ICARDA Annual Report 1992

International Center for Agricultural Research in the Dry Areas

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Annual Report
1992

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P.O. Box 5466, Aleppo, Syria

ISSN 0254-8313

Cover

ICARDA in collaboration with its national partners is attempting to develop sustainable production systems for the overlapping agroecologies of the region. Planting of shrubs such as *Atriplex* spp. in rangelands provides feed for livestock, prevents soil erosion, and fills an important gap in the sheep feeding cycle after the grazing of cereal stubbles in arable areas. Animals, thus, provide the integrating element in the production systems that utilize both arable and non-arable land.

Foreword

At ICARDA, 1992 was a year of review, self-searching and planning for the future, which culminated in the preparation of a Medium-term Plan for the period 1994-98. The Plan was developed in the context of major developments in ICARDA's external environment, which could have far-reaching implications for the Center and its work.

Not least among these developments have been the sweeping changes that have taken place in the global political order and within ICARDA's mandate region, West Asia and North Africa, and the neighboring countries. Also of immediate concern to ICARDA are changes in the thinking of the international research community set out in recent studies of the Technical Advisory Committee of the Consultative Group on International Agricultural Research, including those on the expansion of the System, on the ecoregional approach, and on global, regional and center-specific research priorities. Further, ICARDA's Plan took into account the deliberations of Rio de Janeiro's Earth Summit (UNCED). In particular, Agenda 21 proposes actions in the areas of agricultural policy, capacity building, farming systems, conservation of genetic resources, integrated pest management, and land resource management, which are already on ICARDA's own research agenda.

ICARDA's new Plan proposals do not constitute a major break with concepts advanced in the Center's 1989 Strategy, nor with the research it has been conducting in the recent past in the context of its current Medium-term Plan. Rather, they are small but significant steps to adjust the frontiers of work already in hand. They place greater emphasis on research for the highlands as well as the drier lowlands; they give additional support to natural resource management, including plant genetic resources; they accept work on irrigation as a legitimate area of interest for ICARDA; emphasize research on animal nutrition and a shift from food to feed production; and extend diagnostic socioeconomic research to accommodate studies on pressures encouraging the mismanagement of resources, monitoring the adoption of technical solutions and understanding the role of social institutions and government policies. Above all, the new Plan envisages a substantial buildup of cooperative work with ICARDA's main partners—the national agricultural research systems of West Asia and North Africa.

The Plan and the adjustments that it introduces are in line with ICARDA's mission which will continue to aim at meeting the challenge posed by a stressful and variable environment in which the productivity of primarily 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 is ensured. Those aims are as relevant today as they were when ICARDA was established.

Nasrat R. Fadda
Director General

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Chairman, Board of Trustees

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PART ONE

Major Developments in 1992

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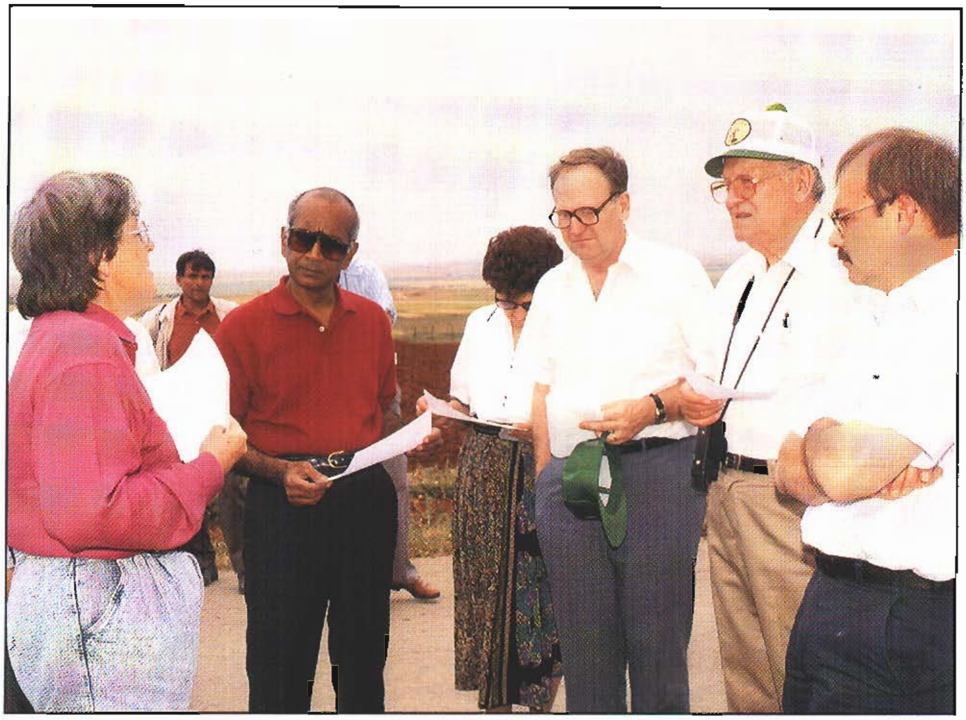
Major Developments in 1992

A coincidence of events turned 1992 into a year of heavy but rewarding demands on the time of staff, management, and the board of trustees of ICARDA. The Center worked simultaneously on two major projects: (i) development of a new Medium-term Plan for 1994-98 for presentation to TAC (Technical Advisory Committee) in April 1993, and (ii) preparations for an external review, scheduled for April/May 1993, of its research programs and management systems. In developing its Medium-term Plan, the Center took into account the emerging vision of the CGIAR (Consultative Group on International Agricultural Research) as reflected in the revised statement of the Group's mission, in the studies related to the expansion of the System, and in the paper on Priorities and Strategies. Agenda 21 of the UNCED (United Nations Conference on Environment and Development) also provided useful background and guidelines. An internal review of specific strategic issues was carried out and extensive consultations with national partners were undertaken.



Mr V. Rajagopalan, CGIAR Chairman (third from left), visited ICARDA in May 1992 and toured the Center's principal research farm at Tel Hadya, Aleppo. Left to right: Drs Hazel Harris, ICARDA; Dr M.C. Saxena, ICARDA; Mr V. Rajagopalan; Mrs Brady; Mr Michael Petit, Director of Agriculture and Rural Development, World Bank; Dr Nyle Brady, formerly IRRI Director General and now Senior Assistant Administrator for Science and Technology at USAID; and Dr Richard Tutwiler, ICARDA.

The 1992 series of ICARDA's coordination meetings with its national partners included 15 country and regional events. Many of these meetings were held under the patronage of, and inaugurated by, ministers of agriculture, reflecting the importance that the countries of the region place on cooperative work with the Center. Over 700 researchers and research managers participated in these meetings. The Center views the high level of effort and participation of its national partners in its programs as a distinct achievement in fulfilling its mandate and mission.

During the year, several international and regional organizations chose ICARDA as a venue for their meetings: the Ford Foundation, the World Bank, TAC, and the Arab Planning Institute (based in Kuwait). ICARDA itself held a number of seminars and workshops at its headquarters, jointly with the CGIAR and other organizations including the FAO (Food and Agriculture Organisation of the United Nations), IBPGR (International Board for Plant Genetic Resources), and ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) with strong international participation. Among the topics covered were biodiversity in wild relatives of wheat, adaptation of chickpea in WANA (West Asia and North Africa), management of gypsiferous soils, priorities for agricultural research, and information networking. Of special importance were visits by the CGIAR Chairman, Mr V Rajagopalan, and several donor representatives from Austria, Belgium, Canada, France, Germany, Italy, Japan, Switzerland, the UK, UNDP (United Nations Development Programme), UNEP (United Nations Environment Programme), USA, and the World Bank.

Evidence, based on the balance between staff stability and turnover rate, points to the fact that ICARDA is now seen as an excellent Center by scientists interested in international research. During 1992, nine P-level staff members joined the Center and four left. The current team of scientists, administrators, and support staff is stronger than ever before in the history of ICARDA; the Center will continue to build on this strength in the years to come.

A climate of financial austerity prevailed at ICARDA during 1992, and is expected to continue in 1993 and beyond. Yet, a substantial investment had to be made on upgrading the computer system, replacing heavy-duty generators and vehicles, over and above the normal annual expenditures. To cope with the shortfall in its projected funding, the Center had to freeze some senior staff positions, delay implementation of certain activities, use RA-level staff to perform P-level functions, contract out research with institutions and scientists from NARS (National Agricultural Research Systems), and administer a strict fiscal control.

Research and Training Highlights

The Weather

Temperatures were below average from the end of November until May in most WANA countries. In Jordan, southern Syria and Lebanon, and in the coastal areas of Egypt and Libya, low temperatures were coupled with unusually heavy precipitation, frequently falling as snow. The severe winter caused substantial losses to vegetable production, citrus groves, vineyards, and even livestock in Jordan and Lebanon. Field crops were not adversely affected and cereal yields were around or above average in Syria, Lebanon, Jordan, Egypt, and Libya.

Morocco experienced the worst drought since the early 1980s. From October to March, precipitation totalled only one-third of the long-term average. Wheat and barley yields, therefore, were much lower than the previous season's harvest. Elsewhere in the Maghreb, however, cereal yields were above average.

In the highlands of Turkey and Iran, adequate moisture supply resulted in above-average crop yields, except for a drought in western Turkey.

In Ethiopia, the spring rains started and ended earlier than usual, resulting in below-average crop yields. The main rainfall in Ethiopia, Sudan, and Yemen started late but was adequate.

Agroecological Characterization

Use of Satellite Imagery to Measure Steppe Degradation

At ICARDA a pilot study is under way to determine the effectiveness of satellite imagery for identifying the extent and location of rangeland degradation. The study area, about 22 500 km^2, lies southeast of Aleppo, Syria. Initial results show that discrimination between different soil/vegetation combinations is possible, particularly by combining the use of both contrast-enhanced ("false color") and classified images.

The image classification was done at the National Remote Sensing Center, Farnborough, UK, using software that takes user-identified sample areas of known types (e.g. wind-eroded units) and generates statistical criteria that are then used to identify all

Landsat thematic map, classified into 15 areas (different colors). Aleppo is at the top left corner, Palmyra at the bottom right.

similar areas on the image. A map is being produced, using a combination of the two images and field data. This research should help answer the question of how far the steppe is being irreversibly degraded, and provide a basis for the analysis of the causes. The work has already revealed interesting information. For example, the importance of *sabkhas* (saline, seasonally flooded depressions) as sources of wind-borne sand and dust, and the redeposition of these materials in fairly stable vegetated formations is clearly revealed (dust redeposits show as blue shading in the contrast-enhanced image).

Germplasm Conservation

Over 1000 new accessions of the mandated crops and/or their wild relatives were collected from the WANA countries, mainly Tunisia and Syria, in cooperation with national partners. Germplasm exchange with other institutions brought another 5000 new entries, raising the total holdings in ICARDA's gene bank to 92 000 accessions.

A collecting mission for wild wheat relatives was organized in Armenia for the first time. The area covered included the Erebuni Nature Reserve, north-east of Yerevan, which is a classic example of *in situ* conservation. In the 1930s, N.I. Vavilov recognized the importance of the site and promoted the idea of creating a Nature Reserve to preserve the unique richness of the wheat gene pool. The Reserve yielded the rare *Triticum araraticum*, *Triticum urartu*, and *Triticum boeoticum* populations.

Barley landraces from China, Algeria, Egypt, and Syria were characterized for their flowering response to varying temperature and day length regimes. A great diversity was found for basic parameters of the photothermal response (earliness *per se*, vernalization, and photoperiod reaction) among the Chinese germplasm. Some Algerian and Syrian landraces were heterogeneous in their response.

The wild *Lens* collection was evaluated for morphological traits and eight isozyme systems. These data have been used to draw the evolutionary relationships of the species in the genus. The relationships between morphological descriptors and ecogeographical data have been determined. Biochemical analysis of leaf proteins showed a high genetic diversity in the wild progenitor of lentil, *Lens orientalis*.

An agreement on "Safety Duplication of ICARDA's Genetic Resources Data at IBPGR" was signed and a duplicate data set was deposited with IBPGR. The data sets will be replaced annually.

ICARDA scientists collecting wild cereal germplasm in Sweida Province, Syria.

Safety duplication agreements for lentil and chickpea were signed with the Indian Council of Agricultural Research (ICAR) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), respectively. Duplicates of all ICARDA collections are now deposited with other research centers, except forage legumes for which a suitable location is being sought.

Utilization of germplasm collections was again high in 1992. Over 24 000 seed samples were distributed from ICARDA's gene bank on request to national programs in WANA, other institutions, and ICARDA scientists.

The Seed Health Laboratory conducted testing for seedborne pathogens/pests in all seed shipments received (11 868 lines) or dispatched (3319 lines) by ICARDA.

Field inspection of newly introduced genetic material grown in the postquarantine observation area revealed no exotic seedborne pathogens or pests.

Germplasm Enhancement

Food Legume Crops

National programs, participating in the International Testing Network, identified and released seven improved chickpea and two lentil cultivars (France, Iraq, Morocco, New Zealand, Pakistan, and Turkey). In addition, several lines were identified for multilocation testing, on-farm trials or prerelease multiplication. A large number of lines resistant to various stresses were also identified. More than 160 participants in 52 countries received over 1050 sets of 34 different nurseries of food legumes for the 1992/93 season.

Release of legume cultivars shows an interesting pattern as illustrated by the example of lentil. Most of the lentil cultivars released by NARS have been the result of systematic exploitation of germplasm. Within the lowland Mediterranean region, selections from Jordanian landraces were registered as cultivars in Iraq, Jordan, Lebanon, and Syria; Lebanese germplasm was released in southeast Turkey, and a reselection from a Syrian landrace was released in Algeria and Tunisia. Releases in highland Turkey originated from germplasm selections from highland Algeria and Iran. Among early lentils, northern Argentina was the source of cultivars for Morocco and Pakistan, Pakistan for a new Nepali cultivar, and central Mexico for an Ethiopian cultivar. This highlights the role that an international center can play in enhancing the use of germplasm from different geographical regions.

The productivity of lentil is greatly constrained by vascular wilt disease caused by *Fusarium oxysporum*. In some Latin American countries vascular wilt has completely wiped out lentil production. Using a wilt-sick plot, ICARDA has developed a field screening method and identified resistant genotypes. Resistant

Lentil line 78S26013, developed from Jordanian germplasm, was released in Lebanon as cultivar Talia 2.

Field screening for wilt resistance in lentil in a sick plot at Tel Hadya, Aleppo.

material is being shared with NARS through the International Legume Testing Network. Some of this material with a high yield potential in lowland Mediterranean environments is being tested jointly with the Syrian national program on farmers' fields in wilt-infested areas.

Yield improvement of kabuli chickpea is possible through the adoption of winter sowing in low altitude areas. Trials at three ICARDA sites (Tel Hadya and Jindiress in Syria, and Terbol in Lebanon) over nine years (1983/84 to 1991/92), with more than 100 newly bred lines tested per year, have shown that winter-sown chickpeas produce 61% (616 kg/ha) more yield (123% with the best 10% of genotypes) than traditional spring-sown chickpeas. Winter sowing is expanding in WANA with the current area estimated at 60 000 ha. Adoption studies in Syria and Morocco have revealed that (i) farmers recognize the advantage of winter sowing, but prefer larger seed size than the present winter-chickpea cultivars provide, and (ii) there is a need for increased extension efforts and improved weed control.

Since chickpeas fix atmospheric nitrogen, they have an important place in cropping systems of the region. The effect of inoculation on nitrogen fixation was examined in relation to the dry matter yield. In uninoculated cultivars, the amount of nitrogen fixed remained relatively constant at about 60% of total nitrogen used by the crop. Thus, with increasing dry matter and grain yield, the amount of soil nitrogen taken up by the crop increased from 20 kg/ha to nearly 50 kg/ha over the range of dry matter yields. With inoculated cultivars, on the other hand, the amount of nitrogen fixed also increased with increasing dry matter yields. The study shows that inoculation may be advantageous where introduced cultivars selected for high yields cannot express their full nitrogen-fixing potential with native rhizobial populations, which tend to be specific to local landraces.

To identify dry pea genotypes adapted to Mediterranean environments of low to intermediate elevation, 438 accessions from different parts of the world were evaluated for cold tolerance at Tel Hadya during 1991/92 when the minimum temperature fell to below zero on 53 nights, the lowest being -8.8°C. Thirty-six lines were rated as cold tolerant; most of them were from the breeding material from Idaho, USA. Promising lines will continue to be tested in a Preliminary Yield Trial in the 1992/93 season to identify those suitable for distribution in WANA through the Pea International Adaptation Trial for 1993/94.

Devolution of faba bean improvement research to North African national programs was completed. BMZ (Federal Ministry of Economic Cooperation, Germany) approved financial support for the 'North Africa Faba Bean Research Network' to ensure that ICARDA-generated faba bean material and technology continue to be utilized by faba bean improvement teams in North Africa. On a recommendation from GTZ (German Agency for Technical Cooperation), a workshop was organized by ICARDA's North Africa Regional Program in Tunis to formally launch the network activities.

Forage Legume Crops

Vetches and chicklings are potential forage legumes for replacing fallow in cereal-based rotations. Adaptation of narbon vetch (*Vicia narbonensis*) and common chickling (*Lathyrus sativus*) to low rainfall, drought-prone environments was confirmed. Their grain yield was 1500 kg/ha and 1300 kg/ha, respectively, at Breda where the total seasonal precipitation was only 263 mm.

A simple field method of screening feed and food legumes for drought resistance with two moisture

Vicia narbonensis **proved to be the most drought-tolerant species at Breda, Syria where the total precipitation in 1991/92 was only 263 mm.**

regimes (rainfed and with supplemental irrigation) was found effective in identifying genotypic differences in drought tolerance. *Vicia narbonensis* was found to be most drought tolerant, based on both its seed and total dry matter yields. Large genotypic differences within the crop were also identified; a few genotypes combined drought tolerance with responsiveness to supplemental irrigation.

Promising lines of *Vicia* spp. and *Lathyrus* spp. were distributed to national programs in response to increased demand. The Moroccan national program advanced *Vicia narbonensis* selection 577/2391 and *Vicia sativa* selection 709/2603 to catalog trials. Jordan identified *Vicia sativa* selection 715 for its non-shattering pods and erect growth habit.

Cereal Crops

Improved cereal cultivars were released in WANA countries from the joint NARS/ICARDA work: Rihane (barley), Cham 1 and Cham 3 (durum wheat), and Cham 4 and Cham 6 (bread wheat).

Cereal cyst nematode (white cysts on roots) and common root rot (discoloration of the subcrown internode) are important barley diseases in the dry areas.

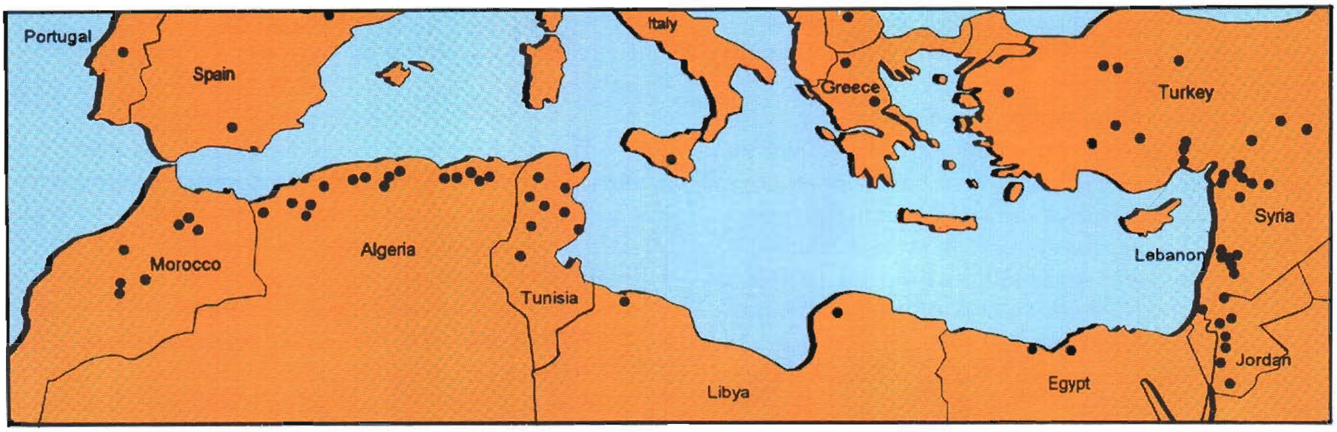
An impact study of new technology (varieties, agronomy, irrigation, etc.) on wheat production in Syria during 1991/92 showed a net benefit of USD 275 million over traditional production practices. Modern varieties contributed 27% of this, and had been taken up by 86% of the farmers surveyed.

Recognizing the role of specific adaptation in cultivar performance, the Center is increasingly decentralizing its germplasm testing activities. In 1992 a new nursery distribution scheme was started for barley in North Africa. The scheme allows selection in early segregating generations by NARS scientists at sites representing the growing areas of potential new varieties.

Research emphasis increased on factors affecting root performance including root rots, cereal cyst nematodes, and boron toxicity. A survey in Syria showed root rot symptoms to be especially severe in the drier cereal areas, particularly on barley. The major causal agent was the fungus *Cochliobolus sativus*. Yield losses of up to 40% were recorded in inoculated plots. Although symptoms are greatly

Two-week old barley seedlings being screened for tolerance to boron toxicity in plastic house at Tel Hadya.

affected by environment, genetic resistance remains the best method of controlling the disease. A high level of resistance was found among a group of 100 barley lines derived from Jordanian and Syrian landraces. The most resistant lines originated from landraces grown in the drier areas.



Distribution of Russian wheat aphid in Mediterranean countries, based on surveys conducted by ICARDA and other institutions.

In semi-arid areas, boron may accumulate in the soil and impair root growth, causing leaf yellowing or death in severe cases. Boron toxicity can also greatly aggravate the effect of drought. Symptoms of boron toxicity were observed on susceptible cultivars (especially barley) in cereal-growing areas in Turkey, Syria, and Egypt. A simple technique based on symptom development has been devised at ICARDA to screen barley germplasm for tolerance to boron toxicity. The technique allows testing of thousands of genotypes each year. Preliminary selection revealed that boron toxicity tolerance in barley line Mari/Aths*2 was as good as in Galleon, an Australian boron-tolerant variety.

Restriction Fragment Length Polymorphism (RFLP) markers in durum wheat were studied for their use as indirect selection criteria for morphophysiologic traits associated with good performance under drought. Some RFLP markers were found to be associated with such traits as leaf waxiness, leaf water potential, leaf rolling, leaf color, canopy temperature, early plant vigor, and awn length. Many of these traits influence yield under drought. Attempts are being made to relate genotypic performance in different environments to specific DNA markers. RFLP markers on the short arm of chromosome 6 were associated with high yield under dry continental conditions, while markers on the long arm of chromosomes 5 and 6 were associated with good performance under irrigated conditions.

Following the introduction and devastating impact of the Russian wheat aphid (RWA), *Diuraphis noxia*, in North America since 1986, ICARDA has teamed with national and international institutions to determine the distribution and impact of this insect pest, and its natural enemies, in its native habitat. Surveys were conducted over two years in several countries of the WANA region. In general, pest density was low to moderate, although in some sites 80% of plants were infested. The aphid and its numerous natural enemies were most often found in areas of low humidity where plants were sparse and subjected to moderate drought stress. During periods of prolonged drought, RWA populations expanded to infest large areas, threatening the most productive wheat and barley-growing areas. The pest occurred least in humid environments with high plant density and vigorous plant growth. A total of 572 parasitoids and predators have been collected. These were shared with Texas A&M University and some have since been released against RWA populations in the Pacific Northwest of the USA, a region with a mild Mediterranean climate.

Resource Management and Conservation

Rotation Studies

Cropping patterns continue to change in the WANA region. The driving forces of change are population pressures, a shortage of arable land, and the concern of governments with food security. These have led to the imposition of policies which favor cereal production, and to a shift from cereal-fallow systems to continuous cereal growing.

A rotation trial at Tel Hadya provides data on the likely outcome of production from continuous wheat cropping compared with production from six alternative sequences with legumes, watermelon or fallow. The trial was established in 1983, so eight years of data for continuous wheat production are now available. The average yield of continuous wheat over that time has been up to 40% less than that from other rotations. The reasons for the yield decline include less available water for the crop (compared with fallow, melon, vetch and lentil rotations), a buildup of insect (*Zabrus tenebroides*) populations, and probably of nematodes and a disease complex. These data show that continuous cereal production is not a sustainable practice.

Semi-nomadic Bedouins in Syria: Migration and Sheep Feeding Patterns

A large proportion of Syria's sheep are based in the steppe, but most of the feed for them is produced elsewhere. That feed is either transported to the steppe or is obtained, mainly in the form of crop residues, by transhumance. Migration and feeding patterns differ among the subgroups of agropastoralists and their flocks, driven variously by the imperative to obtain adequate feed at low cost. To improve the productivity of such systems and, particularly, to conserve the land resources which they use, it is important to gain a clear understanding of their social and economic organization. Eleven Bedouin families from three villages in the steppe fringes of Aleppo Province were monitored over a 15-month period through frequent visits and formal and informal interviews. They had been previously studied by ICARDA scientists about 10 years ago, which provides a useful historical perspective.

Since rangelands, where most of Syria's sheep are based, are not capable of producing sufficient feed, pastoralists must bring expensive feed from elsewhere.

The families studied could be placed into two broad groups: those that have become more sedentary, and those that have become more nomadic. The more sedentary are generally those with smaller flocks, living in villages where arable cropping has largely replaced the local rangeland. The more nomadic are driven by the need to find cheaper forms of feed. Purchased feeds now comprise the largest portion of their annual costs. So, instead of bringing expensive feeds to the sheep, flocks are moved to cheaper grazing sources.

All the families interviewed expressed concern at the reduction of vegetative cover of the rangeland. But, alternative grazing options are increasing. Residues of irrigated crops are of growing importance, being utilized for up to six months. Two main groups of irrigated crops were utilized: cotton, wheat and maize in Aleppo and Raqqa Provinces, and vegetable and other crops along the Mediterranean coast.

Despite transhumant lifestyles, allegiance to the home village and its land remains strong. Families are receptive to new ideas and want to improve their land's productive capacity. They are convinced that planting barley is the best way to utilize degraded rangeland. The planting of fodder shrubs, such as *Atriplex* spp., is regarded skeptically, although combinations of barley with atriplex may be more acceptable.

Nitrogen Cycling Under Different Crop/Livestock Production Systems

Studies continued on the effects on soil nitrogen of introducing different legumes into long-term wheat rotation trials. Six years of results demonstrated that the total soil nitrogen concentration remained unchanged in the rotations that included lentil, fallow or melon, but increased by 15-20% in rotations that included grazed medic pasture (at three stocking rates) or vetch.

The large increases in total soil nitrogen and organic matter in the medic-wheat rotations indicated that there were large inputs of organic nitrogen into the soil. Most of this nitrogen came from the return of the legume shoots to the soil, which was larger at the low and medium stocking rates where the pasture was underutilized.

Nitrogen was also returned in the urine and dung from the grazing sheep, but the amount was only about 20% of the total nitrogen returned in shoots and roots. In a related experiment it was demonstrated that about 55% of nitrogen consumed by sheep grazing medic pasture was removed from the field in milk, and in dung and urine deposited in the night-holding areas.

Predicting the Nutritional Value of Barley Straw

Cereal straw occupies an important place in ruminant diets in the WANA region. The voluntary intake of straw by sheep is an important factor in its economic value. The tests to predict this must use small samples of straw, be able to predict quality, and be inexpensive in time and materials.

Screening tests to predict the ranking of varieties for voluntary straw intake were conducted. The long-term mean intake of nine varieties of barley straw has been estimated from more than 100 lots of straw harvested over seven years. The straw samples included improved six-row, two-row, and landrace varieties. The best long-term predictions were possible with Near Infrared Reflectance Spectroscopy based on three wavelengths, *in vitro* gas production, *in vitro* digestibility, and acid detergent fibre tests.

The ranking for voluntary intake of nine varieties grown in five years was well predicted by Near Infrared Reflectance Spectroscopy. The major exception was for landraces grown in the drought years 1989 and 1990. Grain yield of these varieties was not much affected by drought. As a result, drought increased the voluntary straw intake of these varieties compared with the intake of drought-susceptible varieties.

Seed Production Network

A Seed Production Network was established at a workshop held in Amman and attended by seed program managers from Algeria, Cyprus, Egypt, Iraq, Jordan, Libya, Morocco, Sudan, Syria, Turkey, and Yemen. The workshop was jointly financed by ICARDA and GTZ/Jordan Seed Multiplication Project. The network will be involved in three principal activities: dissemination of seed information, strengthening the infrastructure for seed production in WANA, and formal education in seed production.

Several activities (WANA seed directory, referee testing system, catalog of seed standards, and seed newsletter) have been initiated.

Pasture Legume Pod Collector

Increasing medic seed to quantities sufficient to sow a pasture field has been a bottleneck in pasture improvement efforts of ICARDA. To overcome this problem the Center has, after over three years of research, succeeded in developing a simple but efficient pasture legume pod collector that can be used by both farmers and researchers.

The pod collector is pushed by hand, and has a brush assembly that rotates about a horizontal axis against the direction of travel, and sweeps light

Pasture legume pod collector developed by ICARDA.

materials from the soil surface into a removable basket. In a trial of the machine, two workers at the Qatanieh State Farm in northeast Syria collected almost one tonne of pods in two weeks from a 2-ha field that had been fairly well leveled.

Technical drawings of the pod collector are available from ICARDA for farmers and NARS scientists who wish to have it fabricated locally.

Impact Assessment and Enhancement

Improved Barley Technology Transfer to Farmers in Jordan and Syria

An extensive program of farmer-managed demonstrations of improved barley production packages was initiated in 1989 by Jordan and Syria in partnership with ICARDA's Mashreq project funded by UNDP and AFESD (Arab Fund for Economic and Social Development). Present farmer production practices rely on unimproved varieties and low inputs, which result in low yields.

The 1992 demonstration efforts revealed that improved cultivars were accepted by over 85% of participating Syrian farmers. In Jordan, where there had been prior use of new barley technology, the adoption rate was slower than in Syria.

The 1991/92 program in Syria achieved a success rating of between 87 and 100% for adoption of the demonstrated technologies. The three years of demonstrations in Jordan have more than doubled the number of farmers using the full package.

Economic Analysis of Medic Pasture in WANA

Attempts to transfer Australian ley-farming (pasture-cereal rotation) techniques to the WANA region have been made since the 1960s with little success. A comprehensive investigation on the economics of annual pasture rotations with cereals in the WANA region has been lacking until now.

A large field trial, established at Tel Hadya in 1985, investigated medic, lentil, watermelon, fallow, and vetch in two-year crop rotations with wheat. Results from the first six years of the trial provided yield and pasture offtake data as the physical basis for a whole-farm economic analysis of the pasture-cereal system. Average wheat yields were highest (about 2100 kg/ha) after watermelon or fallow, and about 500 kg/ha lower after lentil or vetch; a further 200 kg/ha reduction was associated with medic pasture.

The economic analysis determined whole farm income, including returns from land, labor, capital, inputs, etc. The medic-wheat rotation did not compete well with other rotations in terms of whole farm income under standard price assumptions. Rotations with labor-intensive crops (lentil and watermelon) did best in the economic analysis. They are also the ones most commonly found in the neighborhood of the study site.

The question of how far wheat yields and pasture productivity would have to improve before the medic-wheat system becomes competitive with traditional crop rotations was answered through a sensitivity analysis. In the case of the small (16 ha) farms, grain yields would have to increase by 600 kg/ha and pasture offtake to double (200%) before medic-wheat becomes more profitable than lentil-wheat, the best of the traditional rotations. The conditions are progressively eased for the 32 and 64 ha farm sizes.

The results allow a prediction that few, if any, farmers who face the prices and growing conditions similar to those depicted in the model would wish to adopt the medic-wheat system, but these conditions are unlikely to hold for all farms or in all countries.

Medic pasture becomes competitive on 64 ha farms but remains the poorest option on 16 ha farms, for example, when hired labor costs are doubled (from about 2 to 4 USD/day), when off-farm work for family labor is not available, and when straw prices are halved. These conditions can occur at locations far from towns. Economic values, thus, have a role in predicting adoption of new practices at each new location.

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. These regional programs were established in recognition of the fact that the Syrian "testbed," no matter how suitably located, cannot meet all the research needs of ICARDA's diverse mandate region. They foster strong partnerships with national research teams, ensuring continuity of the cooperative research, as well as help identify new research needs and opportunities. In addition, they provide a mechanism for decentralizing research and training activities and for the exchange of information. Where possible, they also play a catalytic role in attracting donor funding to national programs.

Highland Regional Program

After two years, the Highland Regional Program is maturing into an effective entity in WANA. With financial support from the Governments of Italy, Iran, and USAID (United States Agency for International Development), the program is developing collaborative research in areas (usually above 750 m) where low temperatures in winter severely limit crop growth.

In Turkey, seven interconnected projects are under way in collaboration with the Ministry of Agriculture and Rural Affairs, Çukurova University, and Ankara University. Their common theme is to overcome constraints to fallow replacement to provide sustainable animal feed supply. Results from the earliest established of these projects in the Taurus Mountains have indicated the scope for improved production of cereals and legumes from selection of appropriate improved crop cultivars and the potential for improved milk production from the introduction of crossbred German Fawn x local Hair goats.

Posting of an ICARDA resident scientist in Tehran, scheduled for 1992, had to be postponed since the development of basic facilities at that site is still under way. However, the ICARDA/Iran collaborative project activities continued through germplasm exchange and development, training, visits, design of initial research proposals, supply of essential equipment, and enhancement of scientific linkages.

In Pakistan, the Arid Zone Research Institute (AZRI) in Quetta, which is part of the Pakistan Agricultural Research Council (PARC), continued to be assisted by resident scientists from ICARDA although their number decreased from three to two during 1992. This collaboration started in 1985 with support from USAID, and aims to strengthen the research capability of AZRI.

As the project moves towards completion in August 1994, the research is being increasingly focused on those technologies that have demonstrated the greatest potential to produce an impact at the farm level. These are: bread wheats with resistance to yellow rust, and the use of fourwing saltbush to establish forage reserves.

In December a workshop was held in Quetta on Small Ruminant Production in the Highlands of West Asia and North Africa. Participants came from Afghanistan, Iran, Iraq, Morocco, Pakistan, and Turkey. As well as reviewing current knowledge of small ruminant production systems, the workshop considered the need to establish collaborative research on small ruminants between the different countries in WANA with large areas above 750 meter altitude.

Improved variety trials of cereals and legumes have shown good promise for local agricultural communities in the Taurus Mountains area in Turkey.

An agreement was signed between ICARDA and the United Arab Emirates to host the Center's Arabian Peninsula Regional Program office in Dubai. Seated from left to right: Dr Nasrat Fadda, Director General of ICARDA; H.E. Saeed Mohamed Al-Raqqabani, Minister of Agriculture and Fisheries, UAE; Dr Abdel-Rahman Abdalla, UN Representative, UAE; and H.E. Hamad A. Salman, Deputy Minister of Agriculture and Fisheries, UAE.

Arabian Peninsula Regional Program

Through the support from the Arab Fund for Economic and Social Development (AFESD), the Arabian Peninsula Regional Program (APRP) continued its research and training activities during the 1991/92 season. The major activities of the Program focused on (a) germplasm exchange, evaluation and improvement, (b) training and human resource development, and (c) visits and consultancies by ICARDA and national scientists from the region. In 1992 the program continued to operate from ICARDA's headquarters in Aleppo, but an agreement was signed with the United Arab Emirates to host the APRP regional office in Dubai.

A total of 64 barley and bread and durum wheats, 34 lentil and chickpea, and 16 forage legume trails were supplied for evaluation under the prevailing biotic and abiotic stresses of the region. F_1s and the related segregating populations of the Regional Crossing Blocks for the Arabian Peninsula, recently initiated at ICARDA, are being developed and distributed to relevant partners in the Arabian Peninsula for evaluation.

Increased attention was paid to seed production. Varietal description and evaluation of the common and improved wheat and barley cultivars from Saudi Arabia and Yemen commenced and a varietal description booklet for the common wheat and barley cultivars grown in the Arabian Peninsula is under preparation.

West Asia Regional Program

Technology transfer is the major focus of this Program, supported by UNDP and AFESD. Results in Syria showed that project-recommended technology resulted in barley yield increases from 28 to 32% for grain and 26 to 30% for straw. Fertilizer application resulted in an average increase of 44% in grain yield in Zone 3 (mean annual rainfall 250 mm).

In Jordan, using the full package of barley production technology, an average grain yield increase of 48% was obtained. Improved cultivars gave 18% more grain yield than the local ones, and fertilizer application resulted in 75% increase in grain yield. In Iraq, the recommended technology produced a grain yield increase of 84% over farmers' practices.

In sheep production studies with farmers' flocks, early weaning resulted in higher net return in Syria and Jordan. The increase in net return ranged from 1.2

Effect of fertilizer application on barley in demonstration trials in Jordan.

to 4 Jordanian Dinar/ewe/season. The use of sponge and hormone resulted in substantial increases in twinning rate. Other activities included the distribution of improved rams to sheep owners, flushing ewes, feeding on urea-treated straw and agricultural by-products, and vitamin A injections for improving ewe fertility.

One faba bean genotype (ILB 1814) was identified by the Iraqi national program for large-scale prerelease field testing. Two barley and two wheat genotypes, one lentil and one chickpea, were identified by Jordan as promising and included in prerelease field verification trails. *Vicia sativa* 715 is also under intensive evaluation and seed multiplication has been initiated in preparation for its possible release in Jordan. In Syria three barley lines—Tadmor, Zanbaka, and Arta—and several wheat and food legume lines were selected and included in on-farm evaluation trials.

Nile Valley Regional Program

The Nile Valley Regional Program (NVRP), started in 1988/89, covers research, transfer of technology, and training to improve the production of cool-season food legumes (faba bean, chickpea and lentil); wheat in cooperation with CIMMYT (International Wheat and Maize Improvement Center), in Egypt and Sudan; and barley in Egypt. The program in Ethiopia also includes field peas.

The NVRP capitalizes on the expertise, human resources, and infrastructure available in the participating countries. On-farm testing is used to develop sustainable technology suitable to farmers' conditions. Funding continued from the Commission of the European Communities (EEC) for the Egyptian component, the Netherlands Government for the Sudanese component, and the Swedish Agency for Research Cooperation for Developing Countries (SAREC) for the Ethiopian component.

Faba Bean

In Egypt an early virus epidemic destroyed the faba bean crop almost completely in Minia and Beni Suif. The Egyptian and ICARDA scientists conducted an intensive survey to determine the cause of the problem and ways to control it. The infection was identified as faba bean necrotic yellow virus, transmitted by several aphid species. Possibly the weather conditions favored the buildup of aphid populations. The value of the new chocolate spot resistant varieties was demonstrated with on-farm yields of up to 4000 kg/ha. Intercropping sugarcane with faba bean proved to be very promising. Using recommended agronomic practices, up to 1300 kg/ha faba bean seed yields were obtained, without affecting the sugarcane yields. Sudan had a record harvest of faba bean because of an unusually cool season and increased adoption of improved production packages, developed and promoted by NVRP.

Chickpea

In Ethiopia, ICRISAT-developed desi chickpea lines and ICARDA-developed kabuli chickpea lines were planted side by side in on-farm trials. Both chickpeas yielded 50% higher than farmers' traditional varieties. Resistance to root rot (wilt) in improved lines, and improved soil drainage, using broadbed and furrow system, resulted in higher yields.

Economic evaluation of improved production packages in on-farm trials showed strong probabilities for a high rate of their adoption. The rates of return were as high as 300% for lentil in Ethiopia, and 500% for lentil, chickpea, and faba bean in Sudan.

Wheat

Wheat production increased significantly in Sudan owing to a combination of factors: cool weather, sound government policies, and the use of improved agronomic practices and varieties. Despite an 18% decrease in area, production increased by 50% to reach an all time high of 0.865 million tonnes, a four-fold increase over production levels 3-4 years ago.

Wheat production in Sudan reached an all-time high in 1991/92.

North Africa Regional Program

The North Africa Regional Program (NARP) executes and coordinates ICARDA's core and special-funded collaborative research and training activities in Algeria, Libya, Morocco, and Tunisia in collaboration with national partners. NARP provided full assistance in completing the devolution of faba bean improvement program to Morocco (see also page 11).

NARP continued to provide support to the UNDP-funded project on Disease Surveillance and Germplasm Enhancement for Cereals and Food Legumes currently executed by national governments in North Africa.

A Regional Coordinator and four staff members from ICARDA are based in North Africa: a cereal and a legume breeder, an agricultural economist, and a sociologist/policy analyst. The economist is sponsored by ICARDA, CIMMYT and the Rockefeller Foundation to support NARS in conducting adoption and impact studies of cereals, while the sociologist/policy analyst is sponsored by ICARDA and the World Bank to assess the potential adoption and impact of winter-sown chickpea technology, with special emphasis on gender issues, in Tunisia.

The IFAD (International Fund for Agricultural Development) special-funded project to increase cereal, food legume, and livestock production in semi-arid areas in North Africa achieved good results despite financial difficulties. National partners tested and verified improved technologies in farmers' fields.

Winter-sown chickpea ILC 3279 on a farmer's field in Sidi Bel Abbes, Algeria.

In collaboration with the CGIAR Gender Program, ICARDA contracted a consultant to explore concepts and methodologies for gender analysis in agricultural research and provide a base for linking gender issues in agriculture within the WANA region with the Center's research activities.

The coordination role of NARP continued at the national and regional levels. The first meeting of the Faba Bean Research Network for North Africa was held in collaboration with GTZ, marking the completion of the devolution of faba bean research to NARS. The second

North Africa/ICARDA Regional Coordination Meeting was held in Rabat, Morocco, and was attended by about 50 researchers from collaborating institutions in North Africa, in addition to staff members from USAID, MIAC (Midamerica International Agricultural Consortium), GTZ, CIHEAM (International Center for Advanced Mediterranean Agronomic Studies), IFAD, and ICARDA. The meeting focused on inter-country and regional activities, reviewed on-going research, and developed research and training plans for 1992/93. The regional meeting followed individual country/ICARDA coordination and planning meetings with each of the four countries of North Africa.

