ICARDA Annual Report 1988

International Center for Agricultural Research in the Dry Areas

ICARDA
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1988

International Center for Agricultural Research in the Dry Areas

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COVER:

Cultivation of marginal land by farmers to meet the rapidly rising population's demand for increased food and feed supplies is seriously threatening the sustainability of agricultural production systems, particularly in low-rainfall areas. ICARDA faces the challenge of developing production technologies that would both improve food and feed supplies and ensure appropriate land use.

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Contents

An Introduction to ICARDA

Established in 1977, the International Center for Agricultural Research in the Dry Areas (ICARDA) is governed by an independent Board of Trustees. Based at Aleppo, Syria, it is one of 13 centers supported by the Consultative Group on International Agricultural Research (CGIAR), which is a consortium of over 40 countries, international and regional organizations, and private foundations.

The CGIAR seeks to enhance and sustain food production and, at the same time, improve socio-economic conditions of people living in developing countries; hence it supports the kind of research that will help small farmers to achieve better and more stable harvests, while conserving the natural resources. In setting up ICARDA, the CGIAR was addressing the problems of developing countries particularly those in West Asia and North Africa. In fact, ICARDA focuses its efforts on areas with a dry summer and where precipitation in winter ranges from 200 to 600 mm.

ICARDA has a world responsibility for the improvement of barley, lentil and faba bean, and a regional responsibility for the improvement of wheat, chickpea and pasture and forage crops; the Center also supports an important program on farm resource management.

Much of ICARDA's research is carried out on a farm of 948 hectares, at its headquarters at Tel Hadya, 30 km south-west of Aleppo. ICARDA also manages other sites where it tests material under a variety of agroecological conditions in both Syria and Lebanon. However, the full scope of ICARDA's activities can be appreciated only when account is taken of the cooperative research carried out with many countries in West Asia and North Africa.

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

ICARDA aims not merely to complement the work of national research programs, but also to strengthen national research capacities. Progressively, much of the work now carried out at the Center will be handed over to scientists at country level.

Foreword

Over the years, ICARDA has tested various formats for the annual reporting of its work. The intention has been the delivery of effective and meaningful information to the Center's various audiences. Earlier reports were primarily targeted to the scientific community and tended to be large, detailed and highly technical. Others were intended for a wider audience including readers not particularly conversant with the intricate issues of agricultural research. Neither format was fully adequate to cover the range of the Center's audiences.

The 1988 Report strives to attain a balance between the two approaches. It is divided into two parts. Part One highlights the major developments in the Center's research conducted during the year with special reference to advances that could have practical implications to increasing food supplies. As the year also saw the Center's Second External Program and Management Reviews and the preparation of its Strategic and Medium-Term Plans, Part One also touches upon the major challenges confronting agriculture in ICARDA's region and the problems they pose to the Center's scientists, and gives a brief overview of the new thrusts in its work that are envisaged in its Strategic and Medium-Term Plans.

Part Two is a summary of ICARDA's work which is reported upon in greater detail in separate Program Reports. This section is primarily addressed to the scientific community interested in familiarizing itself with the range and direction of the work being conducted by the Center. We believe it could also be of interest to the general reader.

In adopting this approach, we trust that we have come nearer to meeting the diverse requirements of all our stakeholders: beneficiaries, clients, donors and cooperators.

While the research results reported here are for the 1987/88 cropping season (Sept/Oct 1987 to Aug/Sept 1988), all other events reported upon cover the period to 31 Dec 1988.

Nasrat Fadda

Nasrat R. Fadda
Director General

PART ONE

Major Developments in 1988

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Major Developments in 1988

Nineteen eighty-eight was one of the most eventful years in ICARDA's history. While the Second External Program and Management Reviews were the major events, the year saw several significant developments in a range of critical areas: senior management, administration, research programs, relations with national programs, and the Center's strategy for the future. Guided by self-evaluation and counsel from its peers and collaborators, ICARDA took concrete steps in 1988 to accelerate the use of its research results by national programs, hand over some of its activities to collaborating countries, and prepare itself to respond to the challenges of the region's fragile environment, high population growth, and pervasive low productivity in the long term. The year will be remembered as one of both consolidation and change.

New Senior Management

The year started with an incomplete senior management team. The positions of the Director General and Financial Controller and Treasurer were vacant; the new Deputy Director General (Research) had just arrived in August 1987; the Deputy Director General (International Cooperation), who was acting as Director General, had already announced his intention to retire.

The new Director General did not join until 1 March, and the Financial Controller and Treasurer until June.

Development of the Strategic Plan

Using its own experience over the past decade, the CGIAR priorities and strategies, forecasts by FAO and IFPRI of future food supply and demand in WANA, the 1988 CIHEAM report, the recommendations of the national programs, and the suggestions from its Board of Trustees, management, and staff, the Center developed its draft Strategic Plan for presentation to the External Program Review (EPR) and External Management Review (EMR) panels in May 1988.

In its report to TAC, the EPR Panel commented that "although the draft contains all the major elements needed to shape ICARDA's future programme and priorities, further refinement is needed to make it more explicit. The conceptual framework to be established by the plan needs to be supported by more analytical evidence for the choices being made. ICARDA should be explicit about these choices, and establish a clear vision of the exact nature of its intended contribution." The Panel further commented that "risk aversion, stress tolerance, sustainability and resource conservation must have higher ratings in its research than food production *per se*, if the Centre is to truly fulfil its mandate."

The EMR Panel commended ICARDA "for its seriousness in approaching strategic planning" and praised the role played by the senior staff and Board of Trustees of the Center and by national institutions in the development of the Strategic Plan.

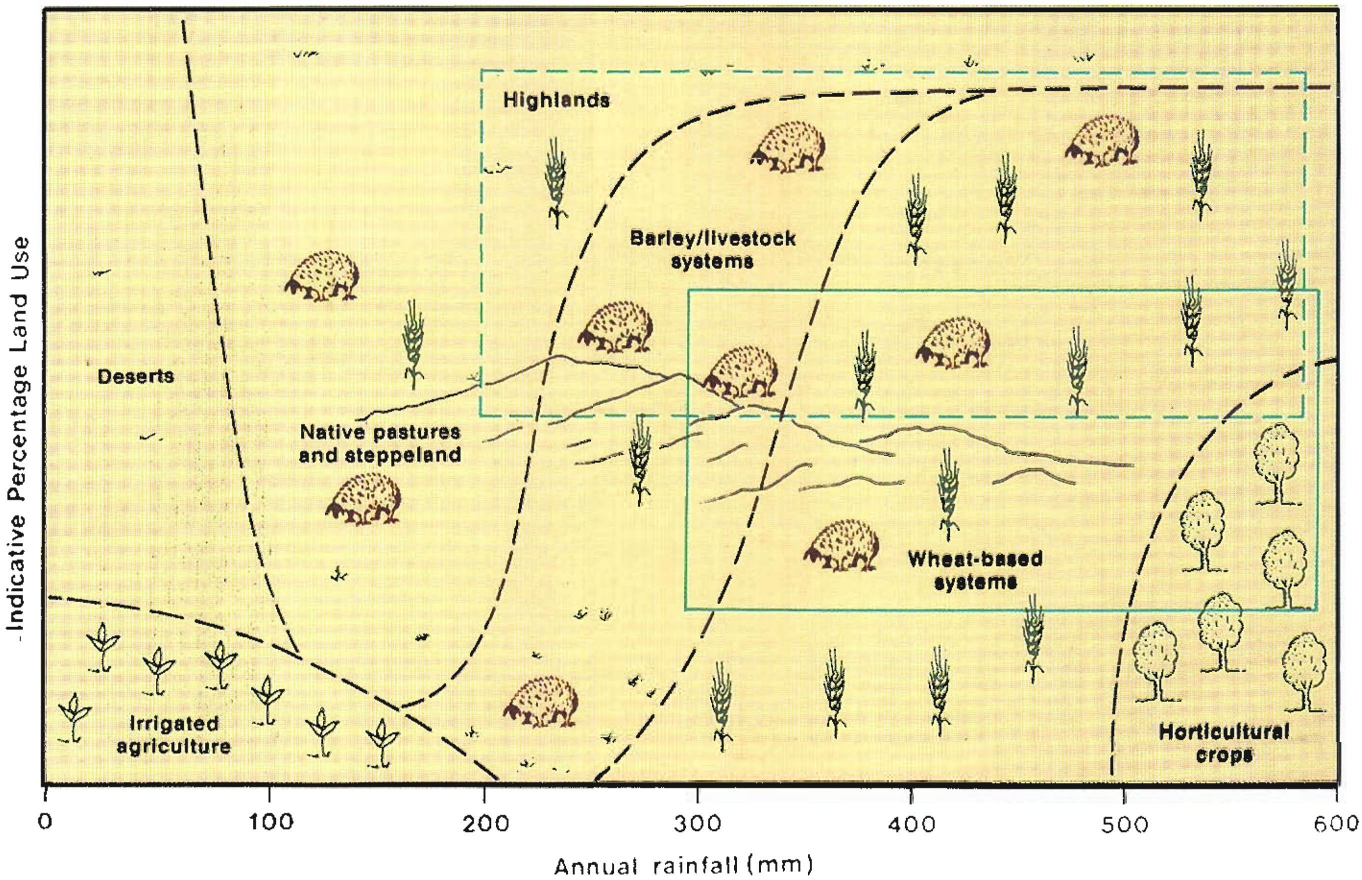
Following the EPR and EMR, a revised draft Strategic Plan was developed, incorporating the recommendations of the two panels, for presentation to TAC at its 48th meeting scheduled for January 1989 at CIMMYT.

Key Features of the Strategic Plan

* ICARDA will, through its own research and training programs, and those of organizations collaborating with it, strive to increase the productivity of the rainfed agricultural systems to progressively higher sustainable levels, in the harsh, stressful, and variable environments of WANA.

* ICARDA recognizes its stakeholders as follows: its main beneficiaries - the small farmer and other producers and consumers of food; its clients - the governments in the WANA region and their national agricultural systems; other IARCs within and outside the CG system which share in its work; and the donor community both as contributors to its resources and users of its research.

* ICARDA's mandate is sufficiently comprehensive and flexible to encompass and accommodate all adjustments in the orientation and content of its work that it deems necessary in the medium and long term.



ICARDA has developed its research programs in the context of the prevailing agroecologies. The agroecologies are primarily associated with rainfall bands and constitute a continuum which, for simplicity, can be classified into five major zones: deserts, steppe and native pastures, barley/livestock, wheat-based farming, and highlands.

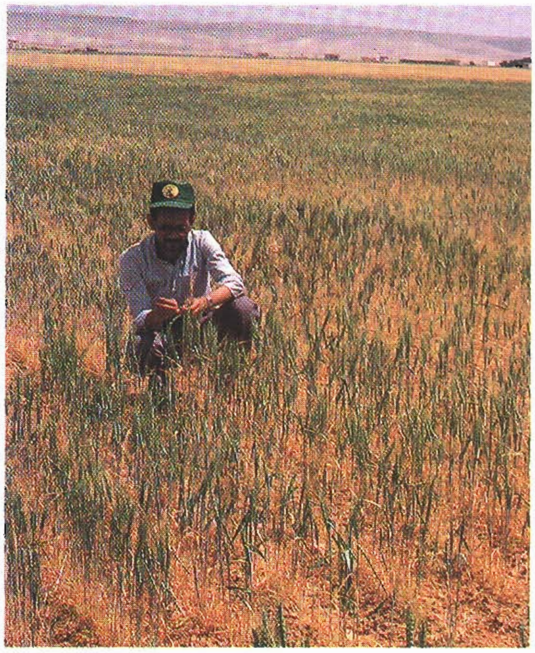
- Though less rewarding because of their low potential, poor infrastructure or inaccessibility, the lower rainfall areas and highland zones are so extensive in WANA that even small increases in their productivity can add up to substantial contributions. ICARDA will increase its work in these zones.

- While retaining the mandated crops, ICARDA will reduce the resources allocated to food legumes, whose demand and supply is projected to be in balance. The bulk of the faba bean improvement research will be transferred to an appropriate national program in WANA. Work on livestock systems will be strengthened.

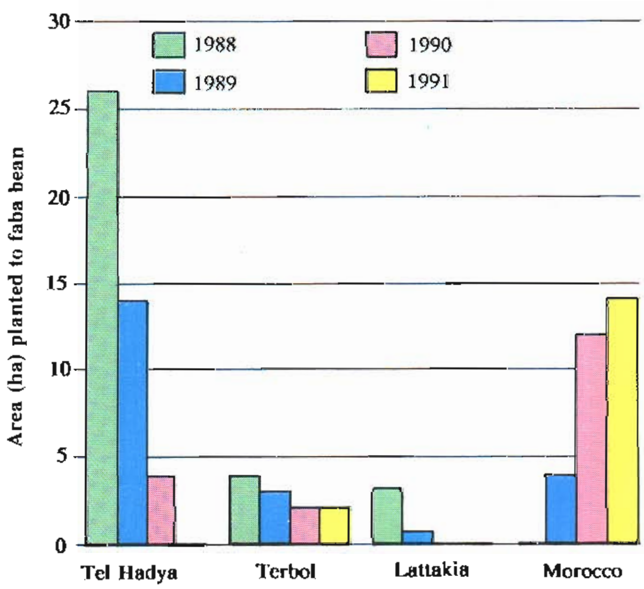
- Increasing attention will be paid to agroecological characterization, germplasm collection and maintenance, farm resource management, and small ruminant management. The basic theme of sustainability of the resource base and of production will permeate all research and training activities of the Center.

- ICARDA's current work combines problem-oriented applied and strategic research. While it will remain firmly problem-oriented, there will be increased emphasis on strategic research. Applied research will be conducted increasingly in subregional programs where NARSs have a special advantage, but ensuring a ready access to the facilities and expertise of IARCs.

- ICARDA will probably move upstream faster in the area of crop improvement, where NARSs are already relatively strong, than in the more



The low-rainfall areas (left) and highlands (right) account for the bulk of land area in WANA. Small increases in the productivity of these areas can make a substantial contribution to the overall food production in the region. ICARDA will pay greater attention to these areas in the coming years.



Shift in faba bean research from ICARDA's core program to the national program of Morocco.

complex areas of resource conservation and livestock production, where appropriate practices, and methods for assessing their impact, still need to be defined.

* Concurrently, with the greater emphasis on upstream research, applied and adaptive research will be increasingly decentralized, initially through networking under ICARDA's umbrella, but, wherever possible, by transferring the responsibility to capable and willing NARSs. This approach will make possible a more equitable sharing in the benefits of advanced technology between zones and countries on a region-wide basis.

* The research-linked activities of training and information will be further developed with greater involvement of NARSs.

* ICARDA will develop and apply appropriate methods for monitoring and gauging the socioeconomic and environmental impact of its work.

* Government policies are critical for the adoption of new varieties, technologies and the economics of agricultural concerns. Among other actions, such policies would also need to be carefully targeted taking into consideration the different commodities and the ecologies in which

ICARDA carefully monitors its training programs to ensure that they meet the specific needs of NARSs.

they are produced. Working closely with NARSs and regional organizations, and taking into account their individual status and needs, ICARDA will assist in the development of packages of policies based on the recommended technologies calculated to preserve the resource base while, at the same time, increasing food and feed production.

* Within the context of an efficient and effective organization and management, ICARDA will develop its structure so as to reconcile the claims of freedom in research pursuits and discipline with accountability in financial and administrative matters. Development of the Center's human resource will receive particular attention.

The Medium-Term Plan

To translate its Strategic Plan into action, ICARDA concurrently developed a Medium-Term Plan to cover the first five-year period (1990-1994). This document will also be presented to TAC at its 48th meeting in January 1989.

The Medium-Term Plan is geared to put ICARDA on the path it has chosen for the future. It will represent a period of transition in ICARDA's life, during which the Center will mould itself to the framework of its new orientations in research, training, and management. The Plan spells out the details of the activities to be initiated or strengthened as well as those to be reduced or phased out. It guides ICARDA in establishing a mechanism of resource allocation by activity instead of by program.

The Second External Program Review

Before the main phase of the review from 22 May to 10 June, visits had been arranged for the EPR Panel to a few countries in WANA: Sudan, 13-16 February; Morocco 16-19 February; Pakistan, 22-25 March; Turkey, 28-30 March.

The EPR Panel Report commended ICARDA's research activities and achievements and the credibility the Center has established with the NARSs in the region. "Research at ICARDA is generally of a high standard and comparable to that of other CGIAR Centers. Important research results have been achieved, most obviously in cereals and food legumes, but also in other areas related to pasture legumes and resource management," the report commented.

The Report makes useful suggestions to establish greater balance between programs' activities, including the strengthening of research in socioeconomics, livestock improvement, and certain aspects of farm resource management, while reducing the effort on food legumes. The Report endorses ICARDA's strategy on research management and organization, particularly the intention of the Center to move towards a matrix/project-based structure.

ICARDA found the EPR Panel Report broadly in line with its own thinking and, as stated earlier, benefited from the suggestions in refining its Strategic Plan.

The Second External Management Review

Country visits had also been arranged for the EMR Panel, before it started its main phase of review at ICARDA headquarters in Aleppo, 20 May to 10 June. With the EPR Panel, one EMR Panel member visited Sudan and Morocco, and another visited Pakistan and Turkey.

In its report to TAC, the EMR Panel commented that "ICARDA is in a period of transition. A new Director General, Deputy Director General (Research) and Financial Controller are in place. Much progress has been made in formulating a strategy more relevant to the needs of ICARDA's clients. The Board and Management have taken some courageous steps to solve several long-standing problems, and are poised to do more."

The Report, however, criticized certain aspects of ICARDA's culture and management. It referred to authoritarian leadership, management by exception, poor linkage between various activity domains, and weaknesses in the staffing of some departments and units, notably human resources and physical plant services. ICARDA believes that some of these comments are attributable to the EMR Panel's unfamiliarity with all aspects of the cultural environment in which the Center works. Nevertheless, ICARDA has already initiated steps to respond to the Report, where possible. While the internal adjustments to improve the efficiency are being implemented, the major impact in the long run will depend on the quality of staff the Center succeeds in attracting.

Research and Training Highlights

The highlights of ICARDA's activities must be reviewed against the background of the weather during the 1987/88 season (for details, see Part Two of this Report). Not surprisingly, the WANA countries again experienced greatly contrasting weather conditions. The season was the wettest in Syria since 1940/41, so the farmers throughout much of the country harvested a bumper crop. Turkey, Cyprus, Iraq, large parts of Iran, Lebanon, Jordan, the Egyptian coast, and Cyrenaika (eastern Libya) had all good to very good harvests. However, to the east of this area, drought conditions prevailed over Afghanistan and Baluchistan. Another area that faced drought stretched from Tripolitania (western Libya) through Tunisia and Algeria into the northeastern corner of Morocco. In Tunisia, the drought was the most severe of this century, with rainfall totals being about 40% below the long-term average. In sharp contrast, most of Morocco enjoyed a season of high, well-distributed rainfall leading to a record crop.

Such a large climatic variability within the same season highlights the challenges that ICARDA and the national agricultural systems must face together.

In this Annual Report, ICARDA Reports its research results and achievements by activity for the first time. The Center recently grouped its total research effort into seven integrative activity-packages:

- agroecological characterization
- germplasm conservation
- germplasm enhancement
- resource management and conservation
- training
- information dissemination
- impact assessment and enhancement

These packages derive their identity from the CGIAR/TAC program approaches and highlight

ICARDA's appreciation of the interlinkages between research needs of the diverse yet congruent agroecologies covered by the Center's mandate. Introduction of the seven multidisciplinary packages has enhanced interaction between programs at the main research station as well as between main station and outreach programs. It has led to a greater coherence of activities and a more efficient use of resources across the Center, and allowed a clearer perception of the balance between and among activities for human and financial resources allotment. The Center can now more effectively measure the appropriateness and effectiveness of its research programs.

Agroecological Characterization

The concept that productivity and profitability are strongly dependent on the season's weather was amply evident in the 1987/88 season. The wetter conditions of the season produced high yields of up to 5000 kg/ha but, even with high rainfall, supplementary irrigation added up to 40% to the yields.

The development of a spatial weather generator, capable of dealing with poor quality data sets with less than optimal length of run and distribution, was completed. It will now be evaluated under a wider range of conditions in collaboration with colleagues from Syria, Turkey, Morocco, ICRISAT, and CIAT.

The initial development of the CERES-N barley crop growth simulation model was completed in collaboration with Michigan State University and the International Fund for Agricultural Development. The model has already been introduced to ICARDA's scientists.

Germplasm Conservation

Work on germplasm exploration, collection, conservation, and enhancement remains the backbone of ICARDA's research. During the year, about 2,500 samples of cereals and food and forage legumes from unexplored areas of Syria and Jordan were collected jointly with national scientists, bringing ICARDA's collection to over 86,000 accessions. The renewal, multiplication, and characterization of earlier accessions was continued and intensified. About 15,000 samples were planted for health inspection or regeneration and two-thirds of these were evaluated and multiplied.

Considerable resources and efforts are being devoted to meet requests for germplasm samples. In 1987/88, a total of 17,000 seed samples were distributed outside ICARDA. This represents a 70% increase over 1986/87, and indicates a rapidly growing interest in, and an extensive utilization of, ICARDA's germplasm collections by its partners.

Germplasm Enhancement

A good measure of the success of ICARDA's work in germplasm enhancement is the number of variety releases based on its material and technology. In 1988, 25 cultivars of barley, durum wheat, and bread wheat were released by national agricultural research systems in Tunisia, Egypt, Jordan, Syria, Iran, YAR, and PDRY. Large quantities of breeder seed of some of these cultivars were sent to Morocco, Algeria, Tunisia, and Iran. Algeria released two varieties of chickpea and two of lentil; France, two of chickpea; Lebanon, one of lentil; Oman, one of chickpea; and Morocco identified several lines for advanced testing. These figures bring the total number of cereal releases to 116 and of food legumes to 35 (Appendix 2).

