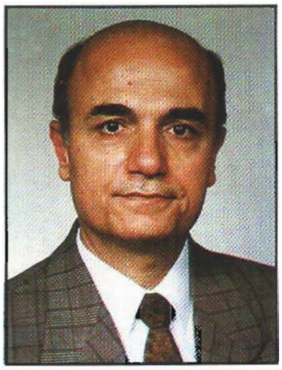
Dr William Ronnie Coffman

Dr William R. Coffman, from the USA, has had a long association with the CGIAR. From 1971 to 1980 he worked as Plant Breeder at the International Rice Research Institute (IRRI), Philippines, where he helped establish, and worked as a member of, an interdisciplinary rice improvement team that produced germplasm cultivated on several million hectares throughout the rice-growing world. Later, as Chairman of the Research Program Committee of the Board of Trustees of the West Asia Rice Development Association (WARDA), he provided leadership in the development of a Strategic Plan and an Implementation Plan (5 years). He was a Visiting Scientist at CIMMYT (International Maize and Wheat Improvement Center), 1970-71, where he contributed to the development of improved germplasm from spring/winter crosses.



Dr Coffman is currently Associate Dean for Research and Director of Agricultural Experiment Station at Cornell University, Ithaca, New York. He has supervised more than 13 graduate students, and teaches courses in plant breeding and international agriculture and rural development. He obtained his B.S. and M.S. degrees in agronomy from the University of Kentucky, and Ph.D. in plant breeding from Cornell University. He has over 80 scholarly publications to his credit.

Dr Toufik Ismail



Dr Toufik Ismail is Deputy Minister of State for Planning Affairs of the Syrian Arab Republic, ICARDA's host country. He obtained his Ph.D. in economics from the University of Louvain, Belgium, and a Diploma in industrial projects analysis from the Economic Development Institute, The World Bank, Washington, D.C.

Earlier, Dr Ismail was Senior Economist, Gulf Organization for Industrial Consulting, Doha, Qatar (1987-92); Dean, Planning Institute for Economic and Social Development, and a member of the Advisory Council of the Ministry of Planning, Damascus (1987); Director, Studies Department, Arab Industrial Organization, Baghdad, Iraq (1982-86); Director, Industrial Planning Department, Damascus (1978-82); and Economist and, later, Deputy Director, Department of Regional Planning, Ministry of Planning, Damascus (1971-78).

Dr Ismail has served either as chairman or a member of several regional delegations and committees on economic and social development in the Arab region. He has published several scholarly articles and a book.

Dr Tomio Yoshida

Dr Tomio Yoshida is a veteran Japanese soil scientist having spent over 40 years in agricultural research. He was a member of the Board of Trustees, CIMMYT, 1984-86, and a member of the Technical Advisory Committee of the CGIAR, 1986-87.

Currently, Dr Yoshida holds the position of Professor of Soil Science, Faculty of Horticulture, Chiba University, Japan. His earlier positions have included Head of Soil Microbiology Department, IRRI; Visiting Professor, University of Philippines; Visiting Scientist, University of California, USA; Consultant, FAO; and teaching positions at several universities in Japan.

Dr Yoshida received his undergraduate degrees from Hokkaido University, Japan, and his M.S. and Ph.D. in soil science from Cornell University. He has been a member of the Japanese and International Soil Science Societies since 1953. Over 110 journal articles, 20 books and 50 general publications bear testimony to his great contributions to research in soil science.

On 31 December 1993 the membership of ICARDA's Board of Trustees was as follows:

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The Board held the following meetings during 1993:

24-26 Jan	Program Committee meeting, Aleppo
27 Jan	Extra-ordinary meeting of the Executive Committee, Aleppo
27-28 Jan	Extra-ordinary meeting of the Board of Trustees, Aleppo
7 May	Program Committee meeting, Aleppo
8 May	Executive Committee meeting, Aleppo
9-10 May	27th meeting of the Board of Trustees, Aleppo
1-2 Nov	Executive Committee meeting, Washington.