An agreement of cooperation was signed with Libya.

Latin America Regional Program

Atahualpa, a hull-less variety, was released in Ecuador. In preparing food from hull-less varieties, there is no need to remove the husk by sieving. Such varieties therefore sell at a higher price in local markets.

The rotation and intercropping of legumes and barley are studied in Mexico with a view to enhancing farming systems productivity. In 1992, a Mexican farmer planted four hectares of medic (*Medicago polymorpha*) to be grazed by cattle and sheep. His experience has encouraged him to expand the area.

The results of intercropping barley with faba bean and berseem clover confirmed previous experience that barley yields were not reduced.

Training

In 1992, ICARDA offered training to 716 individuals. Training participants came from 38 countries including 21 WANA countries, four sub-Saharan countries, two Latin American countries, four East Asian countries and seven European and North American countries. Of these, about 48% were trained at ICARDA headquarters and others in in-country, subregional and regional courses. About 18% of the participants were women.

ICARDA continued its strategy to gradually decentralize its training activities by offering more off-headquarters courses. The Center offered 17 headquarters courses and 20 in-country, regional and subregional courses during 1991/92.

A Manual of Training Procedures was published and implemented.

Information Dissemination

To upgrade ICARDA's computerized information services, the library expanded its CD-ROM coverage by acquiring additional databases: biology, agriculture, water resources, world weather, women in development, and science and technology. Two in-house bibliographic databases were developed: PUBLST (ICARDA publications from 1977 to 1990), and STEPPE (reference citations from 1970 on steppe-related agroecological zones of WANA). Training was provided to four national librarians on library management and use of AGRIS/CARIS systems. During 1992, a network of WANA information personnel—AINWANA (Agricultural Information Network in West Asia and North Africa)—was formed at a workshop held at ICARDA. The network's objective is to bring together information specialists from WANA to strengthen the national library and documentation systems of the region.

Seventy-two publications were produced in-house. A Publications Catalog, listing all ICARDA publications from its inception in 1977 to 1990, was published. Sixty-nine papers were processed for submission to scientific journals, and 29 for presentation at conferences and workshops.

A wide variety of training materials including lecture notes and audio-visual kits was produced.

Press releases in Arabic and English were produced monthly and distributed to over 450 news organizations, newspapers, magazines, and newsletters worldwide. The ICARDA media list was updated and expanded to respond to the increasing demand for information. Donors were kept informed of developments at the Center by the "Ties that Bind" series, which focuses on ICARDA's links with specific donor countries and agencies.

Computer and Biometric Services

Development of computer facilities at the Center gained unprecedented momentum during 1992. A new computer cluster (consisting of two VAX 4000/500 computers), an Ethernet local area computer network, a relational database management system (Oracle), a new suite of financial/administrative application systems, and additional personal computers were installed.

Installation of VAX 4000 computers has greatly multiplied the processing power of central computers. A computer network of VAX terminals, PCs and printers, located in ICARDA buildings at Tel Hadya, was established. Network services such as electronic mail, files transfer, and terminal emulation on PCs became available.

A Steering Committee, including researchers and computer services staff, was established to address ICARDA's research computing needs. Working groups were formed to develop proposals to establish a Meteorological Database, a Breeding Trials and International Nurseries System Database, and a Germplasm Database. Biometrics support was provided in various research areas, notably, analysis of data from long-term rotation trials; comparing responses from researcher-managed trials with farmer-managed trials; and experimental design to evaluate sheep preferences in feeding treatments. Methods were developed for assessing wheat genotypes for drought tolerance and modeling relative growth rate; genotype x environment interaction in barley landraces; and logistic models for growth curves in legumes.

The existing in-house financial system (MAS) is being replaced with Oracle Financial Systems, covering General Ledger, Accounts Payable, Fixed Assets, Inventory Control, Purchasing and Human Resources.

PART TWO

Research and Training Overview

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Research and Training Overview

Outreach Activities

Resources for Research and Training

Research and Training Overview

ICARDA carries out its research in close collaboration with National Agricultural Research Systems (NARS) within a framework of seven integrative activities central to its mandate of increasing crop and livestock productivity. 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 their 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 25); collaborative research and transfer of technology activities with NARS are summarized in the chapter Outreach Activities.

The text here represents only a selection of research results achieved by the Center during the 1991/92 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 3).

The Weather in 1991/92

Three significant weather events marked the 1991/92 cropping season in West Asia and North Africa (WANA): (i) unusually low winter temperatures in the Middle East, (ii) exceptionally heavy winter precipitation in the areas bordering the southeast Mediterranean, and (iii) a drought in Morocco.

From Turkey in the North to Egypt in the South, and in Iran and the Gulf countries in the East, temperatures were below average from the end of November until May. In Jordan, southern Syria and Lebanon, and in the coastal areas of Egypt and Libya, low temperatures were coupled with unusually heavy precipitation, frequently falling as snow. While the exceptionally severe winter caused substantial losses to vegetable production including citrus groves and vineyards—and even livestock in Jordan and Lebanon—field crops, particularly cereals, were not affected. Cereal yields were around or above average in Syria, Lebanon, Jordan, Egypt, and Libya.

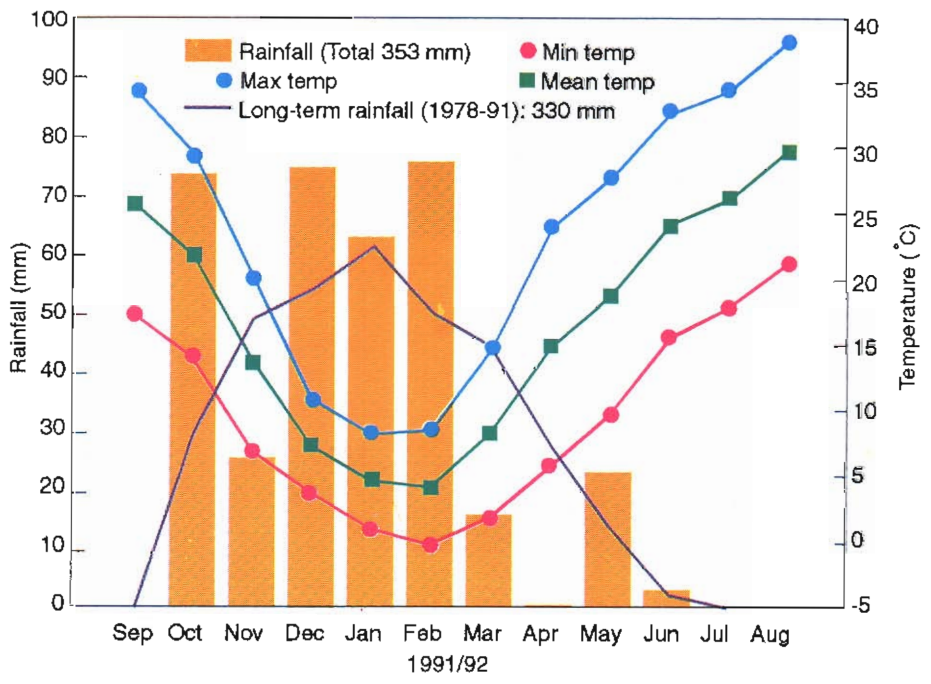


Fig. 1. The weather in 1991/92 at ICARDA's main research station at Tel Hadya, about 35 km southwest of Aleppo, Syria.

Morocco experienced the worst drought since the early 1980s. From October to March, precipitation totalled only one-third of the long-term average. Rainfall later in the season could not compensate for the drought during the crop growth period. Wheat and barley yields declined to one-third of the previous season's harvest and were far below average. Elsewhere in the Maghreb there were no weather extremes and cereal yields were above average.

In the highlands of Turkey and Iran, winter was harsh and unusually snowy. Cool temperatures and adequate moisture supply continued into May, resulting in above-average crop yields. The western part of Turkey, in contrast, received little rain during the first half of the season.

Of the tropical countries in the WANA region, the spring rains in Ethiopia started and ended earlier than usual, resulting in below-average crop yields. The main rainfall started late but was adequate in Ethiopia, Sudan, and Yemen.

Agroecological Characterization

Climatic Adaptation of Chickpea

Until recently ICARDA had given relatively little attention to the detailed description of the current distribution of its target crops in relation to their climatic needs. Now, a new thrust, in collaboration with FAO (Food and Agriculture Organisation of the United Nations) and national meteorological services, to establish regional databases of meteorological and crop information facilitates the study of relationships of individual crops to their agroclimatic environments. Here we focus on the place of the chickpea crop, regionwide, and prospects for increasing production.

The first point to note is that although total production has increased in some countries and in Turkey particularly, yield per unit area has not (Table 1). The long-term yield trend for Turkey is slightly negative (Fig. 2). This is likely related to the replacement of fallow with chickpea and a shifting of chickpea cultivation to drier areas since 1980, when a program of fallow replacement was initiated. With the Alge-

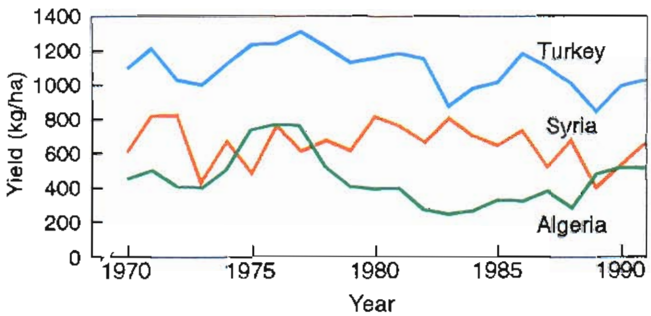


Fig. 2. Chickpea yield trends in Turkey, Syria, and Algeria, 1970-91.

Table 1. Area, yield, and production of chickpea for WANA countries.

Country	Period	Area (x 000 ha)	Yield (kg/ha)	Prod. (x 000 t)	Period	Area (x 000 ha)	Yield (kg/ha)	Prod. (x 000 t)
Algeria	1989-91	37	490	18	1980-91	46	350	16
Egypt	1988-90	6	1670	10				.
Ethiopia					1980-86	152	740	112
Iran	1987-89	563	530	301	1984-89	513	630	321
Iraq	1988-90	3	800	2				
Jordan	1988-90	0.8	960	0.8	1981-90	1.5	680	1.0
Lebanon	1988-90	4	1200	5				
Morocco	1989-91	74	760	56	1961-91	97	650	62
Syria	1989-91	49	520	26	1980-91	69	660	46
Sudan	1989-91	1.3	1570	2.1	1980-91	1.0	1170	1.1
Tunisia					1980-91	33	680	23
Turkey	1989-91	860	950	816	1980-91	526	1010	533

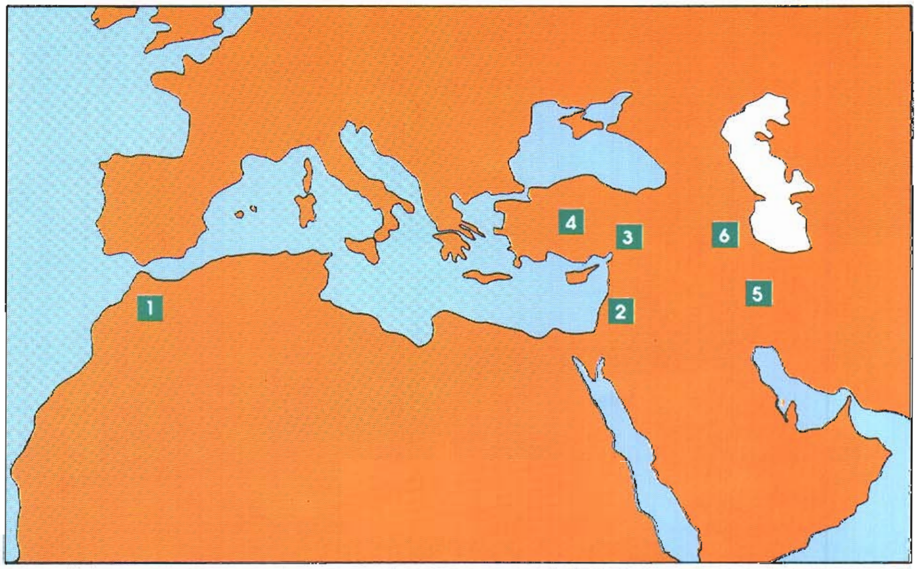
Note: Iran data are for total food legumes, in which chickpea dominates.
Source: FAO Production Yearbooks.

rian data, the yield trend over the last 20 years shows a negative correlation with area. Syrian chickpea yield also shows a negative trend over the 1980s.

The absence of positive yield trends implies either a deteriorating climate that offsets technological gains, a systematic shift to drier areas, or limited technological advances and/or slow adoption by farmers. Given that the phenomenon of no yield increase is widespread, the last explanation seems most likely.

Turkey is the dominant chickpea producer in the region (Table 1), and only seven countries produce more than 10 000 tons annually. A broad analysis of chickpea in relation to climate must inevitably focus on the principal areas of production. Apart from Ethiopia, the climate may be said to be 'Mediterranean', with a cool, wet winter and hot, dry summer. However, the looseness of this description masks important geographical variation in the means and extremes of temperature, and in the means and seasonal distribution of precipitation in chickpea-growing regions. In West Asia, much of the chickpea-growing region is at altitudes above 900 m, and elevation has an important moderating effect on the thermal environment. Further, in these highland areas, peak precipitation tends to be in the spring (April-May) rather than winter (December-February).

The range of climates in which chickpea is grown in WANA, therefore, appears to be fairly broad (Fig. 3). For example, in coastal plains of North Africa, January mean temperatures are typically 10°C or higher, while in northwestern Iran the January mean is below zero. However, because the crop is almost exclusively spring-sown, chickpea-growing regions do have certain climatic aspects in common. These include: a cropping season that begins after the (normal) peak rainfall period, so that crop is typically grown on residual moisture; high temperatures (daily



	Precip. (mm)	Wettest month	Hottest month (°C)	Coldest month (°C)
1 W. Morocco	550	Dec	25	9
2 S. Syria	300	Jan	25	8
3 S. Turkey	500-600	Jan	27	2
4 Anatolia	300-800	Apr	23	2
5 W. Iran	400-550	Apr	27	2
6 NW. Iran	350	Apr	26	-2

Fig. 3. Climates of the major chickpea-growing areas of WANA.

maxima near or exceeding 30°C) and low daily mean relative humidity (near or below 50%) during the pod-filling stage; and negligible risk of damage from frost.

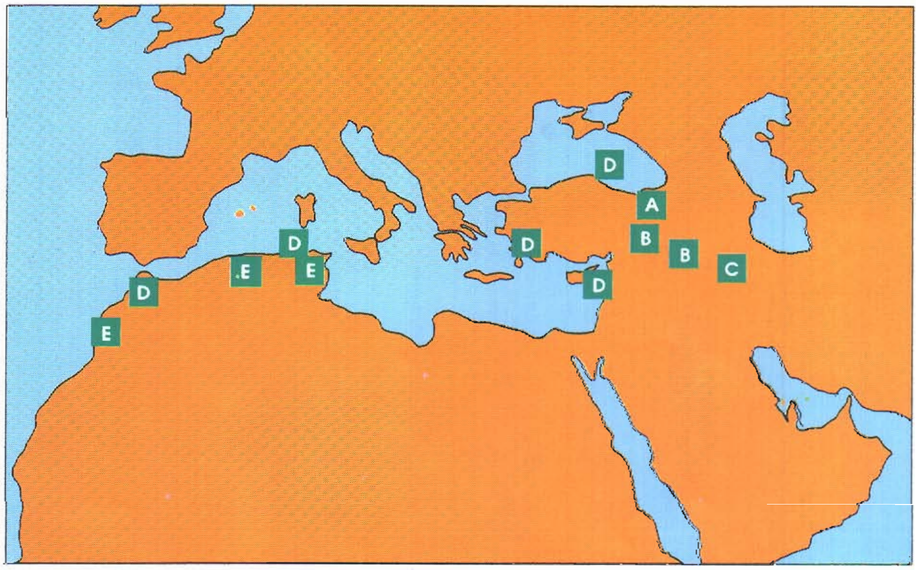
Despite these similarities, important environmental differences remain. We know that seeding date of spring chickpea is related to temperature, and that the chickpea-growing regions of WANA with the mildest winters have earlier (February) seeding, a longer growing season, and shorter mean daylength than the regions that have coldest winters and May seeding.

Analysis of current chickpea production zones in WANA suggests the following climatic constraints to any expansion of the cultivated area:

- high summer temperatures and/or low precipitation, sometimes in combination with winter/spring frost risk (southeast Anatolia, north-central and northeast Syria, and parts of Maghreb);
- low summer temperatures (northeast Turkey); and
- conditions that are too wet/humid (coastal regions throughout WANA).

Any expansion in these zones requires the alleviation of these constraints (Fig. 4). Most research attention has so far been given to the first constraint. Current production is almost entirely of spring-sown chickpeas, which must be regarded, in part, as a risk-avoidance strategy, as the crop is not sown when the season has been dry. The use of winter-sown chickpea potentially breaks the climatic barrier. The growing season of winter chickpea avoids the period of extremely high evaporative demand and high temperatures. The largest area of potential expansion is in southeast Anatolia and extreme northeast Syria, where precipitation mostly exceeds 400 mm. However, frost can occur in this region in March and sometimes in April, so cold tolerance is an important requirement.

Within existing areas of adaptation, the best chances for replacing spring-sown with winter-sown



Constraint	Possible solution
A Summer too cold	Spring chickpea with lower T-base
B Summer too hot	Winter chickpea that tolerates spring frost
C Late spring, hot summer	Winter chickpea if snow adequate
D Too wet	Disease resistance
E Too litle rain	Winter chickpea if rainfall variability not extreme

Fig. 4. Options for the relief of climatic constraints to WANA chickpea production.

chickpea are where:

- frost risk is low and precipitation relatively reliable but not too high, to avoid drought and serious disease risk (some coastal areas of Maghreb); and
- winter snowfall is sufficient to insulate the crop (wetter parts of western Iran, and possibly parts of the Anatolian plateau).

Superimposed on these possibilities, winter or spring chickpea may be a suitable crop for fallow replacement in Morocco, Algeria, Tunisia, and Iran.

National average chickpea yields appear unaffected by technology over the last 20 years. Either by management or breeding, the surest way to improve on this situation is to shift the phenology of the crop (make it earlier) to increase transpiration at the expense of evaporation from the soil surface, and to maximize the transpiration that is achieved at low air saturation deficit. Together, these changes would bring about dramatic improvements in water-use efficiency. Based on experience with other crops (cereals) that have both winter and spring habits, and on paired yield trials of winter and spring chickpea, this seems to be the best way of bringing about yield gains.

Agricultural Environments in Morocco and Syria

In an Agroecological Characterization Project, supported by IDRC (International Development Research Centre), ICARDA and the Moroccan national program scientists conduct stochastic weather simulation and crop modeling studies. Results from these studies are used to compare the agroclimatic aspects of the Doukkala region in Morocco with those of northwestern Syria to understand the similarities and differences between the two environments.

The Doukkala region (Fig. 5) stretches from the Atlantic coast between Casablanca and Safi inland to

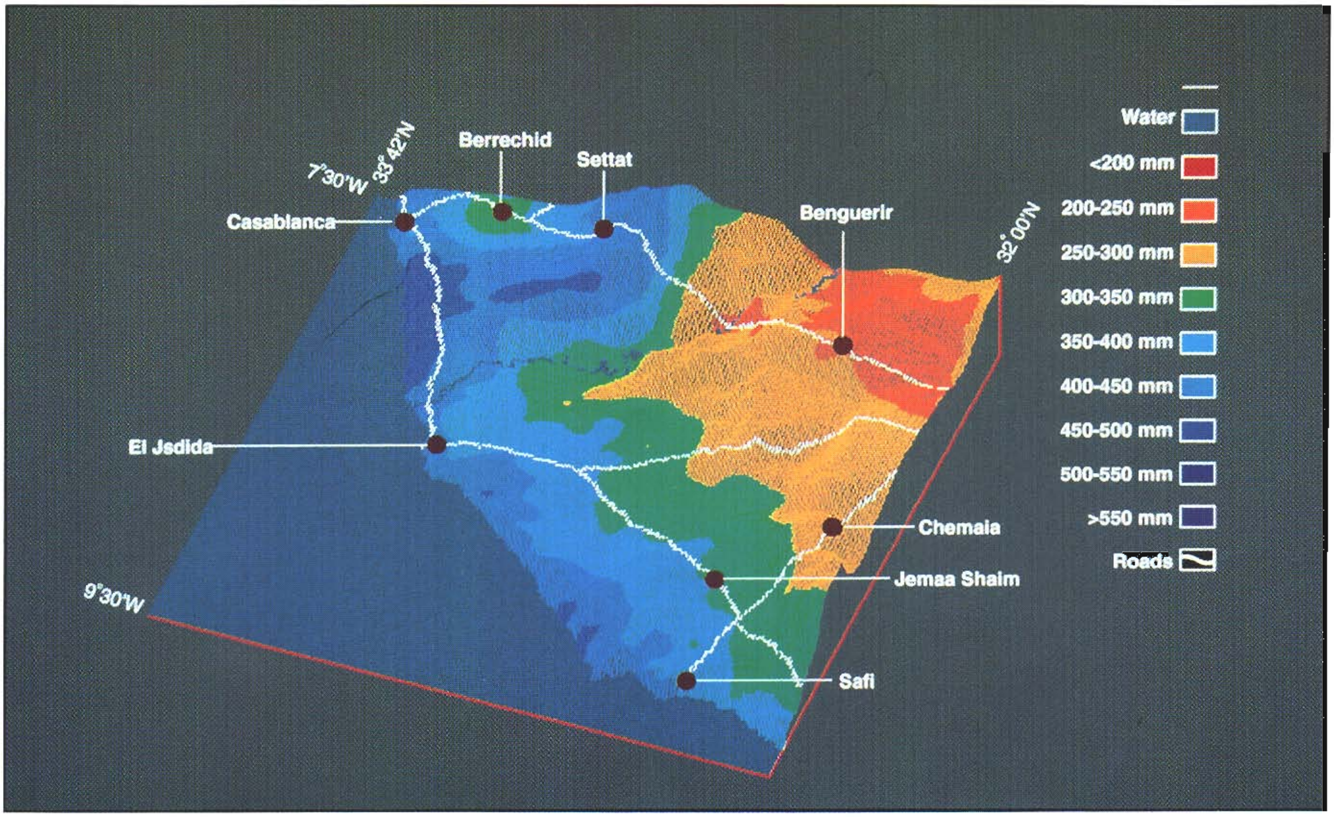


Fig. 5. Mean annual rainfall in the Doukkala region of Morocco. The size of the area is approximately 180 x 180 km; view direction is from west-southwest.

Settat and Benguerir. The highest elevations are around 600 m asl. Rainfall, which occurs mainly between October and May, decreases rapidly from 400 - 500 mm at the coast to less than 250 mm inland, except in the area around Settat in the northeast.

The northwest Syrian region with Aleppo in its center provides a picture similar to the Doukkala region in Morocco. Altitude and rainfall stretch over a range of 100 to 800 m and 600 to 200 mm, respectively, and there is an even steeper rainfall gradient from the west and northwest towards the southeast (Fig. 6). While annual rainfall totals in the two regions are similar, a closer inspection reveals significant differences between the two environments. In the Doukkala region, the number of rainy days per year tends to be smaller than in northwest Syria, the amount of rainfall per rainy day is higher, and the risk of dry spells within the growing season is greater. This is evidenced, for example, by the frequency with which dry spells occur during the early development of wheat (Fig. 7) and by the high efficiency of supplemental irrigation during January (Fig. 8).

Differences in air temperature are even more dramatic. While the mean annual temperature is in the same range of 16 to 20°C, the annual temperature excursion is substantially different (Fig. 9). In northwest Syria the temperature difference between the hottest and coldest month falls between 18 and 23°C, but in Doukkala it ranges from 9 to 18°C as a function of the distance from the sea. Since the summers are equally hot in both regions, this means that the winters are milder in Doukkala than in northwest Syria. While in northwest Syria the number of frost days per year ranges from 10 to over 40, the larger part of Doukkala experiences less than 5 annual frost days.

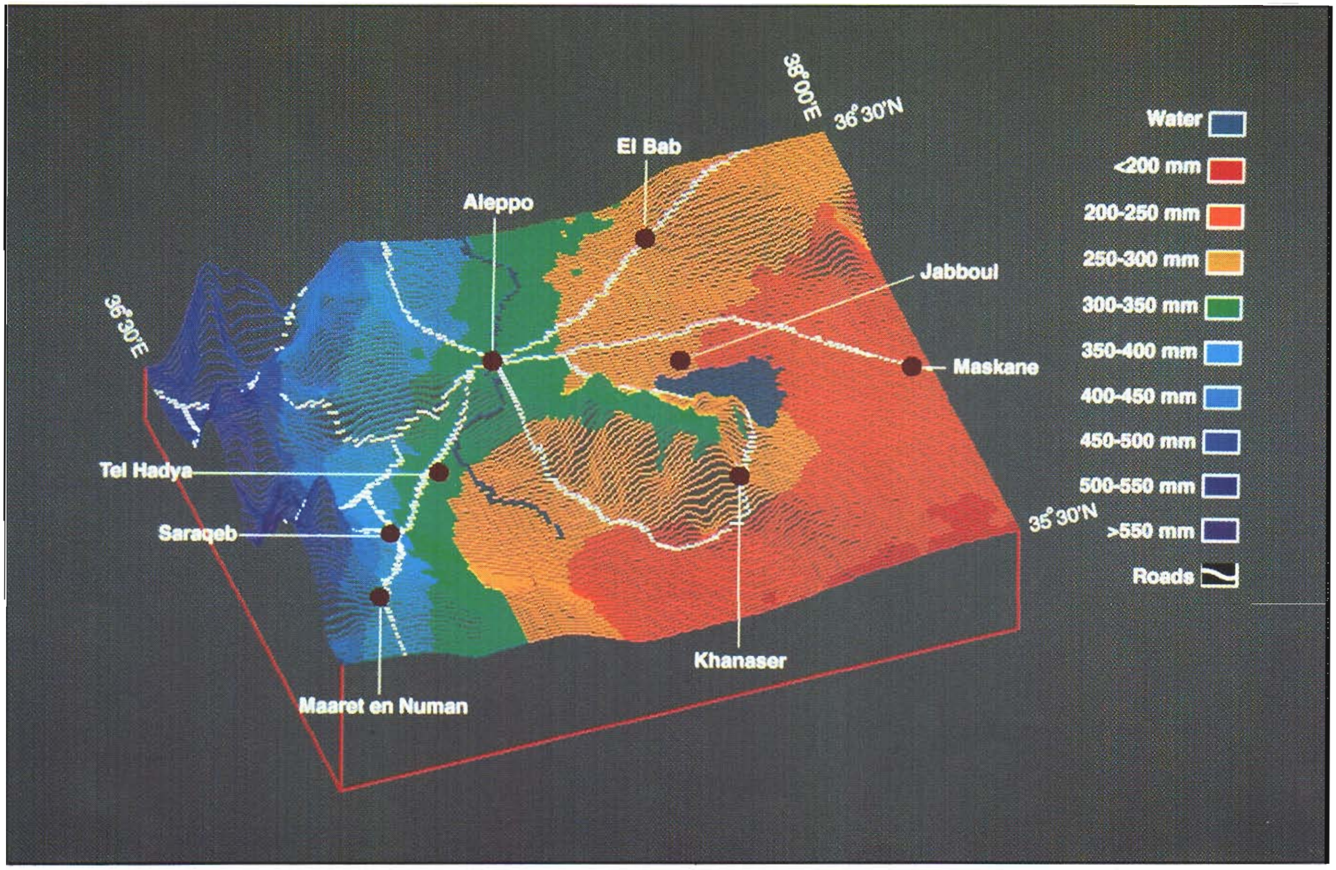


Fig. 6. Mean annual rainfall in northwest Syria. The size of the area is approximately 110 x 130 km; view direction is from south-southwest.

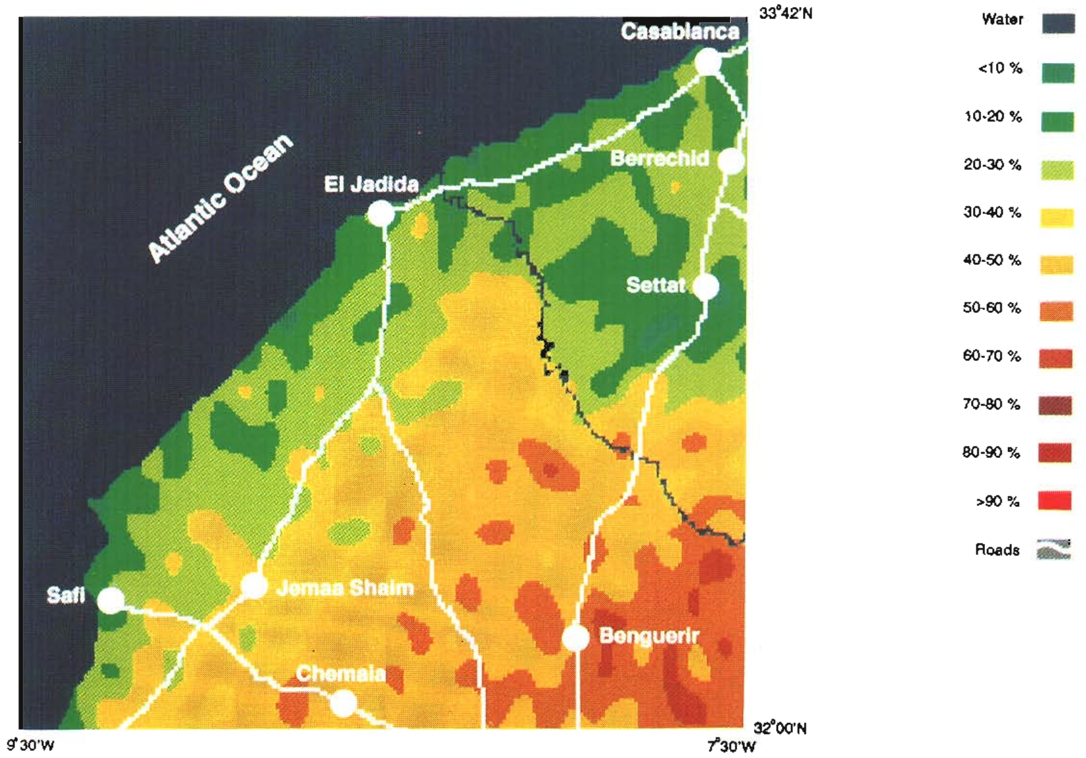
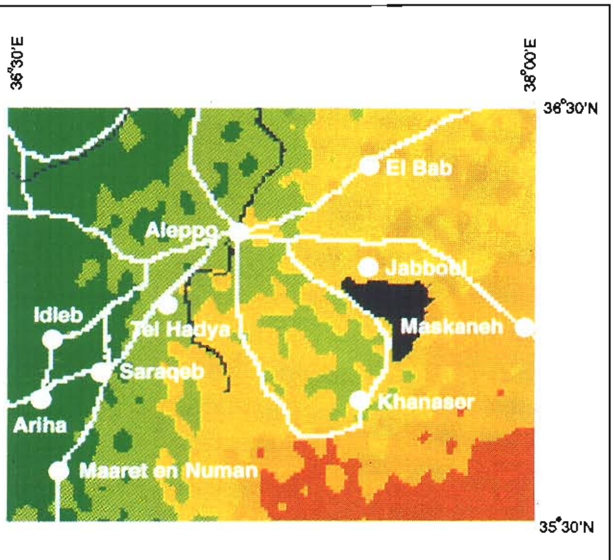


Fig. 7. Frequency of early drought in Doukkala (above) and northwest Syria (below, left). The maps show the chance of having 30 days with less than 30 mm rainfall following the emergence of wheat. These and all other maps are based on 100 spatial simulations of wheat crops planted on 15 November using well-adapted varieties (Nasma for Doukkala, Cham 1 for northwest Syria) and assuming medium textured, deep soil with 160 to 190 mm water-holding capacity and no nutrient limitations.



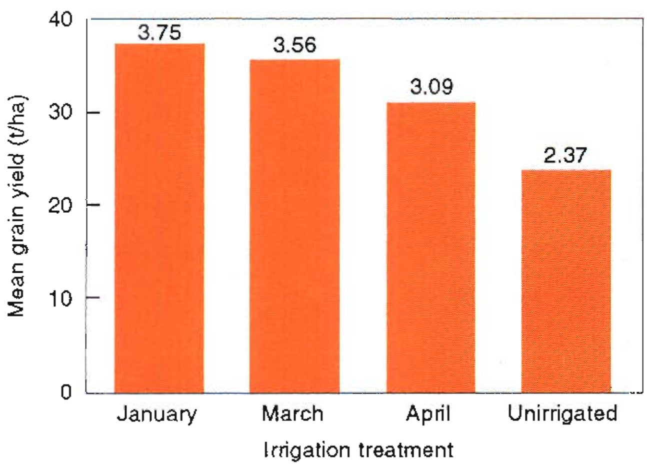


Fig. 8. Effect of supplementary irrigation on wheat grain yield at Jemâa Shaim, Doukkala; 75 mm of irrigation was simulated on 6 January, 10 March or 2 April.

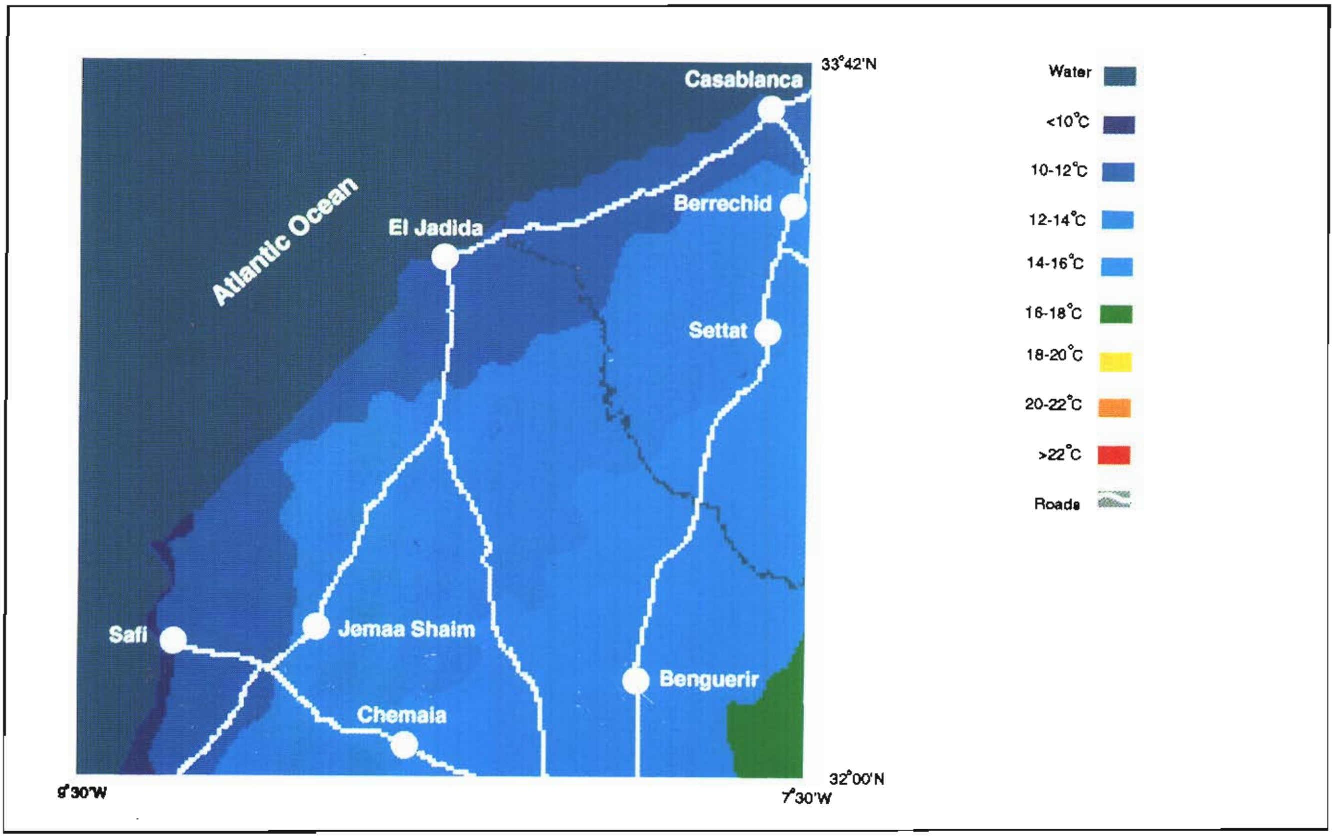
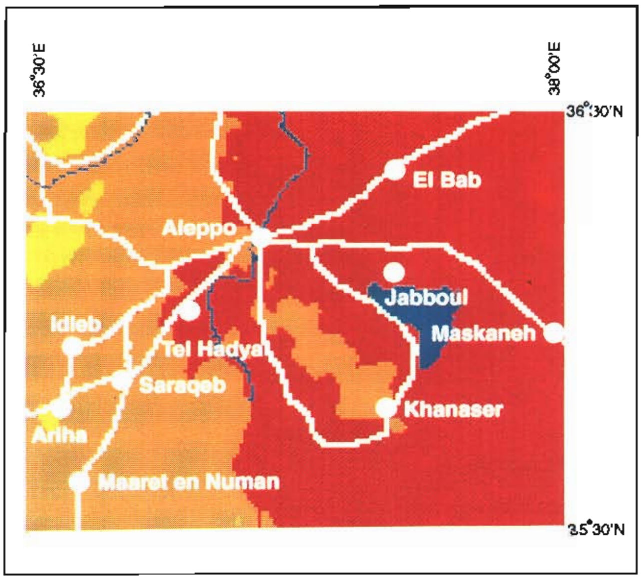


Fig. 9. Difference between the mean temperature of the hottest and coldest month of the year in Doukkala (above) and northwest Syria (below, left).



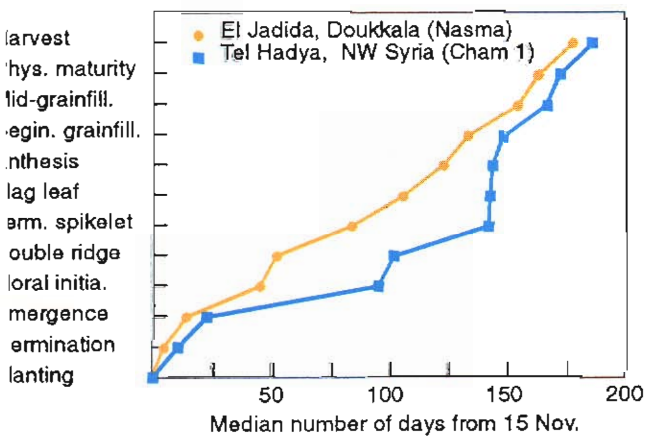


Fig. 10. Median number of days from planting for reaching selected development stages of wheat at El Jadida in Doukkala and at Tel Hadya in Syria. Planting was simulated on 15 November at both locations.