Work continued on the testing of new material. A total of 1,500 barley, bread wheat, and durum wheat nurseries were distributed to 131 cooperators in 50 countries in cooperation with CIMMYT. The nurseries were targeted to low and moderate rainfall and highland areas as well as for testing for specific traits such as heat/drought tolerance and disease resistance. There were also 1,223 food legume nurseries distributed to 160 cooperators in 52 countries.

The plant breeding work is being supported by various upstream activities in physiology, microbiology, and biotechnology. Physiological studies for genotype characterization have shown that C-13 discrimination and leaf color could be useful selection criteria in barley improvement for dry areas.

Special projects to understand the mechanism of resistance to ascochyta blight and leaf miner in chickpea, and to botrytis and *Orobanche* in faba bean, are being conducted in cooperation with centers of excellence in industrialized countries.

Measurement of nitrogen fixation in chickpea using the isotope dilution technique showed highly significant interactions between *Rhizobium* strains and cultivars. The best strain increased total nitrogen fixed by 25%, from 65 to 81 kg/ha, and enhanced the yield of one of the most promising chickpea cultivars (ILC 482) by nearly 1000 kg/ha (49%). Rhizobia suitable for most of ICARDA's medics have now been identified. Strain M29 performed well in Turkey, Syria, Jordan, Algeria, Morocco and France, increasing the nitrogen fixation by *Medicago rigidula* by about 100 kg/ha. Considering the importance of maintaining the sustainability of cropping systems and the inability of many of the region's farmers to afford inputs, these results can have far-reaching practical implications.

Work on haploid production using anther culture and inter-specific hybridization with *Hordeum bulbosum* was initiated in collaboration with institutions in France and Japan. Double haploid plants for bread wheat and barley have been produced from a number of crosses, and accessions of *H. bulbosum* evaluated for cross-compatibility with bread wheat. Interspecific hybridization with maize is being investigated as a possible technique to increase plant regeneration frequency. Biotechnology research will be expanded in cooperation with INRA of France through a regional program.

Resource Management and Conservation

A zero-till planter, capable of seeding directly through wheat and barley stubble was used again in 1987/88. Excellent establishment of chickpea, lentil, vetch, and lathyrus was achieved and high yields obtained. This method has great potential for the control of wind and water erosion and for improving water-use efficiency.

In the continuing series of on-farm fertilizer trials being conducted jointly with the Syrian Soils Directorate, high responses to nitrogen were the main feature. Results confirmed that rainfall, soil fertility, and crop rotations all substantially affect the economics of fertilizer use.

After four years and two complete cycles of a pasture/cereal rotation, the ley farming system has been successfully established on farmers' fields in

A zero-till planter has been assembled at ICARDA using imported commercial units and a locally built seed box.

North Syria. Wheat yields after pasture were greater than after the farmers' alternatives and the stocking rate of regenerating pasture exceeded 7 ewes/ha, an increase of 300% over the average. Profitability of the livestock enterprise was far higher than all other production options, including that of wheat. The stage is now set to take this technology to other countries.

In response to the high rainfall in 1987/88, grain yields of five species of *Vicia* and *Lathyrus* were excellent, reaching about 4900 kg/ha. Results from three years and two sites suggest that *Lathyrus ochrus* may produce grain yields of 750 kg/ha even when rainfall is only 250 mm. This species, however, was severely affected by frost. All tested species of *Vicia* and *Lathyrus* had high quality forage and straw, but protein content was variable.

Herbage yields from grassland top-dressed with superphosphate was more than treble that of untreated grassland. This was reflected in the body mass of ewes and in the reduction of the amount of supplementary feeding.

The intake of barley straw by sheep was directly related to its protein content. Straw length and leafiness were confirmed as factors affecting straw quality, but environmental factors affecting these parameters were shown to be more important than genetic factors.

Training

Training has been the fastest growing of all activities of the Center, and received increased attention in 1988. There were 610 trainees during the year; 272 at headquarters and 337 at in-country or sub-regional courses. Approximately 11% of the participants were women. Participants came from 19 countries in the WANA region, 13 developing countries outside the region, and 4 developed countries of the European Community.

The continuing restricted-core grant of the Arab Fund for Economic and Social Development provided major funding support to 441 Arab participants from the WANA region, while the special project grant of the Ford Foundation was the major funding source in support of graduate research training, with particular emphasis on the training of women in agricultural research.

Additional funding support was provided by AOAD, UNDP, USAID, FAO, GTZ, IFDC, EC, IDRC, the OPEC Fund, and various bilateral donor projects, to meet specific national program or project personnel training needs.

Information Dissemination

ICARDA considers information dissemination an important and integral part of its activities. In 1988, a Publication Committee was established to develop a detailed publication policy for the different categories of publications, and procedures to produce them in English, Arabic and French, as appropriate, for the different audiences of ICARDA.

Apart from regular publications including the Annual Report, the three newsletters - FABIS, LENS, and RACHIS, and seminar and workshop proceedings, over 80 journal articles were processed for publication.

At a meeting of IARC information personnel held at ICRISAT, ICARDA was designated as the "lead center" to solicit the cooperation of libraries participating in AGLINET (the Agricultural Library Network) to serve as depositories of all CG-Centers' publications and offer access to them under normal inter-library loan and photocopying procedures. A positive response has already been received from the libraries of the Agricultural University, Wageningen, Holland, and Agriculture Canada, Ontario. In this vein, ICARDA signed agreements of cooperation with the libraries of the Syrian Atomic Energy Commission, the Egyptian Documentation and Information Center for Agriculture, and the University of Aleppo.

ICARDA is moving towards a greater use of micro-computers. Thirty have been installed and more are on order. The Center is also building up a software library and providing training in software packages in-house and at outreach locations, as well as at NARSs (e.g. Morocco and Tunisia).

Impact Assessment and Enhancement

Eight case studies in five countries on agricultural labor and technological change, and regional and country reviews of agricultural labor, have been completed. Both are being prepared for publication.

Over 200 farmers have participated in a pilot project launched in 1985 to improve wheat production in the Sudan. Using improved wheat varieties and recommended cultural practices, yields of up to 3600 kg/ha, over three times higher than the average, have been achieved. The project is a collaborative effort of the Agricultural Research Corporation of the Sudan, ICARDA, OPEC, and CIMMYT.

A survey of the adoption of Sham 1, a durum wheat variety recently released in Syria, revealed that over 10% of the farmers surveyed had adopted it within only three years of its release.

The number of participating farmers has been rapidly increasing in a pilot/demonstration program initiated three years ago to introduce faba bean in new areas of the Sudan. The project covers the Gezira, Rahad, and New Halfa government scheme areas. In the Gezira scheme alone, the number of farmers rose from 3 to 84 in the past three years. The scheme management estimates that if each farmer grew one acre (0.45 ha) of faba bean, a target of 160,000 additional hectares could be easily reached. This would double the area currently under faba bean in the country.

An economic framework for Centralized Fertilizer Allocation to Crops in Contrasting Production Zones has been developed in collaboration with Aleppo University, and is being evaluated by the Syrian Ministry of Agriculture and Agrarian Reform.

The Outreach Program

In recognition that the range of specific research and training requirements of the WANA region cannot be adequately met from one location, however well placed it may be, ICARDA is actively expanding and decentralizing its research and strengthening its outreach activities in partnership with national agricultural research systems. Currently, the Center is operating, or developing, the following six regional programs based on commonalities of geography and agroecologies or constraints to production. The details of the research activities and achievements of the regional programs are reported in Part Two of this Report. All six programs have strong components of training and information dissemination.

1) *The Highland Program.* The major highlands of WANA are in two distincts masses: one in the East, covering Turkey, Iraq, Afghanistan and Pakistan; the other, in the West, covering the Algerian - Moroccan Atlas range. Highland work is being developed first in eastern WANA.

   The second phase of the USAID-supported AZRI Project in Pakistan, which will concentrate on range management and water harvesting, will be an important component of the highland work.

2) *The Arabian Peninsula Regional Program.* The overall objective of this Program is to narrow the widening gap between the production and demand of wheat and barley in the Arabian Peninsula.

3) *The West Asia Lowland Program.* This Program will cover Jordan, Syria, Lebanon, Iraq, Southern Turkey, and Cyprus, and will be operated from Jordan. It will promote regional cooperation in research, training and information dissemination.

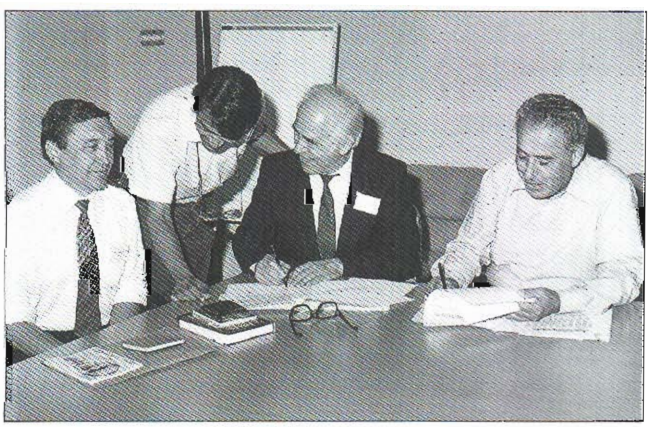
4) *The Nile Valley Regional Program.* This expanded program, in which Egypt, the Sudan, and Ethiopia share research and training to improve the productivity of wheat, lentil, chickpea, and faba bean, will become operational in 1989. CIMMYT is expected to participate in this as well as the Arabian Peninsula Program.

5) *The North Africa Regional Program.* This Program serves Libya, Tunisia, Algeria, and Morocco. The objective is to strengthen research and technology transfer to increase barley, food legume, and livestock production. A sub-component of this Program will be the regional work on faba bean, likely to be based in Morocco.

6) *The Latin America Regional Program.* This Program is still in the planning stage. It will be based on the existing Latin America Barley Program supported by an ICARDA scientist working from CIMMYT, Mexico. The possibility of expanding it to cover food legumes is being considered with ICRISAT.

Widening the Horizon of Partnership

ICARDA's expanding cooperative work in its region and beyond, is being formalized in written agreements. During the year, agreements were signed between ICARDA and the All Union Academy of Agricultural Sciences of the Soviet Union; the Agricultural and Natural Research Organization of the Ministry of Agriculture, Islamic Republic of Iran; the Government of Nepal; the Tropical Agriculture Research Center (TARC) of Japan; the Alemaya University of Agriculture, Ethiopia; the University of Hohenhiem, West Germany; and the International Center for Mediterranean Agronomic Studies (CIHEAM), France. Nearer home, a tripartite agreement was signed with ACSAD and the Steppe and Range Directorate of the Ministry of Agriculture and Agrarian Reform, Syrian Arab Republic. ICARDA's agreements with the Aleppo and Tishreen Universities were renewed.



One of the significant developments in 1988 in ICARDA's collaborative research activities was the signing of an agreement with the USSR.

Buildings

Although the main phase of the headquarters buildings at Tel Hadya had been completed in late 1987, construction of a new Genetic Resources

The new Genetic Resources Building under construction at Tel Hadya.

Building, funded by the Italian Government, was still in progress during 1988. This building, expected to be ready in early 1989, will provide all modern facilities necessary for the conservation, preservation, and evaluation of the precious genetic resources which are the basic raw material for any crop improvement program. This new facility will go a long way in not only facilitating but also accelerating the research activity of NARSs.

Looking Ahead

Whatever the magnitude of strides that ICARDA has made in its brief 12 years, there is still much to be done. Agricultural research in harsh environments is a perpetually complex and painfully slow process which demands great patience.

At the end of 1988, ICARDA was well poised to move into 1989 with a renewed commitment to intensify its support to NARSs and, with their increased participation, to pursue its goal of maintaining as well as increasing productivity and at the same time preserving the natural resource base. The Center recognizes that NARSs are the pivot of its programs. Looking at the increasing resources being allocated to agricultural research in the WANA countries, it is clear that the Center's partners fully appreciate that greater agricultural productivity only can propel them to greater economic prosperity.

PART TWO

Research and Training Review

Contents

Research and Training Review

While ICARDA continues to be structured by program to facilitate human and financial resources management, its total research effort was recently grouped into seven integrative activity-packages. These are: agroecological characterization, germplasm conservation, germplasm enhancement, resource management and conservation, training, information dissemination, and impact assessment and enhancement. Superimposed on the existing structure of ICARDA, these packages derive their identity and character from the CGIAR/TAC program approaches and highlight ICARDA's appreciation of the interlinkages between research needs of the diverse yet congruent agroecologies covered by the Center's mandate. Each package is a multidisciplinary research effort with a well-defined program of work and a set of objectives, designed to contribute to the Center's overall goal of achieving sustainable increases in crop and livestock productivity.

Introduction of the seven multidisciplinary activity-packages has enhanced interaction between programs at ICARDA's main research station as well as between main station and outreach programs. It has also established a greater coherence of activities and a more efficient use of resources across the Center, and allowed a clearer perception of the balance between and among activities in terms of human and financial resources allocation. The Center now can more effectively measure the appropriateness and effectiveness of its research programs.

In this Annual Report, ICARDA reports its research results and achievements by activity for the first time.

The Weather in 1987/88

The highlights of ICARDA's activities must be reviewed against the background of the weather during the 1987/88 season. Not surprisingly, the WANA countries again experienced greatly contrasting weather conditions.

The 1987/88 season was the wettest in Syria since 1940/41 when seasonal rainfall totals exceeded those of 1987/88 by 10 to 20%. The average recurrence interval of seasons with the same rainfall as 1987/88, or more, is estimated to be around 30 years. As the increased rainfall was due to increased cyclonic activity and, therefore, was of the advective type, the relative increase was more pronounced in the drier part of the region: Jindiress, ICARDA's wettest site, received 48% more than the long-term seasonal average of 483 mm; but Bouider, where the long-term average is 212 mm, received 386 mm, or 81% more than "normal" (Appendix 1).

The season started early with heavy rains from 17 October to 6 November. Then followed the only prolonged dry spell of the season which, interrupted only by minor showers at some sites, lasted until 4 December. This period was ideal for planting. December brought less than average rainfall at some sites, more than average elsewhere. January, February, and March were wetter than average across the whole country. The last significant rains of the season fell around the middle of April. However, the good accumulated supply of soil moisture allowed the crops to mature with less stress than in most seasons in the past.

The temperature throughout the season was close to the long-term average with no extremes. The number of frost days was below average, in particular at the drier sites, as the frequent cloud cover reduced the occurrence of radiation frosts. Altogether the weather in Syria during the 1987/88 season laid the foundation for a bumper crop, which was widely achieved.

Turkey, Cyprus, Iraq, large parts of Iran, Lebanon, Jordan, the Egyptian coast, and Cyrenaika (eastern Libya), all had good to very good harvests. To the east of this area, drought conditions prevailed over Afghanistan and Baluchistan. In Baluchistan, a large part of the dryland crops failed to make grain due to late and inadequate rainfall.

Another area, where drought prevailed, stretched from Tripolitania (western Libya) through Tunisia and Algeria into the northeastern corner of Morocco. In Tunisia, the drought was the most severe one of this century with rainfall totals being up to 40% below the long-term average in the most productive cereal-growing areas. Rainfall deficits of similar magnitude were also widespread in Algeria, and in both countries the cereal crops were largely used for grazing. In sharp contrast, most of Morocco enjoyed a season of very high, well-distributed rainfall leading to a record crop.

The season was good for the countries of East Africa and in the south of the Arabian Peninsula.

The spring rains in Ethiopia were adequate and yielded a good harvest. Rainfall during the monsoonal summer in Ethiopia and Yemen was high, causing flooding in places, but also leading to a good crop.

Such climatic variability is a characteristic feature of the environment in which ICARDA works, and highlights the challenges facing the Center and the national agricultural research systems in the region.

Agroecological Characterization

Work on agroecological characterization is intended to help ICARDA and NARSs improve the efficiency, relevance, and targeting of research through the application of techniques which both characterize agroecological variability and predict how such variability will interact with and modify the impact of new technology.

A major feature of the ICARDA region is wide year-to-year variability in weather. Erratic rainfall and its distribution and the unpredictable occurrence of extremes of temperature cause sharp fluctuations in agricultural production, both at national and individual-farmer levels. In addition, wide differences in altitude, slope, and soil texture, depth and stoniness produce contrasts in land use, agronomic practices and economic potential, often over short distances. These complicate the formulation of agricultural policies, the planning and conduct of research, and the extension of research findings.

ICARDA seeks to assemble, adapt, test, and validate existing techniques for agroecological characterization. The Center recognizes that NARSs have a major role to play in the testing and validation of such techniques, both through their access to the required data inputs and their first-hand knowledge of local socioeconomic conditions. Thus, in the extension and application of these techniques within the region, ICARDA will increasingly work in partnership with NARSs through both training and collaborative research projects.

In this report, progress in two methods of characterizing and predicting the impact of variable environments on the performance of crops is presented. The first method demonstrates how statistical procedures (multivariate cluster analysis) can be used to assist plant breeders in understanding the pronounced interaction between genotypes and the environment, and the second illustrates the development and use of crop growth simulation models, and their ability to mimic the response of a wheat variety to contrasting soil conditions and management strategies.

Statistical Techniques for Environmental Characterization

ICARDA has a world responsibility for the improvement of barley, lentil and faba bean, and a regional responsibility in WANA for the improvement of wheat, chickpea, and pasture and forage crops. As these crops are grown in diverse conditions of moisture supply, temperature, soil type, crop management and biotic stresses, large interactions between genotype performance and the environment hinder the progress in breeding more productive materials. The combined analyses of variance across environments using cereal and food legumes international yield trials data of the past years have confirmed large genotype x environment interaction. Clearly, if relatively homogeneous areas with predictable environmental variation and thus reduced size of the interaction could be identified, progress in breeding would be enhanced. One way to achieve this is to divide the world or the region into a small number of relatively homogeneous zones or subregions and then breed for each subregion.

Environments can be classified according to climate, soil type, and other agronomic factors. Based on such information, ICARDA has been attempting to classify various environments and the different nurseries developed by it. Examples are the Chickpea International Yield Trial for the Mediterranean or for Sub-tropical Environments, Lentil and Chickpea Cold-Tolerant Nurseries, Lentil Early Trials and Nurseries for Southern Latitudes, and various disease-resistant nurseries for different regions. The international yield trials data returned by the national program scientists are used for determining correlations among environments and for multivariate cluster analysis. This has enabled the Center to develop empirical statistical approaches to environmental characterization.

The principle of the statistical approach is similar to that of using disease differentials to detect areas with similar pathogen races. By planting a set of differential genotypes at different locations, and by examining the disease reactions of the genotypes, the pathogen race(s) present at a location can be detected, and locations with similar race(s) can be grouped together. For example, the testing of differential sets of food legume genotypes against various diseases across a large number of environments in various countries has led to the grouping of disease-prone and disease-free areas, and to the understanding of the variability in a particular pathogen across environments. Similarly, by planting a set of different genotypes at different locations, one expects differential yield responses among the genotypes, i.e. a genotype or a group of them performs well at certain locations but not at others. The similarity between two locations can be measured by simple correlation coefficients. The similarity between food legume growing environments has been measured using the correlation between them. One step further, the cluster analysis helps identify the locations more similar to one another. Thus, within groups, locations may be relatively similar, but among groups they may be relatively different.

The classification of 21 sites by cluster analysis using two years data from the ICARDA/CIMMYT Regional Durum Wheat Yield Trial is shown in Fig.1. There were four clusters or groups. Cluster (a) consisted of four sites with large differences in latitude in the eastern part of the Mediterranean Basin. Cluster (b) was the largest group and comprised sites around the Mediterranean Sea. With the exception of Sids, sites in this cluster were higher than 650 meters above sea level or situated above 38°N. Sites in cluster (c) were all located above 36°N, while sites in cluster (d) lay in coastal plains or in the lower latitudes, and had high rainfall or full irrigation.

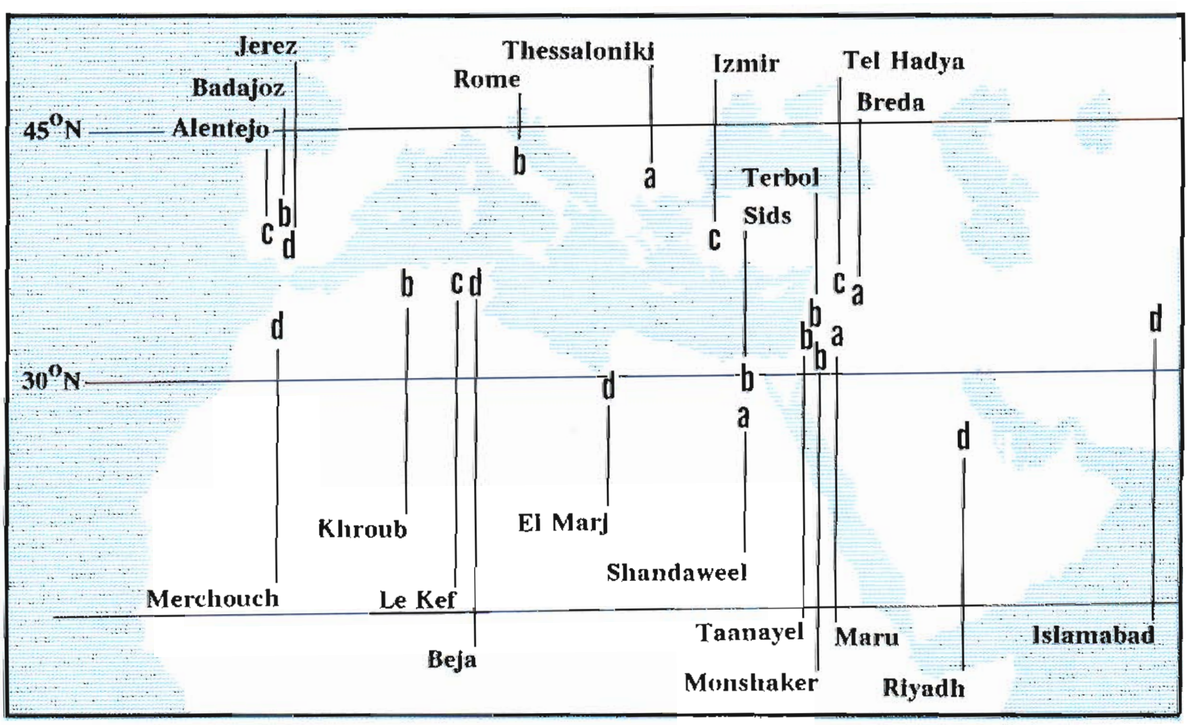


Fig. 1. Classification of 21 durum wheat growing sites by cluster analysis using two years data.