Appendix 13

Senior Staff
(as of 31 December 1993)

SYRIA

Aleppo: Headquarters

Director General's Office

Dr Nasrat R. Fadda, Director General
Dr Aart van Schoonhoven, Deputy Director General (Research)
Mr James T. McMahon, Deputy Director General (Operations)
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

Dr Hassan Seoud, Assistant Director General (Government Liaison)
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
Dr 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, Pre-Audit and Control

Computer and Biometrics Services

Dr Zaid Abdul Hadi, Head
Dr Murari Singh, Senior Biometrician
Mr Bijan Chakraborty, Scientific Application Team Leader
Mr Gerard van Eeden, Scientific Data Base Senior Analyst Programmer
Mr Michael Sarkissian, Systems Engineer
Mr Tomas Bedo, System Program Network Administrator
Mr C.K. Rao, Senior Programmer
Mr Awad Awad, Senior Programmer

Personnel

Ms Leila Rashed, Personnel Officer

Farm Resource Management Program

Dr Michael Jones, Program Leader/Barley-Based Systems Agronomist
Dr Hazel Harris, Soil Water Conservation Scientist
Dr Mustafa Pala, Wheat-Based Systems Agronomist
Dr John Ryan, Soil Fertility Specialist
Dr Peter Smith, Visiting Senior Economist
Dr Richard Tutwiler, Socioeconomist
Dr Theib Oweis, Water Harvesting/Supplemental Irrigation Specialist
Dr Abelardo Rodriguez, Agricultural Economist
Mr Wolfgang Goebel, Agroclimatologist
Dr Akhtar Beg, Visiting Scientist
Mr Ahmed Mazid, Agricultural Economist
Mr Abdul Bari Salkini, Agricultural Economist
Mr Sobhi Dozom, Research Associate

Cereal Program

Dr Habib Ketata, Senior Training Scientist
Dr Salvatore Ceccarelli, Barley Breeder
Dr Guillermo Ortiz Ferrara, Bread Wheat Breeder (seconded from CIMMYT)
Dr Omar Mamlouk, Plant Pathologist
Dr Ross Miller, Cereal Entomologist
Dr Miloudi Nachit, Durum Wheat Breeder (seconded from CIMMYT)
Dr Victor Shevtsov, Visiting Scientist
Dr Muhammed Tahir, Plant Breeder
Mr Joop van Leur, Barley Pathologist
Dr John Peacock, Cereal Physiologist
Dr Tom S. Payne, Winter Wheat Breeder (seconded from CIMMYT)
Dr Franz Weigand, Biotechnologist
Mr Issam Naji, Agronomist
Mr Michael Mayer, Post-Doctoral Fellow
Dr Stefania Grando, Research Scientist
Dr Sui K. Yau, International Nurseries Scientist

Dr Mousa Mosaad, Visiting Scientist
Dr S. Mahalakashmi, Visiting Scientist
Mr Mohamed Asaad Mousa, Research Associate
Mr Alfredo Impiglia, Research Associate

Legume Program

Dr Mohan C. Saxena, Program Leader/Agronomist-Physiologist
Dr William Erskine, Lentil Breeder
Dr K.B. Singh, Chickpea Breeder (seconded from ICRISAT)
Dr Ali Abdul Moneim Ali, Forage Legume Breeder
Dr Michael Baum, Biotechnologist
Dr Susan Gerlach, Entomologist
Dr Margret Mmbaga, Legume Pathologist
Dr R.S. Malhotra, International Scientist Trials
Dr S.M. Udupa, Post-Doctoral Fellow
Dr N.P. Saxena, Visiting Scientist
Dr Mamdouh Omar, Visiting Scientist
Mr Bruno Ocampo, Research Associate
Mr Fadel Afandi, Research Associate

Pasture, Forage and Livestock Program

Dr Gustave Gintzburger, Leader
Dr Ahmed El Tayeb Osman, Pasture Ecologist
Dr Luis Materon, Microbiologist
Dr Thomas Nordblom, Agricultural Economist
Dr Scott Christiansen, Grazing Management Specialist
Dr Anthony Goodchild, Ruminant Nutritionist
Dr Walid Sarraj, Training Officer
Dr Timothy Treacher, Visiting Scientist, Livestock
Dr Harohiro Fujita, Resource Information Scientist (TARC)
Mr Faik Bahhady, Assistant Livestock Scientist
Mr Hanna Sawmy Edo, Research Associate
Mr Nerses Nersoyan, Research Associate
Mr Safouh Rihawi, Research Associate
Ms Monika Zaklouta, Research Associate
Mr Farouk Shomo, Economic Research Associate