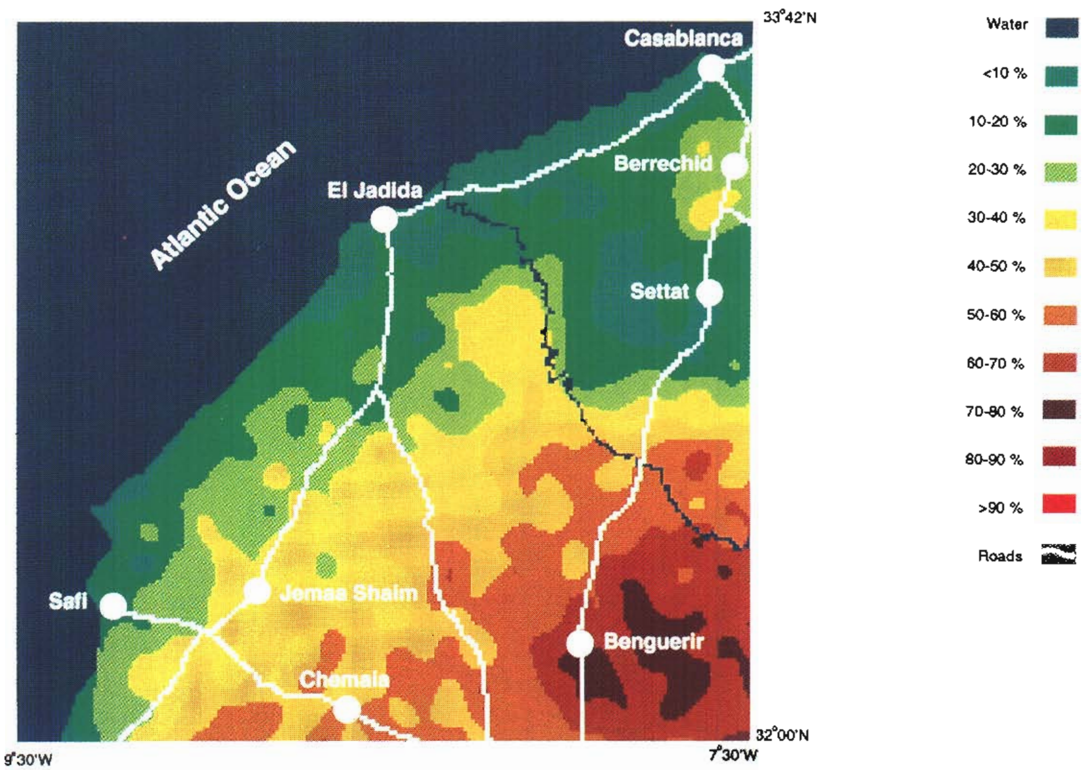
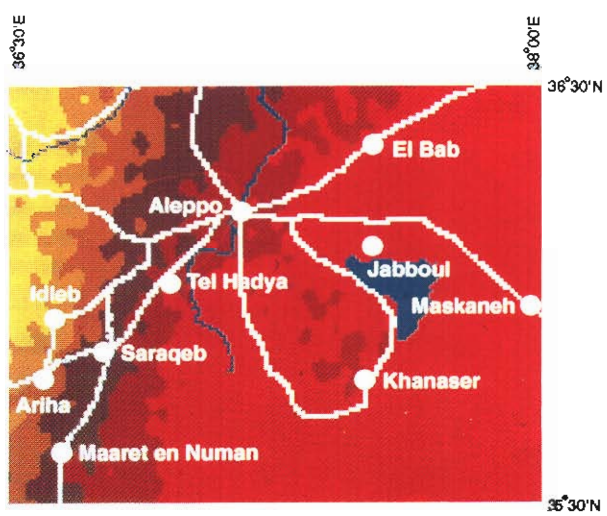
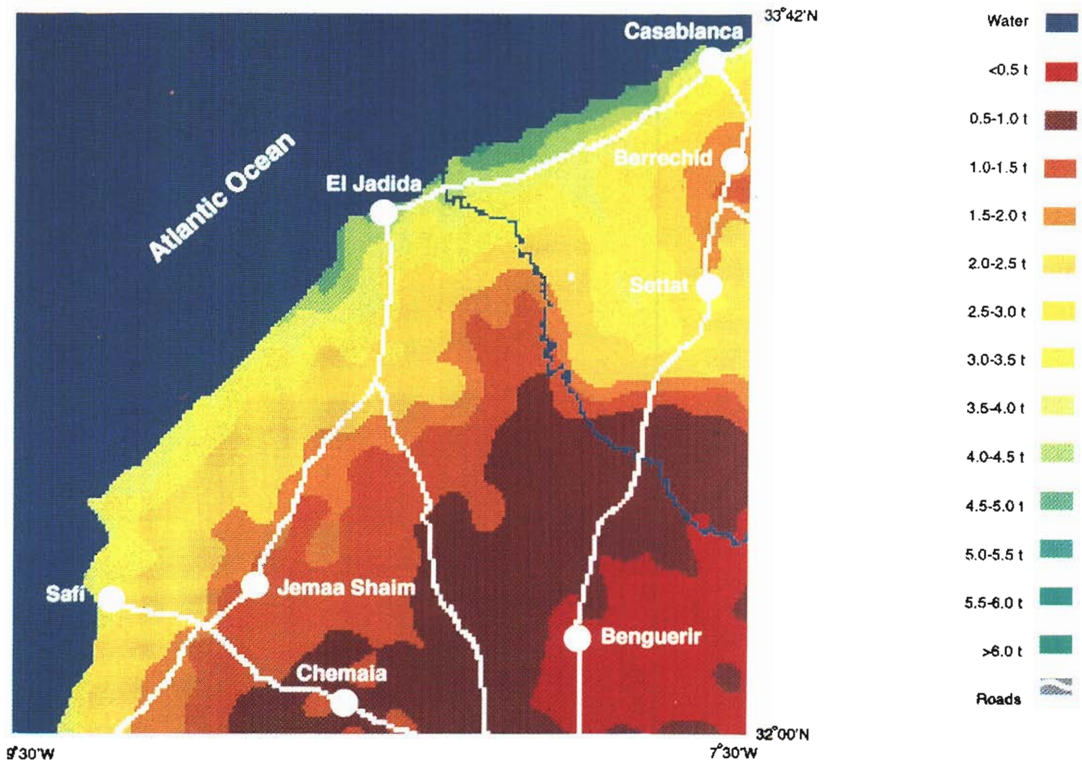


Fig. 11. Frequency of late drought in Doukkala (above) and northwest Syria (below). Drought was assumed to have occurred if there was a severe deficit of soil moisture between the flag leaf and mid-grain-filling stages of wheat, speeding up leaf and tiller senescence and adversely affecting kernel numbers.



The mild winters in Doukkala have a pronounced effect on crop development. While in northwest Syria wheat develops slowly through the winter until about the end of March, in Doukkala development proceeds at a much faster pace. If, as in the example shown in Fig. 10, wheat is planted in mid-November, the floral initiation stage may be reached 50 days earlier in Doukkala than in northwest Syria, and the difference continues to increase until near the end of the vegetative phase. Then development accelerates in northwest Syria as a result of the rapid temperature rise; at anthesis, the difference shrinks to 20 days; maturity and harvest are reached nearly simultaneously in May.

The sharp temperature rise in spring in northwest Syria coupled with the end of the rainy period leads to a rapid depletion of crop-available moisture during the generative phase of wheat development. Moisture stress during the stages from flag leaf to grain filling is



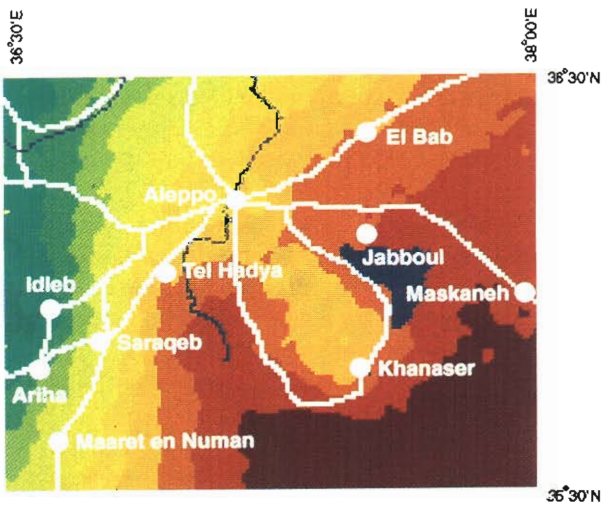
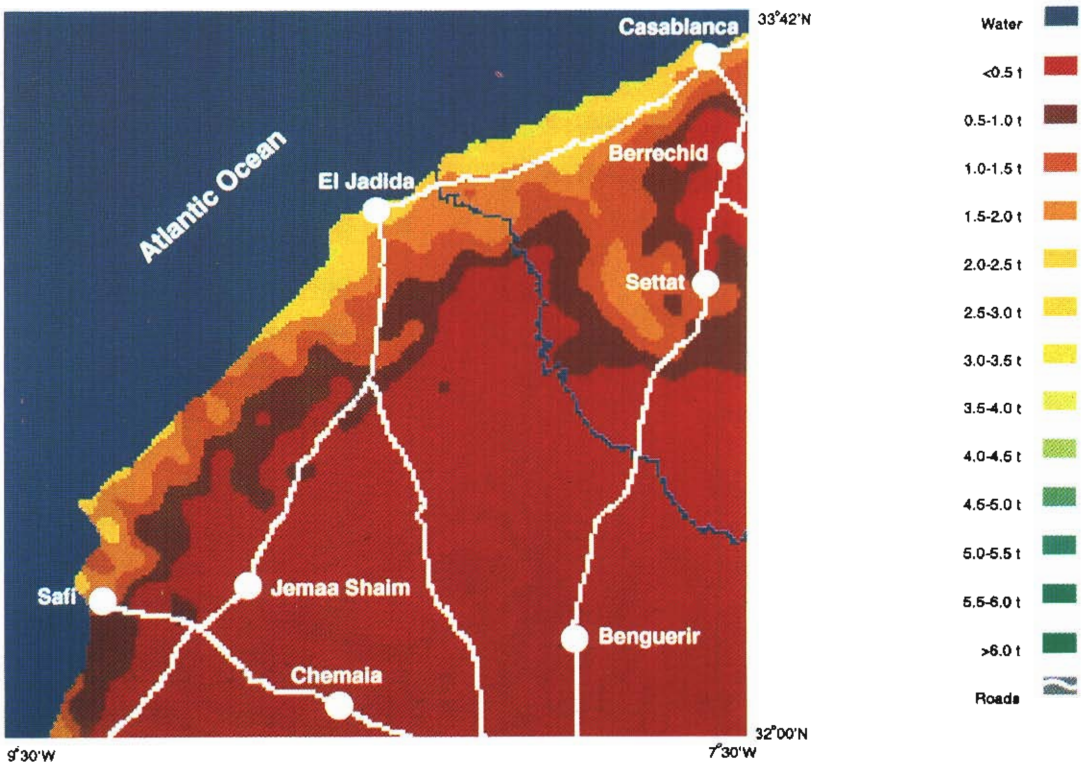


Fig. 12. Mean wheat grain yield of Nasma in Doukkala (above) and Cham 1 in northwest Syria (left).

much more frequent here than in Doukkala, where anthesis occurs earlier in the year (Fig. 11).

The early onset of the generative phase of wheat in Doukkala, coinciding with periods of moisture stress, caused by dry spells, high evaporative demand and high ambient temperatures, frequently hampers growth and has a clear negative effect on



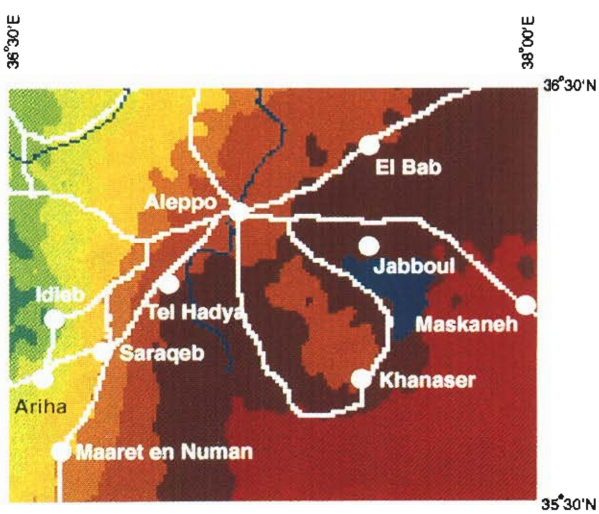
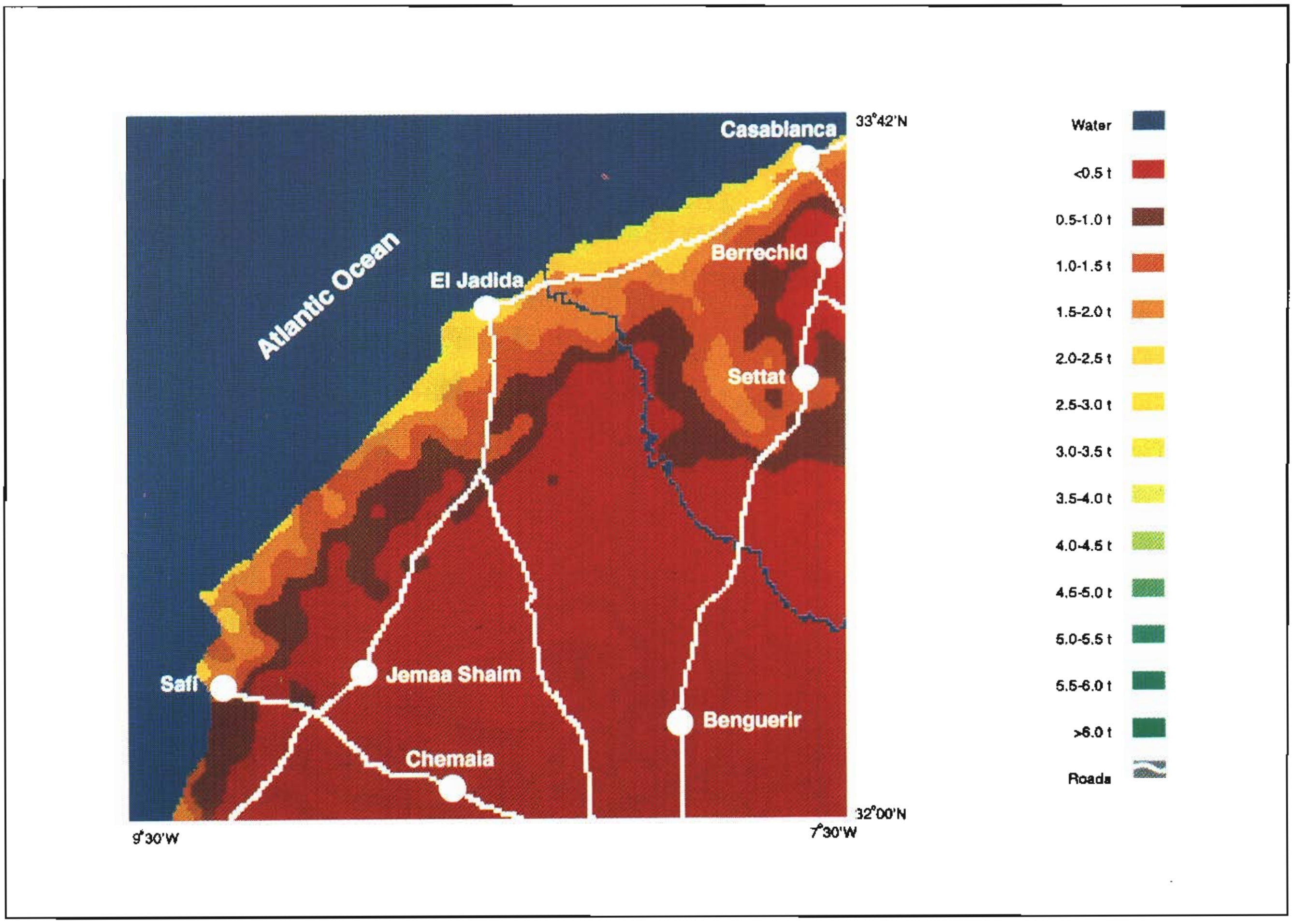


Fig. 13. Reliable* wheat grain yield of Nasma in Doukkala (above) and Cham 1 in northwest Syria (left).

*** yields achievable in 80 years out of every 100.**

the yield potential. Yields are lower and less stable than in northwest Syria, despite the more frequent spring-time droughts there. Apart from the mean grain yield (Fig. 12), this is even more evident from the yield level reached in four years out of every five (Fig. 13). The coefficient of variation of wheat grain yield is twice as high in Doukkala as in northwest Syria (Fig. 14).



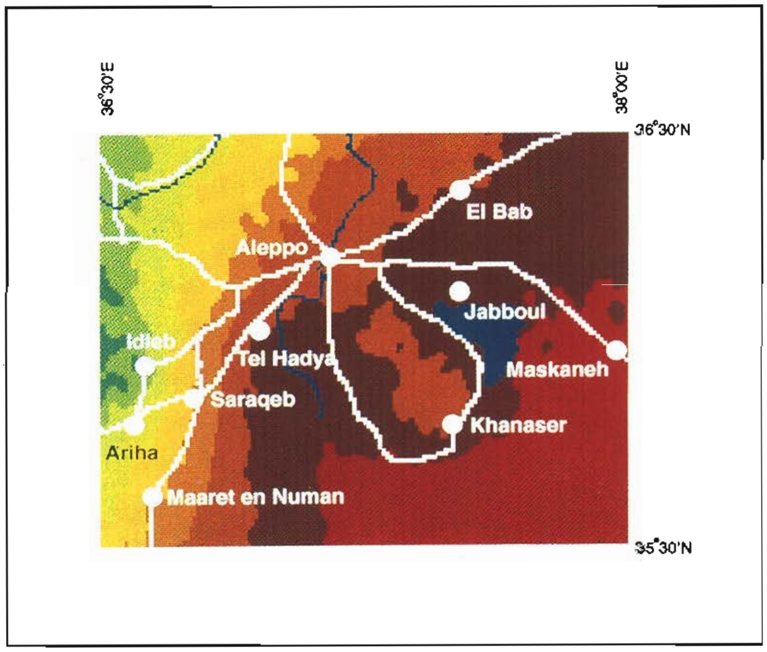


Fig. 13. Reliable* wheat grain yield of Nasma in Doukkala (above) and Cham 1 in northwest Syria (left).

*** yields achievable in 80 years out of every 100.**

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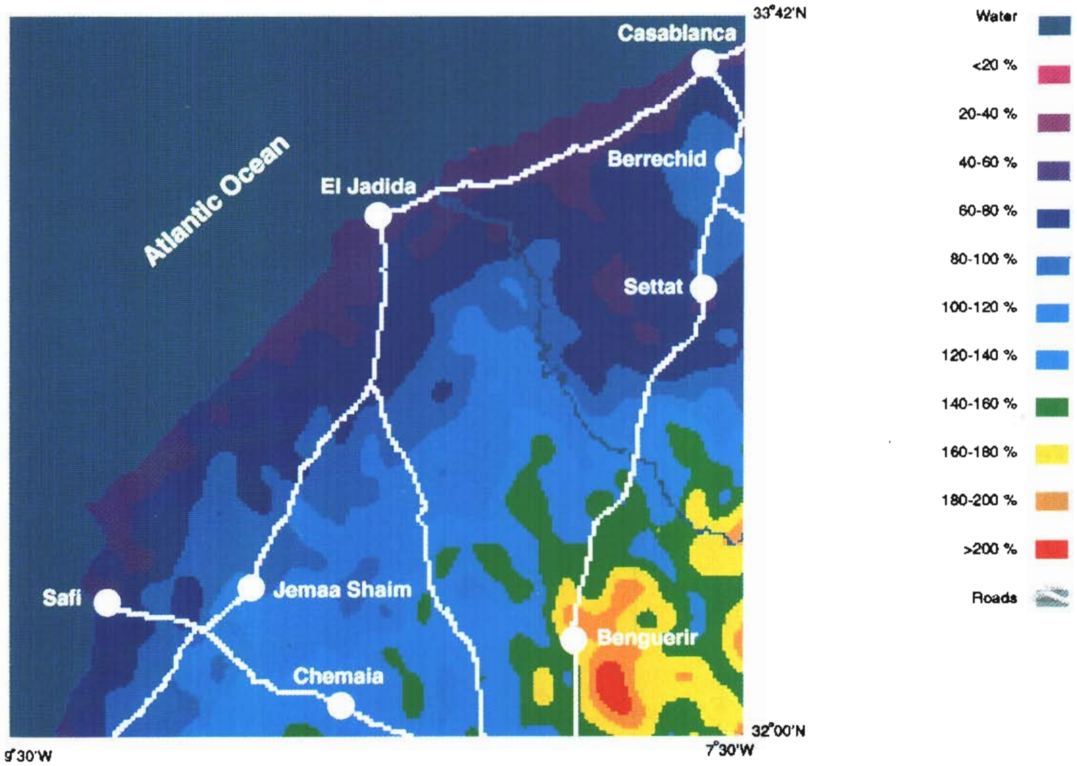


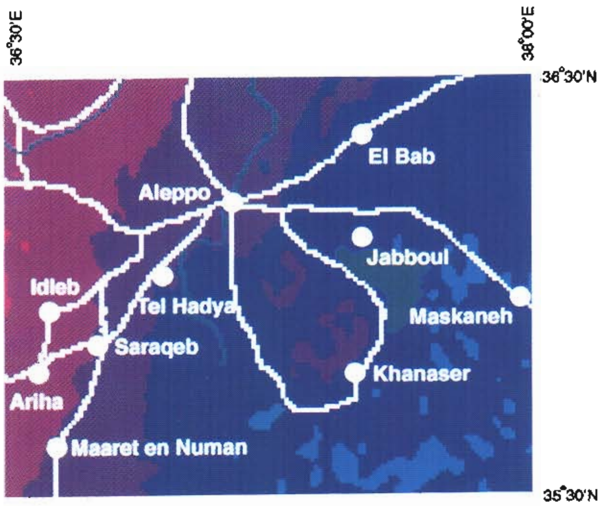


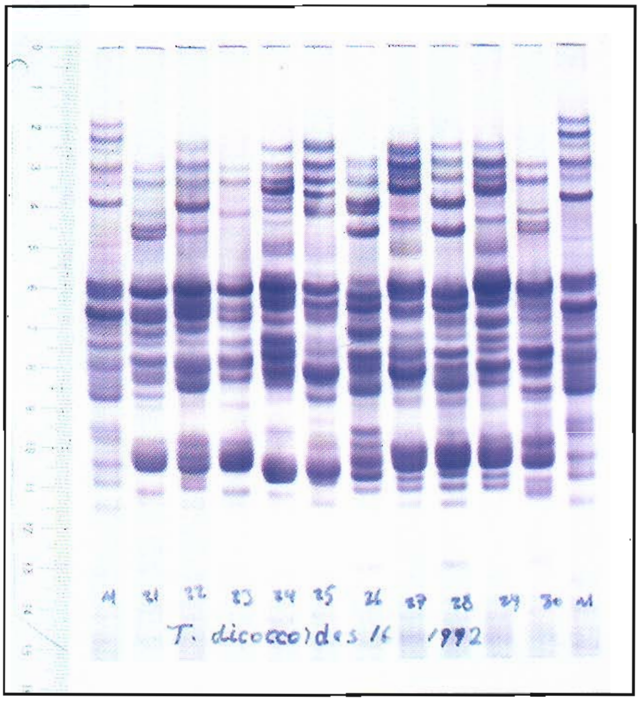
Fig. 14. Coefficient of variation of wheat grain yield in Doukkala (above) and northwest Syria (left).

Germplasm Conservation

ICARDA continued to acquire, characterize, document, conserve, and distribute germplasm of its mandate crops. These activities were conducted in close collaboration with national programs in WANA and the International Board for Plant Genetic Resources (IBPGR). Over 1000 new accessions of the mandate crops and/or their wild relatives were collected from WANA and 500 new entries were received in exchange, bringing the total number of accessions preserved in the Center's gene bank to 92 000. More than 24 000 seed samples were distributed to users worldwide.

Germplasm Collection

A collection mission for wild wheat relatives was organized in Armenia for the first time. The area covered included the Erebuni Nature Reserve, northeast of Yerevan, which is a classic example of *in situ* conservation. Back in the 1930s, N.I. Vavilov recognized the importance of the site and promoted the idea of creating a Nature Reserve to preserve the unique richness of its wheat gene pool. *Amblyopyrum muticum*, an uncommon species of the Anatolian highlands in Turkey, was found near the Reserve. This is so far the only known site outside Turkey for this species. The Reserve also yielded the rare *Triticum araraticum*, *T. urartu*, and *T. boeoticum* populations.



Variability in storage proteins of *Triticum dicoccoides* collected from Syria.

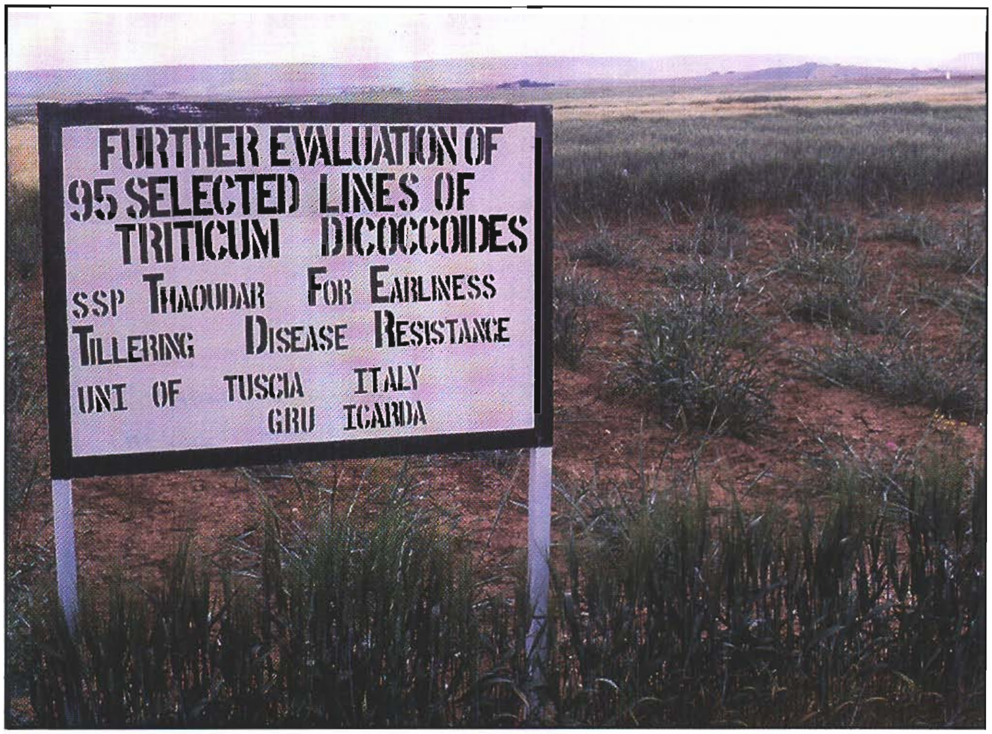
In germplasm collection trips in Syria and Jordan, 68 bulk and 1500 single-head samples of wild relatives of cereals were collected. Presence of *T. boeoticum* in both these countries was confirmed. However, the other diploid wheat, *T. urartu*, was more frequent in Syria where 14 populations were collected in diverse habitats, ranging from the dry eastern slopes of the basaltic Jebel Al-Arab mountains in the province of Sweida, and more fertile, lowland sites in northern Syria, to high elevations of limestone slopes in the Anti-Lebanon mountains in the province of Damascus. The highest site was 1840 m asl, which is a record altitude for the species. Seed storage protein electrophoresis revealed substantial differences in genetic diversity among the wheat populations from southern Syria.

In Lebanon, 37 accessions of wild *Lens* spp. and *Cicer* spp. were collected from the coastal region; and 14 accessions of faba bean and chickpea were collected in Libya.

An ecogeographical survey of pasture and forage legumes was conducted in Tunisia; 380 ecotypes were collected from the central region and data were taken on the relative frequencies of various species. To fill a gap in the collection, 150 ecotypes of pasture and forage legumes were collected from southern Syria.

Germplasm Characterization and Evaluation

A total of 6500 accessions of cereals and legumes were characterized for a number of descriptors. Barley landraces from China, Algeria, Egypt, and Syria were characterized for their flowering response to varying temperature and daylength regimes. A great diversity was found for basic parameters of the photothermal response (earliness *per se*, vernalization, and photoperiod reaction) among the Chinese germplasm. Some Algerian and Syrian landraces were heterogeneous in their response.



Evaluation of *Triticum dicoccoides* for tolerance to frost and other abiotic stresses at Breda, Syria, 1992.

Multivariate statistical procedures were applied to the data in lentil and barley to study the relationships of landraces from different countries and subregions.

In collaboration with the University of Tuscia, Italy, 170 samples selected from *T. dicoccoides* collection were evaluated at two sites in Syria—Tel Hadya and Breda—to identify suitable parents for crosses with cultivated wheat to improve protein content and disease resistance. Variation was considerable for all characters. All *dicoccoides* samples were tolerant of frost at both locations.

The wild lentil collection was evaluated for morphological traits and eight isozyme systems. These data were used to conclude that *Lens orientalis* and *Lens odemensis* are the most closely related wild species by both morphological traits and isozyme data. *Lens orientalis* showed the highest genetic diversity by the Shannon-Weaver Information Index, followed by *Lens nigricans*. The highest genetic diversity for *L. orientalis* was found in southeastern Turkey and northern Syria. The relationships between morphological descriptors and ecogeographical data have been determined.

Collaboration in Genetic Resources Activities

An agreement on Safety Duplication of ICARDA's Genetic Resources Data at IBPGR was signed and a duplicate data set was deposited with IBPGR, Rome. The data sets will be replaced annually.

In 1992 ICARDA was actively involved in various global and regional genetic resources activities. In collaboration with IBPGR, the Center organized and hosted four international events:

- Barley Core Collecting meeting of a working group of the International Barley Genetic Resources Network (IBGRN);
- West Asia and North Africa Plant Genetic Resources Workshop, organized jointly with IBPGR and FAO, in which a collaborative network on plant genetic resources in WANA was established;
- IBPGR/IDRC/ICARDA training workshop dedicated to a self-teaching approach for understanding, analyzing, and developing genetic resources documentation systems; and

- International Workshop on Evaluation and Utilization of Biodiversity in Wild Relatives and Primitive Forms for Wheat Improvement.

Collaboration with IBPGR was further strengthened with the transfer of the IBPGR regional office for West Asia and North Africa from Rome to ICARDA headquarters in Aleppo, Syria.

Seed Health Laboratory

The Seed Health Laboratory conducted testing for seedborne pathogens/pests in all seed shipments received (11 868 lines) or dispatched (3319 lines) by ICARDA.

Field inspection of newly introduced germplasm grown in the postquarantine observation area revealed no exotic seedborne pathogens or pests.

Virology Laboratory

Virus disease surveys focused on faba bean necrotic yellow virus, luteoviruses, and lentil seedborne viruses. Effect of resistance to barley yellow dwarf virus (BYDV) in barley was studied in relation to BYDV movement.

Seed samples from the ICARDA international nurseries were tested for seedborne viruses. The cleaning of GRU/ICARDA barley germplasm collection of seedborne viruses continued. New ELISA (Enzyme-linked Immunosorbent Assay) kits for the detection of plant viruses were developed and distributed to national program laboratories in WANA.

Germplasm Enhancement

Cereal Crops

Decentralization of Barley Breeding

For dryland Mediterranean barley-growing areas, adaptation of the crop to local stresses is the key to yield stability and yield potential. This requires a decentralized selection system to ensure specific adaptation to local stresses. Decentralization for the Maghreb region began in 1991 with the distribution of a special six-row barley nursery. The entries were also evaluated in preliminary yield trials at three ICARDA sites in Syria: Tel Hadya, Breda, and Bouider. In the Maghreb, visual selection was carried out; selection at ICARDA was for yield potential, yield under stress, and early and late heading.

Of the lines selected in the Maghreb, 68.2% (105/154) were discarded at ICARDA; of the lines selected at ICARDA, 52.4% (54/103) were discarded in the Maghreb (Table 2a). This large proportion of wrongly

Table 2a. Is northern Syria a suitable area to select barley germplasm for Maghreb countries?

Selected in[1]	No. of lines	%
Syria	103	35.8
Maghreb	154	53.5
Syria and Maghreb	49	47.6
Syria, discarded in Maghreb	54	52.4
Maghreb, discarded in Syria	105	68.2

[1] Initial population size = 288 lines.

Table 2b. Transition from the old to new system of international nurseries distribution.

Year	New nurseries				Old nurseries		
1990/91	-	-	-	-	BYT	BON	BSP
1991/92	SN92	-	-	-	BYT	BON	BSP
1992/93	PY93	SN93	-	F_2	BYT	-	-
1993/94	AY94	PY94	SN94	F_3-F_4	-	-	-
1994/95	NARS	AY95	PY95	SN95	-	-	-

selected and wrongly discarded lines occurred in a single cycle of selection. All entries were of six-row type, and contrasting selection criteria were used at ICARDA. National scientists reacted positively to these results. In consultation with the Maghreb scientists the transition from the old system of international nurseries distribution to the new system of developing specific germplasm for the Maghreb (Table 2b) will take place through the following steps:

(1) 173 lines selected from the special nursery distributed in 1991/92 (SN92) will be tested at 12 locations in 1992/93 as preliminary yield trials (PY93). Lines selected from PY93 will be tested in advanced yield trials (AY94) in 1993/94 and the best

lines are expected to enter the national testing systems by 1994/95. This sequence will apply also to the special nurseries to be distributed from 1993 (SN93) onward.

(2) A set of 268 F_2s (from 6 x 6 and 6 x 2 crosses) was distributed in 1992 for evaluation as populations at eight locations. These F_2 populations will be selected visually and single-plant selections will be made at Tel Hadya to ensure a common seed source. F_3 families will be increased without further selection at Tel Hadya in 1993/94 and F_2-derived F_4 families will be distributed as the 1995 special nursery (SN95). The SN95 will contain only lines derived from selection within the Maghreb countries.

(3) In the spring of 1993 targeted crosses will be designed with national program scientists. Many more crosses than in the past will be made to incorporate resistance to important foliar diseases in North Africa. Resistant parents have been supplied by Dr A. Yahyaoui (Ecole Superieur d'Agriculture, Kef, Tunisia) and by Dr A. Amri, (INRA, Morocco). In 1995, F_2 populations from these crosses will be distributed and handled as described in step 2. Thus, the SN97 will be the first nursery specific for the Maghreb Region.

Two additional advantages expected are: (i) Maghreb expertise, particularly in pathology, entomology, and virology, will be incorporated into the breeding program. National scientists will handle segregating populations (F_2 and BC) and generate lines which will then enter the special nursery testing phase, and (ii) information will be generated on issues such as selection vs. testing environment, genotype x environment interaction, relationship between yield potential, and adaptation to stress.

The base program at ICARDA will (i) make crosses, (ii) advance generations (including SSD and possibly double haploid production), (iii) produce seed to ensure a uniform seed source, (iv) analyze data, and (v) provide coordination.

If successful, the Center will continue to decentralize barley breeding to other areas. In 1992, a first special nursery was distributed to the Mashreq region (Syria, Jordan, and Iraq), and a number of targeted crosses were made for the Arabian Peninsula. A special nursery will be generated for that region in the next two cropping seasons.

Hull-less Barley

In response to the increasing interest of farmers in hull-less barleys in the Americas and North Africa, new hull-less varieties have been released in Canada, Chile, Brazil, and recently in Ecuador. In 1992, 114 new advanced hull-less barley lines were tested at El Batan in Mexico. Most lines were resistant to stripe and leaf rust races and had good threshability. A high test weight of 73 g was reached in the cross Nepal 1954/Aleli. Table 3 lists the lines with yields higher than 4000 kg/ha.

Table 3. Yield and test weight of hull-less barley lines resistant to stripe and leaf rust at El Batan, Mexico, 1992.

Cross and pedigree	Yield (t/ha)	Test wt (g)
Agave/Colorin//Zarza CMB89-784-0-1Y-1B-1Y-3B-0Y	4.6	61
Mola/Aleli//Mora CMB90-599-E-3Y-10B-0Y	4.5	67
Viringa	4.4	71
Nispero	4.3	71
Lino CMB88A-1008-B-1M-1Y-1B-1B-0Y	4.3	70
Gloria/Come//Lignee640/3/Super Precoz/4/Colorin/Calicuchima CMB90-934-K-1Y-2B-0Y	4.2	67
Mola/Aleli//Mora CMB90-599-E-1Y-1B-0Y	4.2	66
Lino CMB88A-1008-B-3M-1Y-1B-1B-0Y	4.1	67
Gloria/Come//Lignee640/3/Super Precoz/4/Colorin/Calicuchima CMB90-934-K-1Y-1B-0Y	4.1	68
Marco/Colorin//Calicuchima CMB89-340-S-1Y-2B-1Y-3B-0Y	4.1	67

Root Diseases of Barley

Root disease research is of recent origin at ICARDA. Much of the work is devoted to documenting the distribution of different root pathogens and estimating losses caused by them. A systematic survey of 80 fields was carried out for the first time for root diseases in major barley-growing regions of northern Syria. The survey team included Dr Karen Bailey (Agriculture Canada, Saskatoon), Dr Tony Rathjen (University of South Australia, Adelaide) and Dr Richard Sikora (University of Bonn, Germany). Subcrown internodes of a random sample of about 20 plants from each field were scored for the presence of root rot symptoms. Most fields were also sampled for *Heterodera avenae*, the cereal cyst nematode (CCN). Results are summarized in Table 4. Most barley fields had a high percentage of plants with severe root rot, especially in the drier areas. Large differences between neighboring fields were observed; earlier maturing or more drought-stressed crops generally had higher levels of root rot. Within fields, higher levels of root rot were associated with lower tiller numbers.

Table 4. Barley root diseases in northern Syria, 1991/92. Severity of root rot symptoms and presence of cereal cyst nematode.

		Number of fields[1]					
Date	Region	Total	<25	<50	<75	≥75	CCN
	Northeast						
5-6 May	Gezira/Hassake	18	2	4	7	5	0
26-27 May	Gezira/Hassake	15	0	1	3	11	0
	Northwest						
14 May	Jindiress	7	3	3	1	0	0
20 May	Al Bab	9	1	0	5	3	3
18 May	Bouider	5	0	0	1	4	3
19 May	Salamieh	17	2	1	11	3	10
24 May	Saraqeb	4	0	2	1	1	—
	West						
1 June	Al Ghab	5	1	0	0	4	0

[1] <25 - ≥75: percentage of plants with high level of root rot symptoms.
CCN: Cereal cyst nematode.

Heavy infestations by CCN were found in the western part of the surveyed area, especially in Hama and Aleppo provinces. However, no cysts were found east of the Euphrates river. The white females of *H. avenae* were only detected on roots during flowering. Some fields with a high infestation by CCN at the end of April (during anthesis) had no symptoms by the end of May.

Some root samples have been plated to determine the causal agents of the root rot. *Cochliobolus sativus* was identified most frequently, but *Fusarium* spp. were isolated as well. Different media and isolation techniques were tried because saprophytes complicate the identification of pathogenic fungi. Isolations from remaining samples will be made using other techniques. *C. sativus* and *Fusarium* strains will be tested for pathogenicity. Preliminary tests showed that all *C. sativus* but only few *Fusarium* strains were pathogenic.

Barley Growth Habit

A continuous gradation in growth habit, ranging from winter to spring types, occurs in cereals grown in the high-altitude areas of WANA with a continental Mediterranean climate. Germplasm for high-altitude areas must not only be tolerant of biotic and abiotic stresses but also have a range of development patterns to fit the highly variable environments.

To develop suitable germplasm for variable agroclimatic conditions, winter x spring and winter x winter hybrids are made to incorporate desirable traits from both gene pools. As the spring-type character is dominant, the majority of segregants in winter x spring crosses are spring types. Material is classified by growth habit before it is supplied to NARS.

In the spring of 1992, 2141 lines of winter and facultative barley were evaluated (Table 5) for growth habit in early summer when the temperature does not go below 10°C. In PBSN, EBSN, and PBSN-2 a low frequency of facultative and spring types was observed. This was due to earlier selection pressure for cold tolerance. Cold tolerance in general correlates with winter growth habit. However, many crosses have been made involving winter x spring types to incorporate cold tolerance into spring and facultative types. These lines have vigorous early growth compared with winter types, and produce high yields in the Atlas mountain region of Algeria and Morocco, as well as in West Asia.

Table 5. Growth habit of advanced barley breeding material.

	Growth habit			
Nursery	Winter	Facultative	Spring	Total
PBSN	124	11	3	138
EBSN	134	20	27	181
PBSN - Expt. 2	62	4	5	71
Seg. Pop. F5	585	241	925	1751

PBSN: Preliminary Barley Screening Nursery.
EBSN: Elite Barley Screening Nursery.

In the F_5s a high frequency (53%) of spring types was found. All F_5 lines were planted at Haymana in Turkey, and those with cold tolerance were selected.

First International Winter and Facultative Barley Observation Nursery

The first International Winter and Facultative Barley Observation Nursery was available in 1990/91. It was prepared in cooperation with Oregon State University (OSU), USA, to replace the International Winter and Facultative Barley Screening Nursery and the Barley Observation Nursery for High Altitude Areas that were assembled and distributed by OSU and ICARDA, respectively, in previous years.

Fifteen lines were selected six or more times by NARS scientists at 17 locations. Most of the selected lines were resistant or moderately resistant to lodging, powdery mildew, and scald. Five of these lines had a 1000-kernel weight of less than 30 g, so their selection by NARS was a surprise. Six lines had less than 20% survival at -9°C in freezing chambers at Krasnodar, Russia, suggesting that either some locations did not require cold tolerance in the material, or that cold weather was not experienced at those locations during the season.

Drought Tolerance in Durum Wheat

Severe early and intermittent drought occurred during the 1991/92 season in Morocco, western Algeria, Spain, and Portugal. Late drought occurred in Syria, Jordan, Lebanon, and southern Turkey. The average grain yields and precipitation at Breda for the last seven years are reported in Table 6. In 1991/92, mean yield was similar to the mean of the last seven seasons. Grain yields ranged from 409 to 1936 kg/ha.

Table 6. Grain yield (kg/ha) of advanced durum yield trials (ADYT) at Breda, Syria, 1985/86 -1991/92.

		Grain yield (kg/ha)		
Season	Rainfall (mm)	Mean	Max.	Haurani
1985/86	218	1224	1697	1014
1986/87	245	1127	2500	1066
1987/88	408	3608	4372	3066
1988/89	186	758	1237	503
1989/90	179	494	1420	695
1990/91	181	930	1248	846
1991/92	270	1324	1936	1150
Mean		1352	2059	1191

Several lines were identified with yields higher than the stress-tolerant cultivars Haurani, Cham 3, and Om Rabi 5. The results confirmed the superiority of Om Rabi 5 over Cham 3. Om Rabi 5 represents the second cycle of improved durums for dry areas.

Drought-tolerant durum germplasm is being released in many WANA countries to replace landraces in dry areas. Cham 3 is now the most widely grown durum wheat.

The yields of the best lines (Lahn//Gs/Stk = Lagost; Quadalete//Erp/Mal/3/Unkn) in dry conditions at Breda are reported in Table 7. These lines originated from crosses made in 1986 and 1987 and were selected under the double gradient of moisture and temperature (ICARDA Annual Reports 1986, 1987, 1988). Selection emphasized abiotic and biotic stress resistance.

Table 7. Grain yield of drought-tolerant promising durum wheat lines under dryland conditions, 1991/92.

			% increase over	
No.	Cross/entry	Grain yield	Cham 3	Om Rabi 5
1010	Lahn//Gs/Stk	1905	161	131
414	Quadalete// Erp/mal/3/Unkn	1850	156	127
815	Blk2//Snip/Magh	1784	150	123
1310	Om Rabi 3	1750	147	120
1324	Om Rabi 15/Ru	1749	147	120
	Haurani	1020		
	Cham 3	1187		
	Om Rabi 5	1455		
	LSD (0.05)	291		

Relationship of RFLP Markers with Drought Tolerance Traits in Durum Wheat

The objective of this study is to determine if RFLP (Restriction Fragment Length Polymorphism) markers can function as indirect selection criteria for traits associated with drought tolerance. Indirect selection for RFLP markers may have an advantage over direct selection as the "heritability" of the RFLP phenotype is 100%; i.e., genotype = phenotype. Direct selection for RFLP marker loci should result in a correlated response increasing the frequency of favorable alleles associated with drought tolerance. Preliminary results show that some RFLP markers are linked to stress tolerance traits (Table 8). The results are encouraging and point to the possible use of RFLP markers in durum wheat breeding. Further studies of RFLP and PCR (Polymerase Chain Reaction) techniques are under way.