Crop Growth Models and Agroecological Characterization

Crop growth models are being developed by many advanced institutes, and ICARDA continues to cooperate with them for the development and testing of models which have direct relevance to the Center's mandate crops. Such models integrate and translate the effects of agroecological variability, crop genotypic differences and crop management strategies into estimates of potential crop production. They are powerful tools (in conjunction with field testing) for assessing the long-term suitability and impact of new technology across a range of diverse environments for which real or realistically generated weather data are available.

Currently, ICARDA is validating and comparing two existing wheat growth models. SIMTAG, developed in collaboration with the University of New England, Australia, has already been widely validated using regional data. CERES-N Wheat Growth Simulation Model is currently under evaluation, and the Center is cooperating with IFDC and Michigan State University in the development and testing of a CERES-N Barley Growth Simulation Model.

In May 1988, a 5-day internal workshop was held to introduce the colleagues to the background and potential of the CERES growth models, and to offer them the opportunity to test the prototype barley model against their field data.

Two examples of the use of crop growth models are presented here. In the first example, SIMTAG was used to examine the effect and importance of soil depth in determining the length of grain-filling period and the grain yield of Mexipak wheat at Jindiress in North Syria.

During the winter when temperatures and vapor pressure deficits are low, rainfall usually exceeds the water use by crops, and water accumulates in the soil profile. As temperatures rise in the spring and crop canopies develop, water use becomes greater than the supply from rain. Crops then depend on stored soil water to complete their growth, and almost always are stressed.

The amount of stored water available at this time depends not only on total seasonal rainfall

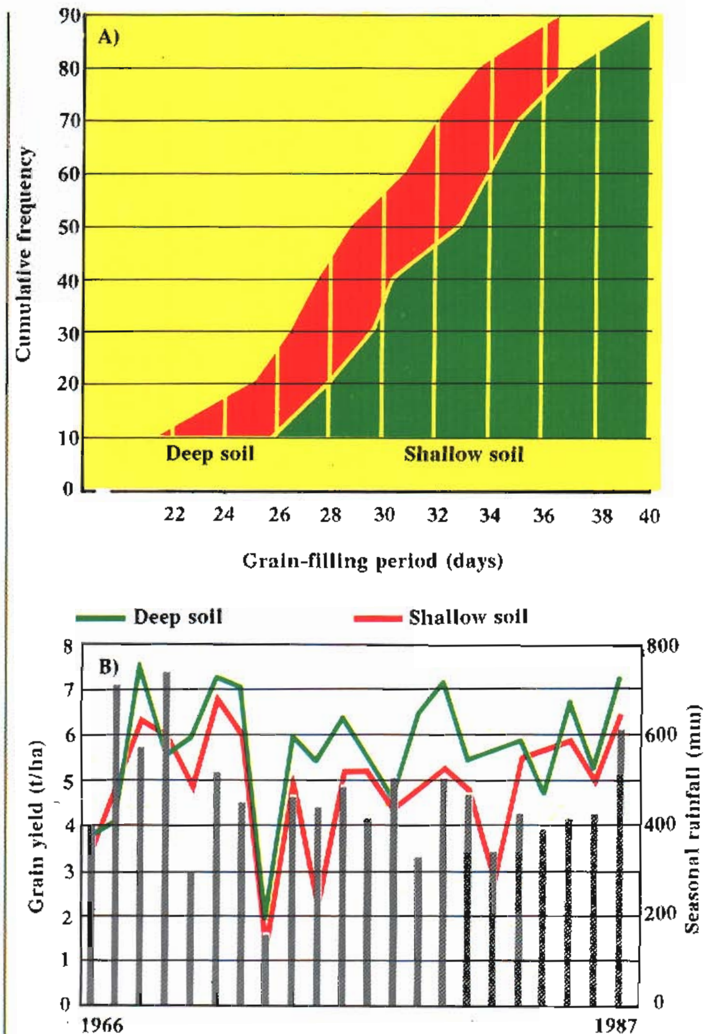


Fig. 2. Computer simulation (SIMTAG Wheat Growth Model) of the effect of soil depth and rainfall on (a) the length of the grain-filling period, and (b) grain yield of wheat (var. Mexipak) at Jindiress, North Syria, 1966-1987. (Vertical bars represent seasonal rainfall.)

and its distribution, but also on soil type and depth. Soil depth is especially important, as even in a wet year not enough water can be stored in shallow soils to meet the needs of crops. Temperatures and stored moisture interact to determine the length of the grain-filling period and the size of the yield. This is illustrated in Fig.2. Farmers are also aware of the implications of soil depth for both the effective length of the growing season and for the crop yield potential. Our survey work has shown that even in the wetter wheat-growing areas, farmers often plant barley, which matures faster, on shallow soils and apply reduced amount of fertilizer. The ability of SIMTAG to characterize the implications of soil depth will greatly assist in targeting genotypes and developing management strategies for a range of soils with contrasting water storage capacities.

In the second example, the CERES-N model was used to assess the impact of two crops (lentil and a summer crop, watermelon), which commonly precede wheat, on the response of wheat to 80 kg N/ha. Using soil fertility data from on-farm trials and soil water profiles recorded following these two crops, the model was run with long-term weather records from Muslimieh (average seasonal rainfall of 350 mm) in North Syria for the period 1960-1985. The model was run using the genotypic coefficients of Sham-1, a newly released durum wheat cultivar. Though CERES-N was originally developed for bread wheat, its initial evaluation with durum wheat suggested that some minor modifications in the thermal time required for individual leaf emergence are necessary. In the runs reported here, the thermal time was modified from 95 to 85 degree days. The output of these runs is presented in Fig.3 (a, b).

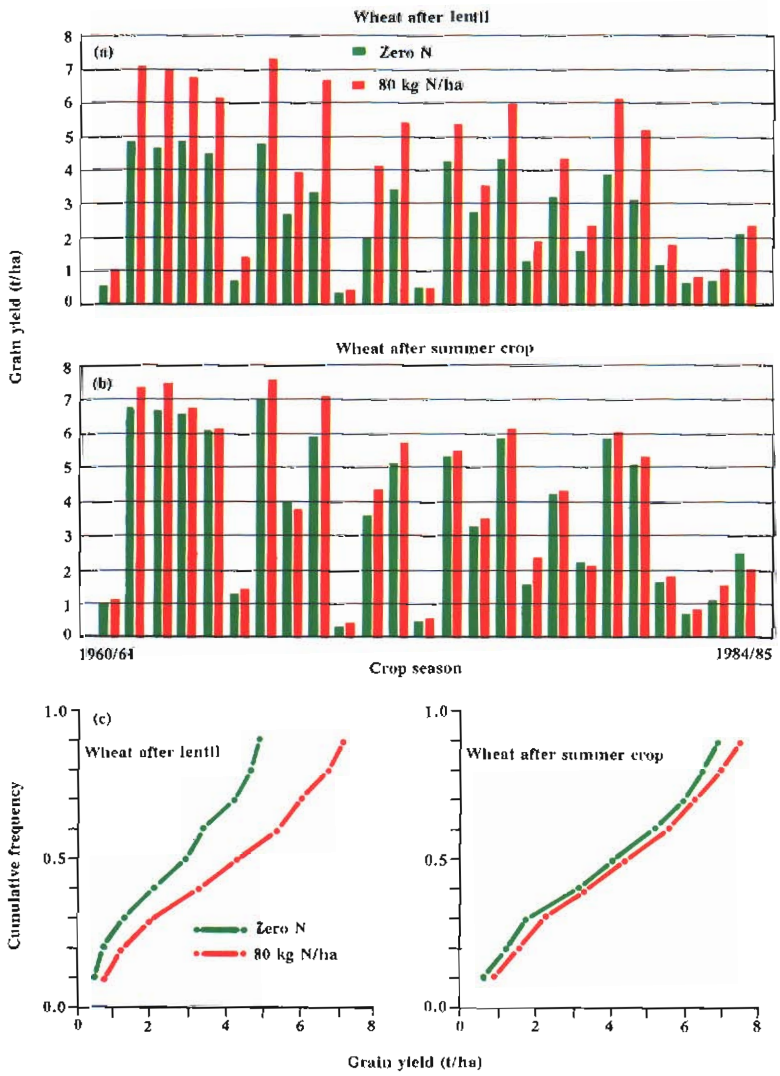


Fig. 3. Simulated (Ceres-N) grain yield (t/ha) of Sham-1 wheat following (a) lentil and (b) water melon at Muslimieh, N. Syria, using daily weather data from 1960 to 1985. Figure (c) presents these data as cumulated frequencies.

With no fertilizer applied, wheat following lentil yielded lower than after the summer crop, a pattern observed at Tel Hadya in four of the last five seasons, and also in many on-farm trials (Table 1). In contrast, the response of wheat to 80 kg N/ha was over 40% greater after lentil than after melon and this again confirmed our experimental data. As there is a strong interaction between nitrogen and water, the size of the yield increase due to N-fertilizer is quite variable, and a negative response following summer crop is predicted in some years at this relatively dry site.

Table 1. Mean increases (%) in grain yield of Sham-1 in response to 80 kg N/ha in on-farm trials in Syria, 1986/87 and 1987/88.

Preceding crop	Number of locations	Grain yield (kg/ha) 0-N	Grain yield (kg/ha) 80-N	% Increase
Lentil	10	2550	3605	41
Summer crop	13	3180	3983	25

These results are very encouraging, as they indicate that the model predicts grain yield with sufficient sensitivity to allow the examination of a number of important issues.

One of the objectives of ICARDA's work on fertilizer is to improve the efficiency of its use by refining recommended application levels according to seasonal conditions. There is scope to do this because most of the nitrogen is topdressed in the late winter or early spring. By this time soil water storage is at its maximum for the season and better judgements should be possible on how much nitrogen to apply.

One planned use of the model is to evaluate the strategies based on this knowledge of soil water storage and the probability of rain in the remainder of the season. By using long runs of real or realistically generated weather data it should be possible to assess the risk, both biological and economic, of alternatives for fertilizer management. This is illustrated in Fig. 3(c). From a biological standpoint, the application of nitrogen following lentil has a low risk. In other words, at all levels of probability the yield of N-fertilized wheat will be greater than without fertilizer. However, when wheat follows summer crop at this location, the yield increase is very small. This analysis, translated into economic terms, can be used to assess various management strategies and their associated risk.

Germplasm Conservation

ICARDA's germplasm conservation activity is part of a worldwide effort which aims at exploring, preserving, and utilizing the diminishing plant genetic resources. This effort is the responsibility of the Genetic Resources Unit of the Center, in cooperation with IBPGR.

The WANA region is especially rich in genetic resources since it includes the centers of origin and diversity of ICARDA's mandated food crops and a wide variety of pasture and forage legume species. Though these genetic resources are of crucial importance in crop improvement and related research, they are being increasingly eroded in the region. These precious resources must be collected and preserved before they disappear from nature.

In 1988, work was continued to explore and collect additional genetic resources, and to multiply, characterize, document, and safeguard the collections. With the collections made in 1988, the total number of germplasm accessions at ICARDA rose to 86,591 (Table 2).

A total of 584 population and 1,930 single-plant samples were collected from unexplored areas in Syria and an additional 167 samples from Jordan jointly with national program scientists. The collected material includes cultivated barley and *Hordeum spontaneum*; durum and bread wheat; wild *Triticum* and *Aegilops* species; chickpea, lentil, and faba bean; wild *Cicer* and *Lens* species; and cultivated and wild forage legumes.

New accessions of durum wheat (2,958), bread wheat (5,566), barley (328), *Hordeum spontaneum* (256), chickpea (501), lentil (298), faba bean (373), annual medics (324), *Vicia* species (15), *Lathyrus* species (19) and peas (4), collected or received in the previous year, were planted in the isolation area for multiplication and health inspection. Three to 10 stable characters were recorded for 1,534 food and forage legume accessions for preliminary characterization of the new germplasm during multiplication.

Table 2. Germplasm collections at ICARDA in 1988.

Crop	Number of accessions		
	Total	In medium-term storage	To be multiplied
Cereals			
Barley	15994	13824	2170
Durum wheat	20141	11700	8441
Bread wheat	10419	3440	6979
Wild relatives	3195	3191	4
Food legumes			
Lentil	6758	6498	260
Chickpea	6804	6437	367
Faba bean	3077	183	2894
Wild *Lens* spp.	199	195	4
Wild *Cicer* spp.	52	39	13
Forages			
Annual medics	4325	1960	2365
Pisum spp.	3304	2461	843
Vicia spp.	3582	1570	2012
Trifolium spp.	1273	-	1273
Trigonella spp.	156	-	156
Astragalus spp.	313	-	313
Lathyrus spp.	946	749	197
Other species	6053	398	5655
Total	86591	52645	33946

A total of 3,976 seed samples of food and forage legumes, temporarily stored in the cold store, were regenerated to obtain a sufficient amount of good quality seed for medium- and long-term preservation.

A total of 10,022 entries were evaluated, partly in collaboration with the commodity programs, and multiplied, including 1,200 barley (23 descriptors), 861 *Triticum turgidum* ssp. *dicoccoides* (22), 651 *Aegilops* species (18), 6,224 chickpea (7), 629 *Medicago polymorpha* (23), 57 *Medicago scutellata* (23), and 400 vetch (16) accessions. A selection of 64 durum wheat landraces from the 1987 collection trip in Syria was evaluated to characterize both within- and between-population variation for selected characters.

In collaboration with the Cereal Improvement Program, 1,209 Ethiopian barley accessions were screened for scald (*Rynchosporium secalis*), and 200 *Triticum turgidum* ssp. *dicoccoides* samples of different origins were tested for yellow rust, leaf blotch, and common bunt resistance.

The documentation system of passport and collection information was updated and a new collecting form and matching accession books were introduced to facilitate the quick transfer of data into the computer. Collection and passport information and evaluation data were continuously added to the datafiles. Information on a total of 9,609 accessions was documented. The second volume of the Barley Germplasm Catalog was published, which includes passport and evaluation information for an additional 4,129 accessions.

ICARDA's germplasm is freely available to *bona fide* users all over the world. The Genetic Resources Unit is devoting considerable resources and efforts to meet requests for germplasm samples from the commodity programs of ICARDA and from other institutions. In 1987/88, a total of 26,197 seed samples were distributed (9,229 samples within, and 16,968 outside ICARDA) from the genetic resources collections. This represents a 70% increase over the 1986/87 figures, indicating a growing interest in and an extensive utilization of ICARDA's germplasm collections.

Exploration for *Aegilops* and wild *Triticum* species in Syria and Jordan

Within the framework of the special project "Collection and Characterization of the Wild Relatives of Wheat," collection trips to Jordan and within Syria were conducted. These were joint missions with the respective national programs: the Jordan University of Science and Technology (JUST) at Irbid, and the Genetic Resources Unit of the Agricultural Research Center at Douma, Syria. Priority was given to the genus *Aegilops* and the wild species of *Triticum*.

In Jordan, a large number of samples of *Aegilops* was collected, including the following taxa: *Aegilops bicornis*, *A. biuncialis*, *A. kotschyi*, *A. longissima*, *A. ovata*, *A. peregrina*, *A. peregrina* ssp. *cylindrostachys*, *A. searsii*, and *A. vavilovii*. Most noteworthy was the widespread occurrence of *A. biuncialis* at higher altitudes, since this species was thought to be very rare in Jordan, and the presence of *A. bicornis*, which was found for the first time in the country's very dry southern region. The mountainous regions of central and northwest Jordan have been the most fruitful areas for collection. In addition, single spikes of *Triticum turgidum* ssp. *dicoccoides* and *T. monococcum* ssp. *boeoticum* were obtained, as well as paired samples of single spikes from cultivated *Hordeum* and its wild progenitor, *H. spontaneum.*

Two regions were visited in Syria: the provinces of Sweida and Dera'a, together with a short trip to northwest Damascus. Nine species of *Aegilops* were collected: *A. biuncialis*, *A. caudata* (northwest Damascus only), *A. columnaris*, (NW Damascus only), *A. kotschyi*, *A. ovata*, *A. peregrina*, *A. searsii*, *A. triuncialis*, *A. vavilovii.* Despite the number of species, the overall occurrence of *Aegilops* on the volcanic soils in the Sweida region was low. *Triticum turgidum* ssp. *dicoccoides* and *T. monococcum* ssp. *boeoticum* were collected as single spikes at seven sites. The new accessions of *T. turgidum* ssp. *dicoccoides* from the Sweida region are of special interest, since earlier studies revealed that most of the samples of this subspecies, previously collected in southern Syria, showed a combined resistance to yellow rust, leaf blotch, and common bunt.

On a second trip, the province of Lattakia and the western part of Idlib were visited, and the following species were collected: *A. biuncialis*, *A. caudata*, *A. columnaris*, *A. peregrina*, *A. ovata*, *A. speltoides*, *A. speltoides* var. *ligustica*, *A. triaristata*, and *A. triuncialis.*

A marked difference between western Syria and the Sweida region was the strong presence of *A. speltoides* and *A. triuncialis*, the former species being completely absent in the south. No wild *Triticum* was found.

Typical variation among spikes of different *Aegilops* **species (left to right):** *Ae. columnaris, Ae. biuncialis, Ae. uniaristata, Ae. ovata. Ae. triuncialis, Ae. bicornis, Ae. squarrosa, Ae. searsii, Ae. ventricosa, Ae. longissima, Ae. speltoides var.* **var.** *ligustica,* **and** *Ae. mutica.*

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Evaluation of *Medicago polymorpha* from the Mediterranean Basin

M. polymorpha has exceptional potential as a pasture species due to its virtually global distribution, its tolerance of soil type and grazing, and appropriate patterns of hardseed breakdown.

Multivariate methods were used to analyze the geographical distribution of different character combinations in a collection of 619 accessions of *Medicago polymorpha* from the Mediterranean Basin. Principal Component Analysis was applied to reproductive and vegetative characters evaluated at Tel Hadya. The relative contribution of different attributes to the first and second component axes is displayed in Fig. 4 (a), and the four corners of the

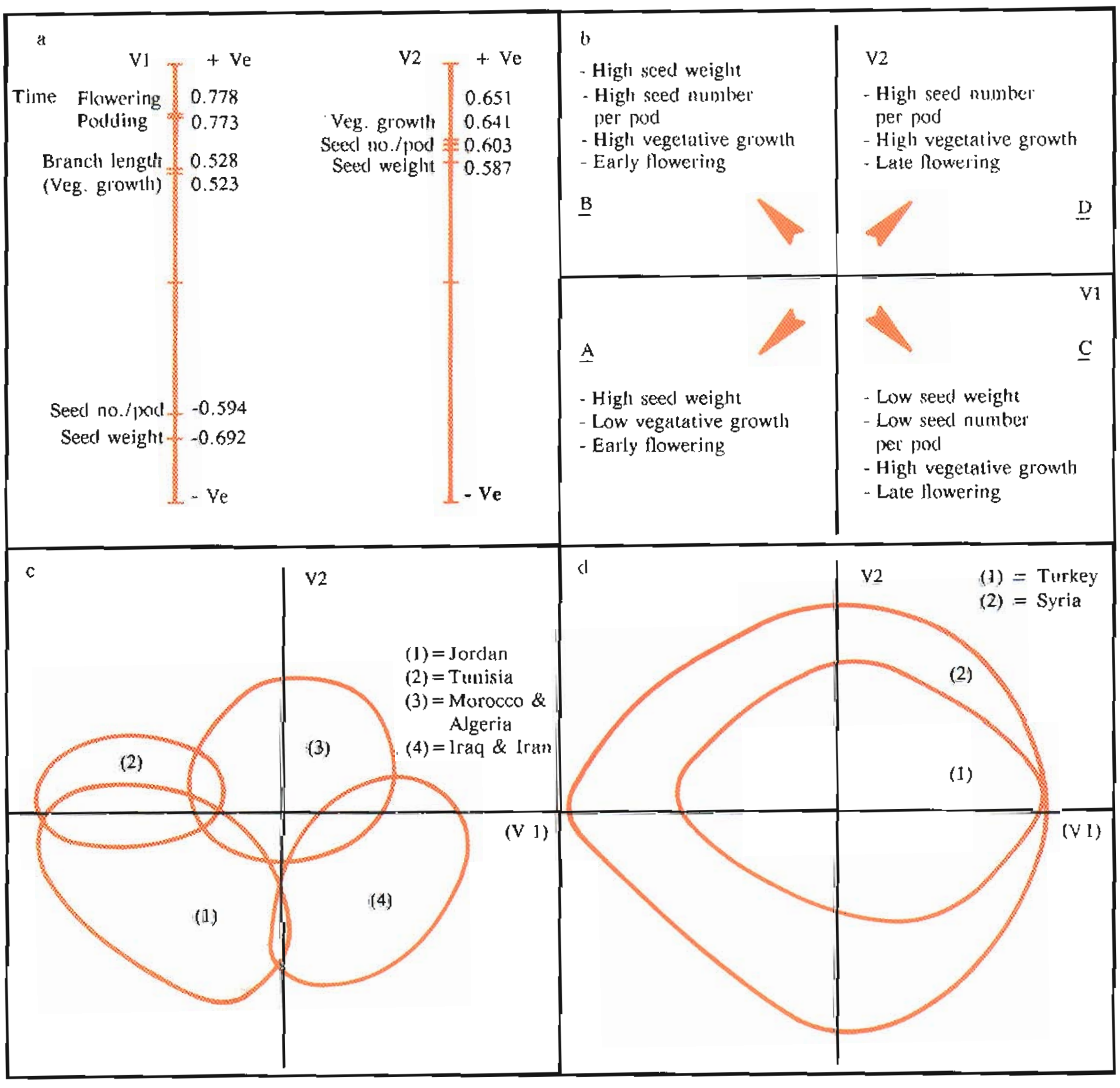


Fig. 4. (a) Loading of original variables on first two axes of principal component analysis (PCA); (b) vegetative and reproductive characteristics of accessions; (c) distribution of accessions in relation to the first two axes of PCA; and (d), distribution of accessions from Syria and Turkey in relation to the first two axes of PCA.

resulting graph comprise the character combinations seen in Fig. 4 (b). The distribution of accessions from six Mediterranean countries in relation to these is shown in Fig. 4 (c) and (d).