Genetic Resources Unit

Dr Jan Valkoun, Head
Dr Khaled Makkouk, Plant Virologist
Dr Ardeshir B. Damania, Cereal Germplasm Curator
Dr Larry Robertson, Legume Germplasm Curator
Dr Michael van Slageren, Genetic Resources Scientist
Dr Jan Konopka, Germplasm Documentation Officer
Mr Bilal Humeid, Research Associate
Ms Morag Ferguson, Research Associate

Communication, Documentation and Information Services

Dr Surendra Varma, Head
Ms Souad Hamzaoui, Center Librarian
Ms Linda Sears, Science Editor
Mr Guy Manners, Science Editor
Mr Nihad Maliha, Information Specialist

Training

Dr Samir El-Sebae Ahmed, Acting Head

Visitors' Services

Mr Mohamed A. Hamwieh, Administrative Officer

Travel Section

Mr Bassam Hinnawi, Travel Officer

Farm Operations

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

Engineering Services Unit

Mr Ohannes Ohanessian (Kalou), Electrical/Electronic Engineer

Facilities Management Unit

Mr Khaldoun Wafaii, Civil Engineer

Catering

Mr Farouk Jabri, Food and General Services Officer

Purchasing and Supplies

Mr Ramaswamy Seshadri, Manager
Ms Dalal Haffar, Purchasing Officer

Labour Office

Mr Marwan Mallah, Administrative Officer

International School of Aleppo

Mr Valyn Anderson, Principal
Ms Nida Kudsi, Deputy Principal/Teacher
Dr Thomas Gilber, Deputy Principal-Counsellor

Damascus

Mr Abdul Karim El Ali, Administrative Officer

LEBANON

Beirut

Mr Anwar Agha, Executive Manager

Terbol Research Station

Mr Munir Sughayyar, Engineer, Station Operations

EGYPT

Cairo

Dr Mahmoud Solh, Regional Research Coordinator
Dr Aden Aw-Hassan, Visiting Research Fellow

JORDAN

Amman

Dr Nasri Haddad, Regional Coordinator

ITALY

Anna Maria Gallo, Research Fellow
Elena Iacono, Research Fellow
Cesar Masconi, Research Fellow
Carlo Coduti, Research Fellow
Marco Biagetti, Research Fellow
Maria Laura Fialchetti, Research Fellow
Gianpaolo Paglia, Research Fellow

MEXICO

CIMMYT

Dr Hugo Vivar, Barley Breeder

MOROCCO

Rabat

Dr Mohamed Mekni, Field Manager

PAKISTAN

Quetta

Dr Euan Thomson, Team Leader

TUNISIA

Tunis

Dr Ahmed Kamel, Regional Coordinator/Cereal Pathologist
Dr Maurice Saade, Visiting Scientist

TURKEY

Ankara

Dr S.P.S. Beniwal, Food Legume Scientist

Consultants

Dr Hisham Talas, Medical Consultant (Aleppo)
Dr Edward Hanna, Legal Advisor (Beirut)
Mr Tarif Kayali, Legal Advisor (Aleppo)
Dr Ahmed el Ahmed, Seed Pathologist
Dr Bassam Bayaa, Lentil Pathologist
Dr Nour Eddine Mona, Coordinator, National Programs
Dr Haru Nishikawa, JICA Representative
Dr Abdullah Dakheell, Consultant (Aleppo)

Appendix 14

ICARDA Calendar 1993

January

17 - 28 *Jordan.* In-country Course on Seed Testing Techniques (GTZ/CAS/ICARDA)
18 - 21 *Damascus.* Meeting of Arab Ministers of Agriculture
19 - 21 *Cairo.* Seed Network Steering Committee (ICARDA/GTZ)
24 - 26 *Aleppo.* 21st Program Committee Meeting
27 *Aleppo.* Extraordinary Executive Committee Meeting
27 - 28 *Aleppo.* Extraordinary BOT Meeting