Table 8. Traits that showed relationship with RFLP markers in durum wheat.

Trait	Probe x chromosomal location
p.m. leaf rolling	b3x1s7s, b35x2s, i26x6s
a.m. leaf rolling	i28x2s, c19x2s, e1x1s, b37x5l6s
Awn length	d11x3l
Canopy temperature	j19x2s
Leaf color	f19x2s, a37x5l6s, a37x5l6s, i37x5l6s, b8x5l, g19x2s
Waxiness	a19x2s
Apex development	b28x2s, b28x2s, f15x5l
Water potential	bb28x2s, o19x2s, g19x2s, d1x1s, d31x4s
Early vigor	e28x2s, c4x1l4l, f15x5l
Chlorophyll b	e28x2s, i37x5l6s
Fertile tillering under stress	k19x2s, f15x5l
Productivity (AS)	b8x5l, g19x2s, f37x5l6s
Spike fertility under stress	d11x3l

Pathogenicity of Septoria Blotch and Common Bunt on *Aegilops* spp.

Aegilops species vary considerably in their susceptibility to wheat diseases, such as yellow rust, leaf rust and stem rust (ICARDA Genetic Resources Unit Annual Report 1991, 1992). However, hardly any infection by *Septoria tritici* blotch (*Mycosphaerella graminicola*) or common bunt (*Tilletia foetida* and *T. caries*) was observed on *Aegilops* in the field. Pathogenicity tests were conducted to evaluate the resistance/immunity of the genus *Aegilops* to septoria blotch and common bunt. In 1991/92, 483 accessions from 18 *Aegilops* species were tested in the seedling stage in the greenhouse against septoria blotch. These were *Ae. ovata, Ae. triuncialis, Ae. biuncialis, Ae. triaristata, Ae. peregrina, Ae. speltoides, Ae. columnaris, Ae. caudata, Ae. ventricosa, Ae. squarrosa, Ae. cylindrica, Ae. vavilovii, Ae. crassa, Ae. umbellulata, Ae. juvenalis, Ae. searsii, Ae. kotschyi,* and *Ae. uniaristata*. Check plants of wheat (Mexipak and Gezira 17) were included after every 10 accessions. All check plants exhibited a high degree of infection.

Together with the previous year's testing, a total of 1188 accessions from 22 *Aegilops* species have been tested for their resistance to septoria blotch (Table 9).

Table 9. *Aegilops* species tested for resistance to common bunt in the field and to *Septoria tritici* blotch in the (a) field and (b) greenhouse at Tel Hadya, Syria, 1988/89-1991/92.

	Common bunt		Septoria blotch	
Aegilops spp.	No. of years	No. of accessions	No. of years	No. of accessions
1. *Ae. bicornis*	1	2	1	11^{b*}
2. *Ae. biuncialis*	3	57	4	160^{a+b*}
3. *Ae. caudata*	3	3	4	26^{a+b}
4. *Ae. columnaris*	3	9	4	35^{a+b*}
5. *Ae. comosa*	2	5	2	4^{a+b}
6. *Ae. crassa*	3	7	4	17^{a+b*}
7. *Ae. cylindrica*	3	4	4	35^{a*+b}
8. *Ae. juvenalis*	1	2	1	2^{b}
9. *Ae. kotschyi*	3	8*	4	28^{a+b*}
10. *Ae. longissima*	3	5	3	5^{a+b}
11. *Ae. mutica*	1	2	1	4^{b}
12. *Ae. ovata*	2	102	3	309^{a+b*}
13. *Ae. peregina*	2	8	3	81^{a+b*}
14. *Ae. searsii*	1	2	2	23^{b*}
15. *Ae. speltoides*	2	17	3	52^{a+b}
16. *Ae. squarrosa*	2	9*	3	22^{a+s}
17. *Ae. triaristata*	2	10	3	78^{a+b*}
18. *Ae. triuncialis*	2	59	3	227^{a+b*}
19. *Ae. umbellulata*	2	9	3	21^{a+b}
20. *Ae. uniaristata*	2	3	2	2^{a+b}
21. *Ae. vavilovii*	2	2	3	26^{a+b*}
22. *Ae. vertricosa*	2	3	3	20^{a+b*}
		328		1188

* Species with typical disease symptoms.

In field testing over the last four seasons, only one species, *Ae. cylindrica*, out of the 22 tested, showed a slight infection of septoria blotch with pycnidial formation. In seedling tests in the greenhouse, 10 species remained immune: *Ae. caudata, Ae. comosa, Ae. cylindrica, Ae. juvenalis, Ae. longissima, Ae. mutica, Ae. speltoides, Ae. squarrosa, Ae. umbellulata*, and *Ae. uniaristata*. The remaining 12 species were susceptible and exhibited symptoms of septoria blotch, i.e., necrosis and pycnidial formation. Percentage pycnidial formation on the affected accessions of susceptible species ranged between 6 and 35, with the highest on *Ae. vavilovii* and *Ae. searsii*. The least pycnidial formation was on *Ae. triuncialis*.

To confirm the results obtained in previous seasons on common bunt, 24 *Aegilops* accessions of 12 species were tested in the 1991/92 season. The species were: *Ae. bicornis, Ae. comosa, Ae. juvenalis, Ae. kotschyi, Ae. longissima, Ae. mutica, Ae. peregrina, Ae. searsii, Ae. speltoides, Ae. umbellulata, Ae. uniaristata*, and *Ae. ventricosa*. The test was conducted in two replicates. Susceptible checks had 85.6% head infection by common bunt.

Together with the testing of previous years, a total of 328 accessions from 22 species have been screened for their resistance to common bunt (Table 9). All species tested over the last four seasons remained disease free, except *Ae. kotschyi* and *Ae. squarrosa* with a slight head infection (3.6% and 1%, respectively). It can be concluded that *Aegilops* species present an excellent source of resistance to septoria blotch and common bunt of wheat.

Characterization of Wheat Germplasm

The objectives of this study were to (1) characterize parental wheat germplasm for its response to photoperiod and vernalization, (2) compare test environments (plastic house vs "conviron"), and (3) identify potential genetic variability for these two factors. Twenty promising cultivars each of bread wheat and durum wheat from WANA, having a wide range of genetic variability, were tested for their response to photoperiod (8, 12 and 16 hours light), with and without vernalization. The experiment was conducted in a plastic house and in controlled conditions in "conviron" cabinets. Results show a wide range of genetic variability among the genotypes tested. The data from the plastic house and the conviron correlated well (r = 0.887), indicating that screening in the plastic house is adequate for testing a large number of genotypes. Crop modeling studies using the collected data are under way.

Evaluation of the response of wheat genotypes to photoperiod in a plastic house at Tel Hadya, Syria, 1991/92.

Russian Wheat Aphid

Subsequent to the reports of Russian wheat aphid's devastating impact in North America since 1986, ICARDA has teamed with other organizations to determine the distribution and impact of this insect pest worldwide.

In early April 1990, scientists from Washington State University, ICARDA, and the Morocco-based USAID-MIAC project surveyed North Africa and the eastern Mediterranean region for Russian wheat aphid (RWA)— *Diuraphis noxia* Mordvilko—and its natural enemies (see map on page 13). In general, RWA density was low to moderate in all the regions sampled, although some sites had a high percentage (about 80%) of infested plants and natural enemies. RWA was most often found in low-humidity areas where plants were sparse and subjected to moderate drought stress. It occurred least in humid environments with high plant density and vigorous plant growth.

In early May 1992, scientists from ICARDA, Washington State University, and Cukurova University (Adana, Turkey) surveyed northern Syria and central Turkey. RWA and numerous natural enemies were again located in drought-stressed, isolated plants near Aleppo in northern Syria. Densities were lower than in 1990 because of the unusually rainy spring and cool weather in 1992. In Turkey, RWA was found in sparsely planted wheat and rye fields in the Tarsus-Aladaglar Range near Pozanti at about 1200 m asl and in foothills north of Tarsus. A heavy infestation devoid of natural enemies other than syrphids was found in a patch of wheat located east of Kahramanmarash near the village of Narli. No RWA were found on the Anatolian Plateau from Konya to Nevsehir, probably because of the severe winter and cool spring in 1992. Concurrently with this survey, RWA was identified in wheat at ICARDA's Terbol research farm in Lebanon's Beka'a Valley, near Zahle, and on a nearby farm operated by the American University of Beirut. RWA is widespread throughout the rainfed wheat- and barley-producing areas of western Asia and northern Africa. Its impact on production in these regions appears to be closely linked to precipitation received during the growing season. In years of normal rainfall RWA is relegated to isolated reservoir populations along the edges of irrigated fields and in drought-stressed patches on eroded hills and in isolated canyons. During periods of prolonged drought, RWA populations expand to infest large areas, threatening the most productive wheat- and barley-growing areas. However, the actual impact of RWA on yield losses during these years is difficult to separate from losses associated with abiotic stresses, as RWA symptoms on individual plants are often confused with those of drought, heat, and cold.

RWA will probably continue to be a marginal pest in most areas of Africa and West Asia, with the exception of southern Africa, Ethiopia, Yemen, and perhaps the Maghreb states of North Africa where its past performance suggests that it can cause serious economic loss unless managed properly. RWA will probably become a more serious pest if wheat and barley are sown in increasingly marginal rainfed environments, as is currently the trend in cereal-deficient countries of West Asia.

Some RWA-resistant wheats and barleys have been identified at ICARDA for use in the Mediterranean region, but almost all exotic varieties have proven highly susceptible to local diseases and maladapted to the unpredictable, harsh climate typical of the region. Landraces or lines originating in areas long infested by RWA seem to be more promising sources of resistance. In its RWA screening program, therefore, ICARDA has increased its emphasis on wheat and barley landraces, wild relatives and advanced lines originating from within WANA. Effective field screening techniques, including a 6-point scoring system combining plant damage due to the aphid's saliva with aphid density per plant (1=resistant, 6=highly susceptible), were adapted from those developed at CIMMYT (Centro Internacional de Mejoramiento de

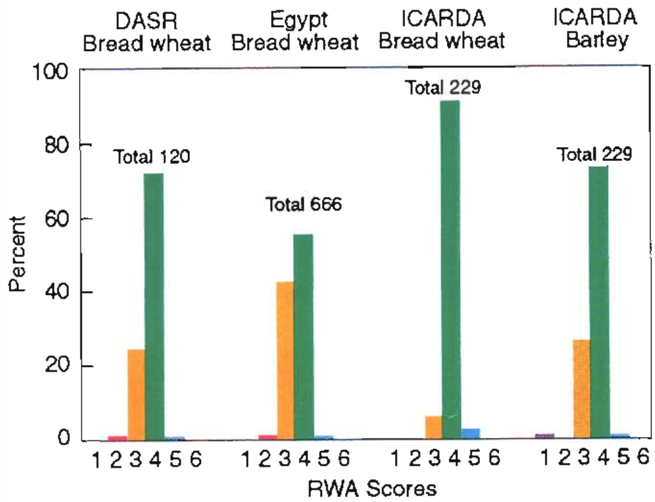


Fig. 15. Distribution of RWA scores on wheat and barley from various sources screened at Tel Hadya, Syria, 1991/92 (1 = resistant, 6 = highly susceptible). DASR: Directorate of Agriculture Scientific Research, Damascus, Syria.

Maiz y Trigo). As might be expected, most wheats and barleys initially screened were susceptible to highly susceptible, although some lines showed tolerance to salival toxins and will be retested (Fig. 15). ICARDA's breeding program seeks to combine RWA resistance with heat and drought tolerance and with disease resistance in both wheat and barley. It is hoped that the use of RWA-resistant varieties, coupled with the preservation and enhancement of endemic natural enemies, will provide adequate protection against RWA outbreaks in the low-input wheat and barley areas of the region.

Summer Planting at Tel Hadya

The facultative bread wheat project uses a summer planting (sown early July) at Tel Hadya to screen germplasm for degree of vernalization requirement (Table 10). The nurseries planted in this test are intended for observational screening purposes only, and not for seed.

Association between field- and hill-plot observations was tested in 1FAWWON, WFSWYT92, and CBFW-Turkey92 (Table 11). Conventional field plots have been used in the past to screen for this trait.

Table 10. Summer planting of facultative bread wheat at Tel Hadya, Syria.

Year	Field area (ha)	Plot type	Genotypes tested (No.)
1991	0.8	Macro (4.5m²)	1500
1992	0.16	Mini (3.3m²)	400
	0.02	Hill (0.09m²)	1382
1993*	0.03	Hill (0.09m²)	2000

* Projected summer land use requirement (12.5 x 24m).

Table 11. Associations between hill and miniplot planting at Tel Hadya, Syria, 1991/92.

Score		No. Entries			
HILL vs	MINI	WFSWTY92	1FAWWON	CBFW-T92	Total
1 same	same	61	98	100	259
2 1-4	seg/mix	6	9	2	17
3 0	seg/mix	4	4	25	33
4 seg/mix	0-4	1	7	4	12
					321

Score: 0 = Vegetative; 1 = Tiller elongation; 2 = Booting; 3 = Heading; 4 = Past anthesis.

However, the area allocation is wasteful. On the other hand, 50 hill plots occupy an area equivalent to one conventional yield trial macroplot. Yet, large conventional plots may be advantageous if a genotype is heterogeneous for its response to vernalization.

The data show that crop development in hill plots accurately reflects mini-field plots. In 86% of plot:plot comparisons, the same, or similar, scores were recorded (category 1+2). In 10% of the comparisons, hill-plot sample size was apparently insufficient to account for segregation or mixture variability observed in the field plot trials (category 3). In 4% of the comparisons, hill-plots incorrectly identified field plot response (category 4). Category 4 errors are most troublesome, yet may point to an interaction of planting density with response to lack of vernalization that may be worth investigating.

Food Legume Crops

ICARDA encourages and supports national efforts in West Asia and North Africa (WANA) and other developing countries with similar ecologies, in improving the productivity and yield stability of cool-season food legumes (lentil, chickpea, faba bean, and dry pea) and annual feed legumes (vetches and chicklings) and in enhancing their role in achieving sustainable increases in the productivity of cereal-based, rainfed farming systems.

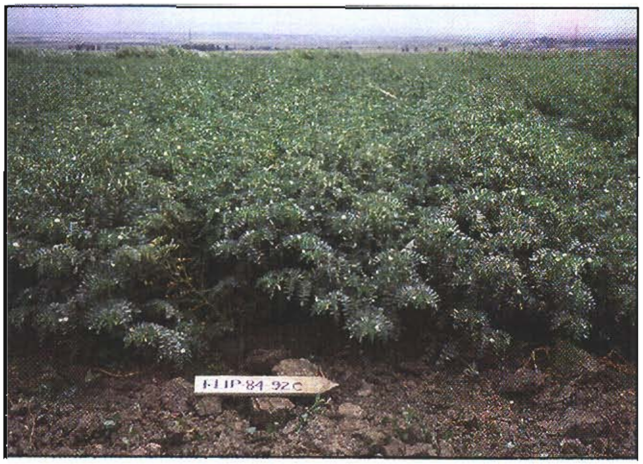
In 1992, the devolution of ICARDA's faba bean improvement research to INRA (Institut National de la Recherche Agronomique), Morocco was completed. All breeding material, research supplies, laboratory facilities and field equipment were handed over to the faba bean improvement team of INRA at Douyet Research Station near Fes. The Federal Ministry of Economic Cooperation (BMZ), Germany approved a financial grant for the North Africa Faba Bean Improvement Research Network to ensure continuity of faba bean research in North Africa. The German Agency for Technical Cooperation (GTZ) was designated as the executing agency for this project, with INRA, Morocco playing the lead role in coordinating the network activities. At the request of, and with financial support from GTZ, a workshop was organized by ICARDA in Tunis, 15-17 July 1992, to formally launch this regional network and develop a work plan for the first phase of the project. Senior research managers and faba bean scientists from all North African countries participated in this workshop, along with representatives from GTZ and ICARDA. A second meeting to plan details of the first season's activities was held in August 1992 in Morocco. GTZ has appointed a network coordinator to work closely with the INRA, Morocco faba bean team in ensuring the implementation of the agreed work plan.

Consistent with ICARDA's strategy of focusing on the dry areas, research efforts on legumes adapted to dry environments were increased. As in previous years, research on kabuli chickpea was conducted jointly with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). Collaboration with institutions in industrialized countries on basic research continued.

Research on lentil, kabuli chickpea, dry pea, chicklings and vetches was mainly carried out 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 lentil and chickpea for generation advancement. Jointly with national scientists, research sites of several national programs were used where screening conditions were ideal for strategic research on developing breeding material with specific resistance to key biotic and abiotic stresses.

Kabuli Chickpea

Winter sowing. Kabuli chickpea yields are low and unstable in WANA, but improvement is possible through the adoption of winter sowing in low-altitude regions. Trials at three ICARDA sites (Tel Hadya and Jindiress in Syria, and Terbol in Lebanon) for nine years (1983/84 to 1991/92) with more than 100 newly bred lines per year have shown that winter-sown chickpea produces 61% or 616 kg/ha higher yields than spring-sown chickpea (Fig. 16). The yield increase from winter sowing rises to 123% with the top 10% yielding genotypes. Winter sowing is expanding in WANA with an estimated area of 65 000 ha for 1991/92.



In 1992 Morocco released a new chickpea cultivar, FLIP 84-92C, which is resistant to ascochyta blight, tolerant of cold, and has an acceptable seed quality. The same cultivar was released also in Tunisia, and is performing well in Algeria.

Use of germplasm by NARS. National programs have made good use of ICARDA-enhanced germplasm. Seven cultivars including one in France (Roye Rene), two in Morocco (Douyet and Rizki), one in Pakistan (Noor 91) and three in Turkey (Aydin 92, Izmir 92, and Menemen 92) were released in 1992. Fourteen NARS have selected 42 lines for prerelease multiplication and/or on-farm trials. Evaluation of 357 ascochyta blight resistant breeding lines, 19 germplasm lines, and 4 high-yielding lines under diseased and disease-free conditions revealed that (1) breeding lines produced 33% higher yield than germplasm lines, (2) high-yielding susceptible lines produced zero yield in a diseased field, (3) some breeding lines yielded over 4 t/ha, and (4) with a unit increase in the disease severity rating, the yields were reduced by 437 kg/ha.

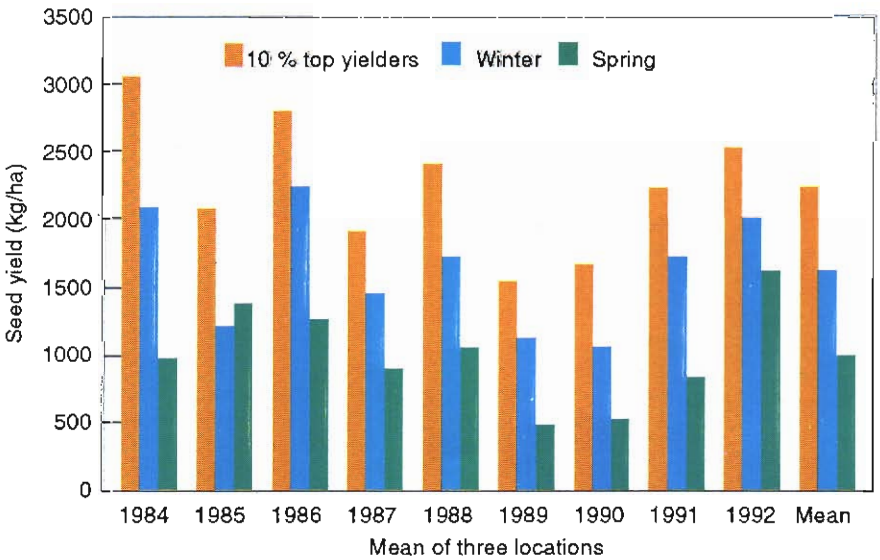


Fig. 16. Increase in chickpea yield by winter sowing.

Resistance breeding. Ascochyta blight resistant lines combining high yield and early maturity (FLIP 90-98C, FLIP 91-22C, and FLIP 91-46C) and high yield and large-seed size (FLIP 91-2C, FLIP 91-24C, FLIP 91-50C, and FLIP 91-54C) have been bred. In the project for the transfer of genes for resistance to cyst nematode from *Cicer reticulatum* and to cold from *Cicer echinospermum* and *C. reticulatum,* to cultivated *Cicer* species, progress made until 1992 suggests that in the next three years gene transfer will have been achieved. A simple, reliable field screening technique for evaluating germplasm lines to drought tolerance has been developed. Evaluation of 1000 germplasm lines using this technique revealed that FLIP 87-51C and FLIP 87-58C were drought resistant.

Molecular biology. Further progress was made in the application of non-radioactive DNA-marker techniques for variety identification for resistance to ascochyta blight, and for studying the variability in *Ascochyta rabiei.* Testing of various isolates has been standardized using the restriction enzyme *Hinf* I and the digoxigenated oligonucleotide probe (GATA)4. Blight fungus isolates were collected from different areas in Syria and added to the collection of six isolates obtained in 1981/82. The genetic typing of new isolates revealed that accessions from two fields close to Izraa (AA10 and AA8), Ghab Valley (AA11), Jindiress (AA17), and one new sample from Tel Hadya could be distinguished from one another and they also differ from all isolates collected during 1981/82 (Fig. 17). A second newly sampled isolate from Tel Hadya (AA15) is indistinguishable from two isolates sampled in 1981/82. These relatively small sets of data indicate that many different genotypes may exist in Syria.

Chickpea entomology. Studies showed that winter-sown chickpea had low leaf miner but high pod borer damage, whereas in spring-sown chickpea the reverse was true. Neem extract effectively reduced damage from both insect pests. Parasitoids of leaf miner were present in high numbers when leaf miner populations peaked. Studies on resistance mechanism showed that amounts of malic acid in leaf exudates and leaf area were related to resistance.

Biological nitrogen fixation. The proportion of plant nitrogen from symbiotic nitrogen fixation (% N_{fix}) increased when chickpea plants were inoculated with superior rhizobia in the presence of native rhizobia,

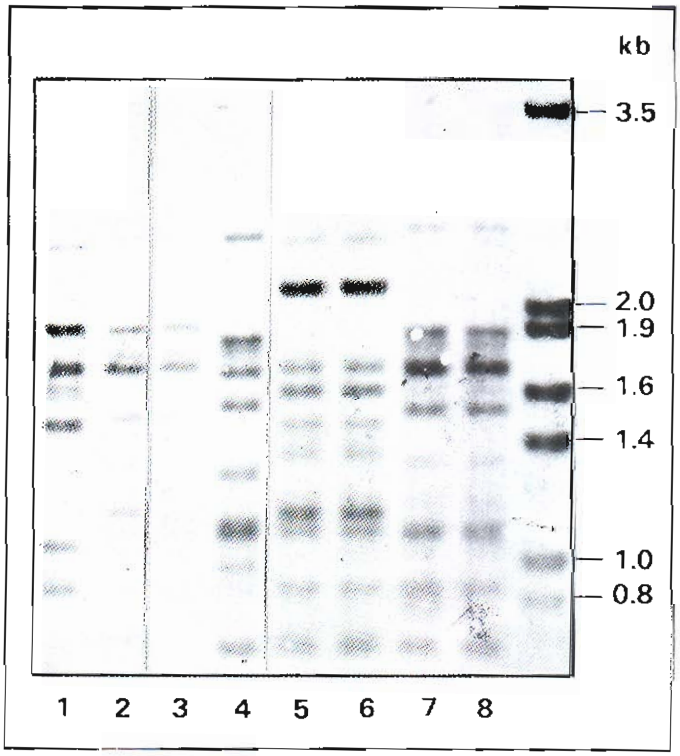


Fig. 17. Genetic typing of new *Ascochyta rabiei* isolates from different locations in Syria: (1) Tel Hadya site "a" (AA13), (2) Tel Hadya site "b" (AA15), (3) Jindiress (AA17), (4) Ghab valley (AA11), (5) Izra'a site "a" (AA10), (6) Izra'a site "a" (isolate from the same lesion as (AA10), (7) Izra'a site "b" (AA8), (8) Izra'a site "b" (isolate from same lesion as AA8). Molecular weight markers are indicated in kilobases.

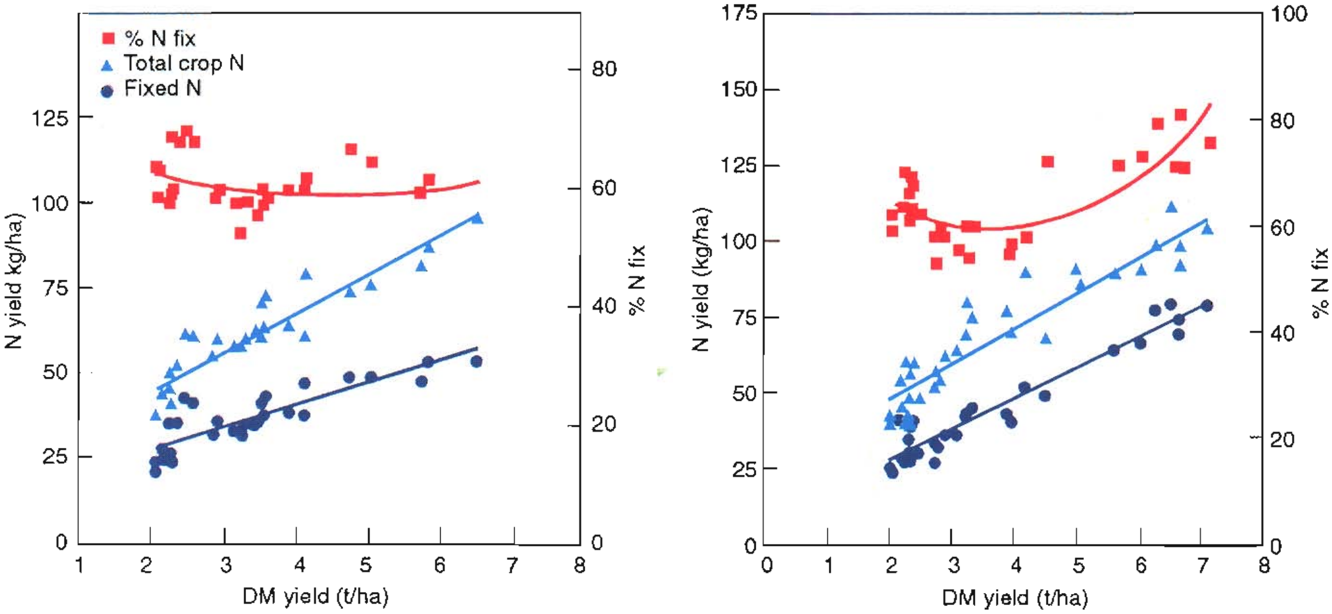


Fig. 18. Nitrogen yield and source in uninoculated (left) and inoculated (right) chickpea grown at varying moisture supply.

although there were no increases in yield (Fig. 18). Thus, the average soil N uptake at a given yield level was lower in the inoculated crop than in the uninoculated crop, irrespective of the yield level, which varied according to the moisture supply. The implications of these findings in the systems perspective are far reaching in view of the preservation of soil nitrogen.

Lentil

Average lentil yields are low because of poor crop management and low yield potential of the landraces. In some areas diseases are also a major constraint to production. Accordingly, an integrated approach to lentil improvement is being pursued covering development of improved technology and genetic stocks. Approximately 250 crosses are made annually and handled in a bulk pedigree system using off-season generation advancement at Terbol. Segregating populations targeted for the different regions are distributed to national programs for selection and cultivar development *in situ*.

Use of germplasm by NARS. A total of 27 lentil cultivars have been registered by national programs in 20 countries so far, of which two were registered during 1992 (ILL 8 in Iraq and ILL 6243 in New Zealand). A large number of lines have been selected for prerelease multiplication or on-farm trials: 15 in the Mediterranean region, 4 in the high-elevation region, 12 in the southern latitude region, 4 in Argentina, 5 in Australia, and 2 in China.

Resistance breeding. A field screening method has been developed using a wilt-sick plot to identify resistant genotypes. Sources of resistance identified are being shared with NARS through the International Legume Testing Network. Some of these sources have a high yield potential in lowland Mediterranean environments and are being tested on farmers' fields in wilt-infested areas in Syria in cooperation with national program partners. Screening of lentil genotypes for resistance to ascochyta blight has revealed that lines ILL 358 and ILL 5684 are resistant at most of the locations and could be used in the breeding program. In collaboration with the Turkish national program, studies have been initiated for developing screening techniques for cold-hardiness. Evaluation of 121 wild lentil accessions for different agronomic traits led to the identification of two accessions of *L. culinaris* ssp. *orientalis* that were faster to flower and mature than the earliest cultivated check ILL 4605. This precocity will be of value in enhancing the adaptation of lentil to drought.

Molecular biology. In a collaborative project with the Washington State University, RAPD (Random Amplified Polymorphic DNA) markers are being used to establish linkage to agronomic traits such as rust and fusarium wilt resistance, seed size, and cold tolerance. Development of DNA markers using an F_2 segregating population depends on the availability of sufficient individual F_2 plants for trait evaluation and extraction of DNA for fingerprinting. Clonal propagation of the individual F_2 plants can be of great value in this regard. However, somaclonal variation has to be ruled out as an unwanted source of genetic variation. DNA-fingerprinting is being used for detecting somaclonal variations in the plantlets derived from a mother plant by tissue culture (Fig. 19).

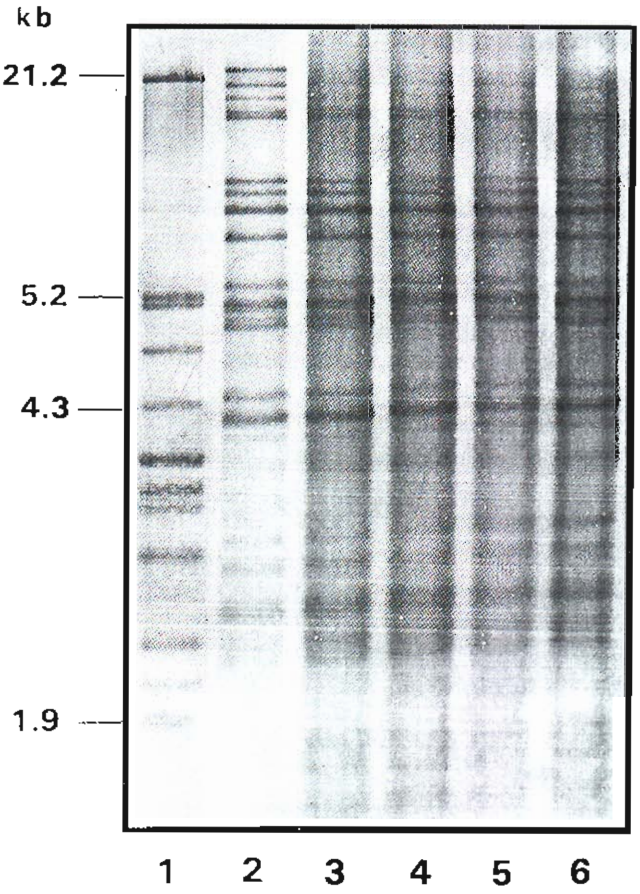


Fig. 19. DNA-fingerprinting of *in vitro* cultured lentil. Total DNA was digested with *Taq* 1 and probed with (GATA)4. Lane 2 contains the donor plant. Lanes 3 to 6 contain the regeneration. Lane 2 shows the molecular weight marker.

Symbiotic nitrogen fixation. Studies revealed that at lower moisture supply, lentil gained a larger proportion of its total nitrogen from fixation than chickpea. As the moisture supply was raised to attain high yield levels, the percentage of plant nitrogen gained from fixation (%N_{fix}) levelled off at 66% (Fig. 20), whereas in chickpea it continued to increase. These observations reinforce the regional practice of growing lentil under the drier environments, and switching to chickpea when rainfall increases to around 400 mm.

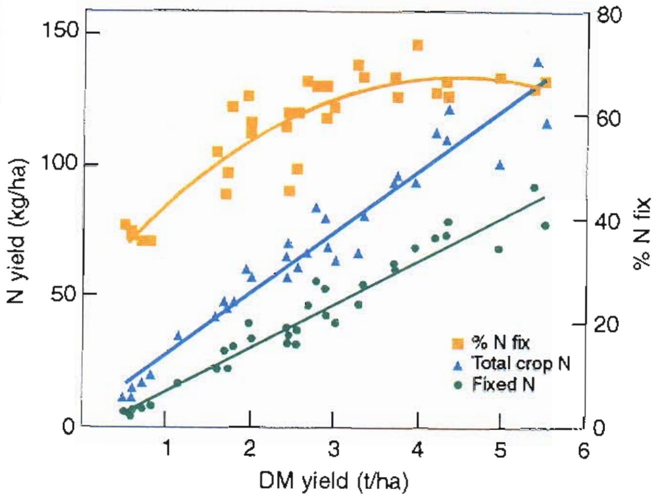


Fig. 20. Total and fixed nitrogen yield and proportion of crop nitrogen derived from fixation (%N_{fix}) in lentil in relation to dry matter yield at Tel Hedya, Syria, 1988-90.

Entomology. Larvae of *Sitona crinitus* cause considerable damage to nodules in lentil. Results from multilocation tests confirmed the effectiveness of Promet seed treatment for sitona control. The seed and total dry matter yield increased significantly at four out of five sites. The results will be verified in on-farm trials in the coming season. Control of *Bruchus ervi*, an important pest of lentil infesting the developing seeds, could be effectively achieved by two sprays of Temiphone or Thiodan at early pod setting and two weeks thereafter.

Dry Pea

Sixty-one new accessions were evaluated in a preliminary yield trial at Tel Hadya (Syria) and Terbol (Lebanon) and the best entries were advanced to the Pea

Evaluation of dry pea germplasm for cold tolerance, Tel Hadya, Syria, 1991/92.

International Adaptation Trial. Evaluation of cold tolerance of 438 lines at Tel Hadya, where the weather conditions in 1991/92 were ideal for cold tolerance screening, provided 31 tolerant lines. Presence of anthocyanin pigmentation was generally associated with cold.

Forage Legumes

Development of forage légume cultivars as an economic alternative to fallow for use in rotation with barley in drier areas received a major emphasis in 1992. As the forage legume species can be used for

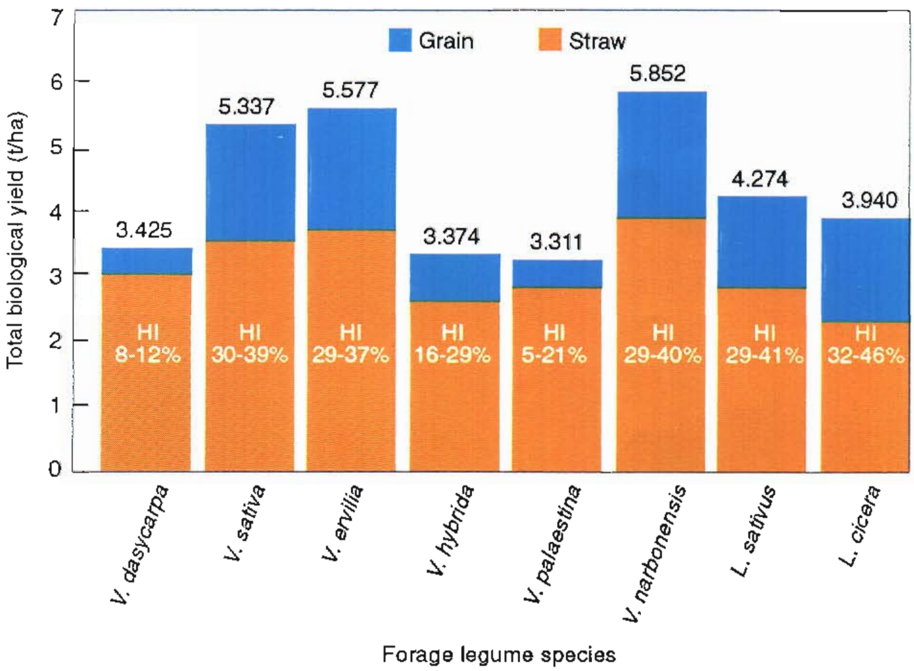


Fig. 21. Overall mean seed and straw yield and harvest index of different forage legume species at Tel Hadya, Syria, 1991/92.

grazing during winter, harvested for hay in spring, or harvested for grain and straw at maturity, they can fit into different farming systems common in the dry areas of WANA. Evaluation of a large number of selected accessions of different species of *Vicia* and *Lathyrus* at Tel Hadya revealed a large interspecific and intraspecific variation in productivity and harvest index (Fig. 21) Narbon vetch (*Vicia narbonensis*) and common chickling (*Lathyrus sativus*) proved more drought tolerant than other species, giving a yield of 1.50 and 1.26 t/ha, respectively, at Breda in Syria where total seasonal precipitation was only 263 mm. The Moroccan national program identified one line of narbon vetch (577/2391) and one of common vetch (709/2603) for catalog trials, and the Jordan national program a common vetch (715) for prerelease multiplication.

Progress was made in incorporating resistance to pod shattering in common vetch. Five superior families with 95-97% non-shattering pods were selected. Studies on breeding for reduced neurotoxin (BOAA) content in common chicklings continued.

Underground vetch. Studies on the use of underground vetch (*Vicia sativa* ssp. *amphicarpa*) as a self-reseeding pasture plant confirmed the potential of this species for use in ley farming (Table 12). The dry herbage yield of self-regenerated vetch from 1988/89 seeding was nearly 3.5 t/ha at 50% flowering in the 1991/92 season.

Crop physiology. A line-source sprinkler system was used at the Breda and Tel Hadya sites in Syria to evaluate the drought tolerance of different legume species. This method was compared with a simple field method of screening genotypes for drought tolerance with two drought intensities created by supplemental irrigation. The latter method was found effective in discriminating drought tolerance amongst forage legume species and cultivars. Among the feed and food legumes tested, narbon vetch was most drought tolerant. The BOAA content in chickling increased as the intensity of drought increased.

Pathology. Screening of promising forage legume accessions against foliar diseases helped in the identification of four lines of narbon vetch resistant to powdery mildew and botrytis blight. Resistant sources for cyst nematode were also identified in *Vicia sativa* and *V. hybrida*.

Entomology. *Sitona crinitus* caused 75% nodule damage in *Vicia villosa* ssp. *dasycarpa* at two locations in northwest Syria. Seed treatment with Promet increased seed and biomass yield (Fig. 22).

Table 12. Effect of grazing management of subterranean vetch on its dry herbage yield in the year of establishment (1989/90), yield of succeeding (1990/91) barley (as compared to barley after barley), vetch seed bank at the start and the end of barley phase, and dry herbage yield of self-regeneration vetch in 1991/92, Tel Hadya, Syria.

	Subterranean vetch					
	Grazing					
Yield/seed bank (kg/ha)	February	March	April	No grazing	Barley	SEm (±)
Herbage yield* 1989/90	830	730	860	2020	—	57
Barley seed yield 1990/91	1966	2035	1925	1909	1599	98
Barley total shoot 1990/91	4347	4193	3947	3877	3143	215
Starting seed bank 1990/91	50	130	160	240	—	27
End-of-season seed bank 1990/91	32	95	141	218	—	34
Herbage yield* 1991/92	3258	3879	3708	3900	—	320

* At 50% flowering.

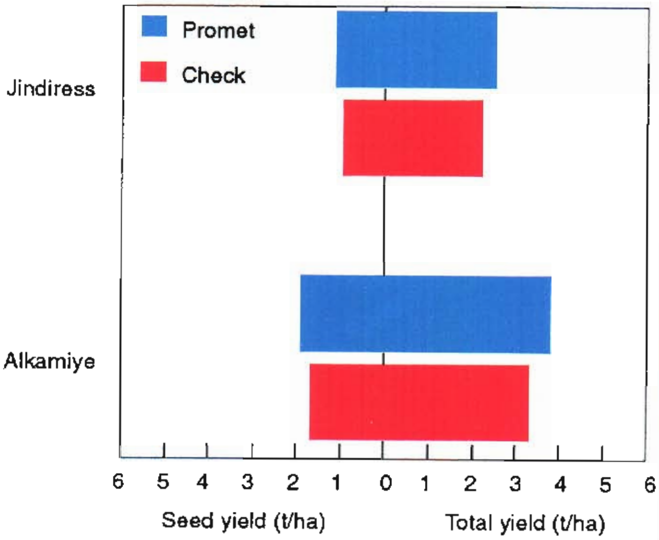


Fig. 22. Effect of seed treatment with Promet (12 ml/kg seed) on seed and total biological yield of *Vicia villosa* ssp. *dasycarpa* at two locations in Syria, 1991/92.

International Nurseries and Networks

A total of 1050 sets of 34 different nurseries of chickpea, lentil, pea, chicklings, and vetches were distributed to 160 cooperators in 55 countries for the 1992/93 season. Several cooperators requested seed of elite lines identified by them from the international nurseries/trials, for on-farm verification trials.

Traveling workshops were organized in Egypt, Ethiopia, Sudan, Syria, and Turkey. Joint training programs, traveling workshops, and regional coordination meetings enhanced interaction and encouraged networking.

Seed Production

To strengthen seed programs in West Asia and North Africa, ICARDA operates a special project "Development of National Seed Production Capabilities in West Asia and North Africa," funded by the governments of the Netherlands and the Federal Republic of Germany. Among the project activities during 1992, one of the most important developments was the establishment of a WANA seed network. The network has initiated several activities to assist in improving the national seed programs.

The national train-the-trainer course continued successfully in Egypt. The seven trainers of 1990 again took the lead in three field inspection methodology courses in 1992. More than 50 Egyptian seed staff benefited from this program.

A new regional approach in train-the-trainer program was initiated; a few selected regional seed staff were trained in (1) seed testing techniques and (2) seed health testing. They will organize follow-up in-country training courses.

ICARDA seed scientists visited the Republic of Yemen to advise on the integration of seed programs of the Northern and Southern Governorates.