Early-flowering genotypes with large seed and low vegetative growth come principally from Jordan, and, to a lesser extent, Tunisia, both countries being characterized by arid, unpredictable environments, and short growing seasons. The more temperate, elevated regions of Morocco, Algeria, Iraq, and Iran are characterized by later flowering accessions with more vigorous vegetative growth. Both Turkey and Syria (Fig. 4d) are notable for the diversity found among accessions. In the case of Turkey, this may be due to the huge variety of ecological conditions found there. Syrian diversity may likewise be explained by the fact that *M. polymorpha* has been extensively sampled throughout the country.

Seed Health

In the 1987/88 season, 77 seed shipments from 39 countries were received and 421 shipments were dispatched, most of them to countries in the region. In-coming seed was planted in the isolation area for frequent inspection. No exotic diseases were detected.

Germplasm Enhancement

Pasture and Forage Crops

Selecting Pasture Legumes Adapted to the Ley Farming System

In the ley farming system, pastures alternate with cereals. Pasture legume varieties set seed in the pasture phase, but the bulk of it remains dormant in the cereal year that follows; it regenerates one year later when the pasture phase is due. These varieties must also survive grazing not only when the pastures are green but also when animals depend on eating dried vegetation during the summer. These requirements result in the need for special attributes in pasture plants, many of which are not fully understood. In addition to these special requirements pasture plants, like other plants of agricultural importance, must be adapted to harsh weather conditions of WANA.

For these reasons ICARDA is using an approach to pasture plant selection in which the relationship between environment and species distribution - the result of natural selection over thousands of years - and survival in the ley farming system itself, are taken into account. There are three steps: collection, and hence knowledge of distribution, of native species; seed multiplication and the evaluation of certain attributes in nursery rows; and the survival of the species within the ley farming system.

The results of the first step in Syria, reported elsewhere in detail (Ehrman and Cocks, in press), showed that the distribution of pasture legumes is influenced by the incidence of frost, amount and distribution of rainfall, and pH and lime content of the soil. In the areas where ley farming is likely to be useful, the most abundant species are *Medicago rigidula, M. polymorpha, M. orbicularis* and a number of other genera; absent were the Australian species - *M. truncatula, M. rugosa, M. littoralis, M. scutellata,* and *M. tornata.* The results reveal the importance of using locally selected ecotypes if the ley farming system is to be successful. Recently, a survey in Morocco revealed that the most frequent species are *M. polymorpha, M. laciniata, M. aculeata,* and *M. orbicularis.*

In the second step, which is primarily intended to increase seed, a preliminary screening can be conducted. At this stage frost tolerance can be checked, and maturity time measured. Our results suggest that a number of other attributes may be of importance: short petioles, long peduncles, and small seeds, all indicators of resistance to grazing.

The third step is to introduce the potentially useful ecotypes into the ley farming system. In the ICARDA experiments, 84 selections from 12 legume species were sown in successive years into a pasture/cereal rotation. The amount of seed in the soil was assessed at the beginning of each summer, later in the summer after grazing was completed, and during the cereal phase. The experiment continued for four years.

The results indicate that two species, *M. rigidula* and *M. rotata*, are likely to be successful. There was a large difference between the years, associated with climatic conditions at the time of sowing, a result which supports the concept of using mixtures of species. In general, species which were not native to the experimental site were less successful.

Seed Banks

The amount of seed available for germination at the start of the growing season is an important determinant of the yield of native and introduced pastures. For this reason the size of the seed bank of annual medics (*Medicago* spp.) and clovers (*Trifolium* spp.) is being closely monitored at Tel Hadya. In medics, after seed had softened over two summers, about 16% (*M. noeana*) to 56% (*M. polymorpha*) of it germinated in the following autumn, while in clovers, germination ranged from 13% (*T. campestre*) to 86% (*T. stellatum*). Possession of an impermeable seed coat (hardseededness) was the mechanism by which the seeds resisted germination. Seeds lost their hardseededness more rapidly in the second compared with the first summer after seed set, but in both years hard seed breakdown occurred most rapidly in autumn (Fig. 5). Some of the species, for example, *M. rigidula* and *M. polymorpha*, germinated promptly after the early autumn rains, while others, for example, *M. rotata*, resisted germination until later. Buried seeds lost their hardseededness more slowly than those lying on the surface.

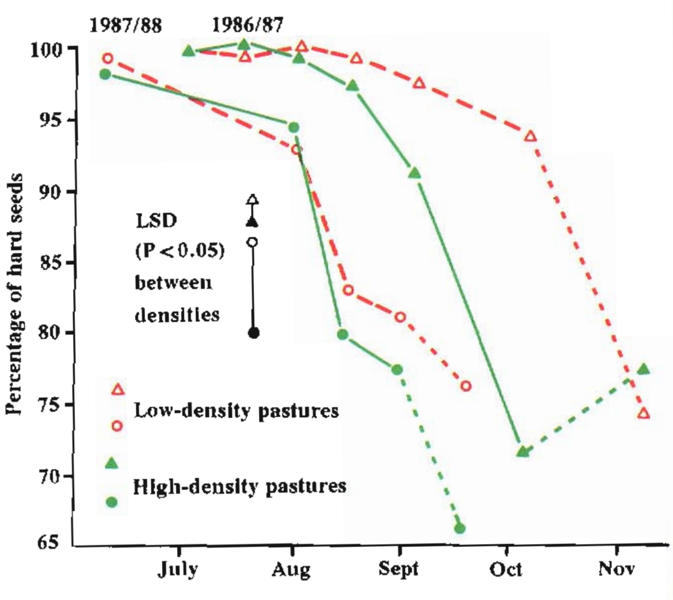


Fig. 5. Effect of age of seed and seed density on the hardseed breakdown of medics at Tel Hadya.

Rhizobiology of Medics

One of the attractions of the ley farming system is its independence of nitrogen fertilizer. When associated with the concept of self-regeneration, the ability of pasture legumes to fix nitrogen and to transfer it to cereals makes ley farming a truly low-input system.

Medicago polymorpha **nodulated by an effective strain (left) and an ineffective strain (right). The strains were collected from the region and reflect the diversity of rhizobia.**

Rhizobia suitable for most of ICARDA's medics have now been identified. For *M. rigidula*, strain M29 has performed well in Morocco, Algeria, Turkey, Syria, France and Jordan, and introduced rhizobia have been shown to persist for several years. In other studies conducted in Jordan there were large differences in the effects of 10 strains of rhizobium on the yield of herbage from *M. rotata* (Fig. 6). Nitrogen fixed by *M. truncatula*, and *M. polymorpha* increased from about 20 kg/ha to nearly 80 kg/ha after inoculation, and nitrogen fixed by *M. rigidula*, which did not require inoculation, reached 100 kg/ha.

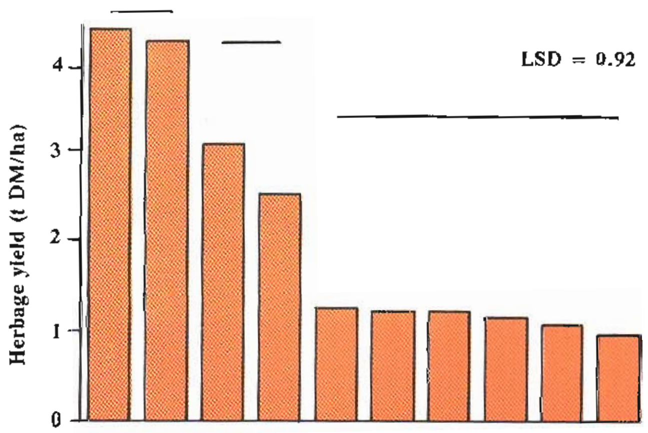


Fig. 6. Effect of inoculating *M. rotata* sel. 2123 at Ramtha (Jordan) with 10 strains of rhizobia. Data covered by the same horizontal line are not significantly different (P<0.05), LSD = 0.92 (tonnes DM/ha).

Pea Palatability

A few years ago scientists at ICARDA believed that forage pea (*Pisum sativum*) was potentially one of the most useful crops for dry areas. It produced high grain yields and appeared to give good economic returns while maintaining barley yields. However, sheep appeared to find the peas unpalatable compared with common vetch at all stages of crop maturity. A project was therefore started to study the genetic variability in the palatability of material in ICARDA's germplasm collection and to identify the compounds responsible for the unpalatability.

The initial study considered the variation in the rate of ingestion (RoI) of chopped straw from 20 genotypes of peas and one vetch (*V. sativa*) at Tel Hadya (Table 3). As expected, the rate of ingestion (RoI) of common vetch was the highest, but there were substantial differences in the RoI of the pea genotypes from 114 g to 222 g per 30 minutes. It is noteworthy that the coefficients of variation were much larger for the least palatable straws than for the 'tasty' straws. This is an indication that as the straws became less palatable, the 'personal likes and dislikes' of the individual sheep increased. The search for the source of variability in RoI is continuing.

Table 3. Mean rate of ingestion (± standard deviation) and coefficient of variation (CV) of one genotype of common vetch and several genotypes of forage peas at Tel Hadya, 1988.

Species	Rate of ingestion[1] (g/30 min)	CV (%)
Common vetch	239 ± 25	10.7
Kodiak	219 ± 48	21.9
Maro	217 ± 57	26.3
Early onward	210 ± 31	16.7
Baf	192 ± 52	27.1
Despe	183 ± 44	24.3
Upton	175 ± 74	42.3
Filby	169 ± 42	24.9
Onward	163 ± 103	63.2
Syrian landrace	133 ± 90	67.7
Facima	114 ± 88	77.2

[1] Digestible dry matter.

Promising Lines of Annual Forages

Substantial progress has been made to identify annual forage legume crops for growing on land left fallow after a barley crop or where continuous barley is grown. These forages provide valuable feed during periods of shortage and where they interrupt barley monoculture, improved barley yields are obtained (Table 4). They are well suited to areas receiving 250 to 350 mm annual rainfall in Syria.

Promising genotypes of five species of *Vicia* and *Lathyrus* were tested in microplots and nursery

Sheep grazing common vetch (*Vicia sativa*) in preference to forage peas growing in the foreground and the background.

Table 4. Yields (kg/ha) of barley after forages, barley, and fallow at Tel Hadya, 1987/88.

	Vetch	Chickling	Barley	Fallow	SEM[1]	Sig[2]
Straw yield	2830	3079	2126	2685	80	**
Seed yield	1599	1727	1401	1536	44	NS
Total	4429	4806	3526	4221	97	**

[1] Standard error of mean.
[2] Significance ** = $P<0.01$, NS = Not significant.

rows at Tel Hadya. In the high rainfall season of 1987/88, grain yields were excellent, reaching 4900 kg/ha for *V. narbonensis* and 4800 kg/ha for *L. ochrus*. Results from three years and two sites suggest that *L. ochrus* may give grain yields of 750 kg/ha even when annual rainfall is only 250 mm. All species had high quality forage and straw, although the protein content of *V. narbonensis* straw was less than the other species.

Cereal Crops

In 1987/88, the cereal researchers continued to refine the breeding methodologies based on their experience that germplasm suitable for specific stresses is more efficiently identified if selected under those stresses. To meet the challenge of harsh environments, increased use of landraces and wild relatives was made, with a strong focus on the preservation and utilization of their variability.

The effectiveness of this strategy was evident from the increased use of ICARDA's germplasm by NARSs for different agroecological conditions and farming systems, particularly in WANA. To date,over 100 varieties of barley, durum wheat, and bread wheat have been released by NARSs using the ICARDA germplasm and/or methodologies (appendix 2).

Barley

Role of *Hordeum spontaneum* in Barley Breeding

Hordeum vulgare ssp. *spontaneum*, the wild progenitor of cultivated barley, is widespread along the Fertile Crescent in diverse environments from the Mediterranean coast to the desert. In barley breeding the use of this species as a source of disease resistance has been reported by many workers. Evaluation of *H. spontaneum* accessions at ICARDA has shown that the species is also a source of tolerance to severe stress conditions. Selected lines of *H. spontaneum* are being used in crosses with landraces and improved cultivars to incorporate desirable traits such as long peduncle and low number of seminal roots. Preliminary data indicate that *H. spontaneum* can also contribute to increased straw protein content. Some *Hordeum spontaneum* lines were identified to have longer seminal roots and higher straw yield and straw protein content than cultivated barley (Table 5).

H. spontaneum is also being used to generate improved genotypes of self-regenerating barley. These genotypes can be utilized as self-regenerating pastures in marginal and fragile ecosystems.

A *Hordeum spontaneum* line which is being intensively used at ICARDA in crosses with cultivated barley to incorporate tolerance to severe abiotic stresses.

Selection for Barley Grain Yield

Experiments under contrasting rainfall conditions in the 1987/88 and the past seasons have demonstrated that selection for grain yield under severe stress does not necessarily reduce yield in favorable environments. Although Syrian landraces performed relatively well under cold and drought, it was possible to identify landrace-lines that also showed good performance in the 1987/88 wet season (Table 6). Cultivars Rihane-03, Faiz,

Table 5. Differences between *Hordeum spontaneum* and *Hordeum vulgare* (Bouider 1987/88).

Characters	*H. spontaneum* Mean	(n=55) Range	*H. vulgare* Mean	(n = 9)* Range	Best *H. vulgare*
Cold damage	3.0	1.0 - 5.0	3.7	1.5 - 5.0	Tadmor
Growth vigor	2.9	1.0 - 5.0	1.6	1.0 - 2.5	Tadmor
Days to heading	141.8	131.5 - 152.5	141.1	138.5 - 145.5	Harmal
Peduncle length	44.2	32.8 - 50.3	23.5	20.3 - 32.1	Rihane-03
Peduncle extru.	18.4	8.2 - 26.3	4.4	1.0 - 10.5	Rihane-03
Straw yield (t/ha)	4.4	2.8 - 6.5	5.1	4.1 - 6.1	Tadmor
Straw protein (%)	5.1	2.7 - 7.0	3.5	2.8 - 4.7	Arabi Abiad

* Harmal, Rihane-03, Kantara, Arta, Tadmor, SLB 39-10, SLB 39-60, Arabi Aswad, Arabi Abiad.

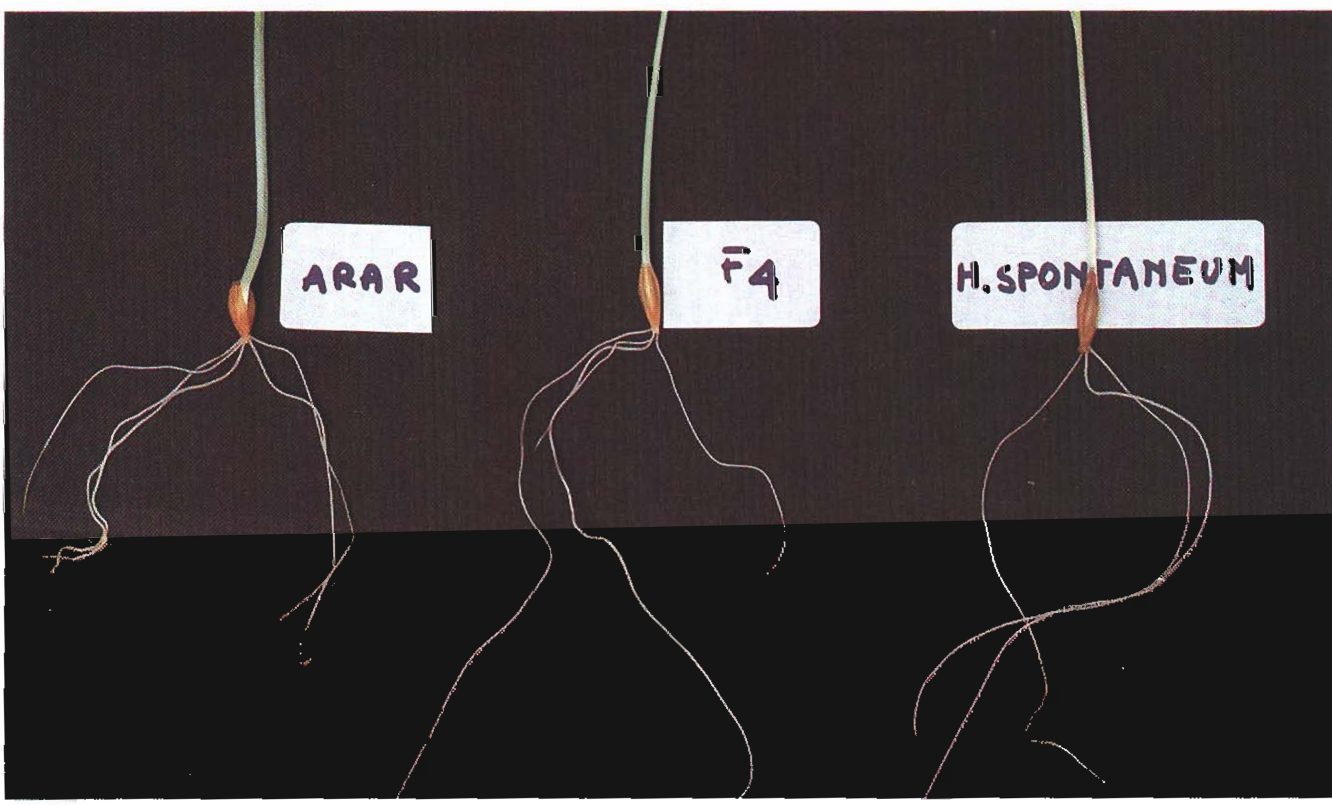
Table 6. Grain yield at Tel Hadya and Bouider of improved germplasm and of landraces in the barley preliminary yield trials, 1987/88.

		Grain yield (kg/ha)			
		Tel Hadya		Bouider	
Material	n	Mean	Range	Mean	Range
Improved	272	4132	763-5934	3099	973-5272
Landraces	288	3933	882-6217	2617	220-4775
Rihane-03		5214		3812	
Harmal		4819		3834	
Arabi Aswad		3445		2589	
Arabi Abiad		4585		2782	

Assala-04, and Ar46/Aths*2, which performed well, were extensively used in targeted crossing for moderate-rainfall areas. The joint ICARDA/CIMMYT barley project in Mexico continued to emphasize the incorporation of multiple disease resistance into germplasm adapted to high elevation, low-latitude areas.

Durum Wheat

The joint CIMMYT/ICARDA durum wheat breeding project continued to focus on broadening the genetic base through hybridization with landraces (214 crosses) and wild emmer (156 crosses) as well as incorporating genes for resistance to diseases (473 crosses) and insects (85 crosses). Notable progress was achieved in increasing the yield level and stability of dryland durum wheat in WANA. The breeding line Korifla was released in Syria under the name of Sham 3, and in Jordan under the name of Petra; while the lines Omrabi 9 and Kabir 1 reached the stage of wide-scale testing both in Algeria and Tunisia. The line Omrabi 17 performed well at dry sites in Syria (Table 7). Furthermore, the multilocation testing in WANA enabled the identification of the lines Dades and Daki for the lower rainfall spectrum and Scoflag and Oronte for the moderate-rainfall areas. Morphological traits were identified (plant height, spike fertility, and fertile tillers) that correlated well with tolerance to terminal moisture-cum-heat stress.



Seminal root system of an improved barley variety "Arar" (left), a *Hordeum spontaneum* accession (right), and an F4 line derived from the cross Arar x *H. spontaneum* (middle).

Table 7. Performance of Omrabi 17 and Haurani in dryland conditions in experimental stations and farmers' field verification trials, 1987/88.

Entry	Yield (kg/ha)		
	Bouider	Breda	FFVT[1]
Omrabi 17	2420	4372	3469
Trial mean	1930	3608	3400
Haurani (check)	1521	3022	2828
LSD (0.05)	628	539	160
CV	12.8	7.8	9.3
Omrabi 17 / Haurani x 100	159.1	144.7	123.0

[1] FFVT = Farmers' field verification trials, 10 sites, in B-Zone (areas with less than 350 mm annual rainfall).