February

1 - 14 *Cairo.* Survey on Viruses of Legume Crops in Egypt
4 - 6 *Bonn.* ICARDA/ATSAF Round Table Discussions on Resource Management Research
9 - 17 *Jordan.* Regional Short-term Course on Utilization of By-products for Feeding Sheep
16 - 20 *Sudan.* NVRP National Food Legumes/Cereals National Traveling Workshop
15 - 18 *New Delhi.* International Conference on Biotechnology in Agriculture and Forestry
17 - 19 *Hamilton/New Zealand.* 6th Australian Conf. on Grassland Invertebrate Ecology - Sustainability of Grassland Ecosystems
22 - 27 *Libya.* Cereals Disease Survey
28 - 11 *Egypt.* Course on Seed Testing Techniques - Follow-up, Regional Train-the-Trainers (GTZ/CAS/ICARDA)
28 - 11 Mar *Egypt.* Course on Seed Health Testing - Follow-up, Regional Train-the-Trainers (GTZ/CAS/ICARDA)

March

1 - 30 June *Aleppo.* Cereal Improvement Long-term Course
1 - 3 *Aleppo.* Workshop on Barley Leaf Blights-Importance and Control Sponsor: USAID (MSU/ICARDA)
1 - 4 *Amman.* Strategic Planning Orientation Workshop for NCARTT Strategy and Medium-Term Plan (ICARDA/ISNAR/NCARTT)
1 - 5 *Southern Morocco.* Cereals Disease Survey
7 - 18 *Aleppo.* Short-term Course on Design, Implementation and Analysis of Rotation Trials
13 - 21 *Sudan.* Course on Seed Testing Techniques-Regional Train-the-Trainers
13 - 24 *Sudan.* In-country Course on General Seed Technology (NSA/ILCA/ICARDA)
18 - 19 *The Hague.* AIARC Board of Directors
20 - 3 Apr. *Rome.* 60th TAC Meeting
29 - 6 Apr. *Egypt.* Regional Course on Cereal Disease Methodology
30 - 31 *Settat.* NARP-Morocco Regional Meeting for Developing Plan for Small Scale Mechanization of Legumes (NARP (ICARDA)/MIAC (Morocco)

April

3 - 7 *Dubai.* ICARDA/United Arab Emirates Planning/Coordination Meeting
3 - 8 *Tunisia.* Barley Traveling Workshop
3 - 10 *Algeria.* Cereals Disease Survey
3 - 15 *Yemen.* In-country Course on Experimental Station Operations Management
4 - 8 *Egypt.* NVRP Regional Food Legumes/Cereals Regional Traveling Workshop
4 - 15 *Aleppo.* Course on Marginal Land Improvement
4 - 18 *Aleppo.* Legume Disease Control Course
4 - 22 *Aleppo.* Course on Biometrical Methods and Related Computing in Crop Improvement
10 - 14 *Egypt.* In-country Course on Wheat Methodology Field Inspection:Train-the-Trainers (GTZ/CAS/ICARDA)
10 - 16 *Iraq.* In-country Course on Legume Hybridization
17 - 9 May *Aleppo.* ICARDA External Review
18 - 22 *Aleppo.* Course on Collection and Preservation of Nitrogen-fixing Microorganisms
19 - 23 *Northern Morocco.* Cereals Disease Survey
25 - 30 *Jordan.* Mashreq Project - Regional Traveling Workshop

May

2 - 8 *Aleppo.* Course on Cereal Identification
2 - 10 *Syria.* Legume Traveling Workshop
2 - 13 *Aleppo.* Breeding Methodology Course in Food and Feed Legumes
7 *Aleppo.* 22nd Program Committee Meeting
8 *Aleppo.* 28th Executive Committee Meeting
9 - 10 *Aleppo.* 27th BOT Meeting
9 - 13 *Aleppo.* Course on Identification of Internal and Blood Parasites
9 - 20 *Aleppo.* Course on Supplemental Irrigation Technology