Roundtable discussions were conducted on (1) seed quality control (Yemen, Ethiopia), (2) legume seed production (Egypt), and (3) standards for seed-borne diseases (Egypt).

A working group has been formed to develop a manual for the production of seed of different food legume crops.

Two international courses were organized. The first course aimed at improving the ability of seed sector staff to evaluate agronomic performance and to test distinctness, uniformity, and stability of new varieties. The second course, organized in cooperation with CIHEAM (Centre International de Hautes Etudes Agronomique Mediterraneennes), focused on a range of seed production aspects.

A seed processing course, funded by the GTZ Seed Project in Egypt, was organized at ICARDA headquarters for the directors of Egyptian seed-processing plants. This course was an example of how a national program could utilize the facilities developed at ICARDA.

ICARDA provided assistance in planting seed of promising cereal lines at the farm of the General Organization for Seed Multiplication (GOSM), Syria for prerelease multiplication.

Resource Management and Conservation

On-farm Barley Trials

In many breeding programs, selection is conducted on experiment stations with improved agronomic practices; but, with the exception of disease resistance, genetic differences expressed under high input levels are irrelevant to target environments with low inputs. To test that hypothesis, 32 trials were planted over three seasons, 1989-92, along a rainfall transect from near Tel Hadya to the steppe fringes, southeast of Khanasser, in Syria. These trials compared 22 barley lines, 11 adapted to moderate rainfall (Group I) and 11 to low rainfall (Group II), in the absence or presence of fertilizer (40 N + 18 P kg/ha), and at high and low seed rates (120, 80 kg/ha).

Rainfall in the three experimental seasons was, respectively, very low, low, and below average. Ranges for growth-season totals (preplanting to harvest) were: 1989/90, 116-185 mm (mean:154 mm); 1990/91, 195-244 mm (mean: 214 mm); 1991/92, 204-270 mm (mean: 237 mm). In consequence, yields were very low or low, with dry matter means across sites of 0.99, 2.50 and 3.40 t/ha in the three successive years.

Nevertheless, genotype differences were statistically significant at most sites each year; and summarizing by years across sites we noted that barley selection for low rainfall (Group II) had a significant positive effect on grain but not straw yield (Table 13). As is usual in this environment, the largest yield increases were from fertilizer application, with means of 35% for grain and 70% for straw.

Table 13. Summary of treatment effects on barley grain and straw yields (t/ha), by years across sites in Syria.

Factor		Year and number of sites 1989/90 (9)	1990/91 (11)	1991/92 (12)	Means (32)
Variety group[1]		***	***	***	***
I	Grain	0.14	0.54	0.75	0.51
II		0.20	0.67	0.89	0.63
SEm (±)		0.006	0.008	0.011	0.005
		**	***	ns	*
I	Straw	0.80	1.99	2.60	1.91
II		0.85	1.83	2.55	1.85
SEm (±)		0.013	0.028	0.035	0.017
Fertilizer		**	***	***	***
-	Grain	0.16	0.48	0.73	0.49
+		0.18	0.73	0.91	0.66
SEm (±)		0.006	0.008	0.011	0.005
		***	***	***	***
-	Straw	0.60	1.32	2.00	1.39
+		1.04	2.50	3.15	2.37
SEm (±)		0.013	0.028	0.035	0.017
Seed Rate		*	ns	ns	ns
Low	Grain	0.18	0.60	0.81	0.572
High		0.16	0.62	0.82	0.576
SEm (±)		0.006	0.008	0.011	0.005
		***	**	**	***
Low	Straw	0.79	1.84	2.51	1.83
High		0.68	1.97	2.64	1.93
SEm (±)		0.013	0.028	0.035	0.017

[1] Group I, barley lines selected for moderate rainfall; Group II, selected for low rainfall. * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

Differences between Groups I and II in grain and straw response to the rather dry environment are reported in Table 14 which also shows the ranking of the individual lines according to the number of occasions their grain and straw yields fell appreciably below the site mean yield. Group II lines occupied 10 of the top 11 places in grain reliability (with the landrace Arabi Aswad and five selections from landraces taking the top 6 places) but were much more scattered in respect of their straw reliability. Scoring highest (in total) on both counts—and farmers are interested in both—were Arabi Aswad (the local landrace) and Tadmor and Zambaka (selections from it).

The scatter of straw reliability was associated with two groups of genotypes, the Group I six-row lines and the Group II landraces derived from Arabi Abiad. Four of the six genotypes with six rows were in the top 4 places for straw reliability. This is likely to be due to their thick stems, often of lower palatability. On the other hand, the landraces derived from Arabi Abiad (Arta and the two SLBs) lost their top places because they grow very short under drought conditions. This explains why farmers in the dry areas prefer black-seeded landraces.

Table 14. Ranking of barley lines, according to the reliability of their grain and straw yield in 32 trials in Syria.

Grain			Straw		
Occasions below site mean yield	Line	Selection group	Occasions below site mean yield	Line	Selection group
0	Arta	II	0	Rihane-03	I
	SLB 39-10	II	1	As46/Aths*2	I
1	Tadmor	II		Iris/Nopal'S'†	I
	SLB 39-60	II	4	Deir Alla/DL71	II
	Wadi Hassa	II	6	Arabi Aswad	II
	Arabi Aswad	II	7	Zambaka	II
	Zambaka	II	8	Cm/3/Api/-	I
6	Harmal	II	9	Tadmor	II
	WI 2291	II		WI 2291	II
7	ER/Apm	I	13	Roho Mazurka	I
	WI 2269	II	16	Arta	II
9	Roho/Mazurka	I		SLB 39-10	II
10	CI08887/CI05761	I	17	SLB 39-60	II
13	Rihane-03	I	18	Giza 121/-	I
17	Iris/Nopal'S'†	I	21	Pitayo/-	I
20	Pitayo/-	I	23	CI08887/CI05761	I
	As46/Aths*2	I		Wadi Hassa	II
24	Salmas	I	25	ER/Apm	I
27	Giza 121/-	I		Salmas	I
30	Cm/3/Api/-	I	26	Harmal	II
31	Deir Alla/DL71	II		WI 2269	II

† Grown in 1990/91 and 1991/92 seasons only (23 sites). Arabi Abiad omitted here, as seed was contaminated in 1990/91 season.

Trends and Sequence Effects in Long-term Wheat Rotations

Long-term rotation trials have attracted ICARDA's interest since its establishment, largely because it is thought they can provide answers to questions of sustainability. Eventually, this is likely to be true. But under a dry climate, with large inter-annual variability, unequivocal differences between cropping systems take a long time to emerge. With yields varying by as much as a factor of ten from year to year, the detection of firm trends requires long runs of data. However, other indicators such as soil organic matter and total nitrogen contents, which are less affected by variable weather, may show meaningful differences earlier.

A large-plot, two-course rotation was established at Tel Hadya in the 1983/84 season. It compares rotations of wheat with fallow, wheat, lentil, chickpea, summer crop (melons), vetch, and medic pasture.

Sampling and analysis of the topsoil prior to the 1991/92 cropping season revealed significant differences between rotations in organic carbon and total nitrogen contents (Table 15). It was clear that the lowest values of both parameters were found in soils growing wheat after wheat and wheat after fallow or summer crop, i.e., those rotations without a nitrogen-fixing legume. Among the rotations that include legumes, those with medic had the highest values, followed by vetch, lentils, and chickpeas.

Aside from long-term yield trends and sustainability, crop yield data from rotation trials provide—much sooner—good indications of which crop sequences are optimal, from the point of view of biomass productivity and economic profitability, and an insight into the underlying mechanisms. Wheat yields from the above trial (Table 16) have shown a fairly consistent order: $W/W \leq W/M \approx W/C < W/L \approx W/V < W/S \approx W/F$. Continued monitoring of the soil water balance of crops in this and other trials has

Established in 1983/84 this long-term rotation trial at Tel Hadya, Syria compares rotations of wheat with fallow, wheat, lentil, chickpea, watermelon, vetch, and medic pasture.

Table 15. Effect of seven different crop rotations at Tel Hadya, Syria on topsoil (0-20 cm) content of organic matter and total nitrogen after eight years cropping.

	Rotation							
	Wheat/ Fallow	Wheat/ Wheat	Wheat/ Lentil	Wheat/ Chickpea	Wheat/ S.crop	Wheat/ Vetch	Wheat/ Medic	SEm (±)
Organic matter (%)	1.03	1.05	1.09	1.07	1.02	1.14	1.21	0.022
Total N (ppm)	668	678	718	696	651	738	792	12.8

Table 16. Wheat grain and above-ground biomass yields (t/ha) in seven two-course crop rotations at Tel Hadya, northwest Syria, 1989/90 to 1991/92.

Season	Preceding crop in rotation							
	Fallow	Wheat	Lentil	Chickpea	W/melon[1]	Vetch	Medic	SEm(±)
Grain								
1989/90	1.14	0.55	0.73	0.62	1.60	0.74	0.54	0.074
1990/91	1.56	0.97	1.25	0.76	1.64	1.17	0.93	0.086
1991/92	2.70	1.92	2.21	2.19	2.77	2.31	2.24	0.123
Mean 1985-92	2.26	1.00	1.81	1.47	2.19	1.84	1.39	
Biomass								
1989/90	4.45	2.59	3.07	3.13	4.98	3.10	3.38	0.130
1990/91	5.52	3.91	4.86	4.46	6.08	4.77	4.89	0.384
1991/92	6.44	5.20	5.71	5.25	5.97	5.36	5.34	0.172
Mean 1985-92	6.31	3.07	5.24	4.44	5.93	5.44	4.45	

[1] Wheat was preceded by fallow in 1989-1991, due to insufficient storage of soil water for planting of water melon.

confirmed that the major factor dictating this pattern is the relative ability of the alternate crop in the rotation to dry the soil profile. Chickpea and medic regularly extract as much water from the profile as does wheat, whereas lentil and vetch, being shorter season crops, do not dry the soil to the same extent, especially at depth. Water remaining after lentil and vetch benefits the succeeding wheat crop, but wheat following chickpea or medic is dependent solely on the current season's rain.

Water use is monitored in three of the rotations, W/F, W/C, and W/M. A measurement is made at the end of the summer, before the start of the rainfall season, and all gain and loss of water from that time is included in the seasonal balance. Fallow efficiencies (proportion of fallow-season rainfall carried over as soil water to the next season) ranged from 39% in 1991/92, reflecting the relative low evaporative demand of the season, to 22% in 1989/90 and 15% in 1990/91. Water-use efficiency (WUE) of wheat after fallow has been calculated by inclusion of the water 'use' of the previous year's fallow as well as use during the crop season. Regardless of the total seasonal rainfall, WUE (kg/ha/mm) for both above-ground biomass and grain was greater in the rotations with legumes than with fallow. Nitrogen application to wheat generally increased efficiency of biomass production, but depression of the WUE for grain in the drought years indicates greater stress during the grain-filling period in fertilized crops.

The major objective of this trial is to examine the biological productivity of the different cropping systems, and the management, in general, seeks to maximize this without considerations of costs. However, the trial does provide an opportunity to examine the longer-term economics of new practices, and to quantify the risks of older ones, such as nitrogen fertilizer use. Economic analyses of the systems, therefore, are being carried out and will be reported subsequently.

Meanwhile, it may be noted that with the current pressures of population expansion on land resources, government policies are driving production systems in the region towards continuous cropping with cereals. The data from this trial illustrate that this is a retrograde trend, the mean yield for continuous wheat being 40 to 100% less than that from other rotations.

Nitrogen Cycling in a Semi-Arid Mediterranean Region

There is a need to quantify the effects on soil N of introducing different legumes into the farming systems of West Asia and North Africa. Six years' results from an ongoing experiment demonstrate the total soil nitrogen dynamics when either medic pasture (three stocking rates), vetch, lentil, fallow or watermelon are managed in two-year rotations with wheat. Trends in total soil N are plotted in Fig. 23. Rotations including medic pasture or vetch increased total N concentration in the soil by 15 to 20% over the course of six years. In contrast the total soil N concentration remained unchanged in the lentil, fallow or melon rotations.

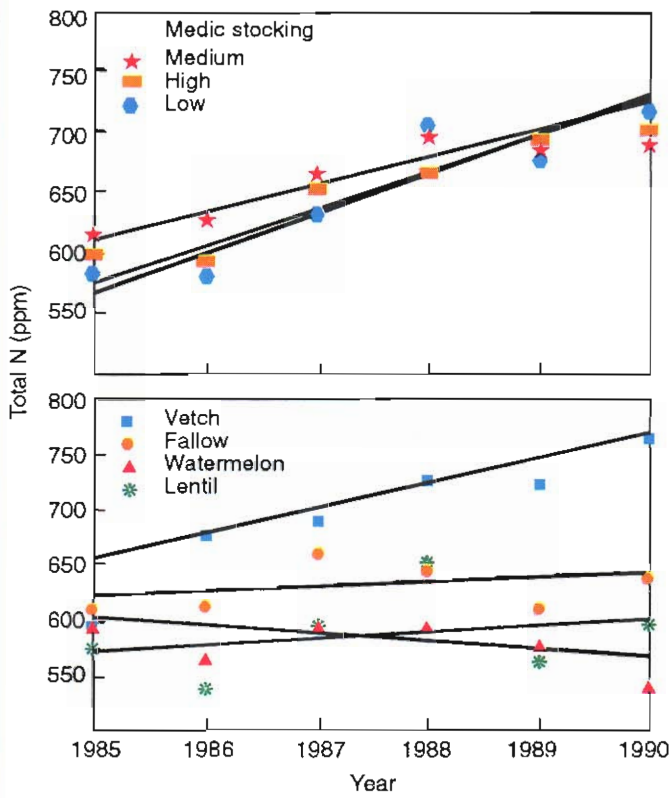


Fig. 23. Total N concentration in the top 20-cm soil during a six-year 1:1 rotation of wheat with medic (3 stocking rates), vetch, lentil, fallow or watermelon.

The rotations examined in this experiment had clear and markedly different effects on the soil. Lentil had no effect on either total soil N or organic matter content. Total soil N also remained constant in the fallow rotation but organic matter content of the soil tended to decrease. The changes in soil properties have implications for the long-term productivity of the different rotations and highlight the importance of retaining a legume crop for maintaining fertility.

The large increases in total soil N and organic matter in the medic rotations indicated that there were large inputs of organic N into the soil. Most of this N came from the return of the legume shoots to the soil. The turnover of shoot material was largest in the low and medium stocking rates where the pasture was underutilized.

The urine and dung of grazing sheep also returned nitrogen to the pasture. This represents only about 20% of the total N returned directly with the shoots and roots; however, in a related experiment, about 55% of N consumed by sheep grazing medic pasture was removed from the field in the form of milk or dung and urine deposited in the night-holding areas. Of the N returned to the soil, more than 50% of that in the urine may have been volatilized.

Animal feed is scarce in WANA and herbage trampled into the ground represents an expensive 'N fertilizer.' More information on the pattern of utilization of herbage and the management of animals may allow greater utilization of herbage by animals while also allowing a more efficient recycling of N via dung and urine.

Differences in the return of N in shoot or root residues may have caused the different rates of soil N accretion between the vetch and lentil rotations despite the management of both crops being the same. The entire shoot of both species was harvested and removed from the soil, apparently leaving little shoot residue in the field in most years. Leaf drop was not measured during the six years of the experiment described here, but results from the 1991/92 season showed that there were substantially more leaves dropped by the vetch than by the lentil near maturity. Differences in the amounts of N in the roots were not determined but may also have been an important factor for differences between species.

Wheat versus Barley Grain Yields after Medic and other Common Crop Rotations in Northwest Syria

Since 1985/86 ICARDA has been experimenting with annual *Medicago* spp. as a pasture legume for use in rotation with wheat. Medic pasture appears to demand more water than lentil, vetch, watermelon or fallow when in rotation with wheat. This is not surprising because of the effect of grazing, causing regrowth of medic while the other crops go through a normal phenological progression to maturity. As a result, wheat yields after medic were, on average, lower by as much as 33% than after fallow treatments, and 13% lower than after vetch and lentil.

In 1991/1992, barley, a plant with a shorter growth cycle, was compared with wheat in rotation with the above crops with the hypothesis that water requirements of barley would be less than of wheat. The results of the first year of the experiment revealed that barley did indeed do better with medic relative to the other rotations under the same conditions.

Best grain and straw yields were harvested from wheat and barley following fallow, except when no nitrogen was applied. Barley grown in rotation with medic outyielded barley in the fallow rotation by 0.33 t/ha each for grain and straw. It also produced 1.47 and 0.98 t/ha more barley grain and 1.19 or 1.58 t/ha more barley straw than measured in lentil and vetch rotations, respectively (Table 17).

In 1991/1992, for both wheat and barley and for both levels of N, the cereal/medic rotation system produced equal or greater cereal grain and straw yields compared with lentil or vetch rotations. These results with barley reverse the trends found in the first six years of the trial using wheat as the cereal when average wheat grain yields were highest (about 2.1 t/ha) after watermelon or fallow, about 0.5 t/ha lower after lentil or vetch, and a further 0.2 t/ha lower after medic.

Results of this one year of experimentation point to the possibility that medic pastures dry the soil to a degree that makes wheat perform suboptimally in rotations for northwest Syria. Results presented here suggest that barley might be a better companion with

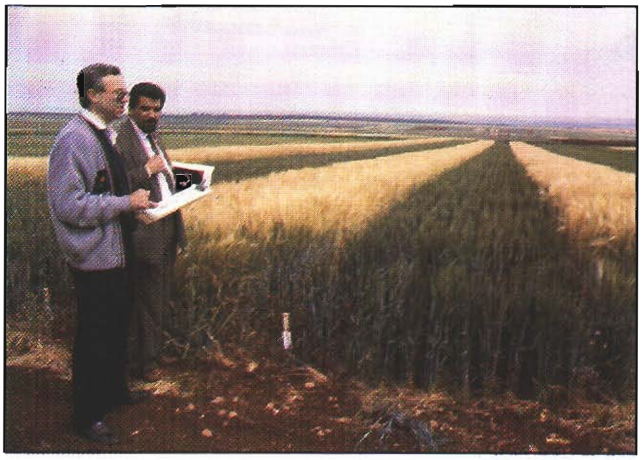
Table 17. Grain and straw yields of barley and wheat grown in rotation following fallow, lentil, vetch, watermelon and medics and two fertility levels of nitrogen (0 and 60 kg/ha, applied as splits in autumn and spring), at Tel Hadya, Syria, 1991/92.

	Fallow		Watermelon		Lentil		Vetch		Medic	
	N-	N+	N-	N+	N-	N+	N-	N+	N-	N+
	Grain yield (t DM/ha)									
Wheat	2.53	3.41	2.92	3.18	1.82	2.27	2.19	2.39	2.26	2.42
Barley	3.57	5.89	3.78	5.79	2.43	4.01	2.92	3.76	3.90	4.49
	Straw yield (t DM/ha)									
Wheat	4.57	7.15	5.30	7.15	3.02	4.60	3.64	4.44	4.45	5.30
Barley	3.21	6.03	3.61	6.22	1.97	3.68	2.36	3.35	3.55	4.66
	Total yield (t DM/ha)									
Wheat	7.10	10.56	8.22	10.33	4.84	6.87	5.83	6.83	6.71	7.72
Barley	6.78	11.92	7.39	12.01	4.40	7.69	5.28	7.11	7.45	9.14

SEm for making any comparisons among N, cereal and rotation ranged from: ±0.03 to ±0.16 for grain; ±0.04 to ±0.24 for straw.

medic in a pasture/cereal rotation because of its shorter maturation period, and hence less demanding requirements for water compared with wheat.

In an economic analysis of the rotations using six years of wheat data, ICARDA has found that an increase of 0.6-1.0 t/ha in wheat grain yields makes the medic rotation competitive with wheat/lentil. This magnitude of increase does not seem feasible with wheat but may be possible with barley.



ICARDA and FAO researchers discuss the use of barley and wheat following medic pasture.

One objective in the coming year will be to undertake an analysis comparing the economics of using barley instead of wheat in this rotation experiment, using sensitivity analyses to further define the place of medic in northwest Syria.

Native Shrubs in Sheep Diets

Natural rangelands in countries of West Asia are heavily degraded because of uncontrolled grazing, increased livestock numbers, uprooting of shrubs, and the encroachment of cereal cultivation. Ongoing research at ICARDA is assessing the establishment of native shrubs (*Atriplex halimus* and *Salsola vermiculata*) on native, unimproved pastures in both Syria and Lebanon.

In 1991 the Center started a collaborative project with the American University of Beirut (AUB), Lebanon to study the botanical composition of sheep diet, using fecal microhistological techniques. Fecal and plant samples were collected in August and November 1992 and sent to AUB. The fecal samples were collected from 72 ewes grazing the shrub-seeded plots in the Maragha project, operated in collaboration with ACSAD and SMAAR, near Aleppo in Syria. Plant samples were collected from all treatments in the experiment. At AUB, the fecal and plant samples were dried and ground through a Willey screen, and a composite was prepared for each ewe. The composites were soaked, rinsed, and mounted on slides with Hoyer's solution. Their botanical composition was then determined on five slides per sample by examining 20 random fields per slide. Undigested plant fragments were identified, recorded, and estimated as percentage of diets. Dietary similarities between groups were calculated using a similarity index.

Preliminary results indicated that reseeding of marginal lands with native shrubs such as the ones tested here may provide sheep with green feed when other vegetation is dry. During the dry season (August), about half the sheep diet (46%) consisted of edible shrubs with equal proportions of *Atriplex* and *Salsola* species (Table 18). Increasing the stocking rate from low (one ewe/2.25 ha/year) to high (one ewe/ 0.75 ha/year) resulted in more *Atriplex* being consumed (16.7% and 25%, respectively). The grass component in the pasture remained unaffected by stocking rate (average 31%). Consumption of *Salsola* was lower under a high stocking rate. It was also noted from the August sample that about 23% of the diet was shrubs and forbs other than *Atriplex* and *Salsola*.

Table 18. Botanical composition (%) of sheep diet under three stocking rates (August 1992) on rangelands improved with shrubs in Syria.

Species	Low stocking	Medium stocking	High stocking	SEm	Grand mean
Grasses	27.02	30.33	28.38	0.085	31.176
Atriplex sp.	16.65	24.34	25.20	0.078	24.071
Salsola sp.	23.57	22.22	15.29	0.060	22.211
Other species	20.82	23.19	18.62	0.069	22.776

Table 19. Botanical composition (%) of sheep diet under three stocking rates (November 1992) on rangelands improved with shrubs in Syria.

Species	Low stocking rate	Medium stocking rate	High stocking rate	SEm (±)	Grand mean
Artemisia herba alba	12.87	10.65	18.88	0.049	14.3
Atriplex leucoclada	0.00	0.00	0.25	0.004	0.08
Ephedra alata	0.00	0.00	0.00	0.000	0.00
Gossypium barbadense	0.00	0.07	0.06	0.002	0.04
Hordeum (grain)	13.47	10.29	9.37	0.047	11.2
Hordeum (straw)	22.75	21.74	22.69	0.074	22.7
Noaea mucronata	11.47	17.86	11.22	0.049	13.7
Salsola inermis	3.15	10.02	4.38	0.042	5.9
Salsola spinosa	0.88	2.86	3.02	0.033	2.2
Other species	30.63	26.41	29.65	0.076	29.3

During the fall season (November), the sheep ate very little *Atriplex* irrespective of the stocking rate (Table 19). Other shrub species (*Salsola* spp. and *Noaea mucronata*) represented 20% of the diet with the greatest contribution from *Noaea mucronata*. About 15% of the diet was *Artemisia herba alba*.

Predicting the Nutritional Value of Barley Straw

Because of the large proportion of cereal straw in ruminant diets in the WANA region, plant breeders are now beginning to take greater account of cereal straw quality. The voluntary intake of straw by sheep is an important factor in its economic value. The most appropriate tests should not only describe the quality in the year and site at which the sample was taken, but also indicate what the quality will be under future growing conditions. Additionally, tests should use small samples of straw and be inexpensive, to make it possible to screen straw for quality early in breeding programs.

ICARDA has been evaluating tests that can predict the mean ranking of barley straw varieties for voluntary intake, from samples taken in a single year. The mean ranking of nine varieties of barley straw has been estimated, using the voluntary intake data of over 100 lots of straw harvested in seven years. The straws include improved six-row and two-row varieties and landraces.

On a set of 35 samples, a number of tests were used to predict the mean ranking for voluntary intake. Of these tests, Near-Infrared Reflectance Spectroscopy based on three wavelengths, gas production *in vitro*, *in vitro* digestibility, and acid detergent fibre gave the best predictions of mean ranking ($P<0.01$). Acid detergent lignin predicted it moderately well ($P<0.05$). In contrast, straw intake using 3 or 4 animals per variety, neutral detergent fibre, crude protein, and energy to grind the sample predicted the mean ranking poorly ($P>0.1$).

Figs. 24 and 25 show the ability of near-infrared reflectance and animal trials to predict, from sets of samples collected in five different years, the mean rankings of nine varieties. In each year, near-infrared had a smoother relationship with mean ranking than did voluntary intake measured in 3 or 4 sheep. We believe that this paradoxical result was caused by between-animal variation. The near-infrared method was calibrated from the results of 35 animal trials in which the errors of large numbers of sheep were averaged out, whereas the results of each separate animal trial (Fig. 25) were averages of only three or four sheep.

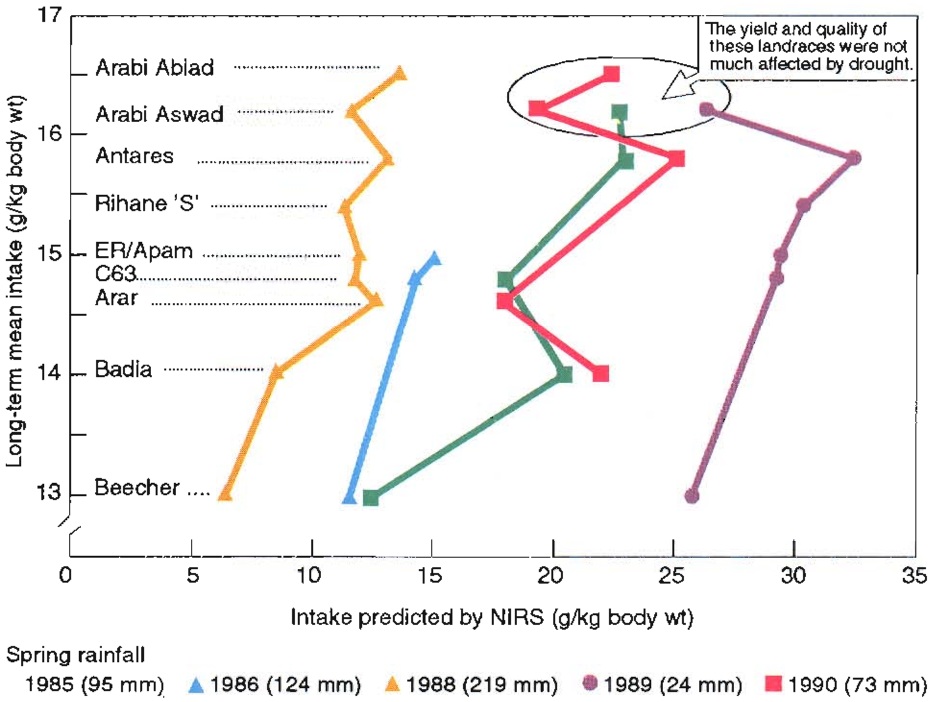


Fig. 24. Predicting the mean rankings of barley straw intake with Near-Infrared Reflectance Spectroscopy (NIRS) over five years.

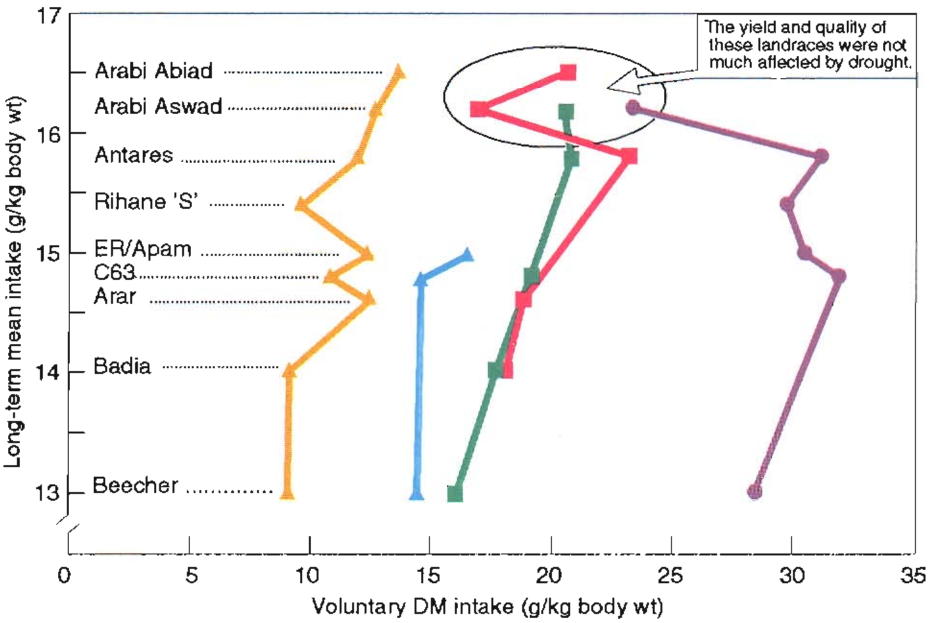


Fig. 25. Predicting the mean rankings of barley straw intake using voluntary intake trials in sheep over five years.

When spring rainfall was low, sheep ate more straw than in wetter years because dry springs increased straw quality (Fig. 25). It was interesting that the voluntary intake of the landraces of barley, e.g., Arabi Abiad and Arabi Aswad, was less affected by dry springs than of the other, less-adapted varieties. That was because the landraces were able to move assimilates into their grain better than the less-adapted varieties, with the result that neither grain yield nor straw quality was as greatly affected by the dry springs.

Oilseeds in WANA

Current production of edible oils in the WANA region is seriously inadequate. Local production from olives, cotton seed, and other oilseeds meets only about 20% of the demand. Total imports of edible oil to fill the gap between production and demand in 1990 were over 4.41 million metric tons, costing more than 2 billion US dollars. Yet, the agroclimate of most Mediterranean and West Asian countries is suitable for the production of winter oilseeds (rapeseed and mustard, safflower, linseed) and/or spring oilseeds (sunflower, sesame), although spring crops in low-rainfall years may require supplemental irrigation.

Oilseeds are already widely grown in the region, but in small areas, and some countries have initiated research on these crops. The need is to support these countries by providing the most appropriate varieties and improved production practices. Crops selected for research at ICARDA are rapeseed (*Brassica napus* and *B. campestris*), safflower (*Carthamus tinctorius*), sunflower (*Helianthus annuus*), and sesame (*Sesamum indicum*), with the following research priorities:

- Screening of old and new varieties from WANA and other countries to identify the promising ones for testing.
- Determination of optimum production practices, such as sowing dates, fertilizer needs, seed rates, supplemental irrigation requirements, and control of pests, diseases and weeds.
- Determination of the appropriate place of oil crops in crop rotations to ensure minimum disturbance to the production of major cereal (wheat and barley) and food legume (chickpea and lentil) crops.

Two trials were conducted on rapeseed at Tel Hadya during the 1991/92 season. The first compared 20 varieties, 5 *Brassica campestris*, 14 *B. napus* and 1 *B. juncea* (mustard) under rainfed conditions (349 mm). The second compared six varieties factorially under six water regimes, rainfed and five rates of supplemental irrigation (18, 61, 111, 163 and 207 mm, applied in two instalments in April and May). Significantly, the wholly rainfed trial, which was planted early and had emerged by 3 November, outyielded all treatments in the later-planted second trial, where emergence was about five weeks later. Mean grain yields in the first trial were 1.08 (± 0.20) t/ha, the highest being those of a *B. napus* variety, Westar (1.48 t/ha), and of a mustard variety, Cutlass (1.43 t/ha). The two *B. napus* varieties designated as "winter-type" produced the lowest yields (0.73 t/ha). The twelve "spring-type" *B. napus* varieties (including Westar) averaged 1.14 t/ha.

In the second trial, the mean yield (across all water regimes) was only 0.56 t/ha, with the mustard variety Cutlass producing the highest yield (0.69 t/ha), and the *B. campestris* variety Parkland the lowest (0.41 t/ha). Mean response to supplemental irrigation was almost negligible. There were signs of yield increases from supplemental water in some varieties, yield depressions in others, but in neither case was there any strong or regular trend. It may be concluded that, under Tel Hadya conditions in 1991/92, early planting was essential for high yields, and the effects of later planting could not be offset by applying additional water to the crop towards the end of the season.

The importance of early sowing was also demonstrated by the safflower trial at Tel Hadya. The trial compared three Turkish safflower varieties and three planting dates. Both variety and planting date had a substantial and significant effect on grain yield (Table 20), but there was no significant interaction between these two factors.

Table 20. Effect of variety and sowing date on grain yield of safflower, Tel Hadya, Syria, 1991/92.

DoS*\Varieties	S.541.2	Dincer	Yenice	Average
24 Nov.	2.104	1.790	0.959	1.62
26 Jan.	1.743	1.359	0.687	1.26
23 Mar.	0.950	0.911	0.538	0.80
Average	1.60	1.35	0.73	
SEm(±) for varieties		0.23		

* Date of sowing.

Safflower variety S 541-2 is spiny, but its average yield of 1.60 t/ha over the three planting dates, and 2.10 t/ha from the November planting, indicates a very good yield potential for early-sown safflower under rainfed conditions. Safflower has the capacity to withstand low temperatures and drought; the severe winter weather in 1991/92 did not affect its growth in any way. Planting earlier than late November, when rain permits, with appropriate plant population and adequate fertilizer, may further improve yields in rainfed environments.

The sunflower trial compared two varieties, a non-oil confectionery-type grown commercially in Syria and an open-pollinated oil-type sunflower, VNIIMK, a Russian variety received from Turkey, at four plant populations and under four rates of supplemental irrigation: rainfed (residual soil moisture) except for 30 mm to facilitate emergence after sowing on 1 April, and 173, 245 and 317 mm.

Open-pollinated sunflower varieties are being evaluated at ICARDA for their potential to increase edible oil production in WANA.

Variety differences in grain yield were negligible, both averaging around 1.0 t/ha, with no significant interaction with population or water regimes. Response to water, however, was highly significant and approximately linear—around 2.5 kg grain/ha/mm—up to the highest rate of application (Fig. 26). Differences due to plant populations were relatively small but imply an optimum of around 30 000 plants/ha, under the conditions of this trial.

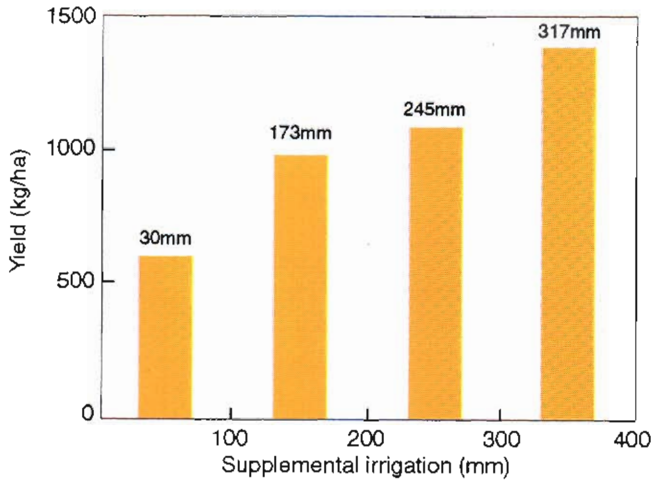


Fig. 26. Sunflower response to supplemental irrigation at Tel Hadya, Syria, 1991/92.

Training

In 1992, ICARDA offered training to 716 individuals; 18% of them were women. Training participants came from 38 countries (Table 21). Of these 48% were trained in courses at ICARDA headquarters in Aleppo, while the remaining were trained in in-country, subregional and regional courses.

ICARDA continued its strategy to gradually decentralize its training activities by offering more non-headquarter courses. In 1991/92 the Center offered 17 headquarters courses and 20 in-country, subregional or regional courses.

The training offered reflected ICARDA's growing emphasis on an agroecological thrust. Besides topics in commodity improvement, courses were offered in plant variety testing, morphological variety description and maintenance, use of computers in breeding experiments, design and analysis of experiments for variety testing, agroclimatic data analysis, farm survey methods, agroecological characterization, water harvesting technology, and winter chickpea technology transfer. Emphasis was also given to courses of an upstream nature such as DNA molecular marker techniques for crop improvement. A course on economic evaluation of environmental factors in development planning was also organized in collaboration with the Arab Planning Institute, Kuwait. A

Table 21. ICARDA training participants, 1991/1992.

A. Latin America		Egypt	75	**D. Asia and the Pacific Region**	
		Ethiopia	48		
Colombia	1	Jordan	38	Afghanistan	1
Mexico	1	Iran	23	Bulgaria	1
		Iraq	14	China	5
		Kuwait	1	India	1
B. Africa (excluding North Africa)		Lebanon	94		
		Libya	18		
Kenya	2	Morocco	19	**E. Industrialized Countries**	
Tanzania	2	Pakistan	6		
Uganda	1	Qatar	1	Canada	1
Zambia	1	S. Oman	6	Germany	5
		Sudan	23	Italy	1
C. West Asia and North Africa		Syria	170	Netherlands	3
		Tunisia	18	Spain	1
Algeria	53	Turkey	43	Sweden	1
Bahrian	2	R. Yemen	32	United Kingdom	1
Cyprus	2	UAE	1		
Total number of participants					716

working draft of a Manual of Training Procedures was published and implemented for the 1991/92 training activities.

Work began on a medium-term plan that will define the direction of ICARDA training activities during the next five years. The plan outlines a training system that has strong components of needs assessment, follow-up communication, and training material development.

In addition to the six audiovisual training modules previously completed, work began on three multimedia training kits that include slide/tape programs, lecture notes and posters. A series of lecture notes was completed.

ICARDA researchers and trainees discuss a greenhouse experiment at Tel Hedya, Syria.

Information Dissemination

To upgrade ICARDA's computerized information services, the library expanded its CD-ROM coverage by acquiring additional databases: biology, agriculture, water resources, world weather, women in development, and science and technology. Two in-house bibliographic databases were developed: PUBLST (ICARDA publications from 1977 to 1990), and STEPPE (reference citations from 1970 on steppe-related agroecological zones of WANA). Training was provided to four national librarians on library management and use of AGRIS/CARIS systems. During 1992, a network of WANA information personnel—AINWANA (Agricultural Information Network in West Asia and North Africa)—was formed at a workshop held at ICARDA. The network's objective is to bring together information specialists from WANA to strengthen the national library and documentation systems of the region.

Seventy-two publications were produced in-house. A Publications Catalog, listing all ICARDA publications from its inception in 1977 to 1990, was published. Sixty-nine papers were processed for submission to scientific journals, and 29 for presentation at conferences and workshops.

A wide variety of training materials including lecture notes and audio-visual kits was produced.

Press releases in Arabic and English were produced monthly and distributed to over 450 news organizations, newspapers, magazines, and newsletters worldwide. The ICARDA media list was updated and expanded to respond to the increasing demand for information. Donors were kept informed of developments at the Center by the "Ties that Bind" series, which focuses on ICARDA's links with specific donor countries and agencies.

Impact Assessment and Enhancement

Gender Issues and the Adoption of Winter-Sown Chickpea in Tunisia

Few new agricultural technologies are neutral in their effects, either on farm size or on gender roles within the farm household. In a rapid appraisal and farmer survey in northern Tunisia these issues were examined in respect of winter-sown chickpea and its likely adoption by farmers.

Previous experiments with winter sowing have demonstrated yield increases of 160 to 243% over traditional spring sowing, but to ensure such productivity an extra weeding operation is required in early spring. Weeding is usually done by hand by women. The question of whether this new technology will benefit women in terms of added income or adversely affect them by increasing their workload without necessarily producing any added benefit, was the main focus of this study.

A set of consistent patterns emerged from the information collected in the rapid appraisal. First, women play a major role in agricultural production in Tunisia, as both family and hired labor, although that role is not well documented in the literature or in national statistics. Secondly, an unequal division exists between men and women with respect to workload and to access and control over income, land, credit and other resources. Thirdly, national and international research and development projects have often ignored the central role of rural women.

Further, the survey data collected show that food legume production is extremely labor intensive compared with other crops, with women contributing a large proportion of the labor. Women plant, apply fertilizer, weed, harvest, thresh, clean and bag all food legumes. They spend longer hours and undertake more tedious work than men in the production of these crops. Weeding and harvesting require the greatest labor input from women. On large farms, women are hired for these tasks, while on small farms most of the weeding and harvesting is done by the female members of the household. The majority of the farmers agree that the major constraints to increasing food legume production are labor costs and whether labor will be available at the time of weeding and harvesting.

An ex-ante economic feasibility analysis showed winter-sown chickpea technology to be an attractive enterprise to most farmers, although actual adoption will probably differ between small and large farms. Large farmers will be the most likely adopters, as they can afford to hire women for weeding and harvesting. Small farmers, except possibly those with "underutilized family labor" or with no cash problems, are unlikely to adopt because of the cost of hiring labor.

However, adoption by large farmers will create additional job opportunities for local women. This increased demand for hired labor might be met by either landless women or women from smaller holdings. It is possible that these women will then bring additional income into the poorer rural households, but at the human expense of more labor that is both tedious and tiresome.

No significant impact from winter-sown chickpea technology is expected on women members of large farm households, as they play a minimal role in chickpea production, but an opposite effect is expected on any small family holdings adopting winter chickpea. Few such farms are likely to adopt, but where they do, the impact on the female members

In WANA, weeding in chickpea is usually done by women from within the family as well as hired as labor. Will the winter chickpea technology provide added income to these women?

will be negative. The additional work required for winter chickpea will become the responsibility of women, who are already overburdened with daily household and fieldwork chores.