Use of Protein Characteristics in Durum Wheat Breeding

In West Asia and North Africa, durum wheat is used in the production of many forms of food: two-layer and single-layer flat bread, burghul, couscous, and pasta are the most common forms. The main quality parameters needed for these include high protein content and gluten strength, high vitreous kernel percentage and, for burghul, couscous and pasta, high yellow pigment content. A simple test based on 3% sodium dodecyl sulfate (SDS) solution can be used to identify genotypes involving *T. durum* and *T. dicoccoides* of high gluten strength. The SDS solution in combination with lactic acid causes gluten protein molecules to swell. The extent to which they swell is an indication of the hydration capacity, an important factor in determining the processing quality of wheat. *T. dicoccoides* lines can reach very high protein levels, which may give misleading high SDS volumes. The SDS volume is therefore divided by the protein content to give an SDS index which is independent of protein content. Both SDS volume and SDS index are highly correlated to classical dough strength parameters such as Brabender Farinograph stability and mixing tolerance, and dough handling properties at baking, as well as to spaghetti cooking quality.

Polyacrylamide gel electrophoresis (PAGE) has been used to identify genotypes with good pasta-making properties. The presence of electrophoretic band with Rm 45 has been related to high gluten strength, whereas its absence has been used to denote lines with inferior quality. Several crosses involving *T. dicoccoides* have been found which indicate that the presence of the band Rm 45 may not be a reliable indicator of good quality in this type of material.

Table 8 presents some lines with the band Rm 45 which had inferior gluten strength, while others with little or no indication of the band were quite satisfactory. On the basis of this preliminary work, the SDS index/PAGE method appears to be a more reliable pointer to superior quality in lines involving *T. durum* and *T. dicoccoides*, than polyacrylamide gel electrophoresis *per se*.

Table 8. Tetraploid genotypes with and without electrophoretic band Rm 45.

Line No.	Protein (%)	% with Rm 45	SDS index	Classification[1]
55	11.3	0	3.00	Strong
170	18.9	25	2.49	Fair
70	18.7	100	1.76	Weak
75	14.0	100	2.07	Fairly weak
62	22.4	100	1.01	Very weak

[1] Based on gluten strength characteristics.

Bread Wheat

The joint CIMMYT/ICARDA bread wheat breeding project also emphasized the development of germplasm for the drier areas of WANA (less than 400 mm of annual rainfall). Genetic stocks tolerant to the prevailing biotic and abiotic stresses have been identified. The modified bulk method of selection proved effective in enhancing disease resistance and yield stability in rainfed wheat and is being adopted in Algeria, Egypt, Morocco, Syria, and Tunisia. Results of the international testing system show a steady adoption of improved bread wheat germplasm especially in the low-rainfall environments. The advanced lines Nesser (Fig. 7) and Gv/Ald performed well in farmers' fields in Syria and Algeria, respectively, under low-rainfall conditions.

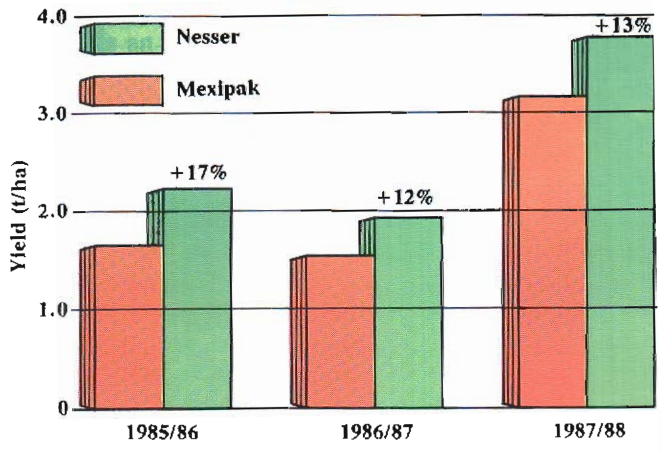


Fig. 7. Performance of Nesser, a promising bread wheat line, under low-rainfall (250-350 mm) conditions in Syria. Farmers' Field Verification Trials, 1985/86 to 1987/88.

The High-Elevation Project

The high-elevation project addresses the needs of large areas of WANA for specific wheat and barley germplasm adapted to the harsh conditions prevailing in those areas. Crosses have been made to combine adaptation traits of local cultivars with resistance or tolerance to cold, drought, and diseases. Wild species of *Triticum* and *Aegilops* are also exploited for the improvement of cold tolerance and/or protein content. Segregating populations are screened at Tel Hadya for diseases and plant height, but final selection is based on performance at high-elevation sites in Syria (Sarghaya), Turkey (Haymana), and other countries of WANA (Iran, Pakistan, Afghanistan, Morocco, and Algeria). Studies have shown that facultative wheats with slow primordium development during early stages and rapid development later in the season are the most suitable types for the majority of the highlands in WANA.

Genetic Variability in Wild Relatives of Wheat

The exploitation of wild types in wheat breeding for tolerance to stresses in unfavorable environments has been insufficient due to three reasons. First, collections of wild progenitors in the past have been fragmentary, and representative material was not available. Second, work on wild forms has primarily concentrated on evolutionary and taxonomic studies. Third, variability within populations of wild species has not been assessed in detail and its utilization not attempted. ICARDA is evaluating the vast pool of genetic variability in wild and primitive forms and has already found useful traits which are being further studied for their cytological compatibility with cultivated forms through a collaborative project with the University of Tuscia at Viterbo, Italy.

An *Aegilops* species that survived drought, heat, and frost at Breda in Syria.

Based on the evaluation results from two seasons, 153 accessions of *Aegilops* spp. have been identified as resistant to yellow rust, frost, and drought. A list of these accessions is given in Table 9.

Table 9. Accessions of *Aegilops* spp. resistant to yellow rust, frost, and drought.

Species	No. of Acces.	Species	No. of Acces.
Ae. biuncialis	16	*Ae. neglecta*	7
Ae. columnaris	2	*Ae. squarrosa*	13
Ae. ovata	52	*Ae. trincialis*	45
Ae. kotschyi	3	*Ae. variabilis*	1
Ae. lorentii	14		

Stress Physiology

Stress physiology research was considerably strengthened with the objective of supporting breeding programs in selection methodologies for abiotic stresses. A strong relationship was found between C-13 discrimination and yield of barley under stress, warranting further investigations to assess the value of this technique as a screening tool for cereal improvement in dry areas.

Detailed studies were made on apex development, vernalization requirement, growth habit, and leaf color in barley. Preliminary results showed that leaf color may be a useful selection criterion in barley improvement for dry areas. In wheat experiments at Tel Hadya in Syria and Wad Medani in the Sudan, heat stress reduced grain yield by up to 70% (Table 10). Heat stress was most detrimental when occurring early in the season. Selection for genotypes able to germinate and emerge under heat stress appears desirable. Other studies have shown that early planting and narrow row spacing (10 cm) are superior management practices for barley in low-rainfall Mediterranean environments.

Early planting (last week of October) and narrow row spacing (10 cm) are superior barley management practices for low-rainfall (200 - 300 mm) rainfed Mediterranean environments.

Table 10. Environmental effects on grain yield, total above-ground biomass and harvest index (means of 24 wheat cultivars). The percent value in comparison to Tel Hadya normal planting (100%) is also given.

Environment	Grain yield (kg/ha)	%	Above-ground biomass (kg/ha)	%	Harvest index	%
TH normal	3560a	100.0	9410a	100.0	0.38ab	100.0
TH terminal heat stress	1570b	44.1	4210b	44.7	0.36b	94.7
TH early heat stress	1200c	33.7	2980c	31.7	0.40a	105.3
Wad Medani	960c	26.9	3950b	42.0	0.24c	63.2
LSD (0.05)	0.30		0.74		0.03	

Numbers followed by a different letter in the same column differ at $P<0.05$.

Pathology

Disease-resistant germplasm pools of barley and wheat have been developed and made available to NARSs. Of 145 advanced barley lines tested in Syria and Morocco for resistance to barley leaf stripe in cooperation with NARSs, 93 were found resistant at both sites. A seedling test for this disease did not correlate well with adult plant's reaction in the field. In contrast, a seedling test for scald was more reliable. However, the pathogen in the latter case is highly variable, so further tests are being carried out in the region. Dryland root rot, identified in barley plots at Breda, Syria, was found to be caused by the fungus *Cochliobolus sativus*.

Crop loss evaluation revealed a 20% grain yield reduction caused by a combination of scald and powdery mildew on susceptible barley. Durum and bread wheat germplasm lines have been screened for resistance to major diseases in the region, including yellow and leaf rusts, septoria leaf blotch, and common bunt. Kernels in common bunt affected spikes were infected to varying degrees, ranging from 2 to 98%, possibly due to partial resistance to the disease. Current studies concentrate on the possible use of such reaction as a means of controlling this disease. Around 200 accessions of wild emmer (*Triticum turgidum* L. var *dicoccoides*) have been tested to assess their potential as sources of resistance to major wheat diseases for subsequent use by breeders. Artificial inoculation experiments showed a reduction of 29% in grain yield due to yellow rust infection on the susceptible bread wheat, Mexipak.

Common bunt on wheat: healthy spike (left), totally infected spike (right), and partially infected spikes.

Screening for barley yellow dwarf virus (BYDV) resistance in cereals yielded about 20 lines each of barley, bread wheat, and durum wheat with tolerance to BYDV.

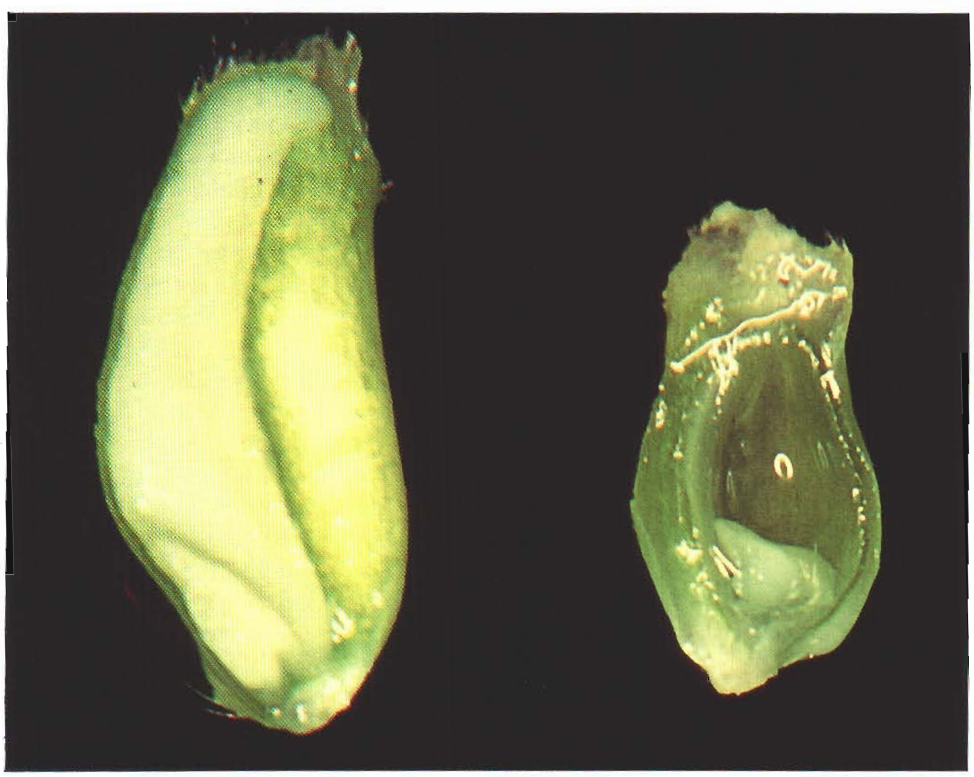
Entomology

Insect screening of a large number of cereal germplasm entries led to identification of barley and/or wheat lines possessing resistance or tolerance to wheat stem sawfly, sunpest, aphids, and Hessian fly. Genetic stocks possessing resistance to these pests have been assembled for use in crossing programs.

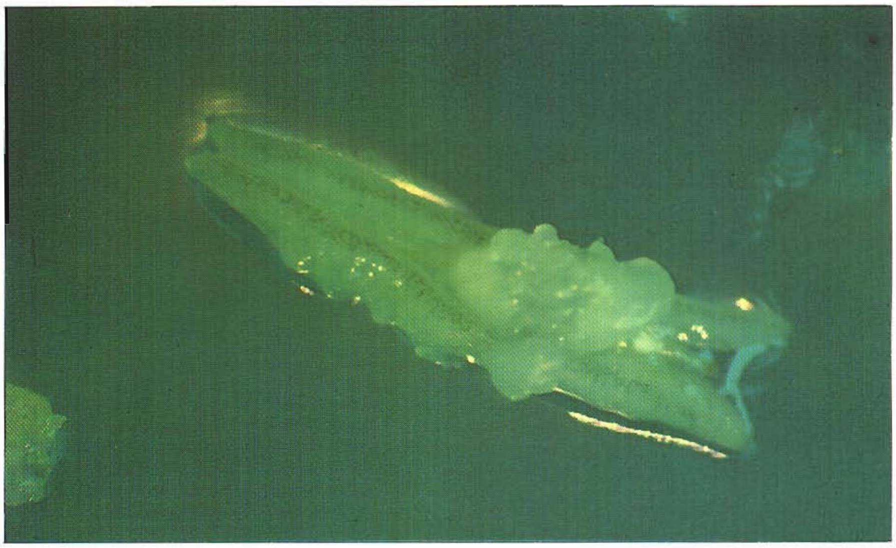
Application of Biotechnology in Cereal Improvement

Breeding new varieties through the conventional methods requires much time and labor. *In vitro* techniques can complement the conventional methods in diversifying and developing the germplasm at a faster pace. Techniques such as haploidization, *in vitro* selection, and embryo rescue are available to accelerate the development of new varieties.

Work on haploid breeding using anther culture and the *Hordeum bulbosum* technique was initiated in collaboration with research institutions in France and Japan. A nursery of 206 *H. bulbosum* accessions collected in Syria was maintained and used in crossing with bread wheat. Cross-compatibility was found to depend on both wheat and *H. bulbosum* genotypes with no significant interaction between the two species. Preliminary work on anther culture in bread wheat yielded 24 green plantlets and 12 albinos with a total regenerating frequency of 0.45%. Further work will be undertaken to increase this frequency.



A wheat haploid embryo developd through crossing with *Hordeum bulbosum* pollen (left: self-pollinated; right: cross-pollinated).



A wheat anther in *in vitro* culture producing haploid embryos.

International Nurseries

The demand for international nurseries continued to increase, particularly for new trait-specific ones. Promising lines submitted by NARS scientists were included in observation nurseries for the first time. Upon receipt of the field books from cooperators, data were analyzed and combined results returned to national scientists. In-depth studies including regression and cluster analyses (Fig 8) were carried out on grain yield data from regional trials to further aid breeders to target their germplasm more precisely.

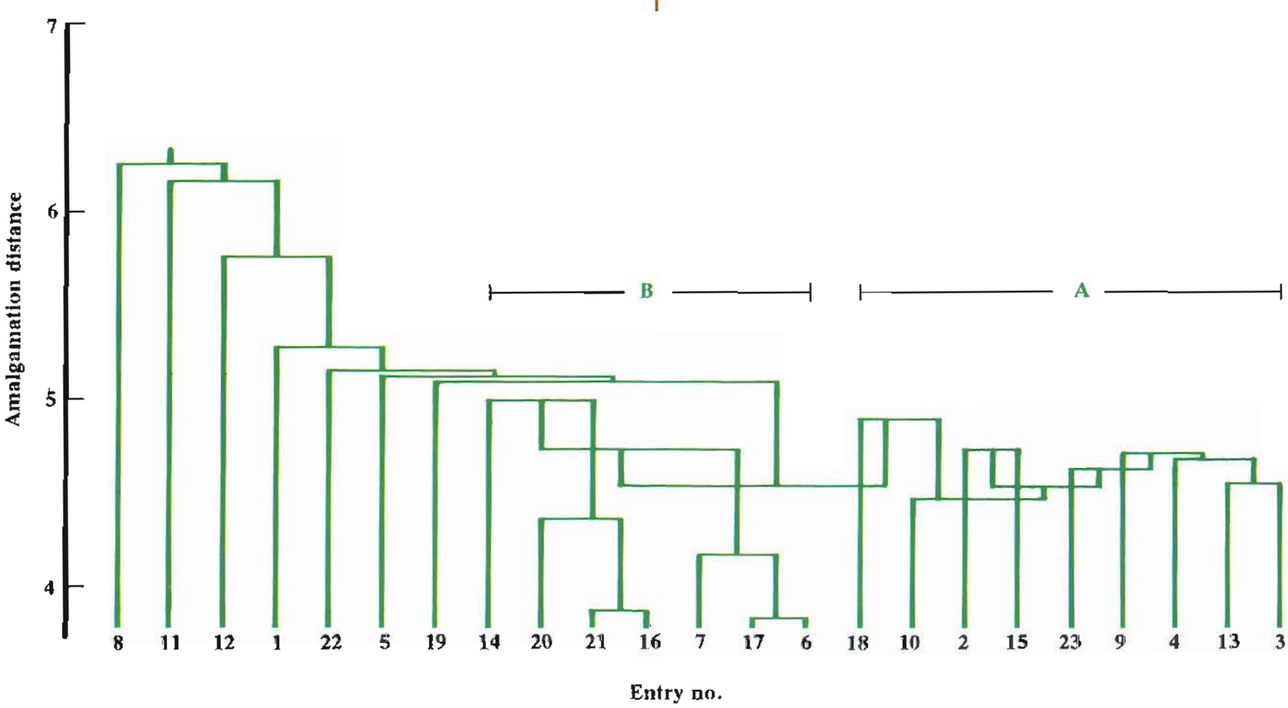


Fig. 8. Amalgamation resulting from cluster analysis of 23 entries based on differential yield responses across 24 sites. Two major clusters were formed: (A) lines selected mainly at Tel Hadya, Syria, and (B) lines selected under favorable but disease-prone conditions outside Syria (CIMMYT, Mexico; Kenya; Izmir, Turkey).

Food Legume Crops

Faba Bean

Increased attention was paid to the development of genetic stocks and early-generation material to broaden the pool of variability in faba bean for use by national programs (Table 11). In Egypt, ILB 1270 was in multiplication for release in the North Delta. A bulk population was selected in Ethiopia for its yield and seed size, and was purified for submission to the variety release committee. ILB 1814 is in demonstration trials in Algeria, 80S-44027 in Syria, and FLIP 87-26FB in Lebanon. One determinate line (FLIP 84-146FB) was selected for on-farm testing for intercropping with cotton in China. In Morocco, 10 lines were selected for verification trials. Other national programs are now using disease resistance sources in crossing blocks and have received segregating populations for the independent vascular supply (IVS) trait and determinate plant types for local adaptation breeding.

Results from local and international testing of our material from more than 25 locations during 1980-87 confirmed the durability of resistance to chocolate spot, ascochyta blight, rust, and stem nematode in several lines (Table 12). Efforts to develop multiple disease resistance have led to the identification of several breeding lines with resistance to the complex of diseases prevailing in the major production regions. Sources of resistance to *Orobanche crenata* and bean leaf-roll virus (BLRV) have been identified.

Studies on host-pathogen interactions revealed the presence of strong inhibitory effects against *Botrytis fabae* in the phyllosphere of resistant genotypes of faba bean. The effect appears to be a combination of some fungistatic leaf exudates and at least three antagonistic fungi naturally occurring in the phyllosphere of these lines. The use of these antagonists as biological control agents suppressed the necrosis due to *B. fabae* in detached-leaf test on faba bean as effectively as the widely used fungicide vinclozoline (Fig. 9).

Faba bean virus surveys conducted in Egypt, Ethiopia, Sudan, and Syria indicated that bean yellow mosaic virus was the most common, followed by broad bean mottle and broad bean wilt viruses. Of 100 faba bean pure lines (BPL) screened for BYMV resistance, four BPLs (756, 757, 758, and 769), all from Afghanistan, showed low disease index. These lines will be retested in 1989.

Growth analysis of determinate faba bean lines, in contrast to the indeterminate lines, revealed

Table 11. Use of ICARDA faba bean lines by national programs in 1987/88.

Country	Line	Use
Algeria	ILB 1814	On-farm trials
	25 lines	Multilocation testing
Chile	ILB 1814	Prerelease multiplication
China	FLIP 86-146FB*	On-farm trials
	22 lines	Multilocation testing
Egypt	ILB 1270	Prerelease multiplication
Ethiopia	74TX 12050 x 74TA 236	Purified for submission to variety release committee
Iran	ILB 1269	Released as 'Barakat'
Iraq	ILB 1814	Large-scale demonstration
		Prerelease multiplication
	79S4	Prerelease multiplication
	8 lines	On-farm trials
Jordan	FLIP 86-146FB*	On-farm trials
	FLIP 87-136FB	
	FLIP 87-138FB	
Lebanon	FLIP 87-26FB	On-farm trials
Morocco	80S 44027, 74 T	Verification trials
	FLIP 87-140, 14	
	FLIP 84-127, 12	
	FLIP 82-30FB	
	B87238, B87253	
Syria	80S44027, FLIP 84-230FS*	On-farm trials
Tunisia	FLIP 83-89FB, 74TA 22, 80S43238	Multilocation testing

* Determinate line.

Table 12. Some important faba bean sources of resistance to chocolate spot, ascochyta blight, and rust.