9 - 20 *Aleppo.* Mechanical Harvesting of Legume Course
15 - 26 *Algeria.* Rapid Rural Appraisal for Algeria and Workshop on Long Term Rotation Trials
15 - 20 *Algeria.* NARP-Regional Food Legume Traveling Workshop
16 - 20 *Aleppo.* Expert Consultation on Sunn Pest (FAO/ICARDA)
17 - 18 *Aleppo.* Biotechnology Steering Committee
20 - 22 *Lebanon.* In-country Course on Agricultural Production Techniques
22 - 29 *Puerto Rico.* Center Directors Meeting
23 - 27 *Aleppo.* Workshop for the Dryland Resource Management Project
23 - 26 *Kamishly, Syria.* Winter Chickpea Technology Course (SMAAR/ICARDA)
24 - 28 *Puerto Rico.* CGIAR Mid-Term Meeting
28 - 30 *Lebanon.* Lebanese Traveling Workshop
30 - 10 June *Iran.* In-country Course on Applications of PC and Related Software in Plant Breeding

June

8 In-House Planning Meeting - Cereals Program
9 In-House Planning Meeting - Legume Program
9 - 10 *Quetta.* ICARDA/AZRI Planning Meeting
10 In-House Planning Meeting - PFLP
13 In-House Planning Meetings- GRU, CBSU
14 In-House Planning Meetings- TCU, SU
17 - 19 *Lebanon.* Agricultural Production Techniques Course
22 In-House Planning Meeting - FRMP
28 - 3 July *East Anatolia.* Legumes Traveling Workshop
28 - 29 *Istanbul.* CIHEAM Meeting
28 - 6 July *Sri Lanka.* 61st TAC Meeting (IIMI)

August

27 - 3 Sept. *Karaj.* Iran/ICARDA Research Planning and Coordination Meeting
29 - 2 Sept. *Sudan.* NVRP-Sudan Regional Coordination Meeting

September

10 - 18 *Ethiopia.* Course on Seed Health Testing - Follow-up, Regional Train-the-Trainers
11 - 12 *Tripoli.* Libya/ICARDA National Corodination and Planning Meeting (NARP)
12 - 16 *Cairo.* NVRP-Egypt/ICARDA National Coordination Meeting (NVRP)
13 - 24 *Rabat.* North Africa Regional Course in Documentation of Genetic Resources
14 *Irbid.* FRMP/JUST Seminar (ICARDA/JUST)
15 - 16 *Amman.* Jordan 5th Coordination Meeting
14 - 15 *Tunis.* Tunisia/ICARDA National Coordination and Planning Meeting (NARP)
17 - 28 *Iraq.* ICARDA/Iraq National Coordination Meeting
19 - 20 *Algiers.* Algeria/ICARDA National Coordination and Planning Meeting (NARP)
19 - 30 *Aleppo.* DNA Molecular Marker Techniques for Germplasm Evaluation and Crop Improvement
19 - 30 *Yemen.* In-country Course on Computer Application of Statistical Methods in Agricultural Research
20 - 22 *Mosul.* Workshop on Rainfed Agriculture in Northern Iraq
20 - Oct. *Rabat.* Sub-Regional Training Course on Documentation of Plant Genetic Resources
22 - 23 *Settat.* Morocco/ICARDA National Coordination and Planning Meeting (NARP)
23 - 24 *Mosul.* 2nd ICARDA/Iraq Coordination Meeting
27 - 29 *Amman.* Mashreq Project 4th Regional Technical Meeting
29 - 4 Oct. *Ethiopia.* NVRP/ICARDA Regional Coordination Meeting

October

2 - 7 *Tunis.* Regional Meeting of the UNDP Maghreb Project on Disease Surveillance and Germplasm Enhancement
3 - 5 *Aleppo.* 12th SMAAR Syria-ICARDA Coordination Meeting
9 - 13 *Algiers.* North Africa/ICARDA Regional Coordination Meeting (NARP/ITGC
10 - 21 *Aleppo.* Course on Use of Electrophoresis in Germplasm Evaluation
10 - 3 *Aleppo.* Course on Library Management and Techniques
16 - 19 *Addis Ababa.* Workshop on Barley Review and Strategy
18 - 19 *Tal Amara.* 3rd Lebanon/ICARDA Coordination Meeting
18 - 23 *Washington.* 62nd TAC Meeting
20 - 25 *Ethiopia.* NVRP National Food Legumes/ Cereals National Traveling Workshop
21 - 22 *Washington.* Center Directors Meeting
25 - 29 *Washington.* International Centers Week