Ultimately, whether or not the adoption of winter-sown chickpea is beneficial to women will depend on a whole complex of interrelated factors, such as local and regional conditions, farm size, farming system, and spending decisions. Results from the rapid appraisal indicate that rural women in Tunisia are usually excluded from income-spending decisions, and that the additional income received by the household from their labor is spent by men according to their own priorities. It is possible to argue, however, that even if women are excluded from direct decision making, their negotiating power within the family may be enhanced by their increased income contribution.

Wheat Germplasm Adoption and Technology Transfer

Improved cultivars must reach farmers before they can have any impact on cereal production. ICARDA 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. Many countries requested and obtained small amounts of seed of newly bred cultivars registered in the region.

An adoption study conducted in Syria during 1991 showed that modern high-yielding varieties accounted for 87% of the area planted and were grown by 86% of the farmers surveyed.

Since 1983, the Syrian national program has released six improved bread wheat varieties. These are: Bohouth 2, 4, and 6; and Cham 2, 4, and 6. The General Organization for Seed Multiplication, Syria, multiplied five varieties (Table 22) for distribution to farmers for the 1992/93 season. Approximately 350 000 ha is estimated to be planted with these varieties. The data in Table 22 support the findings of the adoption study carried out by ICARDA.

Table 22. Seed of bread wheat varieties produced by the Government Organization for Seed Multiplication of Syria and distributed to farmers for the 1992/93 season.

Variety		Year of release	Quantity (tons)	% of total bread wheat	% I > L
Cham 4	(I)	1986	16 500	45.6	300
Bohouth 4	(I)	1987	10 000	27.6	182
Mexipak	(L)	1969	5 500	15.2	100
Cham 6	(I)	1991	4 000	11.1	73
Bohouth 6	(I)	1991	175	0.5	3
Total			36 175		

I = improved; L = local.

In Syria, durum is grown on a larger area than bread wheat (the ratio was 70:30 in 1991) in response to pricing policies. A new policy introduced in 1992 is expected to balance (or even reverse) that ratio to approximately 40:60 over the next five years. Bread wheat prices have been increased and a new bread wheat cultivar (Gomam) is under consideration for release as a commercial variety.

Prospects for Improving Wheat-Production Systems in Lebanon

In Lebanon, locally produced cereals and legumes currently contribute only 13% and 48% of the total domestic needs, respectively. The situation with regard to wheat is particularly critical, as the country imports over 80% of its wheat requirements.

The importance of cereals in Lebanon's agriculture has been falling sharply, as is evident from the decrease in area from 91 700 ha in 1964 to 60 030 ha in 1973, and 41 000 ha in 1990 (63% wheat, 27% barley, 5% maize, 5% others). The cereal area lost has gone mainly to vegetable production (24 000 ha, of which 10 000 ha were allotted in 1991/92 to potatoes alone). Fruit trees increased by about 10 000 ha, legumes by 1400 ha, and 17 000 ha were used for other crops and/or went out of production.

Total output of cereal crops, previously around 83 000 tons, decreased to 76 000 tons in 1990. However, it is to be noted that the decline in production has been much less than the reduction in area. Yield improvements have played an important role. Mean wheat yields have increased from 0.9 t/ha in 1964 and 1.1 t/ha in 1973 to about 2.0 t/ha in 1990, while for barley the figures are 1.0, 0.9, and 1.65 t/ha, respectively. Further, despite the reduced area, cereal production is still considered by many farmers as one of the major components of their cropping systems. In particular, wheat remains important in the cropping systems of the Beka'a valley where 80% of Lebanon's wheat is produced. In drier areas where horticulture is not (or little) practised, the contribution of wheat to total farm income may be 40-90%. However, price subsidy policies, intended to protect the producers, have not kept up with the rapid devaluation of the local currency. The support price for 1991, for example, was one-third less than the price of imported wheat.

Rough estimates of current crop production economics show that wheat production is a good farming enterprise but not the best. In 1991, returns from wheat were 400 000 LL /ha (exchange rate was about 1 US$ = 1000 LL), but returns from other crops could be much higher, e.g., 1.5 million LL/ha for citrus and 2 million LL /ha for potatoes. It is market forces such as these that have pushed many farmers to change their cropping systems even when this does not match the potential of the soil or the experience of the individuals. However, recent developments in marketing (export and prices) are expected to reverse the trend and make cereals (particularly wheat) and legumes (particularly lentils and chickpeas) more competitive again.

Other positive factors for increased wheat production include government-supported moves towards a reduction in fallowing, the elimination of unauthorized crops and the plowing of new lands. Not least, there is a relative abundance of water for supplemental irrigation.

Groundwater is the main source for irrigating wheat. Rough estimates indicate that in the Beka'a Valley groundwater is used on about 80% of the supplemental irrigation areas. Water quality is generally good, with no indications of salinization or lowering and depletion of aquifers. Farmers who do not have wells can purchase water from neighbors, and such a purchase, when needed, is economically sound.

Outreach Activities

For conducting collaborative research with NARS, ICARDA operates six regional programs serving the subregions of North Africa, the Nile Valley, West Asia, the Arabian Peninsula, the Highlands, and Latin America (Fig. 27). These regional programs foster strong partnerships with national research teams, ensuring continuity of the cooperative research, as well as help identify new research needs and opportunities. In addition, they provide a mechanism for decentralizing research and training activities and for the exchange of information. Where possible, they also play a catalytic role in attracting donor funding to national programs.

Highland Regional Program

This Program, supported by the Government of Italy, focuses on an agroecological zone in WANA which remains largely unexploited by either regional or national research and development programs. There is a growing need to develop sustainable agricultural systems that are in harmony with the severe environmental conditions experienced in highland areas, to ensure greater equity in development within the region, and to curtail the current trend of exploitative, environmental degradation.

Highland areas in WANA represent approximately 40% of the total agricultural land and are found principally in Turkey, Iran, Pakistan, Afghanistan, and the Atlas mountains region of Morocco and Algeria. Additionally, a huge area of substantively similar environmental and ecological conditions is found in the newly independent republics of the Newly Independent States. ICARDA's initial research thrust in the highlands has been in West Asia but, in the future, may seek to further exploit lateral linkage with the highlands of central Asia. A program has been operating in Pakistan for seven years; there is a maturing program in Turkey, and an incipient program in Iran.

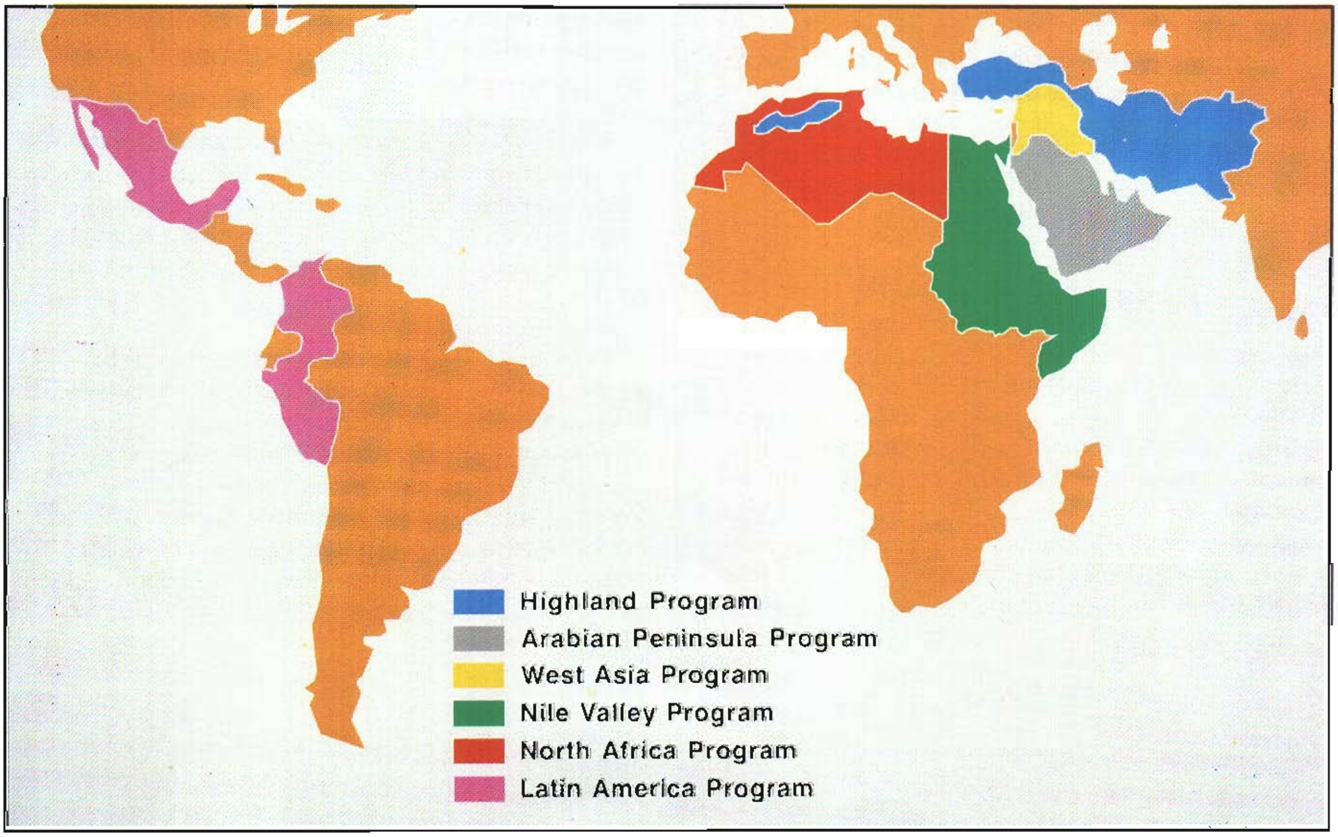


Fig. 27. ICARDA's outreach activities are grouped into six regional programs, based on commonalities of geography, ecology, and constraints to production in each region.

In Pakistan, ICARDA continued its resident supporting role of the Arid Zone Research Institute (AZRI) at Quetta with funding from the USAID project on Management of Agricultural Research and Technology (MART). This supporting role was reduced in 1992 with a reduction in the number of resident scientists from three to one, as the project moves towards completion in August 1994. However, at the same time, AZRI's host institution, the Pakistan Agricultural Research Council (PARC), assisted AZRI by posting additional national scientific staff to cope with the donor funding limitations.

The reduction in the number of resident ICARDA staff posted in Quetta necessitated a further narrowing of the research focus to those technologies that have the greatest potential for impact on the farms of Balochistan. These include the introduction and evaluation of fourwing saltbush and improved selections of wheat, barley, lentil, and vetch.

The potential of fourwing saltbush (*Atriplex canescens*) is becoming clearer from the first grazing trial at AZRI. Flocks of five sheep each grazed 1768 m^2 plot for 16 weeks starting in mid-July, indicating a high carrying capacity for this short period. The sheep, which also received 500 g wheat straw each day in addition to the estimated 180 g dry matter from saltbush, maintained their liveweight during the trial. The saltbush leaves contain only about 10% protein but, even with this modest level of protein content, they are a useful supplement to the basal diet of wheat straw which is very low in protein. Studies will continue to determine the recovery of the plants and their ability to sustain grazing pressure during the spring regrowth period.

A large expansion of the AZRI nursery to 0.3 million seedlings started in late 1992 so that in early 1993 forage reserves can be established on the marginal land of many farms. Marginal but potentially cultivable land owned by farmers is being recommended since farmers have control over such lands and the soil and water conditions are better for establishment and growth of the bushes than on heavily degraded rangelands with shallow soils.

Substantial progress was achieved in multiplying two lines of winter bread wheat with resistance to yellow rust (*Puccinia striiformis*). Both lines demonstrated excellent disease resistance during the last three seasons when the disease pressure was high owing to above-average rainfall in Balochistan. One of the lines, Gerek 79, has been used on a wide scale in Turkey for over 10 years and was introduced into the AZRI testing program in 1989. The second line, ICW1471, originated from ICARDA material. These yellow rust resistant lines have the potential to save about Pakistani Rs 800 million (approx. US$ 31 million) every five years which is the frequency of the disease outbreak. By July 1993 several tons of seed of the two lines is expected to be available for widespread testing by the provincial department of agriculture.

More attention is now being given to contour strip-cropping than to catchment-basin water-harvesting (CBWH) to increase crop yields in the harsh and dry environment of Balochistan. This technology is suitable for resource-poor farmers because it is simple and has lower set-up costs. Its adoption should result in higher net benefits which were only about 22% for wheat using a 1:1 ratio of catchment to cropped area for CBWH. However, the inter-year coefficient of variation of net benefits was reduced by 22%.

In Afghanistan, ICARDA has established a linkage for technology transfer in the southwest of the country with Mercy Corps International. Initial trials of fourwing saltbush have been established as forage reserves and further work on endoparasites is being planned.

In Turkey, two years of research, carried out between Cukurova University and ICARDA in the Taurus Mountain villages in Adana province, indicates that animal production, particularly that of goats, is the most profitable enterprise followed by apiculture. Crop production is considerably less profitable at current yield levels with wheat and chickpea proving to be the most economic crops. However, results from the first year of crop varietal improvement trials have indicated that considerable yield increases may be possible by the introduction of varieties better adapted to mountainous environments. In the case of wheat, for example, farmers have been growing varieties adapted to lowland plain conditions which were not suitable for their specific environments. Evidently, inadequate agricultural extension has been a constraint to farmers in improving their agricultural productivity. Contacts between the University of Cukurova and the research and extension staff of the Ministry of Agriculture have opened new channels of information to the farmers of which they are actively

At Kokez village in the Taurus Mountains: Prof. Dr Onur Erkan, Coordinator of the Cukurova University/ICARDA collaborative research project, being interviewed by the Turkish National Television on the progress achieved by the project.

taking advantage. Farmers, in increasing numbers, continue to visit the University of Cukurova experimental plots in Adana.

In Iran, ICARDA has started implementing some of the components of the joint Iran/ICARDA project. The studies carried out in collaboration with Iranian scientists and through consultancy services indicate a large potential for increasing food, feed, and livestock production in a sustainable manner in the dryland areas of Iran. One of the major objectives is to transfer the existing improved technology to the dryland farmers jointly by Research and Extension Departments through on-farm verification and demonstration trials. Many such trials are planned under the collaborative program when it comes in full operation.

Arabian Peninsula Regional Program

With continuing support from the Arab Fund for Economic and Social Development (AFESD), the Regional Program for the Arabian Peninsula (APRP) continued its research and training activities during the 1991/92 season, despite unstable political conditions in the Peninsula. Although the Program operated from ICARDA's headquarters in Aleppo, an agreement was signed with the United Arab Emirates to host the APRP regional office in Dubai.

APRP aims to strengthen cooperation among the participating countries and with other regional and international organizations operating in the Peninsula. The major objectives of APRP are to enhance agricultural research and provide appropriate training for improving barley, bread wheat, durum wheat, food and feed legumes, pasture, forage and livestock production and the related farming systems in the Arabian Peninsula. The countries participating in APRP are: the United Arab Emirates (UAE), Bahrain, Qatar, Kuwait, Saudi Arabia, the Sultanate of Oman, and the Republic of Yemen.

Major constraints to agricultural research and development 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

The following cereal, food legume, and forage nurseries were provided: UAE (two wheat nurseries for heat and salt tolerance); Qatar (one barley and one chickpea nursery); Saudi Arabia (36 barley and wheat nurseries, 18 food legume and 11 forage legume nurseries); the Sultanate of Oman (10 barley and wheat nurseries, 3 food legume and 1 forage legume nurseries); and the Republic of Yemen (15 barley and wheat nurseries, 12 food legume and 4 forage legume nurseries).

In response to a request from the Director of Plant Research Development, the Public Authority for Agricultural Affairs and Fish Resources, Kuwait, a large number of germplasm samples of selected barley, bread wheat, durum wheat, lentil, chickpea, and faba bean were supplied to Kuwait. This supply will help compensate for Kuwait's germplasm lost during the 1990/91 Gulf crisis and will be evaluated in the different agroecological zones of Kuwait.

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

Wheat and barley regional crossing blocks for the Arabian Peninsula were initiated at ICARDA in 1989/90 in cooperation with the Center's Cereal Improvement Program. The main objective of this activity is to cross ICARDA's high-yielding lines and improved cultivars with the cultivars adapted to the Arabian Peninsula and develop high-yielding cultivars with wide adaptation to the different biotic and abiotic stresses in the Peninsula. Their F_2s will be evaluated during the 1992/93 growing season at ICARDA and in each of the participating countries. Countries participating in this activity are the Republic of Yemen, Saudi Arabia, the Sultanate of Oman, Qatar, and the United Arab Emirates.

Variety description and evaluation for the common and improved wheat and barley cultivars grown in the Arabian Peninsula was initiated in the 1989/90 season in cooperation with ICARDA's Seed and Genetic Resources Units. The study includes eight varieties each from Saudi Arabia and the Republic of Yemen. Results for the 1990/91 and 1991/92 seasons are now available. A variety description booklet will be produced and distributed to the Arabian Peninsula countries by the end of 1993.

Training and Human Resource Development

Forty-three national scientists from the Arabian Peninsula participated in the ICARDA training courses in 1992 (see Table 21). The training courses are listed in Appendix 5. Of these, a special training course on Economic Analysis and Evaluation of Environmental Factors in Planning Development was jointly conducted with the Arab Planning Institute, Kuwait, at

Evaluation of cereal germplasm at the Al-Ain Agricultural Research Station in the UAE.

ICARDA's headquarters in Aleppo. Participants in this course were senior officials from the ministries of planning of the Arab countries including Kuwait, Bahrain, and the Republic of Yemen.

Visits and Consultancies

Despite political unrest in the region and the problems associated with issuance of visas, exchange of visits between ICARDA and the Arabian Peninsula scientists continued in 1992. The Center stayed in constant touch with national coordinators, and research and training plans for 1992/93 were developed.

West Asia Regional Program

The West Asia Regional Program (WARP) covers Syria, Jordan, Iraq, Cyprus, Lebanon, and the lowlands of Turkey. Integrated into WARP activities is a Mashreq Project, funded by UNDP (United Nations Development Programme) and AFESD, for increasing the productivity of barley, pastures, and sheep in critical rainfall zones of Syria, Jordan and Iraq, and for the transfer of technology to farmers.

Mashreq Project Activities

In the Mashreq Project farmers' opinions were monitored and an assessment of the effectiveness of demonstrations was conducted. Extension activities were intensified with more field days, seminars, TV and radio programs.

Results in Syria showed that the project-recommended technology resulted in barley yield increases from 28 to 32% for grain and 26-30% for straw. Fertilizer application resulted in an average increase of 44% in grain yield in Zone 3 (mean annual rainfall 250 mm).

In Jordan, using the full package of barley production technology, an average grain yield increase of 48% was obtained. Improved cultivars gave 18% more grain yield than the local ones, and fertilizer application resulted in 75% increase in grain yield. In Iraq, the recommended technology produced a grain yield increase of 84% over farmers' practices.

Growing barley after forage legumes used for direct grazing resulted in higher barley yield than after fallow or after barley. The increase in grain yield ranged from 13 to 21% over the yield of barley grown after fallow.

Demonstrations of dual-purpose barley with the participation of 17 farmers in central Iraq on a total area of 45 ha produced an average grain yield of 4.1 t/ha after grazing or clipping once or twice.

In sheep production, the following observations were made using farmers' flocks:

- Early weaning resulted in higher net returns (1.2 to 4 JD/ewe/season; 1 U$ = 0.67 JD) to farmers.
- Use of sponge and hormone treatment resulted in birth synchronization and in substantial increases in fertility percentage and twinning rates. The fertility percentage under the treatment groups in Jordan ranged from 70 to 90% compared with a range of 32 to 81% for control flocks. Increase in twinning due to the treatment was 27% in Iraq and 30% in Jordan.

Other activities included the distribution of improved rams to farmers, flushing ewes, feeding sheep on urea-treated straw and on agricultural by-products, and injections of vitamin A to improve ewe fertility.

Germplasm Enhancement

One faba bean genotype (ILB 1814) was identified by the Iraqi national program for large-scale prerelease field testing. Two barley, two wheat, one lentil, and one chickpea genotypes were identified by Jordan as promising and included in prerelease field verification trails. *Vicia sativa* 715 is also under intensive evaluation and seed multiplication has been initiated in preparation for its possible release in Jordan. In Syria three barley lines—Tadmor, Zanbaka, and Arta—and several wheat and food legume lines were selected and included in on-farm evaluation trials.

A germplasm collection mission for barley was conducted in Jordan and another in Lebanon in cooperation with national scientists.

Training and Human Resource Development

Several training courses, seminars, and workshops were conducted during 1992. These are listed in

Training course on hay production techniques, conducted in Cyprus in cooperation with the Cypriot national program.

Appendix 5. A study tour was organized for senior scientists from Jordan, Syria and Iraq, who visited south and southeast of Turkey to share the Turkish experience in technology transfer. Cooperation with Jordan in tillage and residue management project continued for the third year. Cooperation with Jordan and Lebanon in the dryland resource management project also continued.

Coordination Meetings

Four coordination meetings were held during 1992 (see Appendix 5). Mashreq project meetings were also held according to the schedule.

Nile Valley Regional Program

Cool-Season Legumes and Cereals

The Nile Valley Regional Program (NVRP), started in 1988/89, covers research, transfer of technology and training to improve the production of cool-season food legumes (faba bean, chickpea, and lentil) and cereals (wheat in cooperation with CIMMYT in Egypt and Sudan, and barley in Egypt). The Ethiopian component includes field pea as an additional cool-season food legume while barley and, to a lesser extent, wheat are included in certain networks without external funding. The strategy followed in the NVRP involves multidisciplinary, multi-institutional, and problem-oriented networks making full use of the expertise, human resource and the infrastructure available in the participating countries. Funding continued from the Commission of the European Communities for the Egyptian component, the Netherlands Government for the Sudanese component, and the Swedish Agency for Research Cooperation for Developing Countries (SAREC) for the Ethiopian component. Sudan and Ethiopia (SAREC support approved for one year only) started NVRP-Phase II for another three years on 1 Jan 1992, while the NVRP-Phase I for Egypt will terminate on 31 Dec 1993. A proposal for NVRP-Phase II for Egypt is under preparation, while that for Ethiopia is being modified for the remaining two years for consideration by SAREC.

Wheat

In Sudan, the 1991/92 wheat production was very successful because of favorable weather conditions (cool and long season), input availability, and the Government's interest and investment in research and transfer of technology. In spite of an 18% decrease in wheat area, total production was up by 50% to reach an all-time record of 0.865 million tons, making Sudan for the first time self-sufficient in bread wheat. Average yields increased by 87%, 107% and 46% in Gezira, Rahad and the Northern State, respectively. In on-farm demonstrations in major production areas, farmers adopting improved production packages had 9 to 100% increase in yield. The adoption studies in Gezira highlighted the importance of extension, seeding date, preparation and leveling of seedbed, the use of seed drill and seeding methods, irrigation and water management, and a shorter period between seeding and first irrigation.

In backup research, in a multilocation testing, 106 and 70 lines were selected for tolerance to heat and moisture stress, respectively, for further evaluation. In crop physiology studies, it was found that withholding water at tillering stage reduced yield by 14%. Studies on population dynamics of aphids (green bug) and their predators (*Chrysopids* and, for the first time, *Cydonia*) continued; the economic threshold for chemical control of aphids on wheat was determined at 35% level of infestation. Superiority of Gaucho, as a seed-dressing, was confirmed in controlling aphids on wheat with least damage to natural enemies. In screening for resistance to aphids, 15 entries out of 100 breeding lines from ICARDA and 92 from Egypt were found promising. The green bug differentials confirmed the presence of H and B biotypes. In weed control, the critical stage for effective weeding was between 4 and 6 weeks from planting.

In Egypt, on-farm demonstrations of the recommended production packages produced 68, 51, 29 and 9% higher grain yields in Aswan, Sohag, Qena, and New Valley Governorates, respectively. An economic evaluation of improved wheat production packages adopted by farmers in Upper Egypt and Fayoum confirmed previous years' results of a 20 to 44% gain in the gross margin. Regression analysis indicated that Giza 164 was the best heat-tolerant genotype in Upper Egypt, followed by Sohag 3 and Debeira. The variety verification trials in Fayoum confirmed results of previous seasons that Giza 163 and Giza 164 were the best bread wheat cultivars, and Sohag 3 and Beni Suif 1 the best durum cultivars.

Studies on population dynamics of aphids and their natural enemies in wheat in Upper and Middle Egypt showed that highest populations and percentages of parasitism were recorded in March, and that for predators in April. A sharp decline in natural predators (30 to 59%) and percentage of parasitism (17-85%) was recorded after insecticide applications. Screening of cultivated and wild wheats for aphid resistance provided a few promising lines. Screening of 1596 local and exotic wheat lines showed that 1013 lines possessed multiple resistance for the three rusts (leaf, stem, yellow) and powdery mildew or BYDV.

Wheat rust network scientists from the Nile Valley countries discuss results of field research in Egypt.

Barley

In Egypt, farmers were provided with certified seed of Giza 123, to be grown using the recommended package on 42 hectares distributed along the North Coast under rainfed conditions. Except for one location, grain yield increases of 59 to 79% were obtained over the farmers' variety. Economic analysis revealed an average increase of 160, 161 and 102% in profitability, gross margin, and benefit/cost ratio, respectively. In researcher-managed on-farm trials, three improved barley varieties—Giza 123, Giza 124, and Giza 125—exceeded the local cultivar in grain yield by 110, 90 and 116%, respectively.

In backup research, 10 of 80 genotypes screened showed resistance to leaf corn aphid (*Rhopalosiphum maidis*) under controlled conditions. A survey of diseases in major barley production areas (North Coast) revealed that net blotch was the most prevalent disease, followed by leaf stripe, scald and powdery mildew. Of 396 barley genotypes screened for resistance to major diseases, 13 showed multiple resistance to fungal diseases at both seedling and adult growth stages. Studies with N and P fertilizers during the last three seasons (1989/90 to 1991/92) led to the recommendation of using 35 kg N and 35 kg P_2O_5/ha to ensure reliable increases in grain and straw yields and reduce the risk of crop failure due to drought stress.

Faba Bean

Since the 1991/92 cropping season in Egypt was characterized by abnormally low temperatures, an early virus epidemic wiped out almost the entire faba bean crop in Minia and Beni Suif. Nevertheless, in Minia the average results of 110 demonstration plots showed that the recommended production package increased seed yield by 0.15 t/ha (58%) over farmers' practices. Adoption studies indicated that farmers realized the benefit of the improved package components, especially improved cultivar, seed rate, and sowing method (Table 23). In the Delta, the newly released cultivars Giza 461 and Reina Blanca (resistant to chocolate spot) gave the highest seed yields (4.0 and 3.6 t/ha, respectively) compared with 3.3 t/ha obtained by neighboring farmers growing the improved Giza 3. The recommended package for integrated control of *Orobanche*, including a reduced rate of glyphosate, decreased *Orobanche* infestations remarkably, and increased seed yield by 0.69 t/ha (182%) and 0.50 t/ha (45%) in Minia and Fayoum, respectively, compared with farmers' plots.

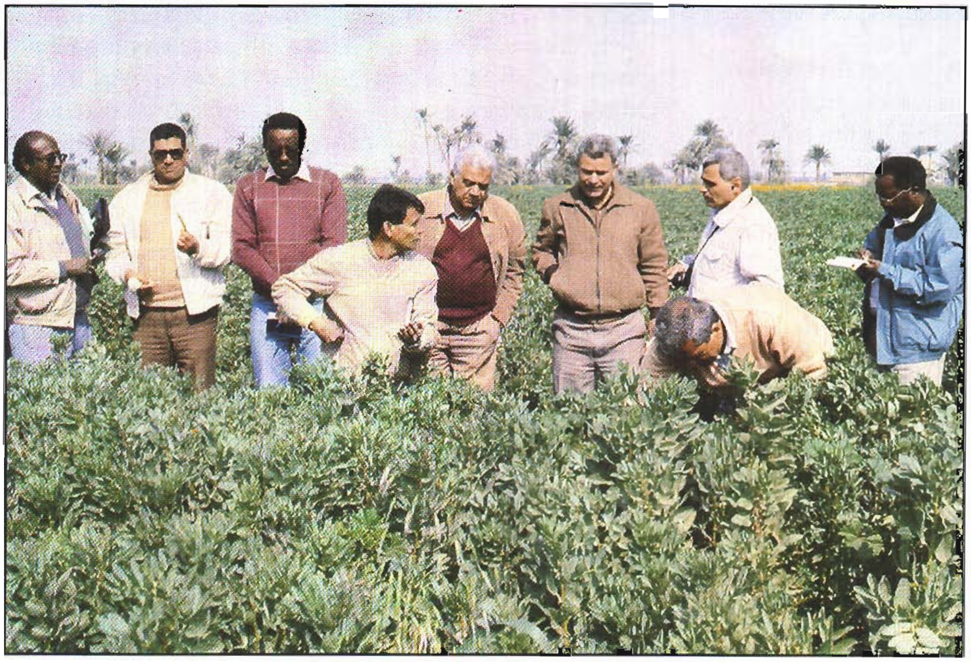
In Ethiopia, on-farm demonstrations of improved faba bean production package (with cultivar CS 20 DK) at 22 sites in 9 locations in the central zone (high-altitude areas) resulted in yield increases of 49 to 317% over farmers' practices.

In Sudan, the 1991/92 season was comparatively cool and long and very favorable to food legume production. Multilocation on-farm demonstration of faba bean production package in Aliab, Wad Hamid, Kaboushia, and Sayal increased seed yield by 44, 38, 33, and 6%, respectively.

Table 23. Adoption rates for different components of faba bean improved production package demonstrated to farmers over three seasons in Minia in Egypt.

Components of package	1988/89 (45/demons.*)		1989/90 (90/demons.*)		1990/91 (90/demons.*)		1991/92 (110/demons.*)		Over four seasons (%)
	No. of farmers	% adoption	No. of farmers	% adoption	No. of farmers	% adoption	No. of farmers	% adoption	
Improved variety	39	87	85	95	90	100	110	100	95
Seeding rate	35	78	78	87	90	100	110	100	91
Sowing methods	32	71	73	81	87	97	102	93	85
Fertilizers N (37.5 kg/ha Starter)	27	60	32	36	47	52	22	20	42
P_2O_5 (71.4 kg/ha)	31	69	41	46	46	51	38	35	50
Weed control	27	60	47	52	10	11	12	11	34
Whole package	6	13	30	33	32	36	39	36	29

* demons. = Demonstrations.



Researchers from the Nile Valley countries and ICARDA discuss faba bean field results in a traveling workshop in Egypt.

Chickpea

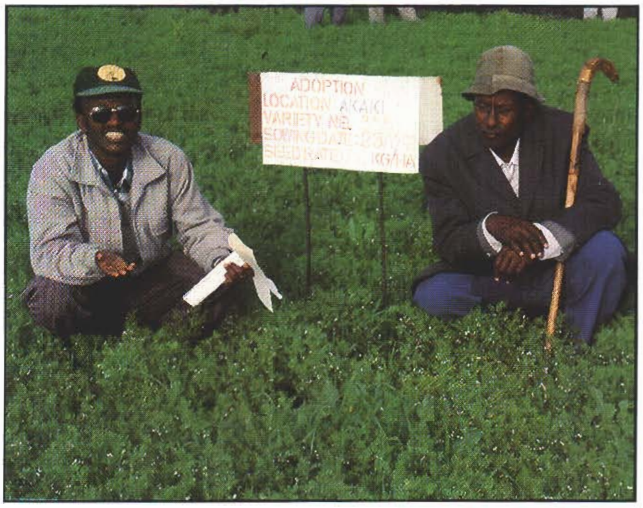
In Ethiopia, a wide range of improved desi and kabuli germplasm was yield-tested in multilocations (Akaki, Debre-Zeit, Sinana, Chefe Donsa, Alem Tana). Lines ICC-12339 (2.27 t/ha), ICC-12428 (2.27t/ha) and ICC-12703 (2.19 t/ha) were found highly resistant to wilt/root rot diseases and high yielding across locations compared with the standard local cultivar Mariye (1.66 t/ha). Screening for wilt/root rot disease revealed one highly resistant line (ICC 84204) at Adet, while in the Debre Zeit wilt/root rot sick plot nine lines showed resistance to both wilt/root rots and chickpea stunt virus. Studies for three seasons on seedbed preparation and P fertilization confirmed the yield advantages (45-67%) of broadbed and furrow (BBF) system because it improves soil drainage and allows earlier planting.

In Sudan, on-farm chickpea demonstrations yielded 1.00 to 2.10 t/ha (mean 1.64 t/ha) compared with 0.75 to 1.08 t/ha (mean 0.98 t/ha) for neighboring farmers, i.e., 68% increase in average yield. In screening for wilt/root rot diseases, six lines (ICCL 82001, FLIP 85-204, FLIP 85-29C, FLIP 85-30C, UC 15 and ICCV-2) were found resistant. Weed infestation reduced chickpea yield by 70%, but Pursuit (0.5 kg a.i./ha) plus one hand-weeding increased yield (2.10 t/ha) by 185% compared with the weedy check (0.74 t/ha).

In Egypt, demonstration plots of improved production packages in Assuit Governorate, the New Lands at Bostan (Beheira Governorate) and Nubaria resulted in 56, 28, and 44% increase over traditional practices. On-farm verification of elite chickpea genotypes indicated that L.70 was the most promising, followed by FLIP 80-14 C, and both outyielded the farmers' cultivar by 30 and 18%, respectively. These lines will be considered for release. On-farm evaluation of *Rhizobium* inoculation with strain 4 plus 36 kg N/ha, as a starter, gave a significant increase (187%) in seed yield over the control treatment.

Lentil

The Sudanese Government is encouraging lentil production to achieve self-sufficiency. The NVRP research efforts in lentil are contributing to both vertical and horizontal increases in production. Lentil was newly introduced in Wad Hamid and reintroduced in Dongola after being neglected by farmers because of unresolved problems in the past. In Wad Hamid, farmers using the recommended package obtained an average yield of 2.65 t/ha over five locations with a net revenue of US$ 1545/ha which is substantially higher than that for cash crops commonly grown in the region.



An Ethiopoan farmer (right) who adopted the improved lentil production package examines his crop with an on-farm researcher in the highlands of Ethiopia.

In Ethiopia, the improved production package increased the lentil yield by 52 to 83% over traditional practices in three major production areas: Shenkora,. Ada, and Gimbichu in central Ethiopia. In backup research, a wide range of lentil germplasm was evaluated at four different altitudes and agroclimatic conditions: Alem Tena (1600 m), Debre Zeit (1900 m), Chefe Donsa (2450 m), and Sinana (2400 m) in which FLIP 89-63L, FLIP 86-51L, 87S-93518, and the local check showed wide adaptation and high yield levels ranging from 2.30 to 2.43 t/ha. As a result of good performance over seasons and multilocations, the rust-resistant lines FLIP 84-78L, FLIP 84-112, and FLIP 89-74L are in prerelease evaluation. In screening lentil germplasm for resistance to rust and ascochyta blight, several lines showed high levels of resistance.

In Egypt, 61 demonstrations of improved lentil production package in the traditional areas were conducted in cooperation with extension agents. The average seed and straw yields were higher by 35 and 17%, respectively, than traditional practices. In backup research, performance of lentil genotypes under rainfed conditions of the North West Coast (NWC) showed that the newly released Precoz yielded more than the check cultivars by 120%.

Regional Activities

Regional cooperation among the three participating countries involved exchange of germplasm, technical information, and improved technology through networks and coordination meetings. The nine regional networks are mostly problem-oriented: rusts, thermo-tolerance, water-use efficiency, aphids/viruses, photoperiod and vernalization in wheat, wilt/rot roots of chickpea and lentil, *Botrytis* spp. control in faba bean, and autogamous faba bean. These networks were formalized at the 1992 Regional Coordination Meeting.

Training and Human Resource Development

During 1991/92, a total of 69 national scientists/ technicians received various types of training (see Table 21 and Appendix 5), and 114 scientists participated in professional visits, workshops, coordination meetings and conferences through the support of NVRP. In addition, five graduate students from Ethiopia and four from Sudan are being supported for M.Sc. degree training.

North Africa Regional Program

The North Africa Regional Program (NARP) covers Algeria, Libya, Morocco, and Tunisia. A Technology Transfer Project, supported by IFAD (International Fund for Agricultural Development), is integrated into NARP activities. The Project aims at increasing barley, food legumes and livestock production in North Africa.

The climatic conditions during the 1991/92 cropping season were quite favorable in eastern North Africa, particularly in northern Tunisia and eastern Libya where rainfall was generally above average and well distributed except in February which was dry. Temperature, rainfall amount and distribution were unfavorable in western Algeria and Morocco. An early drought in Morocco between November and March, although followed by heavy rains towards the end of the season (April and May), caused total crop loss even in some traditionally high-rainfall areas.

Production in Morocco for all cereals fell from the record set in 1990/91 season of 8.5 million tons to 2.2 million tons. Cereal production in Algeria, around 3.5 million tons, was good as in the previous season, in

Excellent inter-country collaboration is one of the major achievements of the North Africa Regional Program. Scientists from participating countries exchange visits, share information and resources, and complement each other's research efforts.

spite of a drought in parts of the country. Lack of rain in some areas in Algeria was compensated for by improved agronomic practices mainly in the eastern regions. In Tunisia, cereal production was significantly above average and reached 2.1 million tons in spite of unfavorable weather conditions in parts of the Center and the South. Yields in northern Tunisia were as high as those of the previous year's record harvest.

In Libya, the high frequency of dry years during the past decade, coupled with scarcity and high feed prices had two important consequences on cereal growing: (i) barley growing increased substantially in traditional wheat growing areas, currently occupying over 80% of the total cereals acreage, while wheat area decreased to less than 20%, and (ii) farmers adopted the strategy of harvesting barley as a forage crop.

Devolution of Faba Bean

The Federal Ministry of Technical Cooperation (BMZ) of the Republic of Germany provided financing for a project on North Africa Faba Bean Research Network, developed by ICARDA with endorsement of the four North African countries, and GTZ was contracted to implement it. ICARDA transferred to INRA, Morocco all the faba bean breeding material, developed over the past years, as well as the field and laboratory equipment. With this, ICARDA fully executed the CGIAR directive to phase out the faba bean improvement program (see also page 46).

Highlights of Collaborative Research

Through collaborative research between ICARDA and North African NARS, high-yielding varieties of wheat, barley, chickpea, lentil and faba bean were released (see Appendix 2) or are at the prerelease multiplication stage in various countries. The chickpea varieties FLIP 84-79C, FLIP 84-92C, FLIP 85-17C, and FLIP 81-293C were identified in Algeria; FLIP 84-92C and FLIP 83-48 in Morocco under the names of Douyet and Rizki, respectively; and FLIP 84-92C in Tunisia under the name of INRAT 88. FLIP 84-92C was selected in all countries of North Africa. The lentil lines FLIP 84-58L and UJ 85 were identified in Tunisia, and Balkan 775, L.B. Redjas, and Setif 618 in Algeria. The faba bean lines FLIP 84-59 and POL 3 were selected in Tunisia and FLIP 82-30 in Algeria. Production packages for many of these varieties were developed for various agroecological zones. Work conducted in collaboration with the Tunisian national program on resistance to the aggressive type of orobanche, the red-flowered *Orobanche foetida* showed that lines 402/29/84, 18054-S, 18105-S, 18009-M, 18025-S, 18035-S, and 8/9-128 were resistant or tolerant to both *O. foetida* and the widely spread *O. crenata* in North Africa.

Germplasm collection missions of legumes were conducted in Libya and Tunisia. An agroecological survey of pasture and forage legumes in Tunisia provided 381 accessions representing 16 genera and 49 species.

A proposal for a regional project on improved integration of sheep, cereal and pasture in rainfed farming systems of North Africa was developed. The project complements the activities of NARS in the Maghreb countries and provides links that cut across national boundaries. Possibilities for special project funding are being explored.

A rapid appraisal study and a survey of 50 farmers in northern Tunisia were conducted to assess the potential adoption and impact of winter-sown chickpea technology on women (for details please refer to page 65). A diagnostic survey of 61 triticale growers in northern Tunisia was undertaken to characterize triticale production and utilization by Tunisian farmers. The results indicate that triticale is highly adapted to the conditions of northern Tunisia with most growers satisfied with its performance. About 15% of total production is used on the farm as grain feed for sheep and cattle while the rest is sold to the State. However, a sharp decline in production in 1992 was due to farmers' uncertainty about the Government's continued support to triticale production.

Technology Transfer

The IFAD Technology Transfer Project, in its third year in 1992, made good progress. In Algeria, 61 test sites were used; 50 of these had 21 collaborating farmers and 11 were used as reference sites in fields managed by the Sidi Bel-Abbes experiment station. Yield differences between the improved and local varieties in the farmer-managed trials reached more than 400 kg/ha for wheat and 200 kg/ha for barley. For winter chickpea, yields of the varieties tested were still below their real potential because of the problems of weeds. In terms of yield levels, ILC 3279 was better than ILC 482.

The results obtained in Morocco, Tunisia, and Libya on farmers' fields also confirmed the superiority of the proposed improved production packages involving improved varieties.

To build on the valuable results obtained in the IFAD Project, ICARDA and the four national programs developed a project on Transfer, Adoption, and Impact of Improved Agricultural Technologies in the Semi-Arid Regions of North Africa. Greater emphasis is placed in this second phase on strengthening institutional linkages especially between agricultural research and extension systems. The Arab Fund for Economic and Social Development (AFESD) has agreed to co-finance this project for a three-year period starting in 1993.