Disease	Sources[1]
Chocolate spot	BPL 110, 112, 261, 266, 710, 1179, 1196, 1278, 1821; ILB 3025, 3026, 2282, 3033, 3034, 3036; 3056, 3106, 3107, 2302, L83114, L82003, L82009
Ascochyta blight	BPL 74, 230, 365, 460, 465, 471, 472, 646, 818, 2485; ILB 752; L83120, L83124, L83125, L83127, L83136, L83136, L83142, L83149, L83151, L83155, L83156, L82001.
Rust	BPL 7, 8, 260, 261, 263, 309, 406, 417, 427, 484, 490, 524, 533, 539; Sel. 82 Lat. 15563-1, 2,3,4.
Stem nematode	BPL 1, 10, 11, 12, 21, 23, 26, 27, 40, 63, 88, 183

1. There are several sublines of most sources listed. The accessions are listed in the decreasing order of their efficacy.

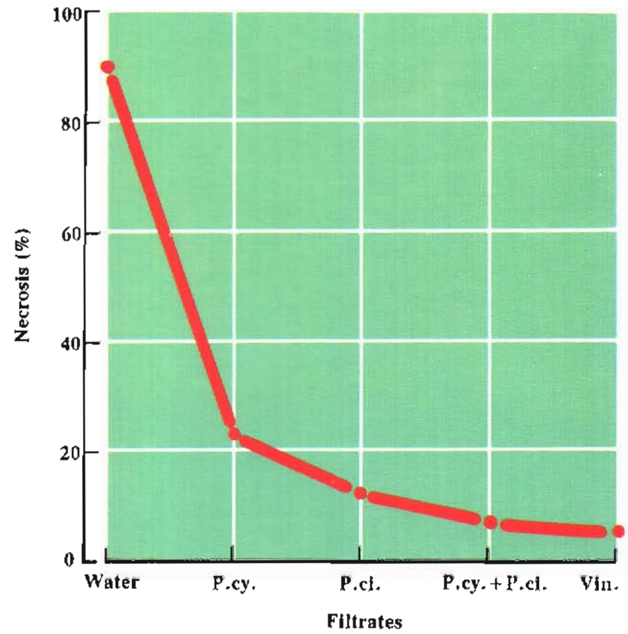


Fig. 9. Reduction in *Botrytis fabae* necrosis on leaflets of the faba bean line R40 in the presence of the antagonistic filtrates of *Penicillium cyclopium* (P.cy.), *P. citrinum* (P.ci) and a combination of both, as compared to that with the standard fungicide vinclozoline (Vin.).

that yield was limited due to low total dry-matter production because of lower leaf area index. Appearance of late branches was another constraint. Both constraints can be partly removed by using population levels higher than 40 plants/m^2.

Work on aphids, the most important insect pest of faba bean, was carried out primarily in the Aphid Screening Laboratory in Egypt by Egyptian scientists in collaboration with ICARDA. A field study of seven breeding lines previously selected revealed that one of them was particularly promising. An aphid screening research network has been developed covering the Nile Valley Region with a potential link with the North African Regional Program. Considerable progress was made in understanding the biology of leafminer and its control through the work in the Nile Valley Project in Sudan.

On-farm research in the Nile Valley Project has demonstrated the economic feasibility and great potential for improvement in the productivity of faba bean in all three participating countries -- Egypt, Sudan, and Ethiopia, through adoption of improved agronomic practices and improved cultivars of faba bean.

Lentil

Lentil yields are generally small because of poor crop management and the low yield potential of landraces. In South Asia and East Africa, diseases are also a major constraint to production. Accordingly, an integrated approach to lentil improvement is being followed covering the development of improved genetic stocks as well as production technology. The breeding work aims at increasing biomass yield and removing other limiting factors specific to each of three major agroecological regions: Mediterranean low-mid altitude region; high-elevation area in Iran and Turkey; and South Asia and East Africa. In 1988, a total of 350 simple crosses were made to cover specific needs of each of these target areas.

Selections from the breeding program for the Mediterranean region were tested in 17 trials at three rainfed locations differing widely in average rainfall (Table 13). A large number of lines ranked above the best check or yielded significantly more than the best check.

Table 13. Results of the lentil yield trials for seed (S) and biomass (B) yields (kg/ha) at three contrasting rainfed locations: Terbol (Lebanon), Tel Hadya, and Breda (Syria), 1987/88.

Location	Breda		Terbol		Tel Hadya	
Rainfall	(710 mm)		(504 mm)		(400 mm)	
	S	B	S	B	S	B
Number of trials	17	17	17	17	17	17
Number of test entries*	83	83	83	83	83	83
% of entries sig. (P > 0.05) exceeding best check**	11	19	18	27	2	6
% of entries ranking above best check (excluding above)	41	59	40	36	25	31
Yield of top entry (kg/ha)	1859	4685	2865	7702	3325	9300
Check mean yield (kg/ha)***	1415	3495	1629	4811	2497	6831
Location mean (kg/ha)	1394	3687	1654	4979	2054	6094
Range CV (%)	7-11	6-15	12-44	11-21	9-21	9-18
Mean advantage of lattice over RBD	112	116	128	121	107	104

* Entries common over location.

** Large-seeded checks: ILL 4400 long-term, Idleb 1 improved; Small-seeded checks: ILL 4401 long-term, 78S26013 improved.

*** Improved checks.

Greenhouse technique for screening lentil germplasm for vascular wilt resistance. Good correlation has been observed between the greenhouse and field testing.

In addition to the six lentil lines already released by national programs, several other lines were selected for on-farm trials or prerelease multiplication in Algeria, Egypt, Lebanon, Jordan, Morocco, Spain, Syria, Tunisia, and Turkey. In the high-elevation region of Iran and Turkey, a large-seeded red-cotyledon line with cold tolerance allowing winter sowing is in prerelease multiplication.

In the lower latitude regions of the Indian subcontinent and East Africa, rust and ascochyta blight cause major yield losses. The national programs of Ethiopia and Pakistan have screened for resistance to both diseases in a cooperative program and sources of combined tolerance have been identified (Table 14).

Vascular wilt, caused by *Fusarium oxysporum* f.sp. *lentis*, is a major disease of lentil in Syria

Table 14. Reaction of selected lentil lines to ascochyta blight at NARC, Islamabad, Pakistan and Debre Zeit, Ethiopia and to rust at Debre Zeit and Akaki, Ethiopia on 1-9 scales.

		Ascochyta score		Rust score	
Selection	ILL	NARC	Debre Zeit	Debre Zeit	Akaki
	358	1	5	2	3
78S26052	5604	2	6	1	1
FLIP 84-78L	5748	3	5	3	1
FLIP 85-33L	5871	1	-	1	-
FLIP 86-21L	6007	3	5	1	1
FLIP 86-38L	6024	-	5	3	1

and several other West Asian countries. Field screening for resistance to this disease has been under way at ICARDA since 1986, but has been necessarily opportunistic because of the uneven distribution of the disease in the field and the lack of a wilt-sick plot. During the 1987/88 season, ICARDA, in cooperation with Aleppo University, developed a plastic house technique involving the use of (i) field soil in metal trays sown with test entries and a susceptible check in rows, and (ii) inoculation with 14-day old liquid culture of *F. oxysporum* isolated from stems of wilted plants and applied two weeks after sowing. The repeatability of the technique was high, with a correlation of r = 0.86 between repeated sowings of 25 lines, varying in their disease reaction from resistant to highly susceptible. Of 162 lines screened using this technique, 29 were found promising with no disease incidence. A study of the effects of temperature and growth media on fungal development indicated optimum growth at 23°C on lentil dextrose agar (LDA).

The economic importance and damage levels of *Sitona* spp. in lentil were related to rainfall and time of sowing. Early sowing increased damage. Increase in yield because of control of *Sitona* spp. damage through use of Carbofuran was curvilinearly related to rainfall in the range from 250-700 mm with maximum response occurring at 525 mm (Fig. 10). This information will be useful in developing an economic control schedule for *Sitona* spp.

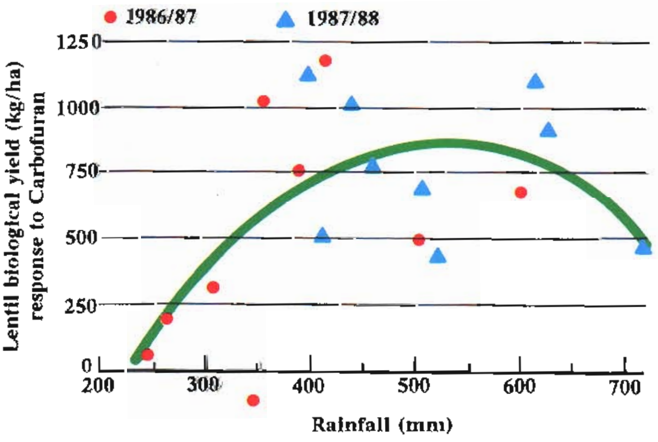


Fig. 10. Response of lentil biological yield to *Sitona* control (20 kg/ha Carbofuran 5% G) at locations with different rainfall during 1986/87 and 1987/88.

A predictive model for the response of time-to-flower to variation in temperature and photoperiod, developed in an ODA-funded collaborative project with the University of Reading, using six contrasting genotypes in controlled environments, was tested on a wide range (240 accessions) of germplasm in a glasshouse. The model fitted the data well ($r^2 = 0.915$), and can therefore be used for assessing the phenological adaptability of a genotype to different locations.

The adaptation of lentils to rainfed environments in the Mediterranean region was studied and the importance of early to mid-season vigor and early maturity to produce high crop biomass was highlighted.

Harvest mechanization. Lentil harvest by hand is becoming increasingly expensive. Systems for mechanized harvesting have been developed at ICARDA, and Syrian farmers have started to use them. At the Syrian-Libyan Company (SYLICO), Ras el-Ain, Syria, over 95 ha of lentil were grown rainfed with careful seed-bed levelling, and harvested by a Combine harvester, with an average seed yield of 1,630 kg/ha and an estimated seed loss of below 5%. In a comparison covering 70 ha, cultivar 'Idleb 1', released in 1987, and the line 78S 26013 yielded 40% more than the local check (Table 15), when machine harvested.

An improved lentil variety, with tall upright growth habit and less pod dehiscence, being harvested by a Combine.

Table 15. Results of a comparison between three lentil varieties harvested by a Combine at SYLICO.

Variety/Line	Area (ha)	Yield (kg/ha)	Mean plant height (cm)
Idleb 1	23	1,890	54
78S 26013	25	1,846	52
Haurani 1 (local check)	22	1,281	45

Kabuli Chickpea

In 1987/88, emphasis was placed on both winter- and spring-sown kabuli chickpeas. A comparison of the performance of newly-bred lines sown during winter and spring for five years (1983/84 to 1987/88) at three sites differing in seasonal rainfall and thermal regimes showed an average of 54% higher seed yield with winter than the spring-sown crop (Fig. 11). Winter sowing over spring was even more advantageous when seasonal precipitation was sub-normal, but this advantage decreased when the severeness of cold increased in the cropping season. Algeria, Morocco, and Italy released two cultivars each for winter sowing using ICARDA's germplasm.

Emphasis in screening germplasm and breeding lines for resistance to ascochyta blight and cold tolerance continued for the development of stable yielding chickpea genotypes for winter sowing in

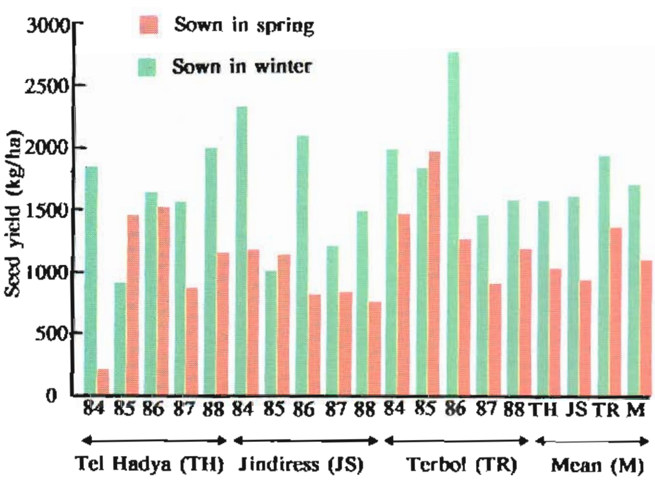


Fig. 11. Mean seed yield of 72, 96, 96, 98, and 284 entries of chickpea grown in winter and spring at Tel Hadya, Jindiress, and Terbol from 1983/84 to 1987/88.

the Mediterranean region. Lines found tolerant/resistant to ascochyta blight in field screening are rescreened in plastic house trials against individual races of differing virulence. Only a few lines showed a resistant reaction to race 6 or isolate 'F', the two highly aggressive isolates, although a large number of accessions showed resistance to more common but less aggressive isolates.

Evaluation of a large number of kabuli chickpea germplasm lines has helped in the identification of resistant sources to ascochyta blight, leafminer (*Liriomyza cicerina*), and *Fusarium oxysporum* wilt, as well as cold (Table 16), but not to cyst nematode (*Heterodera ciceri*) and seed beetle (*Callosobruchus chinensis*). Therefore, 137 accessions of eight wild *Cicer* species were screened for their resistance to various stress factors. A high level of resistance to ascochyta blight, leafminer, cyst nematode, and seed beetle, as well as cold, was observed in some of them (Table 17). Accessions of *Cicer bijugum* and *C. judaicum* appeared to be promising because of their high level of resistance to most stresses. It was interesting to note that accessions of *C. reticulatum*, which easily crosses with cultivated

Table 16. Resistance sources to different biotic and abiotic stresses in chickpea at Tel Hadya, 1987/88.

Stress	Lines screened	Sources identified
Ascochyta blight	15,000	ILC-182, -200, -2506, -2956, -3274, -3856, -3866, -3870, -4421, -5586, -5921, -6188.
Cold	5,200	ILC-794, -1071, -1251, -1256, -1444, -1455, -1875, -3465, -3598, -3746, -3747, -3791, -3857, -3861.
Leafminer	6,200	ILC-5901
Fusarium wilt	2,500	ILC-857, -848, -850, -851, -857, -858, -860, -871, -904, -911, -5032, -5411.
Cyst nematode	3,800	None
Seed beetle	4,000	None

Table 17. Evaluation of wild *Cicer* species for resistance to biotic and abiotic stresses at Tel Hadya, 1987/88.

Cicer species	Ascochyta blight	Leaf-miner	Cyst nematode	Seed beetle	Cold
C. bijugum	R	R	R	HR	HR
C. chorassanicum	S	HR	S	S	S
C. cuneatum	R	HR	S	HR	S
C. echinospermum	S	R	S	HR	HR
C. judaicum	HR	HR	S	HR	R
C. pinnatifidum	HR	R	S	R	R
C. reticulatum	S	S	R	HR	HR
C. yamashitae	S	-	S	S	S

HR = Highly resistant; R = Resistant; S = Susceptible.

species, possessed resistance to cyst nematode, seed beetle, and cold. These accessions are being used in germplasm enhancement work. To exploit the desirable variability in other wild species, more research is needed to overcome the crossability barriers between them and cultivated species.

Disease surveys in Algeria, Morocco, Syria, and Tunisia revealed that along with ascochyta blight, *Sclerotinia* sp. stem rot was observed in winter-sown chickpea in Morocco and Algeria and *Fusarium* sp. wilt and stunt in the spring-sown crop in North Africa. Epidemiological studies confirmed that the ascochyta blight inoculum could be disseminated by wind and that the length of incubation period at nearly 100% RH determined the severity of disease development in moderately susceptible and resistant genotypes. A miniaturized inoculation technique was developed that ensures precisely controlled duration of incubation.

Methods for population assessment and damage levels for leafminer, the major pest of spring-sown chickpea in the Mediterranean region, were further refined. Using water-filled trays kept between the plant rows, the number of full grown larvae dropping from the leaves to the soil for pupation was counted and found to be highly correlated with mining percentage of leaves (Fig. 12). It could thus be used as a selection criterion for screening a large number of genotypes for leafminer resistance.

Potential benefits from winter-sowing of chickpea were demonstrated to extension personnel in Morocco.

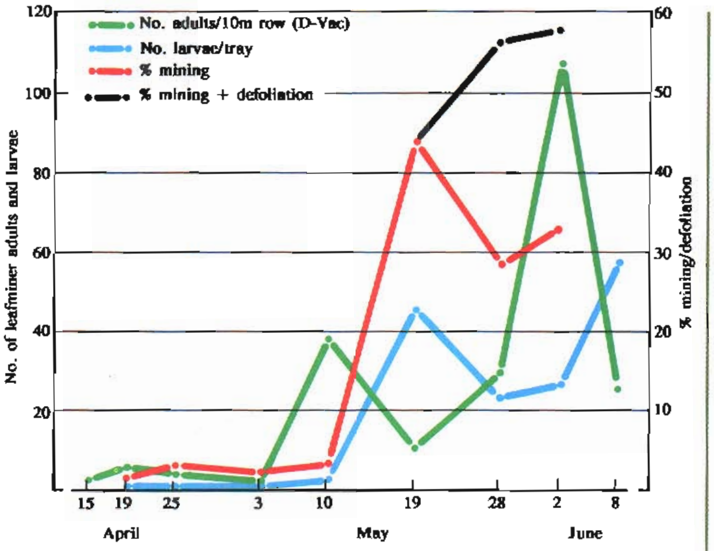


Fig. 12. Chickpea leafminer adult and larvae population development and percentage leaflets mined, Tel Hadya, 1987/88.

Studies on drought tolerance using the line-source sprinkler system to vary moisture availability were continued and results confirmed that the method could be used for routine screening. Early flowering and early maturity appeared to be the most important attributes for high yield under drought stress. Studies on supplemental irrigation confirmed the yield advantage obtainable from this practice in both spring- and winter-sown chickpea. Genotypic differences in response to supplemental irrigation were established.

Biological Nitrogen Fixation

Enhanced biological nitrogen fixation by legumes is vital for improved and sustainable production in the cereal-based farming systems of the dry Mediterranean areas. Defining the conditions where inoculation with cultures of *Rhizobium* spp. is necessary, is an essential component of legume nitrogen fixation research at ICARDA. The need to inoculate may exist where the native rhizobial population is low, or where the native rhizobia are not efficient in nitrogen fixation with newly introduced improved legume cultivars.

Use of the line-source sprinkler system for evaluating genotypic differences in drought tolerance of chickpea at Tel Hadya.

Use of intact field soil cores for the evaluation of a large number of strains of rhizobia for their efficiency in symbiotic nitrogen fixation.

A methodology was tested involving yield comparison of plants wholly dependent on nitrogen fixed by native rhizobia, with those supplied with nitrogen fertilizer adequate to produce high yield. Over the last two seasons, inoculation treatments have been included in these trials, using the best strains selected at ICARDA to verify the use of N fertilizer yield response to predict response to inoculation.

Regression coefficients of the relationship between nitrogen and inoculation response for the three food legume crops indicated a strong positive correlation over a range of cultivars in multilocation trials (r = 0.73, 0.62, and 0.58 for chickpea, lentil, and faba bean, respectively). The results for chickpea are shown in Fig. 13. These studies indicate the validity of using N fertilizer response to predict response to inoculation with selected superior strains.

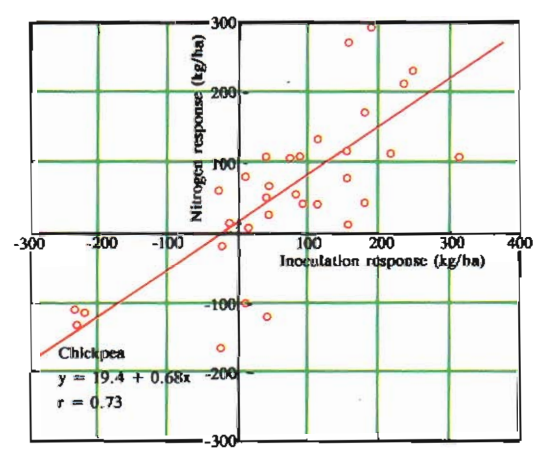


Fig. 13. Relationship between chickpea response to 120 kg N/ha and to inoculation with best *Rhizobium* strains, for 15 cultivars over three locations in N. Syria. Axes represent seed yield increase over uninoculated and unfertilized control.

Strain selection research has yielded sets of highly effective, competitive strains of rhizobia for the three crops, with complementary antisera for serological identification in field situations. Testing of these strains at ICARDA stations with a wide range of elite germplasm gave a clear indication of the success of the screening program. Seed yield increases due to inoculation were as high as 116% in chickpea, 47% in lentil, and 54% in faba bean. Average yield increases across 12 cultivars of each legume species were 13, 14 and 15% for chickpea, lentil, and faba bean, respectively, with inoculation using best strains. The increase in plant nitrogen yield in a chickpea cultivar using different strains of *Rhizobium* is shown in Fig. 14. The results indicate a potential role of inoculation in all three crops, even in traditional production areas where high native rhizobial populations exist.

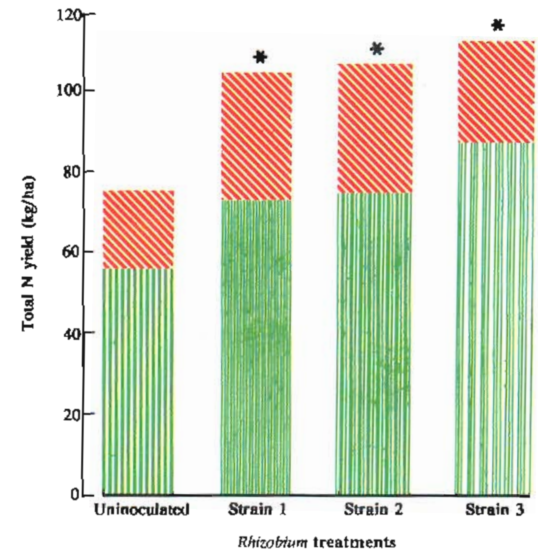


Fig. 14. Effect of *Rhizobium* strain treatment on plant nitrogen yield and source for chickpea cv. ILC 482. Lower portion of bar represents N-fixed; upper, N from soil. *Significant at $P < 0.05$.