25 - 5 Nov. *Ethiopia.* Regional Course on Forage Seed Production
31 - 11 Nov. *Aleppo.* Course on Water Harvesting Concepts and Techniques

November

1 - 2 *Washington.* 29th Executive Committee Meeting
1 - 4 *Aleppo.* Workshop on Winter Chickpea Technology Transfer in WANA (FAO/ICARDA)
1 - 10 *Morocco.* Course on Analysis of PFLP Experiments
6 - 12 *Aleppo.* 33rd Science Week (Aleppo Univ.)
8 - 12 *The Netherlands.* The Third International Workshop on Orobanche
10 - 28 *Aleppo.* Library and Information Management Training Course
18 - 20 *Hissar, India.* Integrated Weed Management for Sustainable Agric., Int. Symposium
20 - 30 *Amman.* Specialized Training Course on Seed Testing
27 - 28 *Aleppo.* NVRP Steering Committee Meeting
28 - 29 *Aleppo.* Training Course on CDS/ISIS
28 - 30 *Amman.* Workshop on Grazing Management

December

14 -21 *Addis Ababa.* National Cool Season Legume Conf. 1993 (IAR/NVRP)
6 - 7 *Adana.* Third Annual Coordination Meeting of ICARDA/Cukurova University
4 - 8 *Kanpur/India.* International Symposium on Pulses Research (ICARDA, Pulses Res. Dir.)
8 - 10 *Ankara.* Turkey/ICARDA Highlands Coordination Meeting
12 - 14 *Taez.* First Meeting of the Yemeni National Program on Plant Genetic Resources
13 - 14 *Amman.* Mashreq Project - Steering Committee Meeting
16 - 20 *Ethiopia.* Food Legume National Review Workshop (IAR/NVRP)

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)
ANERA	American Near East Refugee Aid
AOAD	Arab Organization for Agricultural Development
AZRI	Arid Zone Research Institute (Pakistan)
BDPA	Bureau pour le Developpement de la Production Agricole (France)
BOT	Board of Trustees (ICARDA)
CG	Consultative Group (USA)
CGIAR	Consultative Group on International Agricultural Research (USA)
CIHEAM	Centre International de Hautes Etudes Agronomique Mediteraneenes (France)
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo (Mexico)
CLIMA	Center for Legumes in Mediterranean Agriculture (Australia)
DGIS	Directorate Central for International Cooperation (the Netherlands)
EEC	European Economic Community
GCC	Gulf Corperation Council (S. Arabia)
GOSM	General Organization for Seed Multiplication (Syria)
GTZ	Deutsche Gesellschaft fur Technische Zusammenarbeit (German Agency for Technical Cooperation)
IBRD	International Bank for Reconstruction and Development (World Bank, USA)
IPGRI	International Plant Genetic Resource Institute (Italy)
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)
IDA	International Development Association (World Bank)
IDRC	International Development Research Centre (Canada)
IFAD	International Fund for Agricultural Development (Italy)
ILCA	International Livestock Centre for Africa (Ethiopia)
INRA-M	Institut National de la Recherche Agronomique (Morocco)
IRAT	Institut de Recherche en Agronomie Tropicale (France)
IRCT	Institut de Recherche sur le Coton et les Textiles (France)
IRFA	Institut de Recherche sur les Fruits et Argumes (France)
MART/AZR	Management of Agricultural Research and Technology/Arid Zone Research Project (Pakistan)
MIAC	Midamerica International Agricultural Consortium
NARS	National Agricultural Research System(s)
OPEC	Organization of Petroleum-Exporting Countries (Austria)

PARC	Pakistan Agricultural Research Council
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)
USAID	United States Agency for International Development
WANA	West Asia and North Africa

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
ES	Spain
FR	France
GB	United Kingdom
JO	Jordan
SD	Sudan
SY	Syria
TR	Turkey