Regional Collaboration

Inter-country collaboration within ICARDA's activities covered various aspects. Moroccan scientists helped in conducting a cereal disease and insect survey in Algeria, and Algerian scientists helped in a survey of legume diseases in Tunisia. Two Tunisian researchers were trained in Morocco on Hessian fly, two Moroccans were trained on barley diseases in Tunisia, and 12 junior researchers from Algeria were trained in Tunisia by Tunisians, Moroccans and Algerians on cereal disease diagnosis and assessment. Furthermore, two senior researchers from Morocco lectured in the ICARDA-organized in-country subregional training course on cereal improvement at Khroub, Algeria, and one senior Tunisian scientist lectured in a subregional course on winter chickpea technology at Sidi Bel-Abbes, Algeria. Cereal and food legume germplasm was exchanged among the four countries through specialized North Africa observation nurseries and yield trials. A North Africa Cereal Traveling Workshop, organized in Algeria, was well attended by scientists from the region.

Training and Human Resource Development

Training of junior researchers from North Africa continued to receive attention. During 1992 a total of 96 trainees from North Africa attended ICARDA - organized training courses at headquarters or in North Africa (see Table 21). In addition, 67 researchers from

North Africa were supported by ICARDA for attending professional meetings/seminars.

Regional and international activities organized by ICARDA in North Africa included four subregional training courses on cereal, legume, seed production, and experimental design and computer analysis (see Appendix 5), in addition to three traveling workshops and various regional meetings. Following the individual country/ICARDA coordination and planning meetings held with Algeria, Libya, Morocco and Tunisia, the Center organized the Second North Africa/ICARDA Regional Coordination Meeting in Rabat, Morocco, 5-9 Oct 1992. Attended by 50 researchers from the collaborating institutions in North Africa in addition to staff members from USAID, MIAC, GTZ, CIHEAM, IFAD and ICARDA, the meeting focused on inter-country and regional activities, reviewed the ongoing collaborative research, and developed work plans for 1992/93.

Latin America Regional Program

An ICARDA/CIMMYT Barley Project in Latin America focuses on developing improved barley germplasm with high yield potential and disease resistance in high-rainfall environments.

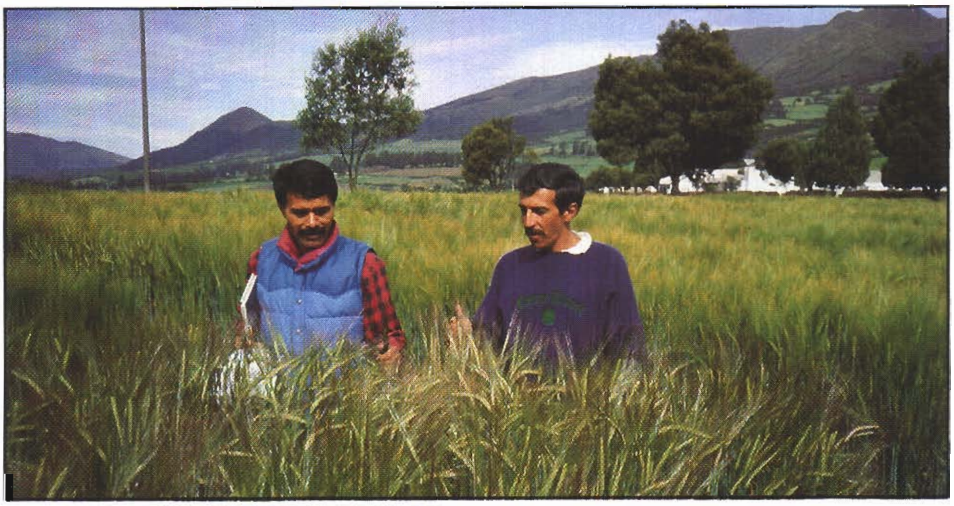
Two barley varieties were released in Ecuador and one in Thailand. The Ecuadorian varieties, Calicuchima and Atahualpa, carry multiple disease resistance to stripe, leaf rust and scald.

Russian wheat aphid (RWA) is known to be present in Latin America, but has not caused as serious damage as has been observed in North America. Barley lines resistant to this aphid were field-tested in Mexico and Chile with good success. Inheritance of resistance to the aphid was studied in two barley lines and a single dominant gene was identified. Collaborative research with CIMMYT resulted in mapping the gene in chromosome 2.

Partial resistance to leaf rust was identified in barley lines in Ecuador. This source of resistance could be of great interest to NARS, since the line is resistant to other diseases found in the Latin America region.

Three hull-less barley varieties have been released in Brazil, Chile, and Ecuador in the last five years. The utilization of hull-less varieties is variable. Ecuador's hull-less variety Atahualpa is used for food, while in Chile and Brazil the varieties are used by the feed industry.

Two new barley varieties in China led to an area increase to 120 000 hectares in 1992. The variety Zhenmai 1 is grown for its superior resistance to head scab and Barley Yellow Mosaic Virus (BYMV) resistance.



Barley varieties Atahualpa and Calicuchina, released in Ecuador, are both high yielding and resistant to stripe, leaf rust and scald.

Resources for Research and Training

Finance

ICARDA's programs are funded by its generous donors (Table 24, see also Appendix 11). In 1992 the Center's grant funding was USD 18.411 million. Combined with other income of USD 2.216 million, the operating revenue was USD 20.627 million (7% below the 1991 revenues of USD 22.214 million). The operating expenses during 1992 totalled USD 20.550 million, resulting in a net surplus of USD 77,000.

The strict budgetary control measures introduced during the past three years clearly paid off; ICARDA was saved from making any unusual budgetary adjustments in terms of reducing staff or activities.

In addition, AFESD pledged its support of USD 666,000 for the project on "Transfer, Adoption and Impact of Improved Agricultural Technology in the Rainfed Semi-Arid Regions of North Africa project, and IFAD affirmed its continuous support of USD 700,000 for the project on "Collaborative Research and Technology Transfer Program to Increase Barley, Food Legumes and Livestock Production in North Africa."

Table 24. Sources of funds for ICARDA's programs and capital requirement (x 1000 USD), 1992 and 1991.

	1992	1991		1992	1991
ANERA	--	10a	IFAR	--	3a
Arab Fund	605	622a	India	25	25
Arab Planning			Italy	1216	1195a
Institute	17	--	Japan	311	300
Australia	296	155a	Mexico	10	10
Austria	150	175	Netherlands	732	969a
Canada	839	844	Norway	458	457
China	50	30	OPEC	50	50a
Denmark	348	410	Spain	125	125
FAO	24	23a	Sweden	663	697
Finland	--	278	UNDP	298	200a
Ford			United Kingdom	905	1189a
Foundation	274	313a	USAID	4267	4576a
France	746	377a	Exchange gain/		
Germany	2134	2330a	(loss), net	(847)	1387
IBRD			Earned income	922	881b
(World Bank)	3700	4000	Other	2141	469c
IDRC	87	114a			
IFAD	81	--	Total	20,627	22,214

a Part or all of these amounts were provided for specified activities ("restricted core" and "special projects").
b Investment income.
c Overhead recovery and sale of crops.

Staff

During 1992, nine senior staff members joined ICARDA: Dr Gustav Gintzburger, Leader, Pasture, Forage and Livestock Program; Dr Zaid Abdul-Hadi, Head, Computer and Biometric Services; Dr John Ryan, Soil Fertility Specialist; Dr Margaret Mmbaga, Legume Pathologist; Dr Williem Janssen, Economist; Dr Peter Smith, Visiting Senior Economist; Dr Franz Weigand, Biotechnologist; Dr Michael Baum, Biotechnologist; and Dr Elizabeth Bailey, Project Officer.

Four senior staff members left the Center during 1992: Dr Habib Ibrahim, Senior Training Scientist; Dr Alexander Allan, Water Harvesting Specialist/Agronomist; Dr Williem Janssen, Economist; and Dr Bakhiet Said, Senior Scientist.

Two senior staff members proceeded on sabbatical leave: Dr Khaled Makkouk, Plant Virologist; and Dr. S. Varma, Head of Communication, Documentation and Information Services.

ICARDA was deeply grieved over the death in a car accident of Dr Graham Walker, Agroclimatologist.

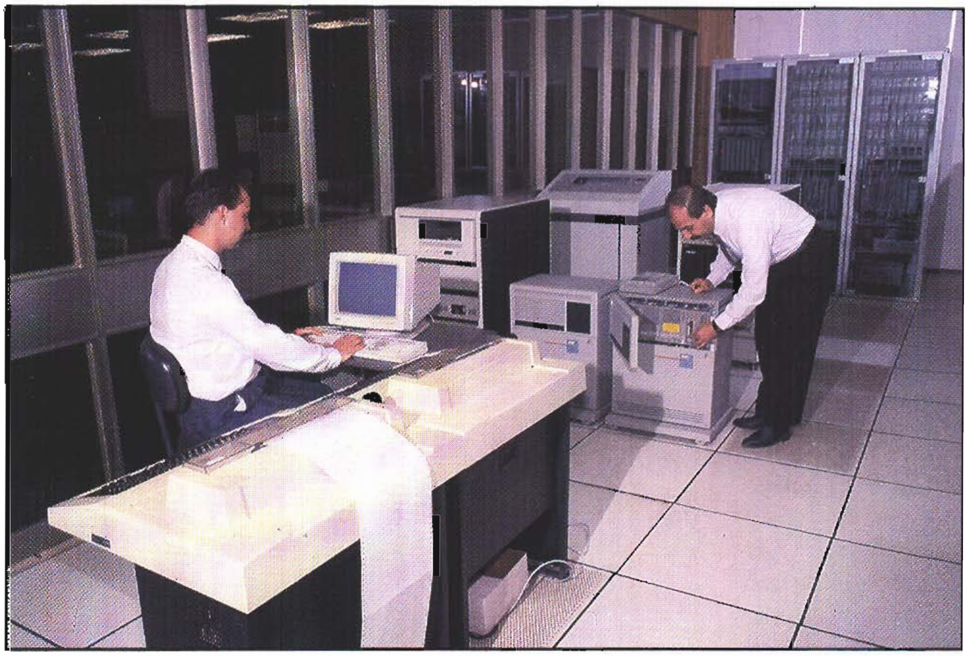
A list of senior staff as of 31 December 1992 is given in Appendix 13.

Computer and Biometric Services

In 1992, the Computer and Biometric Services Unit (CBSU) was reorganized into four groups: General and Technical Support, Scientific Computing, Biometrics, and Management Information Systems. Five new staff members were recruited to enhance the capabilities of the Unit.

General and Technical Support

A landmark achievement during the year was the installation of two new VAX 4000/500 computers and a campus-wide computer network. This opened new avenues for client-server computing, with file, disk, printer and application services becoming available to all network users. Other services such as electronic mail and terminal emulation on PCs also became



ICARDA's computing capacity increased substantially with the installation of two VAX 4000/500 computers in 1992.

available. With the addition of 64 new personal computers, the total number of PCs at ICARDA rose to 210. A relational database management system, Oracle, was also installed.

Scientific Computing

A Research Computing Steering Committee, including researchers and CBSU staff, was formed to address ICARDA's research computing needs. Working groups were established to define requirements for Meteorological, Breeding Trials, International Nurseries System, and Germplasm databases. A project on Central Registry of Research Data was initiated. A consultant expert developed a strategic plan for implementing GIS technology at the Center.

Support was provided to users in data manipulation and analysis and software installation covering the following statistical packages: SAS, GENSTAT, SPSS, CRISP, MSTAT, ALPHA LATTICE. A number of software packages were evaluated for possible use in research computing: CLICOM, STATEXACT, SAFE, S-PLUS, SIGMA-PLOT, NPK, NNANAL, MAPMAKER. The last three were made available to research programs. Also, GENSTAT version 5 Release 2.2 was installed on the new VAX-4000/500 system.

Biometrics

Support in statistical planning, analysis, interpretation and presentation of results and statistical reviews was provided to researchers. This included the following: analysis of data from long-term rotational trials to examine the effect of rotations, nitrogen, grazing, tillage, stubble burning and chemical control methods etc. on wheat and barley yields and soil ammonia data; statistical technique for comparing responses from researcher-managed trials with farmer-managed trials using a transfer function for response surfaces; clustering geographical areas using meteorological variables; techniques in evaluation of effects of time of storage and temperature on germination in medic species; analysis of data from a barley and medic experiment; experimental design using sheep as responding unit was suggested to evaluate preference of sheep to feeding treatments; analysis of data on the effect of body conditions of sheep on pregnancy.

A study on requirements specification for analysis of data from long-term experiments was undertaken. Statistical analysis procedures were worked out to assess rotational effects and fertility treatment effects on rotations with barley crop: a method for assessing wheat genotypes for drought tolerance, selecting most influential traits for yield and yield components and modeling relative growth rate; genotype x environment interaction in barley landraces; analysis of data from in-vitro culture in lentils; analysis of data from germplasm collections from Turkey; logistic models for growth curves in legumes; analysis of crop loss assessment data; data on size and shape of plots for cereals; combining split-plot data on chickpea with heterogeneous errors across environments, estimation of disease progress curves and testing for parallelism.

Biometrical techniques in collaboration with scientists were developed for estimation of area of chickpea pinnules using a model employing an errors-in-variable approach; number and types of crosses in self-pollinated crosses; effect of outliers on interpretation of wheat breeding data on heat tolerance; assessment of screening techniques for heat tolerance in wheat; and estimation of heritability from varietal trial data.

Management Information Systems

Several commercially available packages of financial/administrative software were evaluated and Oracle packages were selected to replace the old in-house systems. These covered General Ledger, Accounts Payable, Purchasing, Inventory Control, Fixed Assets, and Personnel. The packages were installed on the new VAX computers.

Training

Four in-country training courses on the use of computers in agricultural research and biometrics were held (see Appendix 5). Trainees in the headquarters courses offered by the Cereal, Legume, and Pasture, Forage and Livestock Programs also received training in computers. One person each from Turkey, Libya, Syria, and Lebanon received individual training in computers. ICARDA staff training proceeded at a fast pace, with 348 persons trained in 21 courses covering basic use of computers, DOS operating system, wordprocessing, spreadsheeting, database management, and statistical computing.

Farms

ICARDA operates five sites in Syria and two in Lebanon (Table 25). These sites represent a variety of agroclimatic conditions, typical of those prevailing in West Asia and North Africa.

Table 25. 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

The 1991/92 growing season at Tel Hadya started early. The October precipitation of 73 mm was the highest recorded in the past 14 seasons. Water supply was well above average until February, but temperatures were below average from December to March. Precipitation in March and April totalled 16 mm only, compared with the long-term average of 68 mm. As a result, crop yields were lower than expected with a total of 353 mm precipitation for the season.

In the past, cover crops at the Tel Hadya farm consisted mainly of cereals, harvested at full maturity for grain, and legumes (mainly *Vicia sativa*), cut for hay in early April. This has partly changed after the Center accomplished the mechanization of legume production. Now, a part of the legume cover crop area is grown to chickpeas and lentils, with fully mechanized harvest. Costs to ICARDA are covered by the yields of these crops.

The groundwater table in the area continued to drop at an average rate of 2 m per year, in spite of above-average precipitation received in the 1991/92 season. In Breda, ICARDA drilled a 450-m deep well to reach water below the falling level of the first aquifer.

Vetch, used as cover crop at Tel Hadya, being made into hay bales.

A new zero-till planter arrived in 1992. It places fertilizer and seed separately, in order not to impede the germination rate. Experience will be gathered with this machine on the suitability of zero-till practices for practical farming.

The agricultural machinery workshops continued to support the Center's farm operations. Following an Australian innovation, a standard boom sprayer was modified into a synchronized plot-length trimmer and tested in a cereal plot.

0-till planter and fertilizer bander at work at Tel Hadya.

Appendixes

Contents

Appendix 1

Precipitation (mm) in 1991/92

	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	TOTAL
SYRIA													
Tel Hadya													
1991/92 season	0.0	73.0	25.2	74.0	62.3	75.4	15.8	0.4	23.0	3.5	0.0	0.0	352.6
Long-term average (14 seasons)	0.5	28.0	46.8	55.2	61.1	52.0	41.8	26.4	14.8	3.0	0.0	0.1	329.7
% of long-term average	0	261	54	134	102	145	38	2	155	117	n/a	0	107
Breda													
1991/92 season	0.0	18.8	28.6	36.4	51.4	75.8	20.4	0.0	28.8	3.0	0.0	0.0	263.2
Long-term average (34 seasons)	1.2	16.9	30.7	52.8	48.8	39.4	33.9	30.5	16.5	1.5	0.1	0.0	272.3
% of long-term average	0	111	93	69	105	192	60	0	175	200	0	n/a	97
Boueider													
1991/92 season	0.0	24.2	18.4	48.4	47.0	74.6	10.8	0.0	20.0	6.0	0.0	0.0	249.6
Long-term average (19 seasons)	0.1	15.2	22.8	35.7	38.1	36.0	28.6	16.6	9.9	0.9	0.1	0.0	204.0
% of long-term average	0	159	81	136	123	207	38	0	204	667	0	n/a	122
Ghrerife													
1991/92 season	0.0	18.4	21.0	54.3	50.0	70.4	14.4	0.0	27.8	15.6	0.0	0.0	271.8
Long-term average (7 seasons)	0.0	35.7	23.4	40.8	44.9	40.4	34.6	11.4	14.3	2.7	0.0	0.0	248.2
% of long-term average	n/a	52	90	133	111	174	42	0	194	578	n/a	n/a	110
Jindiress													
1991/92 season	3.2	19.8	45.9	139.4	29.0	93.6	28.0	0.8	27.3	37.8	0.0	0.0	424.8
Long-term average (32 seasons)	1.5	31.0	54.8	93.5	82.4	74.5	64.7	42.4	19.6	3.4	0.3	0.8	468.9
% of long-term average	213	64	84	149	35	126	43	2	139	1112	0	0	91
LEBANON													
Terbol													
1991/92 season	0.0	26.8	85.0	260.6	127.4	233.1	172.9	11.4	43.7	23.8	0.0	0.0	984.7
Long-term average (11 seasons)	0.0	34.2	64.5	44.5	94.5	109.7	102.6	24.9	16.2	2.7	0.3	0.0	533.9
% of long-term average	n/a	111	132	276	135	212	169	46	270	881	0	n/a	184

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 25 on page 83.

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
Bolivia	1991	Kantuta
Brazil	1989	Acumai
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
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
Peru	1987	Una 87, Nana 87
	1989	Bellavista
Portugal	1982	Sereia
	1983	CE 8302
	1991	Ancora
Qatar	1982	Gulf
	1983	Harma

Country	Year of release	Variety
Barley (contd.)		
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
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
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
Libya	1985	Marjawi, Ghuodwa, Zorda,
		Baraka, Qara, Fazan
	1992	Khiar 92
Morocco	1984	Marzak
	1989	Sebou, Om Rabi
	1991	Tensif
	1992	Brachoua, Om Rabi 5
Pakistan	1985	Wadhanak

Country	Year of release	Variety
Durum Wheat (contd.)		
Portugal	1983	Celta, Timpanas
	1984	Castico
	1985	Heluio
Saudi Arabia	1987	Cham 1
Spain	1983	Mexa
	1985	Nuna
Syria	1984	Cham 1
	1987	Cham 3, Bohouth 5
	1992	Om Rabi 3, Om Rabi 3, Lahn
Tunisia	1987	Razzak
Turkey	1984	Susf bird
	1985	Balcili
	1988	EGE 88
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
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
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

Country	Year of release	Variety
Bread Wheat (contd.)		
Qatar	1988	Doha 88
Sudan	1985	Debeira
	1987	Wadi El Neel
	1991	Neelain
Syria	1984	Cham 2
	1986	Cham 4
	1987	Bohouth 4
	1991	Cham 6, Bohouth 6,
	1992	Gomam
Tanzania	1983	T-VIRI-Veery 'S' T-DUMA-D6811-Inrat 69/BD Tunisian release
Tunisia	1987	Byrsa, Salambo
	1992	Vaga 92
Turkey	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
	1991	FLIP 84-79C FLIP 84-92C
China	1988	ILC 202, ILC 411
Cyprus	1984	Yialousa (ILC 3279)
	1987	Kyrenia (ILC 464)
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)
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)

Country	Year of release	Variety
Kabuli Chickpea (contd.)		
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)
Syria	1982/86	Ghab 1 (ILC 482)
	1986	Ghab 2 (ILC 3279)
	1991	Ghab 3 (FLIP82-150C)
Tunisia	1986	Chetoui (ILC 3279)
		Kassab (FLIP 83-46C)
		Amdoun 1 (Be-sel-81-48)
	1991	FLIP 84-79C, FLIP 84-92C
Turkey	1986	ILC 195, Guney Sarisi 482 (ILC 482)
	1990	Damla 89 (FLIP 85-7C)
		Tasova 89 (FLIP 85-135C)
	1991	Akcin (87AK 11115)
	1992	Aydin 92 (FLIP 82-259C)
		Menemin 92 (FLIP 85-14C)
		Izmir 92 (FLIP 85-60C)
Lentil		
Algeria	1987	Syrie 229
	1988	Balkan 755, ILL 4400
Argentina	1991	Arbolito (ILL 4650x-4349)
Australia	1989	ILL 5750
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

Country	Year of release	Variety
Lentil (contd.)		
Iraq	1992	ILL 8 (78S26002)
Jordan	1990	Jordan 3 (78S 26002)
Lebanon	1988	Talya 2 (78S 26013)
Morocco	1990	Precoz (ILL 4605)
Nepal	1989	Sikhar (ILL 4402)
N. Zealand	1992	FLIP 87-53L (ILL 6243)
Pakistan	1990	Manserha 89 (ILL 4605)
Syria	1987	Idleb 1 (78S 26002)
Tunisia	1986	Neir (ILL 4400)
		Nefza (ILL 4606)
Turkey	1987	Firat '87 (75kf 36062)
	1990	Erzurum '89 (ILL 942)
		Malazgirt '89 (ILL 1384)
	1991	Sazak '91 (ILL 854)
USA	1991	Crimson (ILL 784)
Faba Bean		
Egypt	1991	Reina Blanca, Giza 461
Iran	1986	Barkat (ILB 1269)
Portugal	1989	Favel (80S 43977)
Sudan	1990	Sellaim-ML
	1991	Shambat 75
		Shambat 104
Syria	1991	Hama 1 (Selection from Aquadulce)
Peas		
Sudan	1989	Karima-1
Forage Legumes		
Morocco	1990	*Vicia sativa* (ILF-V-1812)

Appendix 3

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January

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Miller, R.H., K.S. Pike, L. K. Tanigoshi and L.L. Buschman. The Russian wheat aphid, *Diuraphis noxia* Mordvilko (Homoptera: Aphididae) and its natural enemies in Morocco, Jordan, Syria, and Turkey.

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Obregon MX Management and Use of International Trial data for Improving Breeding Efficiency

Yau, S.K. Statistical analysis of international yield trial data in the Cereal Program of ICARDA.

February

Aleppo SY Natural Resources and Environmental Management in the Dry Areas

Nordblom, T.L. Land tenure, social systems and institutions for dryland farming.

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Linke, K.-H., J. Sauerborn, and M.C. Saxena. Options for biological control of parasitic weed *Orobanche*.

Karachi PK Second International Symposium on New Genetical Approaches to Crop Improvement

Haq, M.A. and K.B. Singh. Creation of new genetic variability in chickpea.

New Delhi IN Small Ruminant Production: Systems for Sustainability

Rodriguez, A. Social and economic considerations of sheep and goat production marketing in Balochistan, Pakistan.

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Scarborough GB BSAP Winter Meeting

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.

Wageningen NL Symposium on Durability of Disease Resistance

Singh, K.B. Experiences, difficulties, and prospects of disease-resistance breeding in chickpea.

March

Cairo EG Crop Genetic Resources Egypt

Valkoun, J. Genetic resources activities at ICARDA and collaboration with Egypt.

Nairobi KE First Meeting of ICRISAT/African Development Bank (AFDB) Pigeonpea Improvement Project in East Africa

Solh, M.B.. The Nile Valley Regional Program: a successful model for technology transfer.

Sutton Bonington GB 52nd International Easter School, University of Nottingham, School of Agriculture

Hamblin, J. Can resource capture principles assist plant breeders or are they too theoretical?

April

Cairo EG 2nd International Food Legume Research Conference

Andolfi, A., F. Calcagno, P. Crino, G. Gallo, A. Infantino, L. Monti, C. Mosconi, B. Ocampo, A. Porta- Puglia, F. Saccardo, M.C. Saxena, K.B. Singh and G. Venora. Development of chickpea germplasm with combined resistance to ascochyta blight and *Fusarium* wilt using wild species.

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Beniwal, S.P.S. and A. Trapero-Casas. Integrated control of diseases of cool season food legumes.

Bezdicek, D.F., M. Quinn, L. Forse, D. Heron, D. Beck, and S. Weigand. Cloning *Bacillus thuringiensis* toxin genes for control of nodule feeding insects.

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Bouznad, Z., S. Boukerma, S.P.S. Beniwal, M. Labdi, M.E. Maatowgi, N. Nouri and M.B. Solh. Ascochyta blight of chickpea in Algeria: pathogen variability and screening for varietal resistance.

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Clement, S.L., N.E. Sharaf El Din, S. Weigand and S.S. Lateef. Screening techniques and sources of resistance to insect pests in cool season food legumes.

Di Vito, M., N. Greco and M.C. Saxena. Pathogenicity of *Pratylenchus thornei* on chickpea in Syria.

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Gregory, P.J., N.P. Saxena, J. Arihara and O. Ito. Root form and function in relation to crop productivity in cool season food legumes.

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Johansen, C., L. Krishnamurthy, N.P. Saxena and S.C. Sethi. Genetic improvement of chickpea in receding soil moisture environments.

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Keatinge, J.D.H., I. Kusmenoglu and D. Sakar. Addressing production constraints for cool season food legumes in WANA through on-farm research: problems and ways forward.

Kharrat, M., M.H. Halila, K.-H. Linke and T. Haddar. First report of *Orobanche foetida* Poiret on faba bean (*Viciafaba* L.) in Tunisia.

Khoury, W. Anatomy of ascochyta blight field epidemics on chickpea genotypes.

Malhotra, R.S. and M.C. Saxena. Genotype x environment interaction and stability in seed yield in field peas.

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Pieterse, A.H., L. Gracia-Torres, O.A. Al-Menoufi, K.-H. Linke and S.J. Terborg. Integrated control of the parasitic angiosperm *Orobanche* (broomrape).

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Sprent, J.I., J. Brockwell, D. Beck and H. Moawad. Biological nitrogen fixation: basic advances and persistent agronomic constraints.

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Weigand, S., S.S. Lateef, N.E. Sharaf El Din, S.F. Mahmoud, K. Ahmad and K. Ali. Integrated control of insect pests of cool season food legumes.

Wery, J., S.N. Silim, E.J. Knight, R.S. Malhotra and R. Cousin. Screening techniques and sources of tolerance to extremes of moisture and air temperature in cool season food legumes.

May

Aleppo SY Training Workshop on Economic Analysis and Evaluation of Environmental Factors in Planning Development

El-Sebae Ahmed, S. Some key issues related to development and management of agricultural natural resources in West Asia and North Africa.

Zaragoza ES Seminar on the Use of Induced Mutations and Related Biotechnology for the Crop Improvement in the Middle East and Mediterranean Regions

Haq, M.A., K.B. Singh. Creation of new genetic variability by mutagenesis in chickpea (*Cicer arietinum* L.).

June

Angers FR 1st European Conference on Grain Legumes

Hadjichristodoulou, A., R.S. Malhotra and K.B. Singh. Selection criteria in chickpea (*Cicer arietinum*) varieties for Mediterranean environments.

Infantino, A., A. Porta-Puglia and K.B. Singh. Screening wild *Cicer* species for resistance to *Fusarium* wilt.

Jimenez-Diaz, R.M., W.J. Kaiser, K.B. Singh and J.L. Trapero-Casas. Resistance to *Fusarium* wilt in *Cicer* spp.

Ocampo, B., G. Venora, K.B. Singh and F. Saccardo. Use of karyotype analysis in breeding of chickpea (*Cicer arietinum*).

Ankara TR Symposium of Agriculture in the Turkish Republic

Keatinge, D. The role of ICARDA and CIMMYT in supporting agricultural research and training in West and Central Asia.

Florida USA International Symposium on Physiology and Determination of Crop Yields

Saxena, N.P., M.C. Saxena and K.B. Singh. Functional ideotypes to increase and stabilize yield of rainfed spring and winter chickpea in West Asia. Poster.

Rome IT La Ricerca Agricola Internationale Per Una Aridocoltura Sostenibilel Nel Bacino Del Mediterraneo

Saxena, M.C, Lentils, faba bean, and chickpea: Role of grain legumes in human nutrition and sustainable productivity.

July

Ames US First International Crop Science Congress

Hamblin, J. The ideotype concept: useful or outdated?

Malhotra, R.S., M.C. Saxena and A.M. Ali. Evaluation of forage legumes for cold tolerance under Mediterranean environments.

Robertson, L.D., S.B. Hanounik, Z. Fatemi, S.P.S. Beniwal, and M.C. Saxena. Integrated control of *Orobanche* in faba bean.

Tahir, M. Winter and facultative barley germplasm improvement for continental Mediterranean environments.

Angers FR XIIIeme Eucarpia Congress

Valkoun, J. and A.B. Damania. Gliadin diversity in populations of *Triticum urartu* and *T. dicoccoides* in Syria.

Beijing CN 19th International Congress of Entomology

Miller, R., K.S. Pike and L. Tanigoshi. The impact and expected damage by the Russian wheat aphid in West Asia and North Africa.

Copenhagen DK CTA Seminar on Seed Pathology

Diekman, M. Seed health measures at international agricultural research centers.

Lattakia SY Status of Current Evaluation of Arab Organizations for Agricultural Statistics

Mazid, A. Data requirement for adoption and impact studies; case study: impact of agricultural technology on wheat in Syria.

Urbana-Champaign US Participatory On-farm Research and Education in Agricultural Sustainability

Rhodes, R.E. and R.H. Booth. The farmer-back-to-farmer: 10 years later. The history and future of a practical idea.

August

Nairobi KE Oilcrops Research Workshop

Akhtar, B.E.S. Status and potential of oilseed crops in WANA.

Orlando US International Symposium on Soil Testing and Plant Analysis

Matar, A.E. Soil testing as a guide to fertilization in West Asia and North Africa (WANA) region.

Saltillo Coahuila MX XIX Congreso Nacional de Fitopatologia

Sandoval, I.J., K.S. Osada, H.E. Vivar, R.I. Benitez, O.D. Teliz and E.R. Garcia. Seleccian de lineas precoces y resistentes a roya amarilla y escaldadura.

Sandoval, I.J., K.S. Osada, H.E. Vivar, R.I. Benitez, O.D. Teliz and E.R. Garcia. Correlacion entre resistencia de plantula y resistencia de planta adulta a roya amarilla y escaldadura de la cebada.

September

Alexandria EG International Conference on Manipulation of Rumen Micro-Organisms to Improve Efficiency of Fermentation and ruminant production

Goodchild, A., S. Ceccarelli, S. Grando, J. Hamblin, T. Treacher, E. Thomson and S. Rihawi. Breeding for cereal straw quality.

Bari IT International Conference on Supplementary Irrigation and Drought Water Management

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

Oweis, T., H. Zeidan and A. Taimeh. Modelling approach for optimizing supplemental irrigation management.

Salkini, A. and D. Ansell. Agroeconomic impact of supplemental irrigation on rainfed wheat production under the Mediterranean environment of Syria.

Perth AU Breeding and Selection of *Vicia* and *Lathyrus* for Grain Production

Saxena, M.C., A.M. Abd El Moneim and M. Ratinam. Role of vetches (*Vicia* spp.) and chicklings (*Lathyrus* spp.) in the farming systems in West Asia and North Africa and improvement of these crops at ICARDA.

Rabat MA 5th African Conference for Biological Nitrogen Fixation

Lahrach, N., L.A. Materon and M. Ismaili. Effect of rotation on biological nitrogen fixation and on following wheat crop.

Materon, L., M. Zaklouta and B. Abudan. Symbiotic relationships and nitrogen fixation in annual *Medicago* species.

Tunis TN FAO Commission on Land and Water

Matar, A. Phosphorus in relation to fertigation.

Weihenstephan DE 8th European and Mediterranean Cereal Rusts and Mildews Conference

Bassiouni, A.A., O.F. Mamluk, A.A.A. Abdel-Shafi, Y.H. El- Daouudi and S. Abu El-Naga. Resistance genes for stem rust of wheat in the Nile Valley and Yemen.

October

Aleppo SY 11th Annual Coordination Meeting between Syrian National Program and ICARDA

Fadda, N. Agricultural research challenges in the dry areas.

Aleppo SY International Workshop on Evaluation and Utilization of Biodiversity in Wild Relatives and Primitive Forms for Wheat Improvement

Damania, A.B. and M. Tahir. Heat and cold tolerance in wild relatives and primitive forms of wheat.

Hakim, S., A.B. Damania, M.Y. Moualla and H. Altunji. Variation for storage proteins in *Triticum dicoccum* Schuelb.

Van Slageren, M. Taxonomy and distribution of wheat wild relatives.*

Valkoun, J. and O.F. Mamluk. Disease resistance and agronomic performance of durum and bread wheat lines derived from crosses with *Triticum monococcum*.

November

Aleppo SY Adaptation of Chickpea in the West Asia and North Africa (WANA) Region

Malhotra, R.S., K.B. Singh, H.A. van Rheenen and M. Pala. Productivity of chickpea.

Damascus SY 32nd Science Week

Abd El Moneim, A.M. and M. Bellar. Screening forage pea (*Pisum sativum* L.) for resistance to cyst namatode (*Heterodera ciceri*) and estimating yield loss.

Nairobi, KE Halophytes as a Resource for Livestock Husbandry

Osman, A.E. and M. Abo Shalla. Use of edible shrubs in pasture improvement under Mediterranean environment in northern Syria.

December

Addis Ababa ET IGADD Regional Workshop on Collaboration in Agricultural Research and Training

Solh, M.B. The Nile Valley Regional Program: a successful research collaboration model involving NARS, IARCs and donors.

Amman JO Mashreq Project Workshop

Goodchild, A., T. Treacher, S. Rihawi and A. Termanini. Review of recent work at ICARDA on the quality of feed and supplementation strategies.

Mazid, A., R. Tutwiler, Y. Sweidan and A. Kneifis. Effectiveness of Mashreq Project demonstration in Syria.

Treacher, T.T., A. Goodchild, F. Bahhady and S. Filo. Nutritional strategies for improving the performance of Awassi flocks.

Treacher, T.T., A. Goodchild, F. Bahhady and H. Hreitani. Comparison of the performance of selected Turkish and unselected north Syrian Awassi ewes.

Media Coverage

Scientist's plant find could help farmers, Countryman, Australia, 16 January 1992.

ICARDA hosts study workshop on agricultural quarantine, Al-Ruwad, Syria, 15 February 1992.

ICARDA hosts a training course on agricultural quarantine, Al-Wathaeq, Syria, February 1992.

The genetic resources unit at ICARDA: goal and purpose, Al-Wathaeq, Syria, February 1992.

Third meeting of the Mashreq Project steering committee to be held tomorrow, Al-Dastour, Jordan, 17 February 1992.

Committee to review agricultural production, Jordan Times, Jordan, 18 February 1992.

Mashreq committee meeting begins, Jordan Times, Jordan,19 February 1992.

Discussions on cooperation between the Ministry of Agriculture and ICARDA, Al-Khaleej, United Arab Emirates, 26 February 1992.

ICARDA hosts regional conference on natural resource management and the environment, Al-Ruwad, Syria, 15 April 1992.

Ley farming could relieve grazing pressure on marginal lands, Arab World Agribusiness, Bahrain, May 1992.

Water resources: a precious gift not to be always exploited limitlessly, La Voce Repubblicana, Italy, 23 May 1992.

ICARDA: Research on sustainability in West Asia and North Africa, entwicklung + landlicher raum, Germany, May 1992.

The computer age in agriculture, Milliyet, Turkey, 6 May 1992.

ICARDA digs into training, Middle East Times, Greece, May 1992.

People-oriented technology transfer, Arab World Agribusiness, Bahrain, May 1992.

Dryland agriculture: what to do?, Terra e Sole, Italy, June 1992.

Special workshop on production of improved seed, Al-Rai, Jordan, 22 June 1992.

Dryland agriculture in the Mediterranean Basin, Agra Press, Italy, 8 June 1992.

To cultivate without water: one can, La Voce Repubblicana, Italy, 16-17 June 1992.

ICARDA, GTZ to hold workshop, Jordan Times, Jordan, 22 June 1992.

Scientists agree regional seed sharing secures food, Jordan Times, Jordan, 23 June 1992.

Workshop to establish a seed production network for West Asia and North Africa, Al-Rai, Jordan, 23 June 1992.

Special workshop on seed production in West Asia and North Africa begins today, Al-Dastour, Jordan, 23 June 1992.

From Syria, chickpeas with promise, The Land, Australia, 25 June 1992.

Wheat, barley survivors vital in harsh terrains, The Land, Australia, 25 June 1992.

Water harvesting a hard row to hoe, The Land, Australia, 25 June 1992.

Dryland agriculture in the Mediterranean basin, L'Informatore Agrario, Italy, June 1992.

Harvesting water in bid to lift yields, Elders Weekly, Australia, 9 July 1992.

New hardy wheat in bid to beat tough climates, Elders Weekly, Australia, 30 July 1992.

Regional training course on water harvesting in dry areas, Al-Dastour, Jordan, 15 August 1992.

11-day water harvest meeting to open in Amman, Jordan Times, Jordan, 16 August 1992.

University of Jordan hosts seminar on water harvesting, Jordan Times, Jordan, 17 August 1992.

Opening of course on water harvesting in dry areas, Al-Dastour, Jordan, 17 August 1992.

Regional course on water harvesting at Jordan University, Al-Rai, Jordan, 17 August 1992.

Scientific research for sustainable dryland agriculture in the Mediterranean Basin, Energia e Innovazione, Italy, September 1992.

Dying of hunger for lack of water, Protecta, Italy, July 1992.

One can produce even without water, Sardegna Agricoltura, Italy, September 1992.

Second annual coordination meeting between ICARDA and Lebanese agricultural establishments, An-Nahar, Lebanon, 16 September 1992.

Lebanese University and the American University of Beirut participate in meeting with the national program and ICARDA, As-Safir, Lebanon, 16 September 1992.

Sudan is determined to modernize agriculture, Al-Engaz Al-Watani, Sudan, 12 October 1992.

Emirates offers to host program headquarters, Al-Bayan, United Arab Emirates, 5 November 1992.

Supporting the farmers while increasing production, Bolge, Turkey, 6 November 1992.

Scientific agriculture in mountain villages, Ekspres, Turkey, 6 November 1992.

ICARDA hosts TAC meeting, Arab World Agribusiness, Bahrain, November 1992.

Ways to conserve environment in low rainfall areas, Arab World Agribusiness, Bahrain, November 1992.

Regional workshop on increasing forage productivity to be held in Amman, Al-Dastour, Jordan, 6 December 1992.

Regional workshop on increasing barley production, Al-Rai, Jordan, 6 December 1992.

Agriculture in dry areas to be discussed in Amman, Jordan Times, Jordan, 10-11 December 1992.

Discussion of research in land use, maintaining the farming system and technology transfer, Al-Rai, Jordan, 14 December 1992.

Agriculture minister calls for Arab strategy, Jordan Times, Jordan, 14 December 1992.

Participants in workshop to increase livestock, barley and forage productivity continue deliberations, Al-Dastour, Jordan, 15 December 1992.

Working papers on increasing productivity and profitability for farmers, Al-Rai, Jordan, 15 December 1992.

Recommendations of participants in the regional workshop on increasing barley and forage production, Al-Dastour, Jordan, 17 December 1992.

Special workshop on increasing the productivity of barley and forage reviews importance of improved barley cultivation, Al-Rai, Jordan, 16 December 1992.

Agriculture meeting concludes, Jordan Times, Jordan, 17-18 December 1992.

Speech by Dr Dyno Keatinge, regional research coordinator, West Asian and North African highlands, and the international workshop on small ruminant, Balochistan Times, Pakistan, 9 December 1992.

Sudan's Minister of Agriculture: "With the wrong policies you reap nothing," The Star, Jordan, 10-16 December 1992.

UAE signs agreement for agricultural research with ICARDA, Al-Ittihad, United Arab Emirates, 20 December 1992.

UAE-ICARDA cooperation agreement, Khaleej Times, United Arab Emirates, 20 December 1992.

Cooperation agreement with ICARDA signed, Al-Bayan, United Arab Emirates, 20 December 1992.

Centre for agricultural research to open office, Gulf News, United Arab Emirates, 20 December 1992.

Cooperation agreement between Ministry of Agriculture and ICARDA signed, Al-Khalij, United Arab Emirates, 20 December 1992.

Sustainable agriculture strives to protect environment while increasing food production, Jordan Times, Jordan, 20 December 1992.

Sudanese Minister of Agriculture: "With the wrong policies you reap nothing," Arab World Agribusiness, Bahrain, December 1992.

Appendix 4

Graduate Theses Produced with ICARDA's Assistance

Master's

JO* University of Jordan, Amman

Quraisha Namatullah Abdali (JO). Variation in some agronomic characteristics in three populations of chickpeas (*Cicer arietinum* L.). 122 p.

MA Universite de Moulay Ismail

Nadia Lahrach (MA). Effet du phosphore et de la rotation culturale sur la fixation biologique de l' azote chez les medicago annuels. [Effect of phosphorus and cropping systems on biological nitrogen fixation in the annual medicago]. 134 p. (In French).

SD University of Gezira, Wad Medani

Imad Abd El-Rahim Mahmoud (SD). Anther culture, *in vitro* plant regeneration and detection of somaclonal variation using DNA - fingerprinting in lentil (*Lens culinaris* Medik.). 69 p.

Omer Hasab-el-Rasoul Ibrahim (SD). Addressing principles of water management for maximum wheat yield and efficient use of water and nitrogen. 144 p.

SY Damascus University

Huda Zahi Kawas (SY). [Viral diseases of chickpea in Syria: identification, characterization, transmission, and evaluation of chickpea germplasm and wild *Cicer* species resistance to infection]. 131 p. (In Arabic, English summary).

Mohammed Khazma (SY). [Introduction of ley farming system into crop rotation by small farmers in Southern Idleb region]. 133 p. (In Arabic, English summary).