International Food Legume Testing Program (IFLTP)

The International Food Legume Testing Program furnished 1,241 sets of 45 different types of nurseries to cooperators in 60 countries in and outside the WANA region for the 1988/89 season. These nurseries included 11 yield trials, 9 advanced generation screening nurseries, 6 segregating population nurseries, 9 screening nurseries of resistant sources to disease, insect, and cold, 3 need-to-inoculate trials, 3 inoculation response trials, and 4 weed control trials. Since 1977/78, diversification of nurseries has continued in order to meet the specific needs of the cooperators (Fig. 15). This year six new nurseries, three in faba bean and three in lentil, were added.

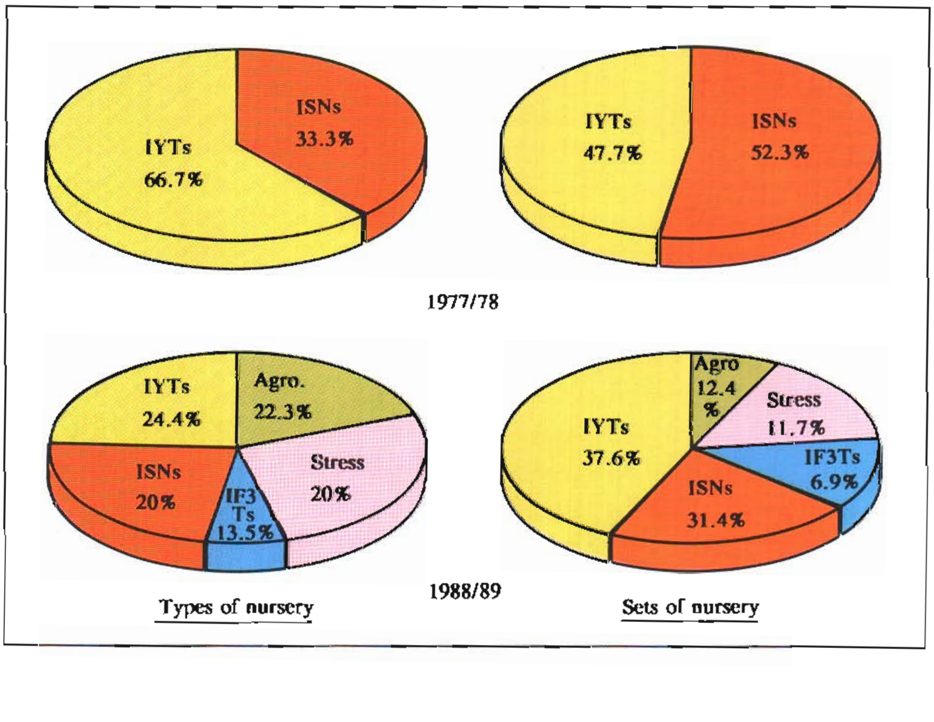


Fig. 15. Diversification and distribution of nurseries during 1977-88, as reflected by the types of nurseries available and sets of these supplied to the co-operators. IYTs = International Yield Trials; ISNs = International Screening Nurseries; IF3T = International F3 Trial; Agro. = Agronomy.

Traveling Workshop: scientists from Egypt, the Sudan, and Ethiopia examine a determinate faba bean line adapted to the Nile Valley conditions.

In 1987/88, 16 varieties of kabuli chickpea and lentil were released by national programs in WANA and elsewhere (Appendix 2).

The stability analyses for one international yield trial each in faba bean, lentil, and chickpea revealed that the performance of the ICARDA-developed genotypes was predictable in lentil and chickpea. But in the case of faba bean, there were differences in behavior of genotypes, some being highly unpredictable over environments.

Three food legume traveling workshops, one each in West Asia, North Africa, and the Nile Valley, were organized. These provided network scientists with opportunities to see materials of fellow scientists and exchange ideas and experience.

Seed Production

A seed testing and seed production laboratory and a seed processing plant became operative at ICARDA in January and June 1988, respectively, to train staff of national seed production programs.

The first three residential seed production trainees completed their 3-month training at ICARDA headquarters in 1988. A 2-week General Seed Technology Course was organized jointly with the Seed Production Organization in the Yemen Arab Republic. A total of 23 participants attended. In Egypt, a 1-week Seed Certification Course was organized jointly with USAID/Michigan State University, GTZ, and the Egyptian Seed Organization; more than 50 Egyptians attended the course.

A small seed processing plant became operative in June 1988 to train WANA seed production staff and to meet the seed processing needs of ICARDA.

A 3-day workshop on seed certification (organized jointly with CAS, GTZ, and USAID/MSU) was held in Cairo, April 1988, to review the different seed certification schemes with the objective of developing recommendations for Egyptian seed certification activities.

A small workshop "Seed Production in the Arabian Peninsula" was organized (jointly with the Ministry of Agriculture and the EC Seed Multiplication Project) in the Yemen Arab Republic in March 1988. The objective was to review progress and constraints in the different national seed production programs and to promote and intensify collaboration.

Two training manuals were published in English and one in Arabic during the year.

Seed harvested from the research farm at Tel Hadya was cleaned and treated at the seed processing plant, and quality seed of different ICARDA crops was produced.

Breeder Seed (the first step in the seed multiplication cycle) of wheat, barley, lentil, and chickpea was produced and a start was made to develop morphological descriptions of varieties.

Resource Management and Conservation

Fallow Replacement

It has been estimated that there are approximately 30 million hectares of fallow land in West Asia and North Africa. In Syria alone there are 2 million hectares, mainly where rainfall is between 200 and 350 mm. This huge area, which is either left bare or used for low-quality grazing, is potentially the most important resource for increasing feed supplies for livestock. ICARDA's challenge is to replace fallows without reducing cereal yields.

Two strategies are under investigation at ICARDA: replacement of fallow with a legume crop, and replacement with self-regenerating pastures. Both strategies are aimed at increasing livestock feedstuffs.

Fallowing may benefit the subsequent crop by a variety of mechanisms, including: storage of water in the soil profile; control of weeds (grazing and spring tillage prevent seeding); control of diseases (absence of host); and greater nitrogen availability from cumulative mineralization. Even so, it is an inefficient use of land, because the benefit to the next crop only partially compensates for a season's loss of production. Moreover, where soils are shallow, storage of water is usually negligible.

In the lowland areas of West Asia, low and erratic rainfall combined with long, hot, and arid summers results in poor fallow efficiency. This is illustrated by the data (Table 18) from an on-going crop rotation trial at Breda in northern Syria. This location typifies areas in Syria where barley production is currently practised in rotation with a fallow year.

Maximum water storage occurs towards the end of February, but even at this stage 50% or more of the rainfall is lost through soil evaporation. By the time of barley harvest (mid-May), the water-use efficiency falls further and is highly variable, depending on the nature and timing of rainfall. In both 1985/86 and 1986/87, when the efficiency was greatest, there were few but relatively heavy rainfall events. Further evaporation occurs during the summer and, by the start of the next cropping season, less than 10% of the previous season's rainfall remains stored in the soil profile.

Table 18. Moisture storage under fallow as percentage of rainfall at three times during the season at Breda, Northwest Syria.

Season	1983/84	1984/85	1985/86	1986/87	1987/88
Rainfall (mm)	204	277	218	245	408
Moisture storage: as percent of rainfall					
Maximum	33	53	54	27	47
By barley harvest	14	25	46	37	29
By end of summer	3	7	5	8	9

Results from the same trial indicate that if a fallow is replaced by a forage legume (vetch), the yields of a subsequent fertilized barley crop are somewhat reduced (Table 19), especially in dry

Table 19. Water-use efficiency of barley and vetch in three rotations at Breda, Northwest Syria .

Season	1983/84	1984/85	1985/86	1986/87	1987/88
Rainfall (mm)	204	277	218	245	408
Barley after fallow					
Grain plus straw (t/ha)	3.43	4.78	5.47	3.39	8.79
Crop water use (mm)	200	246	208	237	333
Water-use efficiency (kg/ha/mm)	17.2	19.4	26.3	14.3	26.4
Barley after barley					
Grain plus straw (t/ha)	2.12	4.31	2.09	2.26	4.09
Crop water use (mm)	185	236	177	227	310
Water-use efficiency (kg/ha/mm)	11.5	18.3	11.8	9.9	13.2
Barley after vetch					
Grain plus straw (t/ha)	2.41	4.83	4.11	3.12	7.97
Crop water use (mm)	189	237	190	231	346
Water-use efficiency (kg/ha/mm)	12.7	20.3	21.6	13.5	23.0
Vetch after barley					
Hay (t/ha)	0.82	2.83	2.50	2.53	3.67
Crop water use (mm)	160	218	153	205	258
Water-use efficiency (kg/ha/mm)	5.1	13.0	16.3	12.3	14.3

[1] Barley received 20 kg N/ha and 60 kg P_2O_5/ha.

years such as 1983/84 and 1985/86, when the water stored in a previous fallow is of particular benefit. However, these reductions in yield are small compared with the much greater reduction occurring when continuous barley production is practised. Several reasons for this have been identified. Vetch, harvested as hay, uses less water than barley, and some of the unutilized moisture remains available for the next year. In addition, the vetch crop is largely able to meet its own nitrogen requirements through biological nitrogen fixation, and thus more native soil nitrogen is available for use by the next year's barley crop. Vetch acts as a suitable break crop which counteracts the buildup of soil residues and diseases which commonly occur in barley monoculture.

If farmers were to adopt the use of forage legumes, it might be reasonably expected that in any one year, they would have half the land under barley, and half under vetch, compared with either half their land under barley and half under fallow, or all of their land under barley. Productivity and water-use efficiency must therefore be considered for the total rotation, and this is illustrated in Fig 16. The barley-fallow rotation, where only half the land is cropped, is the poorest in terms of both productivity and water-use efficiency, and the barley-vetch rotation is the best. Continuous barley initially appeared superior to barley/fallow, but in the last three years, yields have been so low that it seems unlikely that this practice, which is being increasingly adopted by farmers, will be sustainable in the longer term.

But farms are even more complex than rotation experiments, especially because they include livestock. Therefore, experiments on farmers' fields form an invaluable part of ICARDA's research on fallow replacement.

The profitability of replacing fallow with either vetch (*Vicia sativa*) or chickling (*Lathyrus sativus*) on farmers' fields is evident from the data in Table 20. The experiment, on farms where barley/fallow is the traditional rotation, was conducted over six years. The farms were small (average size 5 ha) and the annual rainfall varied from 200 to 320 mm. Without phosphorus, profitability increased by 50% with vetch and 170% with chickling, and, if phosphorus was added, by up to 280%. So the results obtained at ICARDA's

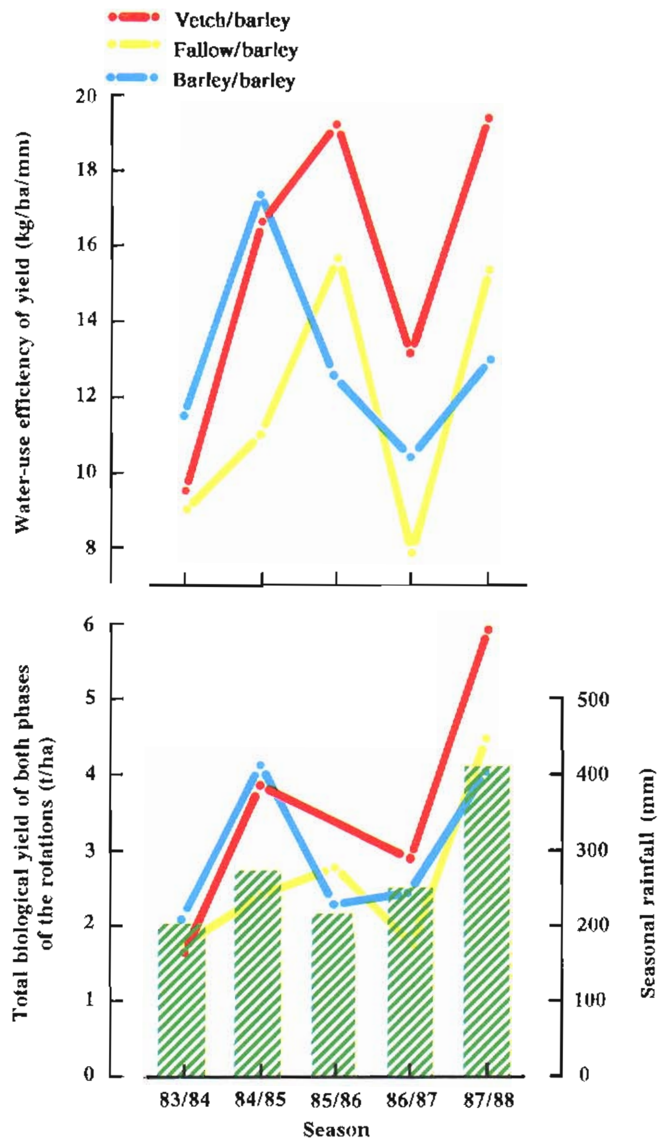
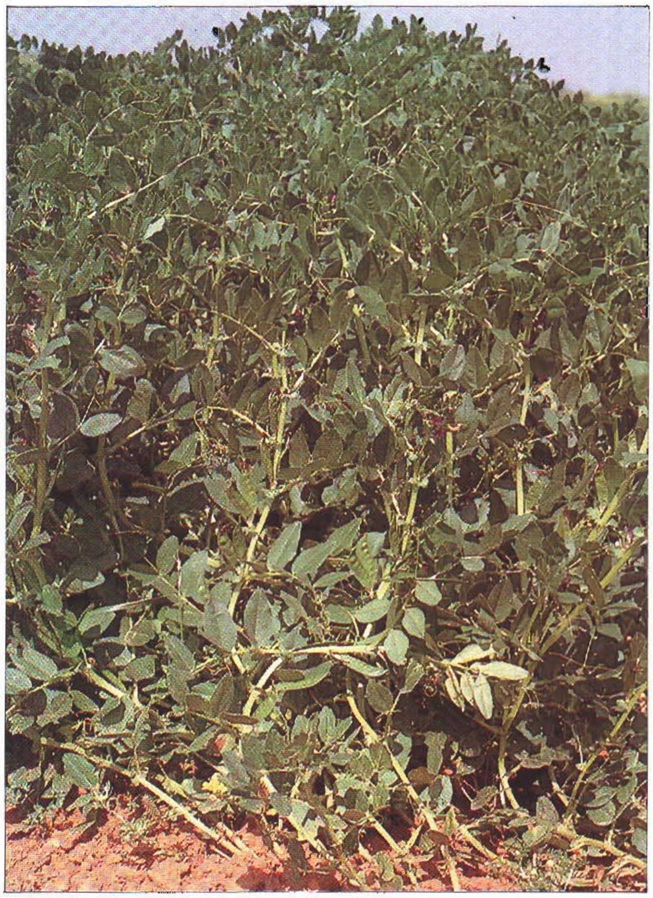


Fig. 16. Production and water-use efficiency of contrasting rotations at Breda in northern Syria, 1983-1988.

research farm were applicable on farmers' fields even when, as here, most of the management decisions were taken by farmers.

The forage legumes used in this experiment were those obtainable in the local market, not necessarily those with highest yield. The vetch, for example, has pods which are likely to shatter before harvest, causing yield losses of about 30%. They may not even be the best species: ICARDA is collecting evidence that another vetch species, *Vicia narbonensis*, may be better adapted to these



Vicia narbonensis **(narbon vetch) is a promising vetch species to replace fallow in the dry areas.**

Table 20. Net benefits from barley-fallow and barley-forage rotations BF = barley-fallow; BV = barley-vetch; BC = barley-chickling; P = phosphorus).

	Rotation				
	BF	BV -P	BV +P	BC -P	BC +P
Gross revenue: (SYP/ha per 2 years)					
Forage grain	0	1115	2156	2430	3349
Forage straw	0	785	1130	745	1027
Barley grain	1305	1213	1698	1449	1949
Barley straw	839	831	1091	906	1141
Total per 2 years	2144	3944	6075	5530	7466
Total per year	1072	1972	3038	2765	3733
Direct costs: (SYP/ha per 2 years)					
Cultivation	200	400	400	400	400
Broadcasting	127	254	381	254	381
Seed (140 kg/ha)	231	756	756	756	756
Fertilizer	0	0	120	0	120
Hand harvest[a]	300	600	900[b]	600	900[b]
Total per 2 years	858	2010	2557	2010	2557
Total per year	429	1005	1279	1005	1279
Net revenue SYP/ha (per year)	643	967	1760	1760	2455

[a] Excludes cost of transport and threshing.

[b] Increased by 50% due to higher crop density.

dry areas. Indeed, ICARDA believes that new species of *Lathyrus* (*L. ochrus* and *L. cicera*) may also have a place in rotation with cereals in the dry areas.

An alternative to replacing fallows with forage crops is to replace it with pastures. ICARDA uses the term 'pastures' to describe self-regenerating species of annual legumes, the dormant seed of which regenerates in successive years on what would otherwise have been fallow land. The system, which is based on the Australian ley farming system, is a low-input system for two reasons: the pasture legumes fix nitrogen and they do not require annual re-seeding.

The concept is to replace weeds in weedy fallows with pasture legumes, the latter being more productive than weeds because they are independent of soil nitrogen. Any legume can be used provided, like a weed, it has the ability to persist without re-seeding. Because they produce 'hard' seeds, many wild Mediterranean legumes have this capacity. The concept of a 'seed bank' of hard seeds of the pasture legumes is central to the use of self-regenerating pastures.

To introduce ley farming requires consideration of all its components: pastures, livestock, cereals, soil fertility, and farmers. Critics claim that there has been a lack of consideration of socioeconomic conditions, and an excessively academic approach to the technical problems. For these reasons ICARDA considers it essential to work on farmers' fields.

ICARDA's first on-farm experiments were sown in the autumn of 1984 at El-Tah village in Idlib province, Syria. Six farmers were chosen on the basis of whether or not they owned livestock and on their reliability as collaborators as judged by the village leader. Fields of one hectare were sown to a mixture of Australian and local medic cultivars and the grazing managed by farmers in close consultation with scientists. The key criterion for grazing was seed set during spring, with summer grazing restricted so that approximately 200 kg/ha of seed remained in the 'seed bank' in autumn. We used only machinery which was available to farmers.

At the end of 1987/88 there were 22 farms in the project including those in the second cereal cycle (four of the original six farms) with first year pasture (four new farms). The mean size of the seed banks for all groups of farms was at least 200 kg/ha, and by 1987/88 ley farming had been satisfactorily established (Table 21). Indeed, of the 22 farms only 3 could be considered failures, a most remarkable result given the new skills required by farmers to manage the system.

Table 21. Size of the medic seed bank after grazing in the summer of 1987/88 at El-Tah, Syria.

After first year medic (mean of four farms)	212 kg/ha
After two years of medic (two farms)	360 kg/ha
After the second medic cycle (seven farms)	257 kg/ha
After the first wheat crop (four farms)	199 kg/ha
After the second wheat crop (five farms)	286 kg/ha

On these fields average stocking rate (for all farms measured), calculated on a year-round basis, was more than 7 ewes/ha. In fact, farmers do not stock pastures continuously; they prefer to stock heavily from March to August, their sheep grazing green pastures until the end of April and eating pasture residues (including pods) and cereal stubbles through the summer.

Wheat yields after pasture and after control crops are shown in Table 22. Again, the 1987/88 results confirmed those of earlier years that wheat yields after pastures are higher than after other crops. In 1987/88, wheat yields after first year pasture were not significantly greater than after the control crops, although in 1986/87 even this difference was significant.

At current prices the net returns from pasture greatly exceeded that of the alternative crops. Of the traditional rotations,wheat/lentil was the most profitable. Since wheat yields after pasture exceeded yields after lentils, and since the profits from pasture were nearly three times that of lentils, the wheat/pasture rotation, was easily the most profitable.

Table 22. Wheat yields (t/ha) after first year and regenerating medic compared with wheat yields in traditional rotations at El-Tah, Syria.

	First year		Regenerating	
	Medic	Control	Medic	Control
1985/86	1.29	1.24[a]	NA	NA
1986/87	1.40	1.08[b]	NA	NA
1987/88	1.95	1.64[a]	2.67	1.77[b]

NA = Not applicable: the first crops sown after regenerating medic were in 1987/88.

(a) Difference between after medic and after control not significant.

(b) Difference between after medic and after control significant at $P<0.05$.

Phosphate Application on Native Grasslands

Before human settlement the areas of native grasslands in West Asia were dominated by small trees, shrubs, and perennial grasses. Today, however, these grasslands are dominated by annual species of grasses, legumes, and herbs and they are overgrazed and subjected to severe soil erosion. Improving the productivity and management of these grasslands is therefore a high priority in the development of sustainable farming systems. One approach to increase their productivity is to apply phosphate fertilizer which encourages growth of the legumes in particular.

Herbage yield at Tel Hadya from a grassland topdressed with superphosphate was more than treble that of an unimproved grassland and the response was mainly the result of better legume growth (Fig. 17) with some improvement in grass growth. This was also reflected in the body mass of ewes and the amount of supplementary feed needed. The study, which has now completed four seasons, indicates the potential sheep productivity of West Asia grasslands. It was estimated that stocking rate increased by 2.5 to 3 times above the zero phosphate level of application when 25 to 60 kg P_2O_5/ha was applied.

Phosphate application (left) significantly improves the biomass productivity and feed quality of native pasture, particularly its legume component (insert).