Appendix 16

ICARDA Addresses

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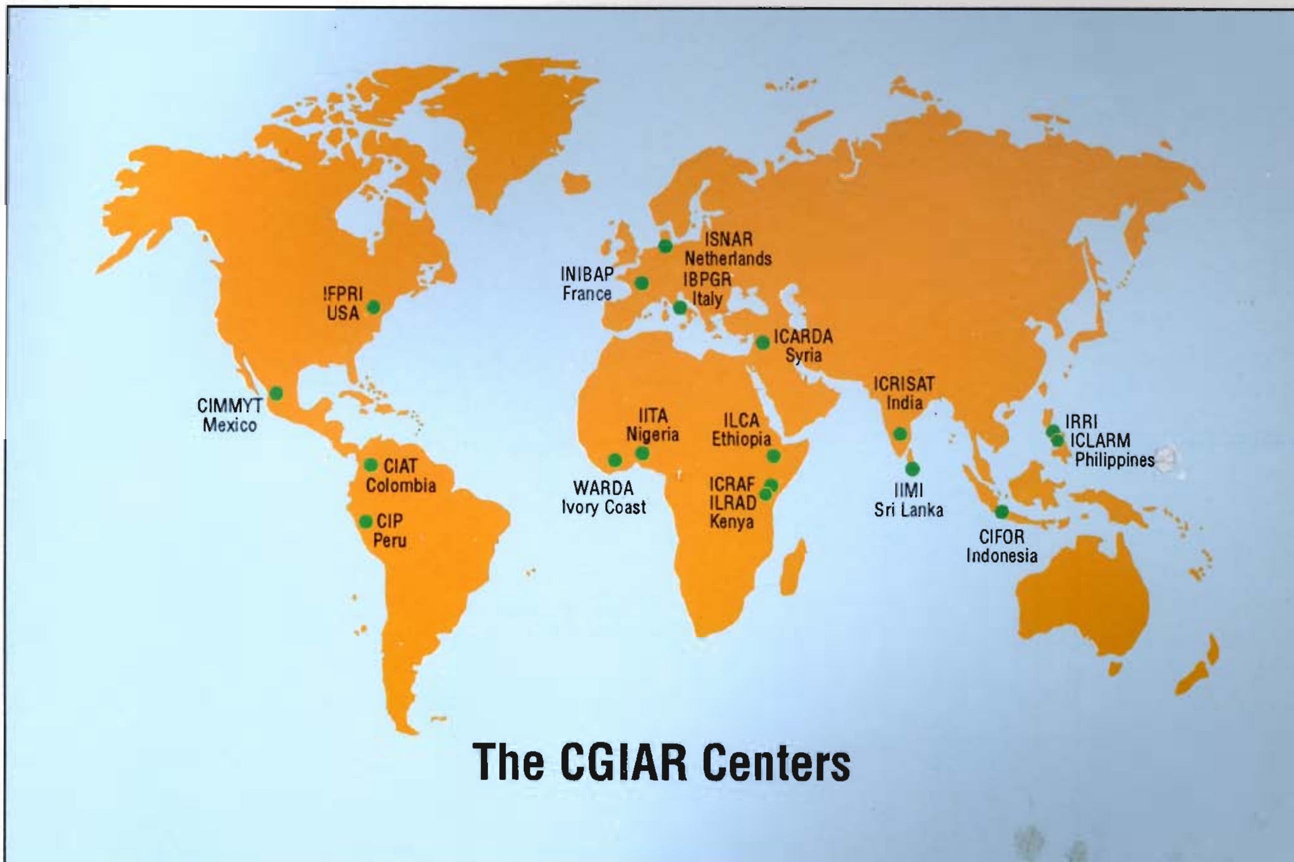
The CGIAR

CARDA is one of 18 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.

The CGIAR has the following mission: "Through international research and related activities, and in partnership with national research systems, to contribute to sustainable improvements in the productivity of agriculture, forestry, and fisheries in developing countries in ways that enhance nutrition and well-being, especially of low-income people. The mission implies a focus on: international research that complements and supports national research efforts; complementary activities aimed at strengthening national research capacities such as specialized training and information services, but excluding other development or technical assistance activities; satisfying human needs from agriculture, forestry and fisheries, without degrading environment or the natural resources on which they depend; the large numbers of poor people; and the importance of technological change in generating new income streams for the poor.

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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