Suha Fayez Ismail (SY). [Distribution of two races of smuts [*Tilletia foetida* (Wallr) Liro and *T. caries* (DC.) Tul.] on wheat and their relative virulence on certain varieties on bread and durum wheats, and identification of physiological races of smuts in Syria]. 67 p. (In Arabic, English summary).

SY Tishreen University, Lattakia

Elias S. Fayad (SY). Studies on the potential of subterranean vetch (*Vicia sativa* spp. *amphicarpa* Dorth.) as a pasture plant for arid areas. 145 p.

Sawsan Abd-El-Rahman Hakim (SY). [Genetic variability in accessions of *Triticum dicoccum*]. 113 p. (In Arabic, English summary).

TR University of Cukurova, Adana

Abdoul Aziz Niane (TR). Phosphine resistance in field strains of *Rhizopertha dominica* (Fabricius) (Coleoptera; Bostrichidae) infesting wheat and barley in different storage facilities of northern Syria (Aleppo). 70 p.

Doctoral

DE University of Hohenheim

Michael Mayer (DE). Breeding experiments with doubled haploid lines and F2-bulks towards the improvement of barley in the dry areas of north Syria. 94 p.

Edwin Weber (DE). Role of vesicular-arbuscular mycorrhizae in the mineral nutrition of chickpea (*Cicer arietinum* L.) grown in northern Syria. 135 p.

ES Universidad de Cordoba

Elias Afif Wadih (SY). Effecto de las propiedades del suelo en la disponibilidad y nieveles criticos de fosforo en suelos calcareos de area Mediterranea. [Effect of soil properties on the availability of critical levels of phosphate in calcareous soils of the Mediterranean area]. 153 p. (In Spanish).

* See Appendix 15 for country codes

GB University of Reading

Abdel Bari Salkini (SY). Impact assessment of supplemental irrigation on rainfed wheat-based farming systems in Syria. 419 p.

SY Damascus University

Ahmad Hussen Al-Soud (SY). [Studies on some aspects of integrated control of pod borers in chickpea (*Cicer arietinum*) in Southern Syria]. 187 p. (In Arabic, English summary).

SY University of Aleppo

Mohamed Shafik Hakim (SY). [Inheritance of resistance to two races of yellow rust in eight wheat cultivars]. 183 p. (In Arabic, English summary).

Appendix 5

ICARDA Calendar 1992

January

8 - 9 *Washington DC.* Conference on The Global Dimensions of Intellectual Rights in Science and Technology.

13 - 23 *Aleppo.* Training course on Application of Biometrical Methods and Computer in Agricultural Research.

13 - 30 *Aleppo.* Training course on Computer Application in Agricultural Research.

26 - 29 *Aleppo.* Rural Poverty and Resources/Africa Staff Meeting.

February

1 - 13 *Yemen.* In-country training course on Seed Quality Control.

2 - 4 *Cairo.* Symposium on Small Farmers in the Arab Region.

4 - 7 *Sudan.* NVRP Traveling Workshop.

Feb. (1st week) *Tunisia.* Workshop on Farming Systems Development in N. Africa: Present Situation and Needs Assessment.

2 - 13 *Yemen.* In-country training course on Seed Quality Control.

6 - 11 *Tunisia.* Regional training course on Biometrical Techniques for Crop Improvement.

8 - 23 *Sudan.* In-country training course on General Seed Technology.

9 - 12 *Lattakia.* FRMP in-house Strategy Planning Meeting.

16 - 27 *Aleppo.* Seminar on Natural Resources and Environmental Management in the Dry Areas (World Bank/AOAD/ICARDA).

17 - 19 *Amman.* 3rd Steering Committee Meeting (Mashreq Project).

24 - 28 *The Netherlands.* Symposium on Durability of Disease Resistance.

27 - 6 March *Cairo.* NVRP Traveling Workshop.

28 - 29 *New Delhi.* USAID Livestock Sustainability Conference.

March

1 - 7 *Egypt.* NVRP Traveling Workshop.

1 - 30 June *Aleppo.* Long-term course on Cereals.

1 - 30 June *Aleppo.* Long-term course on Seed Production.

9 - 19 *Aleppo.* Short specialized training course on Legume Disease Control.

12 - 22 *Aleppo.* 57th TAC Meeting.

17 - 19 *Perth.* Workshop on Crop Production on Duplex Soils.

22 - 25 *Amman.* Workshop on Regional Seed Network for West Asia and North Africa.

22 - 26 *Aleppo.* TAC visit to Turkey.

23 - 25 *Ciudad Obregon,* Mexico. CIMMYT Durum Wheat Workshop.

23 - 2 Apr. *Rabat.* Regional training course on Septoria Disease.

30 - 2 Apr. *UK.* 52nd University of Nottingham Easter School Resource Capture by Crops.

April

6 - 10 *Cyprus.* Subregional training course on Hay Production Techniques.

8 - 12. NVRP Travelling Workshop (Cereals), Egypt/ICARDA.

11 - 15 *Egypt.* In-country training course on Wheat Field Inspection Methodology.

11 - 16 *Algeria.* Regional training course on Cereal Improvement Techniques.

12 - 16 *Cairo.* 2nd International Food Legume Research Conference.

12 - 23 *Aleppo.* Course on Pasture and Forage Legumes.

18 - 29 *Egypt.* Subregional training course on Legume Seed Production.

18 - 7 May *Egypt.* Regional training course in Plant Virology.

20 - 3 May *Aleppo.* Short-term course on Pasture and Forage Legumes.

20 - 28 *Aleppo.* Regional training course on Cereal Disease Diagnosis and Scoring.

20 - 30 *Aleppo.* Short, specialized training course on Insect Control in Legumes and Cereals.

24 - 30 *Aleppo.* BOT Meetings: Seminar on Evolving CG-Priorities for Agricultural Research.

25 - 30 *Syria.* Mashreq Project Traveling Workshop.

26 - 5 May *Jordan.* Regional training course on Seed Certification.

27 - 3 May *Diyarbakir.* Subregional training course on Use of Computers in Breeding Experiments.

May

May *Jordan.* Mashreq Project Traveling Workshop.

2 - 3 *Aleppo.* Barley Core Collection Meeting.

3 - 6 *Jordan.* Mashreq Project Traveling Workshop.

3 - 14 *Aleppo.* Short, specialized training course on Breeding Methodology in Legumes.

3 - 14 *Aleppo.* Economic Analysis and Evaluation of Environmental Factors in Planning Development.
4 - 6 *Aleppo.* ICARDA Presentation Days.
4 - 7 *Aleppo.* Joint IBPGR/ICARDA workshop on WANA Plant Genetic Resources Network.
5 - 6 *Vienna.* Benefits Committee Meeting.
10 - 21 *Aleppo.* Short, specialized training course on Mechanical Harvest of Legumes.
11 *Quetta.* AZRI Planning Meeting.
11 - 29 *Morocco.* International course on Morphological Variety Description and Maintenance.
12 - 7 June. FAO/ICARDA Sunn Pest Assessment Mission (Syria, Iran, Turkey).
16 - 19 *Jordan.* Auto-Milking Techniques: Khanasreh Station.
16 - 21 *Egypt.* In-country training course on Computer Applications for Multilocational Testing.
16 - 23 *Algeria.* N. Africa Cereal Traveling Workshop.
17 - 4 June *Aleppo.* Regional training course on Supplemental Irrigation Technology.
17 - 4 June. Supplemental Irrigation Technology.
17 - 20 *Sidi Bel Abbas.* Subregional training course on Winter Chickpea Technology Transfer.
18 - 19 *Lebanon.* In-country training course on Farmer's Orientation Workshop.
18 - 22 *Turkey.* CGIAR Mid-Term Meeting.
23 - 4 June *Amman.* Training course on Extension and Technology Transfer (Mashreq Project).
24 - 25 *Aleppo.* UNDP Biotechnology Steering Committee Meeting.
24 - 26 *Kamishly.* Subregional training course on Winter Chickpea Technology Transfer.
25 - 27 *Addis Ababa.* Annual Coordination Meeting - NVRP/Ethiopia.

June

1 - 3 *Angers.* 1st European Conferences on Grain Legumes.
2 - 7 *Rome.* INTAGRES Meeting.
3 - 12 *Rio de Janeiro.* UNCED Meeting in Brazil.
14 - 25 *Egypt.* In-country training course on Seed Processing and Storage.
15 - 18 *Nairobi.* Center Directors Meeting.
21 - 25 *Aleppo.* Regional training workshop on Genetic Resources Documentation.
22 - 25 *Amman.* Seed Network Workshop.
22 - 28 *Rome.* 58th TAC Meeting.
26 - 30 *Turkey.* West Asian Traveling Workshop.
27 - 29 *Iraq.* First Coordination Meeting between ICARDA and Iraq.
28 - 4 July *Beijing.* XIX International Congress of Entomology.
29 - 1 July *Ankara.* In-country training course on Lentil and Chickpea Production Technology.
29 - 10 July *Washington D.C.* CGIAR Management Course.

July

6 - 8 *Lebanon.* In-country training course on Agricultural Production Techniques.
6 - 11 *Tunisia.* Design and Analysis of Experiments for Varietal Testing.
6 - 11 *Angers.* XIII EUCARPIA Congress: Reproductive Biology and Plant Breeding.
7 - 10 *CIS.* International Symposium on Conservation Tillage Practices for Grain Farming in Semi-Arid Regions.
12 - 13 *Amman.* Mashreq Project Planning Meeting.
13 - 19 *Tunisia.* GTZ Meeting on Faba Bean Research Network for North Africa.
14 - 22 *Ames, Iowa.* The International Crop Science Congress, Iowa State University.
19 - 21 *Damascus.* Mashreq Project Planning Meeting.

August

10 - 11 *London.* Benefits Committee.
16 - 27 *Amman.* Subregional training course on Water Harvesting Techniques.
17 - 20 *The Hague* (ISNAR). 1992 Meeting of CGIAR Social Scientists.
28 - 4 Sep. *Mosul.* Mashreq Project Planning Meeting.
29 - 1 Sep. *Jordan.* Artificial Insemination and Sheep Reproduction Physiology.
30 - 26 Oct. *Aleppo.* Basic Secretarial Science.

September

2 - 9 *Ethiopia.* In-country training course on Seed Certification.
5 - 9 *Iraq.* Mashreq Project Traveling Workshop.
6 - 10 *Sudan.* NVRP National Annual Coordination Meeting.
8 - 11 *Weihenstephan.* European and Mediterranean Cereal Rusts and Mildews Conference.
10 - 11 *Lebanon.* Lebanon Annual Coordination Meeting.
12 - 13 *Libya.* Libya - National Coordination Meeting.
13 - 18 *Egypt.* NVRP National Annual Coordination Meeting.

14 - 18 *Lebanon.* In-country training course on Food Legume Improvement.
14 - 19 *Rabat.* 5th Conference of the African Association for Biological Nitrogen Fixation.
15 - 17 *Tunisia.* Tunisia National Coordination Meeting.
15 - 25 *Queensland.* 2nd International Symposium on Integrated Land Use Management for Tropical Agriculture.
19 - 21 *Algeria.* Algeria National Coordination Meeting.
20 - 22 Oct. *Aleppo.* Short course on Experimental Station Management.
20 - 1 Oct. *Aleppo.* Short, specialized course on DNA Molecular Marker Techniques.
21 - 26 *Perth.* Symposium on Vetches and *Lathyrus.*
23 - 25 *Morocco.* Morocco National Coordination Meeting.
26 - 28 *Amman.* Mashreq Project 3rd Regional Technical Meeting.
27 - 2 Oct. *Bari.* International Conference on Supplementary Irrigation and Drought Water Management.
29 - 30 *Amman.* 4th Jordan/CARDA Annual Coordination Meeting.

October

3 - 5 *Aleppo.* 11th Syria/ICARDA Annual Coordination Meeting.
5 - 9 *Adana.* FAO/ICARDA/CIHEAM/EAAP/CUZF Workshop on the Strategies for the Development of Fat-tail Sheep in the Near East.
5 - 9 *Rabat.* 2nd North. Africa/ICARDA Regional Coordination Meeting.
5 - 10 *Ethiopia.* NVRP (Ethiopia) Traveling Workshop.
11 - 15 *Khartoum.* NVRP Regional Coordination Meeting.
12 - 15 *Aleppo.* International Workshop on Evaluation and Utilization of Biodiversity in Wild Relatives and Primitive Forms for Wheat Improvement.
15 - 24 *Washington.* 59th TAC Meeting.
16 - 17 *Washington.* Benefits Committee Meeting.
18 - 29 *Jordan.* Regional training course on Seed Testing Techniques.
18 - 29 *Amman.* Seed Health Testing with the University of Jordan and GTZ.
19 - 20 *Washington.* Gender Workshop.
20 - 22 *Turkey.* Dryland Pasture and Forage Coordination Meeting for the Highlands Subregion.
22 - 23 *Washington.* Center Directors Meeting.
26 - 30 *Washington.* International Centers Week.

November

2 - 3 *Washington.* Executive Committee Meeting.
4 - 6 *Adana.* Taurus Mountain Project Planning Meeting.
5 - 12 *Texas.* International Symposium on Applications and Prospects of Biotechnology for Arid and Semi-Arid Lands.
7 - 13 *Damascus.* 32nd Science Week in Syria.
9 - 12 *Aleppo.* Joint ICARDA/ICRISAT Workshop on the Adaptation of Chickpea in WANA.
9 - 13 *Settat.* Training Workshop on Spatial Weather Generation and Crop Modeling (INRA/DMN/IDRC/ICARDA).
15 - 20 *Aleppo.* Workshop of Information Specialists from North Africa, Jordan, Lebanon and Syria.
21 - 27 *Perth.* CLIMA Policy Board Meeting.
22 - 26 *Aleppo.* Workshop on Management of Gypsiferous Soils.
22 - 27 *Egypt.* NVRP Steering Committee Meeting.
30 - 1 Dec. *Aleppo.* Mini-workshop on Soil Water-N Interactions.

December

6 - 9 *Quetta.* Workshop on Small Ruminant Production in the Highlands of WANA-Current Systems, Problems and Perspectives.
13 - 15 *Amman.* Mashreq Project Workshop.
14 - 16 *Turkey.* Highlands Coordination Meeting.
16 - 17 *Amman.* 4th Mashreq Project Steering Committee Meeting.

Appendix 6

Special Projects

During 1992, 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 contributions by the respective donors are reported in Appendix 11. The reports on the activities listed are encompassed in the appropriate sections of the body of this Annual Report 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.

DGIS (Netherlands)

Collection and Characterization 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.

EEC

Nile Valley Regional Program - Egypt.

FAO (Food and Agriculture Organization of the United Nations).

Joint support with ICARDA of an Expert Consultation on Sunn Pest.

Jointly sponsored with IBPGR Plant Genetic Resources Workshop.

Support to create Global Grain Legume Drought Research Network.

Ford Foundation

Graduate Research Fellowships.

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'.

BMZ/GTZ (Germany)

Development of National Seed Production Organizations.

Land Use Management for Marginal Lands in the Barley/Livestock Zones of Jordan and Syria (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 (with Biologische Bundesanstalt für Land und Forstwirtschaft).

IDRC (International Development Research Centre, Canada)

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

Study of Marginal Lands in the Middle East and North Africa: Current Situation and Future Potential.

Agroecological Characterization.

Dryland Resource Management - Yemen.

IFAD (International Fund for Agricultural Development)

Maghreb Project: 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.

OPEC Fund for International Development

Barley Development Program.

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

Rockefeller Foundation

Support of two Social Science Postdoctoral Research Fellows: Impact of Improved Cereal Varieties in North Africa; Impact of Nile Valley Regional Project.

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.

USAID (United States Agency for International Development)

Determination of C13 Discrimination as an Indirect Selection Criterion for Barley in Dry Environments.

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

Collaborative Project: ICARDA/CIMMYT/Ministry of Agriculture and Land Reclamation, Egypt.

Appendix 7

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.

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).

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

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).

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).

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).

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).

ICRISAT

1978 with the International Crops Research Institute for the Semi-Arid Tropics, ICRISAT, on chickpea research (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 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.
Barley Pathology	Research on the epidemiology, virulence and resistance of pathogens of importance to barley cultivation in WANA. Development of breeding methodologies to control diseases. NARS scientists encouraged to take regional responsibilities.
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.
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
J. Van Leur (CP)	REG	Morocco, Algeria, Tunisia, Egypt, Turkey, USA (MSU)	USAID Restricted Core	CO-OP
A.B. Damania (GRU) L. Pecetti (Italy)	INT	6, in 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.
Biological Nitrogen Fixation in Legumes: Rhizobium Ecology Network (REN)	Network in undertaking research on competitiveness and survival of introduced superior rhizobium strains against varied background of soil types and native rhizobia populations.
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
D. Beck (LP)	REG	Turkey, Egypt, Tunisia, Syria	ICARDA/ UNDP	CO-OP MATERIAL
A. Matar (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, Aleppo	REG	WANA countries IBPGR, FAO, ACSAD		CO-OP INFO
N. Maliha (CODIS) and LP	INT	Worldwide	IDRC; ICARDA Core	INFO
N. Maliha (CODIS) and LP	INT	Worldwide	IDRC; ICARDA Core	INFO
N. Maliha (CODIS) and CP	INT	Worldwide	ICARDA Core	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):	
A 1. Integrated Management of Wilt and Root Rots in Chickpea and Lentil	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.
A 2. 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.
A 3. Screening of Faba Bean for Resistance to Aphids	Identify sources of resistance to aphids (*A. craccivora* and *A. fabae*). Test promising material in the field in the country of origin. Develop and evaluate a Regional Aphid Screening Nursery. Incorporate resistance into germplasm with suitable agronomic characteristics for the Nile Valley countries.
A 4. Survey of Legume Viruses	Identify the major viruses, and their vectors, infesting legumes in the Nile Valley countries.
A 5. 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.
B 1. 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.
B 2. An Approach to Identify Thermotolerance in Wheat and Maintaining Yield 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.
B 3. Water Use Efficiency of Wheat (Sudan & Egypt)	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.
B 4. Integrated Control of Aphids in Wheat	1. Screening wheat for resistance to *R. padi* and *S. graminum*, to develop resistant/tolerant cultivars to aphids.

Coordinator	Scale[1]	Countries/Institutions involved	Donor	Type[2]
G. Bejiga (Ethiopia)	SUBREG	Egypt, Ethiopia Sudan; ICRISAT	EEC, SAREC DGIS	CO-OP MATERIAL
M. El Sherbeeny (Egypt)	SUBREG	Egypt, Ethiopia Sudan	EEC, SAREC DGIS	CO-OP
N.E.S. Eldin (Sudan)	SUBREG	Egypt, Ethiopia Sudan	EEC, SAREC DGIS	CO-OP MATERIAL
M. Hussein (Sudan)	SUBREG	Egypt, Ethiopia Sudan	EEC, SAREC DGIS	CO-OP
S.K. Khalil (Egypt)	SUBREG	Egypt, Ethiopia	EEC, SAREC	CO-OP MATERIAL
Y. El-Daoudi (Egypt)	SUBREG	Egypt, Ethiopia Sudan	EEC, SAREC DGIS	CO-OP
H.M. Ishag (Sudan)	SUBREG	Egypt, Ethiopia Sudan, CIMMYT	EEC, SAREC DGIS	CO-OP
A.M. Abdul Shafi (Egypt)	SUBREG	Egypt, Sudan	EEC, DGIS	CO-OP
G.S. Youssef (Egypt)	SUBREG	Egypt, Sudan	EEC, DGIS	CO-OP

Title	Objectives/Activities
	2. Study the feasibility of biological control of aphids in wheat through enhancement of natural enemy populations.
B 5. Screening for Barley Yellow Dwarf Virus (BYDV) resistance	To identify sources of resistance to BYDV.
B 6. Survey of Barley Yellow Dwarf Virus (BYDV)	Identify BYDV occurrence and strains; identify the vectors of BYDV by identifying isolates with ELISA.
B 7. Characterization of Wheat Germplasm for Response to Photoperiod and Vernalization	Evaluate response of wheat commercial varieties in Nile Valley countries to photoperiod and vernalization. Identify parental material with moderate reaction or insensitivity to photoperiod and temperature for use in breeding program to enhance wide adaptation.
C 1. 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.

Barley Networks Operating under the Latin America Regional Program

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 with improved nutritional value and low fiber.
3. Development of Barley Yellow Dwarf (BYD) Resistant Lines	ELISA testing of barley lines. Yield testing of identified resistant lines in Latin America. International testing in Chile, Ecuador and Kenya where disease has reached epidemic proportions.
4. Development of Germplasm Resistant to Scab and Barley Yellow Mosaic Virus (BYM)	Development of scab resistant barley with tolerance to BYM for China
5. Development of Barley Lines Resistant to Spot Blotch Caused by *Helminthosporium sativum*	Crossing sources of resistance identified in Thailand and North America. International field testing in Thailand, Vietnam, Uganda.
6. Development of Leaf Rust Resistant Barleys	Network of researchers investigating leaf rust resistance.
7.	

Coordinator	Scale[1]	Countries/Institutions involved	Donor	Type[2]
N.E.S. Eldin (Sudan)	SUBREG	Egypt, Sudan	EEC, DGIS	CO-OP
M. Abdul Ghani (Egypt)	SUBREG	Egypt, Ethiopia, Sudan	EEC, SAREC DGIS	CO-OP
M. Abdul Ghani (Egypt)	SUBREG	Egypt, Ethiopia, Sudan	EEC, SAREC DGIS	CO-OP
J. Peacock (ICARDA)	SUBREG	Egypt, Ethiopia, Sudan	EEC, SAREC DGIS	CO-OP
	SUBREG	Egypt, Ethiopia, Sudan	EEC, SAREC DGIS	CO-OP
H. Vivar (LARP)	REG	Oregon State University, Latin American NARS, CIMMYT	CIMMYT/ ICARDA Core	MATERIAL
H. Vivar	INT	CIMMYT, Canada, Australia, Colombia	CIMMYT/ ICARDA Core	MATERIAL
H. Vivar	INT	CIMMYT, Chile, Ecuador, Kenya	CIMMYT/ ICARDA Core	MATERIAL
H. Vivar	INT	CIMMYT, China	CIMMYT/ ICARDA Core	INFO MATERIAL
H. Vivar	INT	CIMMYT, Vietnam, Uganda, Thailand	CIMMYT/ ICARDA Core	MATERIAL
H. Vivar	INT	Virginia Tech., North Dakota State Univ., CIMMYT, Latin American NARS	CIMMYT/ ICARDA Core	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 1992, the International School of Aleppo (ISA) was granted full accreditation by the Middle States Association of Colleges and Schools. This achievement marked the end of a two-year in-depth study and analysis of the many programs of the school. The International Baccalaureate Program completed its initial year at ISA in1992, and plans are being made to further develop the class offerings of this academic program.

Ten students graduated in 1992. The graduates were accepted at the American University of Beirut, Aleppo University, McGill University, and other well known universities. This confirms the quality of instruction and overall positive climate at ISA.

Enrollment continued to be high, with 280 students in 1992, representing nearly 30 countries from around the world.

The development of the academic, physical, social, and emotional well-being of every student continued to be a top priority of the school.

Appendix 10

Visitors to ICARDA

During 1992, ICARDA received 1648 visitors. These included scientists, consultants, representatives of the CGIAR System, donor representatives, diplomats, senior government officials, Board of Trustees members, conference participants, outreach staff, auditors, farmers, students, job interviewees, and others from all over the world.

Appendix 11

Statement of Activity
For the Year Ended 31 December 1992
(x 1000 USD)

	1992	1991
REVENUE		
Grants	18,411	19,477
Exchange gains/(loss), net	(847)	1,387
Interest income	922	881
Other income, net	2,141	469
Total revenue	20,627	22,214
EXPENSES		
Research		
Farm resource management	2,070	2,121
Cereal improvement	2,700	2,855
Legume improvement	2,017	2,577
Pasture, forage, and livestock	1,763	1,855
Total research	8,550	9,408
Research support	4,861	4,549
Cooperative programs	1,498	1,193
Training	720	770
Information	840	907
General administration	2,331	3,126
General operation	1,750	1,581
Subtotal	12,000	12,126
Total operating expenses	20,550	21,534
EXCESS OF REVENUE OVER EXPENSES	77	680
ALLOCATED TO		
Capital invested in property, plant and equipment	69	187
Operating fund	8	493
Surplus	77	680

Statement of Grant Revenue
For the Year Ended 31 December 1992
(x 1000 USD)

	Current year grants	Funds received	Receivable 31 Dec 1992	(Advance) 31 Dec 1992
CORE UNRESTRICTED				
Australia	296	<296>	-	-
Austria	150	<150>	-	-
Canada	839	<839>	-	-
China	50	<50>	-	-
Denmark	348	<348>	-	-
Ford Foundation	150	<150>	-	-
Germany	836	<836>	-	-
India	25	<19>	14	-
International Bank for Reconstruction and Development (World Bank)	3700	<6700>	-	<3000>
Italy	174	-	174	-
Japan	311	<311>	-	-
Mexico	10	-	10	-
Netherlands	423	<423>	-	-
Norway	458	<458>	-	-
Spain	125	<125>	-	-
Sweden	663	<663>	-	-
United Kingdom	905	<905>	-	-
United States Agency for International Development	4250	<4250>	-	-
	13713	<16523>	198	<3000>
CORE RESTRICTED				
Arab Fund	500	<237>	500	<237>
France	728	<369>	-	-
Germany	1085	<660>	-	<233>
International Development Research Centre	67	<112>	-	<56>
International Fund for Agricultural Development	81	<351>	-	<18>
Italy	334	-	170	<389>
Closed Projects	-	<820>	-	-
	2795	<2549>	670	<933>

	Current year grants	Funds received	Receivable 31 Dec 1992	(Advance) 31 Dec 1992
SPECIAL PROJECTS				
Arab Fund	105	<173>	-	<250>
Arab Planning Institute	17	<17>	-	-
Food and Agriculture Organization	24	<44>	-	<20>
Ford Foundation	124	-	18	-
France	18	-	-	<197>
German Agency for Technical Cooperation	211	<50>	177	<46>
International Development Research Center	20	<22>	-	<2>
Italy	709	-	-	<633>
Netherlands	310	<399>	81	<367>
The OPEC Fund for International Development	50	<55>	4	-
United Nations Development Programme	298	<321>	-	<98>
United States Agency for International Development	17	-	-	<21>
Closed projects	-	<86>	-	<1>
Future projects	-	<17>	-	<17>
	1903	<1184>	280	<1652>
GRAND TOTAL	18411	<20256>	1148	<5585>

Appendix 12

Collaboration in Advanced Research

ICARDA received Special Project funding in 1992 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 Center for the Improvement of Maize and Wheat (CIMMYT), Mexico
- Wheat and barley improvement: CIMMYT has seconded three wheat breeders to ICARDA, and ICARDA has seconded a barley breeder to CIMMYT.

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad, India
- Chickpea improvement: ICRISAT has seconded a chickpea breeder to ICARDA and provided consultancy in chickpea pathology.

ICARDA and ICRISAT collaborated in the creation of a Global Grain Legume Drought Research Network.

Australia

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

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, Montpellier
- 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.

Federal Republic of Germany

University of Giessen
- Ecogeographic survey of legumes in the Syrian steppe.

University of Hohenheim
- Economics of irrigated food-legumes production by small-holders in Sudan.
- Physiological factors as determinants of yield in durum wheat.
- Integrated control of *Orobanche* spp. in food legumes.
- Influence of heterozygosity and heterogeneity on yield performance and stability of barley in dry areas.
- 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.

University of Leipzig/Aleppo University
- Economics of slaughtering and fattening of sheep in Syria.

Italy

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

University of Napoli; ENEA, Rome; Ministry of Agriculture, Sicily; Department of Pathology, Ministry of Agriculture, Rome
- Development of chickpea germplasm with combined resistance to *Ascochyta* blight and *Fusarium* wilt using wild and cultivated species.

University of Perugia
- Inoculation of annual medics with *Rhizobium* spp.
- Increasing the productivity of marginal lands in western Syria.

University of Perugia and Ministry of Agriculture, Catania
- Improving yield and yield stability of barley in stress environments.

University of Tuscia, Viterbo
- Enhancing wheat productivity in stress environments utilizing wild progenitors primitive forms.

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

Japan

Japanese International Cooperation Agency (JICA)
- Intestinal, lung, and blood parasites of small ruminants in Syria.

Tropical Agriculture Research Center, Tskuba, Ibaraki
- Analysis of rangeland vegetation using remote sensing.

Netherlands

DGIS: The Directorate General for International Cooperation
- Virulence analysis of yellow rust of wheat in some countries of WANA.

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 conditions.

Spain

Polytechnical University, Madrid
- Improvement of the energy efficiency of medic rhizobia.

University of Cordoba
- Effect of environmental stresses on nitrogen fixation.
- Developing *Orobanche* resistance in faba bean.
- Developing wilt resistance in chickpea.
- Soil phosphate studies.

University of Cordoba and INIA
- Barley stress physiology.

University of Granada
- Isolation of VA-Mycorrhiza from forage legumes.

Switzerland

IUED (Institut Universitaire d'Etudes du Developpement), Geneva
- Social and economic analysis of agro-pastoral systems in the dry areas of Syria.

United Kingdom

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

Overseas Development Natural Resources Institute, London
- Evaluating the nutritive value of straws for small ruminants.

Plant Breeding Institute, Cambridge
- Characterization of barley genotypes.

Royal Veterinary College, London
- Factors that cause peas to be unpalatable to sheep

University College, London
- Development of metabolic index for drought stress in barley and durum wheat.

University of Nottingham
- Factors influencing adoption of new agricultural technology in dry areas of Syria.

University of Reading
- Root studies of barley and wheat.
- Investigation of seed dormancy in plant populations on grazed marginal land.
- Impact assessment of supplemental irrigation on rainfed wheat-based farming systems.
- Investigation of N-cycling in crop rotations using ^{15}N.

United States of America

Montana State University, Bozeman
- Research and training on barley diseases and associated breeding methodologies.

Oregon State University, Corvallis; Montana State University, Bozeman; and Kansas State University, Manhattan
- Interdisciplinary research and training to enhance germplasm of selected cereals for less favorable environments.

University of Nebraska
- Statistical analysis of rotation trials.

University of Pennsylvania
- Phylogenetic studies of *Rhizobium meliloti.*

Washington State University, Pullman
- Transfer of *Bacillus thuringiensis* gene in *Rhizobium* for the control of *Sitona* larvae in lentil and peas.

Appendix 13

Board of Trustees

Three new members joined the Board of Trustees in 1992: Dr Julie Virgo, Dr Joseph Cassas, and Dr Ersin Istanbulluoglu.

Drs Nazmi Demir, Alexander Poulovassilis, and Carl Gotsch completed their tenure as Board members.

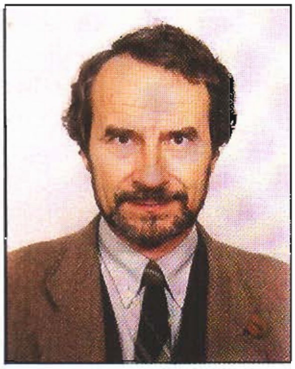
Dr Julie Virgo

An Australian national, Dr Julie Virgo currently serves as Executive Vice President and Chief Operating Officer of the Carroll Group, Inc., a leading management consultancy firm in the U.S.

Dr Virgo possesses an undergraduate degree in library science, a master's in library and information science, a master's in business administration, and a PhD in sociology of science. Her specializations include general management, information management, and organizational behavior. Dr Virgo has taught library and information science, finance, accounting and management in the U.S. She has been a consultant to the U.S. Federal Government for the Department of Education, National Science Foundation, National Center for Educational Statistics, National Commission of Libraries and Information Science, and National Endowment for the Humanities.

In addition to being a member of ICARDA's Board of Trustees, Dr Virgo is also on the Board of seven national and international organizations. In 1991-92 she was a member of External Management and Program Review Panels of ILCA and IRRI.

Dr Joseph Cassas



A French national born in Algeria, Dr Joseph Cassas is no stranger to West Asia and North Africa. In his current position of Research Director at the Institut National de la Recherche Agronomique (INRA), Dr Cassas is a central figure in one of Europe's most advanced institutes for agricultural research.

Dr Cassas holds a diploma in rural economy from the Institut National Agronomique, Paris, and advanced degrees in economics from Montpellier. His professional endeavors have focused on the national policies on agricultural research in the countries of the Mediterranean Basin and sub-Saharan Africa. He has analyzed the national agricultural research systems in Chad, Cote d'Ivoire, Cuba, Madagascar, Mali, Morocco, Niger, Tunisia, and Yugoslavia.

Dr Cassas was a member of the Board of Directors of several national and international institutes including IRAT, IRCT, IRFA, and BDPA. His other international responsibilities have included the following: member, Board of International Foundation for Science, Stockholm; member, Scientific Council of CIHEAM, Paris; senior research officer at ISNAR; and member of the External Review Panels of CIMMYT, CIAT, and CIP.

Dr Ersin Istanbulluoglu

Dr Ersin Istanbulluoglu is the Deputy Under-Secretary at the Turkish Ministry of Agriculture and Rural Affairs. Throughout his distinguished career, he has made an indelible mark on agricultural development, not only in Turkey but throughout West Asia and North Africa.

Dr Istanbulluoglu earned his undergraduate degree in veterinary science from the University of Ankara, and completed his studies at the master's and PhD levels at the Faculty of Veterinary Medicine of the University of Illinois, USA.

Since obtaining his PhD in 1974, Dr Istanbulluoglu has occupied a number of important positions dealing with livestock development. Furthermore, he has gained considerable managerial experience as a senior official at the Turkish Ministry of Agriculture and Rural Affairs. His international relations have included the following responsibilities: Manager, five World Bank-supported livestock development projects, Executive Committee member of the European FMD Commission, Chairman of the MINEADEP-FAO Executive Committee, Secretary General of the Office International des Epizootie Committee for the Middle East, and member of the WHO Consultation Group on Rabies and Health System Research.

On 31 Dec 1992 the membership of ICARDA's Board of Trustees was as follows:

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The Board held the following meetings during 1992:

24-26 April	20th meeting of the Program Committee, Aleppo
27 April	26th meeting of the Executive Committee, Aleppo
27-28 April	26th meeting of the Board of Trustees, Aleppo
2-3 November	27th meeting of the Executive Committee, Washington

Appendix 14

Senior Staff
(as of 31 December 1992)

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 Mohamed K. Barmada, Finance Officer, Outreach
Mr Suleiman Is-hak, Finance Officer, Cash Management
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, Senior Programmer-Project Leader
Mr Michael Sarkissian, Systems Engineer
Mr Suheil Salameh, Database Administrator
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 Economist
Dr Richard Tutwiler, Socioeconomist
Dr Theib Oweis, Water Harvesting/Supplemental Irrigation Specialist
Dr Abelardo Rodriguez, Agricultural Economist
Mr Wolfgang Goebel, Post-Doctoral Fellow/Agroclimatologist
Dr Akhtar Beg, Visiting Scientist
Dr Karel Timmerman, Post-Doctoral Fellow
Mr Ahmed Mazid, Agricultural Economist
Mr Abdul Bari Salkini, Agricultural Economist
Mr Sobhi Dozom, Research Associate
Mr Mahmoud Oglah, Research Associate

Cereal Program

Dr John Hamblin, Program Leader/Breeder
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 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

Dr Stefania Grando, Research Scientist
Dr Sui K. Yau, International Nurseries Scientist
Dr Mousa Mosaad, Visiting Scientist
Dr S. Mahalakashmi, Visiting Scientist
Dr Hala Toubia-Rahme, Post-Doctoral Fellow
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 Trails Scientist
Dr Ahmed Hamdi Ismail, Post-Doctoral Fellow
Dr Mark Ratinam, Post-Doctoral Fellow
Dr N.P. Saxena, Visiting Scientist
Dr Mamdouh Omar, Visiting Scientist
Dr Barakat Abu Irmaileh, Visiting Scientist
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Mr Fadel Afandi, Research Associate

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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 Shiguru Takahata, Visiting Scientist
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 Shamo, Economic Research Associate

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Dr Khaled Makkouk, Plant Virologist
Dr Ardeshir B. Damania, Cereal Germplasm Curator
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Mr Peter Eichhorn, Farm Machinery Supervisor
Mr Ahmed Shahbandar, Assistant Farm Manager
Mr Bahij Kawas, Senior Horticultural Supervisor

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Mr Ohannes 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

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Ms Nida Kudsi, Deputy Principal/Teacher

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Mr Abdul Karim El Ali, Administrative Officer

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Terbol Research Station

Mr Munir Sughayyar, Engineer, Station Operations

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Rudi Petti, Research Fellow
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Carlo Coduti, Research Fellow

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Quetta

Dr Euan Thomson, Team Leader

TUNISIA

Tunis

Dr Ahmed Kamel, ICARDA Representative/Cereal Pathologist
Dr Maurice Saade, Visiting Scientist
Dr Lamia Fattal, Visiting Scientist

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Ankara

Dr J.D. Keatinge, Regional Coordinator, Highlands Regional Program

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Dr Edward Hanna, Legal Advisor (Beirut)
Mr Tarif Kayali, Legal Advisor (Aleppo)
Dr Ahmed el Ahmed, Seed Pathologist
Dr Bassam Bayaa, Lentil Pathologist
Dr Nour Eddine Mona, Coordinator, National Programs
Dr Haru Nishikawa, JICA Representative
Dr Abdullah Dakheell, Consultant (Aleppo)
Dr Marlene Diekmann, Seed Pathologist

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)
DGIS	Directorate Central for International Cooperation (the Netherlands)
EEC	European Economic Community
GOSM	General Organization for Seed Multiplication (Syria)
GTZ	Deutsche Gesellschaft fur Technische Zusammenarbeit (German Agency for Technical Cooperation)
IBPGR	International Board for Plant Genetic Resources (FAO, Italy)
IBRD	International Bank for Reconstruction and Development (World Bank, USA)
ICAR	Indian Council of Agricultural Research
ICARDA	International Center for Agricultural Research in the Dry Areas (Syria)
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics (India)
IDRC	International Development Research Centre (Canada)
IFAD	International Fund for Agricultural Development (Italy)
INRA	Institut National de la Recherche Agronomique (France, 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
GB	United Kingdom
JO	Jordan
SD	Sudan
SY	Syria
TR	Turkey

Appendix 16

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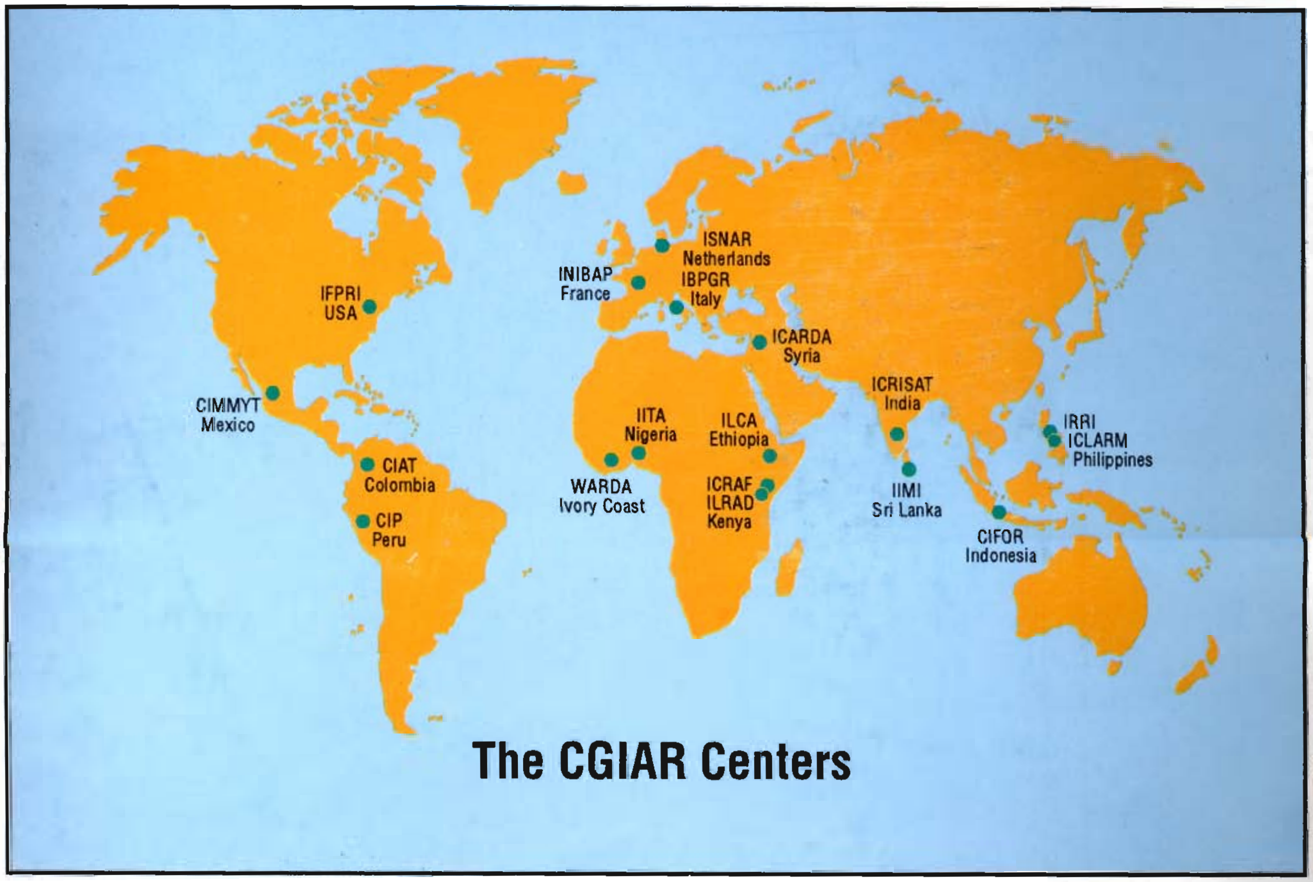
The CGIAR

ICARDA 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.

ICARDA-064/5000/Oct 1993