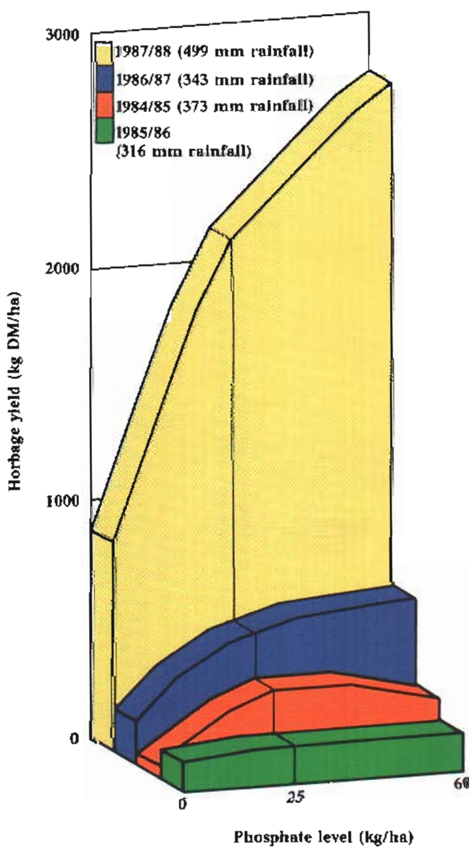


Fig. 17. Herbage yield of legumes on grasslands receiving phosphate fertilizer in different seasons at Tel Hadya.

Effect of Long-term Tillage Systems on the Stability of Wheat/Lentil Rotation

Water infiltration studies in a trial, where tillage is carried out at different times and with different soil moisture conditions, were reported last year (FRMP Annual Report 1987). Infiltration was reduced where both primary and secondary tillages were completed prior to rain. Dry sieving analyses carried out in the laboratory this year showed a difference in the stable aggregate size distribution between the dry tillage and the treatments where some or all of the tillage followed rain. A greater proportion of the aggregates in the 0-10 cm soil layer falls into the smaller size categories (0.5-1.0 mm; 0.2-0.5 mm; and <0.2 m) with dry tillage. This appears to support the hypothesis that dry tillage causes soil structural degradation, but further work is required to clarify the complex situation.

We have also reported in previous years (FRMP Annual Report 1986, 1987) on the dynamics of weed populations over time in relation to the timing of tillage and weed control methods. The weed control treatments were discontinued three years ago, and weeds have been uniformly controlled since then.

However, in the wet 1987/88 season, wheat plots previously hand-weeded suffered severe infestation of an unidentified grassy weed resistant to herbicide. Similarly, in the case of lentil a leguminous weed invaded plots previously treated with a broad spectrum herbicide. The effects were most severe in zero-till plots which are sown before the opening rains, and have implications for the sustainability of zero tillage which is otherwise showing promising results.

Improving Nitrogen Fertilizer Use Efficiency on Wheat through Soil Testing

Throughout West Asia and North Africa, wheat-growing soils are low in organic nitrogen, and even when wheat is grown in rotation with legumes such as chickpea or lentil, responses to nitrogen fertilizer are common and widespread. Wheat growers are increasingly using nitrogen fertilizer to boost their yields. For example, farm surveys in the Goubellat area of Tunisia, which receives 440 mm of average annual rainfall, showed that 85% of the farmers use nitrogen fertilizer, and in the wheat-growing areas of Northwest Syria a similar figure of 87% was found. This increase in the use of nitrogen fertilizer on rainfed wheat has been dramatic in recent years throughout the region as reflected in the data in Table 23.

Table 23. Nitrogen fertilizer use in selected countries of West Asia and North Africa (kg N/ha of arable land and permanent crops).

	1975	1985
Algeria	5.3	12.9
Iraq	4.7	22.0
Jordan	4.9	25.6
Morocco	8.2	16.2
Syria	8.8	24.2
Tunisia	4.8	9.1
Turkey	17.4	35.1
Yemen Arab Republic	2.5	11.1

Source: FAO Fertilizer Yearbook 1986.

In most countries, nitrogen fertilizer recommendations for wheat growers exist, but all too often these recommendations are targeted towards broad agroecological zones and fail to take account of the year-to-year variability of rainfall, or the diversity of soil conditions and crop sequences, all of which have a substantial effect on the economics of nitrogen fertilizer responses. Farmers are aware of these interactions and respond accordingly. For instance, in Syria, our survey work has shown that soil quality, rainfall prior to top-dressing (end of February), weed infestation, and previous crop are all factors which influence a farmer's decision on how much nitrogen to apply to a wheat crop.

ICARDA has developed an extensive series of on-farm nitrogen and phosphate fertilizer trials on wheat and barley in which sites are characterized with regard to soil type, depth and fertility, previous crop, and seasonal rainfall. The specific objective of these trials is to quantify environment x fertilizer response interactions and thus produce more specifically targeted fertilizer recommendations. Such targeted recommendations will allow more efficient use of fertilizer both at the farm and the national level.

Our results to date highlight the pronounced effects of seasonal rainfall amounts and levels of available nitrogen in the soil on the response of cereals to nitrogen fertilizer. Figure 18 presents data derived from over 50 on-farm barley trials throughout northern Syria, and clearly illustrates great variability in N-fertilizer response which would be expected from a single blanket recommendation.

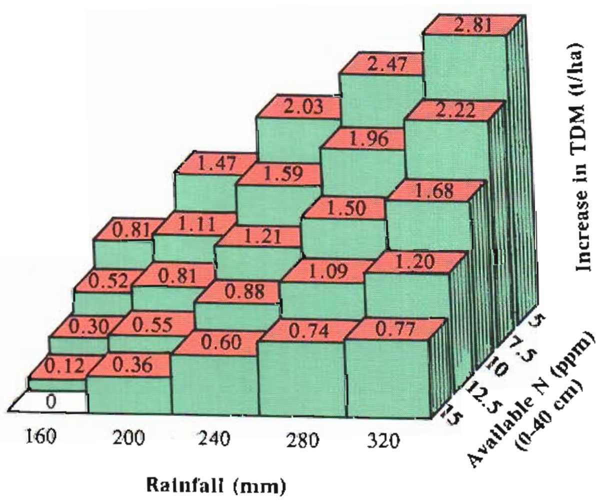


Fig. 18. Increase in total dry matter of barley resulting from the application of 40 kg N/ha as affected by rainfall and available soil nitrogen.

Table 24. Correlation coefficients between grain yield, total dry matter, and total N uptake by wheat and various soil N tests, from zero N treatments in 40 N and P experiments conducted over two seasons (1986/87 and 1987/88) in northern Syria.

Yield components	Nitrate 0 - 60cm	Ammonium 0 - 60cm	Mineral N 0 - 60cm	Kjeldahl N	Organic matter	Mineralization potential
Total dry matter	0.72	0.33	0.70	-0.12	-0.29	0.32
Grain yield	0.60	0.43	0.63	-0.17	-0.39	0.36
Total N uptake	0.77	0.21	0.71	-0.05	-0.13	0.33

Table 25. Correlation coefficients between grain yield, total dry matter and total N uptake by wheat and various soil N tests, from zero N treatments at low N sites from the 40 N and P experiments conducted over two seasons (1986/87 and 1987/88) in northern Syria.

Yield components	Nitrate 0 - 60cm	Ammonium 0 - 60cm	Mineral N 0 - 60cm	Kjeldahl N	Organic matter	Mineralization potential
Total dry matter	0.63	0.30	0.59	0.21	-0.02	0.60
Grain yield	0.61	0.33	0.60	0.18	-0.06	0.71
Total N uptake	0.67	0.27	0.59	0.19	-0.04	0.74

Fertilizer research is also under way in the wheat-growing areas of Syria, and ICARDA is coordinating a regional network of soil scientists and agronomists who are conducting similar research in their own countries.

One of the problems this network is tackling is the identification of the most suitable soil test to predict the level of available soil nitrogen. Traditionally, organic nitrogen (as assessed by Kjeldahl method) has been used, but this has not been found satisfactory. At a meeting in Amman in September 1988, the network scientists agreed that nitrate-nitrogen was a better index of availability, but even so, results using this technique were not consistent. They strongly recommended that the potential for the mineralization of soil organic nitrogen should also be considered as a suitable indicator.

During the last two seasons, ICARDA has conducted 40 on-farm fertilizer trials (N and P) on wheat throughout Syria. As part of this study, soils were sampled and various soil tests for nitrogen were studied in the laboratory, and their ability to predict the nitrogen uptake and yield of the zero-N plots in these trials was assessed. The soil tests used were: organic matter, organic nitrogen, nitrate-nitrogen, ammonium nitrogen, mineral nitrogen (nitrate plus ammonium), and the nitrogen mineralization potential determined through incubation[1]. The results are presented in Table 24.

Across all 40 locations, nitrate-nitrogen proved to be the best and, as expected, both Kjeldahl-N and organic matter the poorest indicators. The mineralization potential did not appear particularly useful. However, if only the locations which had low levels of initial available nitrate (less than 7 ppm) were considered, the potential of those soils to mineralize nitrogen proved to be the best indicator (Table 25).

The results of this research indicate that a simple predictive model can be developed which will allow more targeted N-fertilizer recommendations to be made. Several important criteria will influence the development of such a model. First, the critical level of soil available mineral nitrogen above which responses will be small depends on the season-specific and location-specific expected

1 The mineralization potential was determined according to the procedure of Stanford and Smith (1972). Commun. Soil Sci. Plant Anal., 36: 465-472.

yield of wheat. Second, both initially available mineral nitrogen and the mineralization potential of soils are important contributors to nitrogen uptake by wheat. Third, the efficiency with which nitrogen fertilizer is utilized by the wheat crop is also rainfall-dependent. Lastly, however precise fertilizer recommendation models may be in biological terms, they will become practical tools only when the economics of fertilizer use are also incorporated.

Effect of Wheat Stubble Management on the Productivity of Contrasting Farming Systems

This year ICARDA reports the first full set of results from its stubble management studies begun two years ago in two-course wheat-legume rotations. Chickpea and lentil yielded as well when sown into the standing stubble of a previous wheat crop as they did when the stubble was heavily grazed. However, there was a reduction in the yield of wheat where stubble was fully retained or grazed at a moderate level two years ago. The most likely explanation is that the amount of stubble affected the nitrogen balance of the wheat crop, even though there was no apparent interaction between stubble retention and nitrogen treatments. The effect of stubble on nitrogen dynamics will be included in the FLIP/FRMP work in this trial.

For the second year in succession, the response of lentil seed yield to residual nitrogen was measured in a rotation trial. In this trial, nitrogen at four levels (0, 30, 60, and 90 kg N/ha) is applied in the wheat phase of the rotation. This year there was a yield increase in the lentil following 30 kg N/ha applied last year, despite the fact that Sitona weevil, which reduces BNF by feeding on root nodules of lentil, was controlled. And, for the second year in a row, lentil seed yield was depressed by the application of 90 kg N/ha to the preceding wheat crop.

Degradability of Leaf and Stem Fractions of Barley Straw

Cereal straw and stubbles are such important components of animal feed in WANA that straw often approaches grain in economic value and an estimated 50 million tonnes of it are produced annually. For these reasons ICARDA has been studying the factors determining straw quality and also searching for simple predictors of straw quality that can be used by cereal breeders to screen germplasm.

Many of the high-yielding cereal varieties have short straw, and it has been clearly shown that short cereal plants have a higher proportion of leaf than tall ones. Furthermore, since leaf is far more digestible than stem, short varieties have a higher nutritional value than tall varieties. However, genetic variability in the nutritional value within the leaf and stem fractions from cereals growing in low-rainfall areas has received little attention.

The separation of leaf and stem fractions of straw in quantities sufficient for a conventional measurement of feed intake and digestibility is a laborious exercise. For this reason the nylon-bag technique was introduced to ICARDA in 1987 (ICARDA Annual Report 1987). This widely used technique allows the estimation of the rate and extent to which straw fractions are degraded in the rumen. These parameters are important determinants of the amount of a feed that a ruminant ingests and therefore its growth rate or milk yield.

Samples of leaf and stem fractions were available from an experiment conducted by ICARDA's Cereal Program in which barley was sown at increasing distances from irrigation sprinklers. This procedure resulted in tall plants close to the sprinklers, such as one would get in a year when rainfall was abundant, and short plants farthest away from the sprinklers, as one would find in a drought year. Since the other factors which affect plant growth and chemical composition were similar, precise comparisons between the leaf and stem fractions from different genotypes and stem heights could be made.

The rumen disappearance of the leaf and stem fractions from four barley varieties over a wide range of stem heights (Fig. 19) was measured and the results are shown in Table 26. The lower rate and extent of rumen disappearance of stem as compared with leaf is well known (Fig. 20) and reflects the higher content of lignin in the stem. This lignin is almost indigestible and it also encrusts other potentially digestible polysaccharides, thereby rendering them less available to microbial attack.

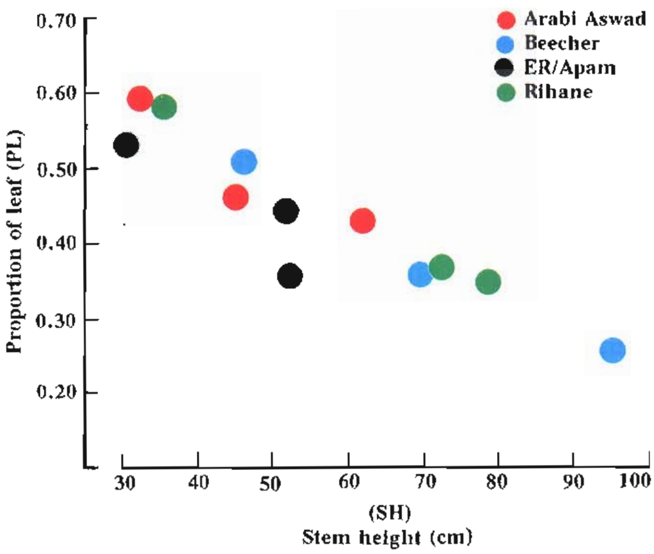


Fig. 19. Effect of stem height on the proportion of leaf in the straw of four barley genotypes, Arabi Aswad, Beecher, ER/Apam, and Rihane.

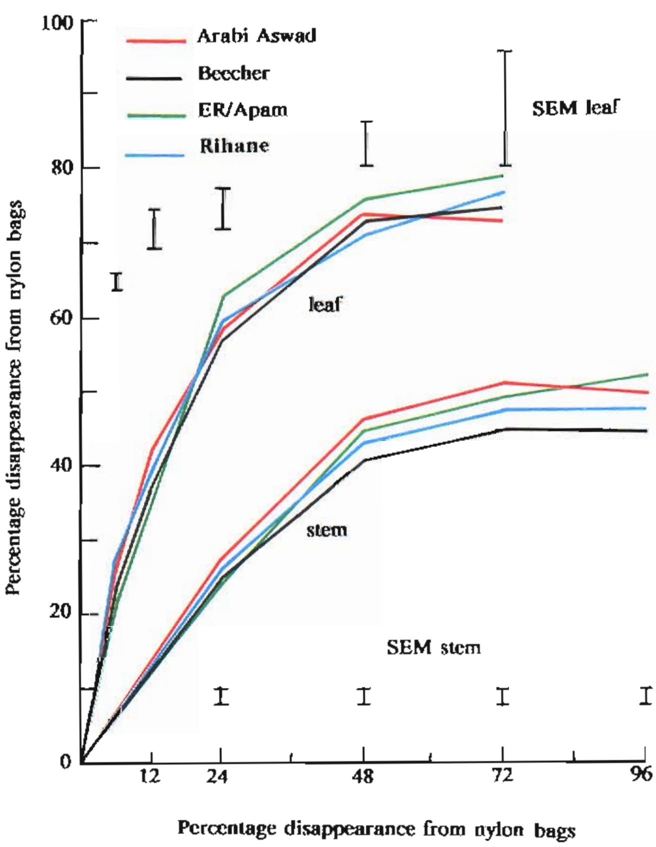


Fig. 20. Percentage disappearance of leaf (upper curves) and stem (lower curves) fractions from the straw of four barley varieties incubated in nylon bags for different times.

Table 26. Effect of barley genotype and stem height on the leaf proportion and disappearance of leaf from nylon-bags incubated in the rumen of sheep for 48 and 72 hours.

	Stem height (cm)	Leaf proportion	Disappearance (%) 48 hour	72 hour
Genotype				
Arabic Aswad	46.3	0.49	72	72
ER-Apam	44.3	0.45	74	78
Rihane	61.7	0.43	73	76
Beecher	70.3	0.38	72	73
Stem height				
Short	36.3	0.55	80	81
Medium	61.0	0.41	73	76
Tall	69.8	0.36	66	68
Standard Error (±)	5.72	0.029	2.4	4.1
Significance				
Genotype (G)	-	-	NS	NS
Height (H)	-	-	***	***
G X H	-	-	NS	NS

NS = non-significant; *** $P < 0.001$.

Of particular interest was the decrease in the rate and extent of disappearance of leaf as stem height increased and the small variation between the varieties within the two fractions. This finding confirms studies made on barley plants grown in a temperate environment. However, stem height appeared to have little effect on the rate and extent of rumen disappearance of stem.

These findings indicate that different barley varieties with a similar stem height, and therefore leaf and stem proportions, are likely to have straw with a similar nutritional value. Other research at ICARDA has shown how small differences in the protein content of straws from different barley varieties can have a marked effect on nutritional value. Researchers at ICARDA are optimistic that they will soon have identified several simple predictors for breeders to use in screening cereal germplasm for straw quality.

This research was conducted by Frances Herbert who was an ODA-funded scholar registered for a doctoral degree at the University of London at the time of her tragic death in a road accident near ICARDA headquarters in May 1988.

Improved Production Practices for Lentil

Improved production practices for lentil were again evaluated in Northwest Syria in seven on-farm trials. Despite some site-to-site variation in yield levels and net revenue, early sowing, Sitona weevil control, and weed control were found to be profitable at all locations. Yields in the 1987/88 wet season were higher than those in the last two seasons. Mean grain yield obtained by early sowing was 1,940 kg/ha, 49% greater than that of late sowing. Sitona and weed control provided 1,740 and 1,725 kg/ha mean yields, representing a 16% and 42% yield increase, respectively. They were more effective in early sowing. Phosphate application increased yield by only 4% and N fertilizer was not able to replace carbofuran use for Sitona control.

Improved Production Practices for Chickpea

A reevaluation of improved production practices for chickpea in northwest Syria in six on-farm trials revealed that early winter sowing, drill use and chemical weed control were profitable at all locations. Mean grain yield obtained by early winter sowing was 1,475 kg/ha, 46% higher than that of late winter sowing. However, this year we had three dates of sowing due to weather conditions: early December, early February, and spring, which resulted in mean grain yields of 2,080, 1,505, and 895 kg/ha. Drill use and P application provided 1,300 and 1,285 kg/ha mean yields, representing a 10% and 7% yield increase, respectively, over broadcast sowing and no P application. Weed control gave a mean grain yield of 1,240 kg/ha which was 35% higher than that of the weedy check.

Ceres-N Wheat and Barley Models

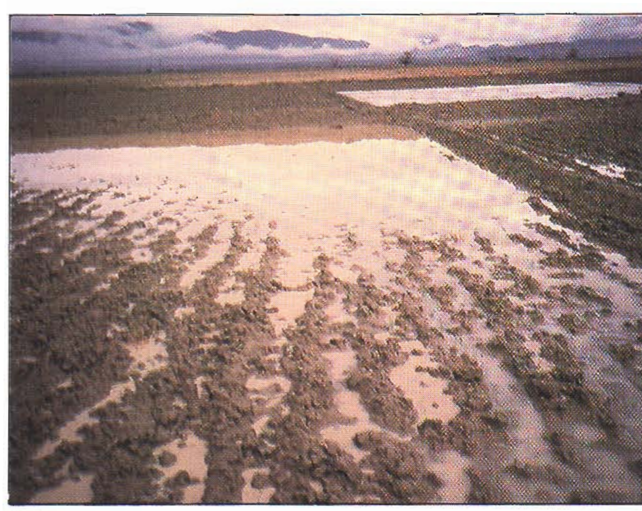
During 1988 we obtained an updated version of the Ceres-N wheat model and an initial version of a Ceres-N barley model which was jointly developed by ICARDA, Michigan State University, and IFDC. An in-house workshop was held during which senior staff of ICARDA were introduced to the theory, development, and use of these models. This was the first time that ICARDA held a special course to introduce its own senior scientists to a new research technique.

During the year we have tested the performance of the Ceres-N wheat model against specific data sets and assessed its sensitivity in predicting observed crop rotation and climate effects on the nitrogen responses of wheat. The results are very encouraging indeed. A visiting scientist from Stanford University has joined ICARDA to utilize these models together with farm survey data in assessing farm level risks and strategies associated with nitrogen fertilizer use on cereals in the Mediterranean region.

Water Harvesting in Baluchistan

In the 1987/88 season, little rain fell before February: in most locations, the total for the cropping season was unusually low, and crop failures were widespread. Years as dry as 1987/88 can be expected not more often than one year in ten, and the season thus provided a rare opportunity to test the full potential of water harvesting.

The trials involved preparing catchment areas at the top of gently sloping (0.5 - 1% slope)



Water harvesting in Dasht, Baluchistan.

fields to encourage incident rainfall to run down to the lower area where the water was contained by earth-banks and the fields were cropped. Soil water was sampled on 21 March 1988 to a depth of 1 m and at three different positions within each plot of a water-harvesting field at Dasht; this was after 78 mm of rain had fallen in five showers. Measured gravimetrically, soil water was significantly ($P<0.1\%$) increased by the run-off, and yields were increased on all plots. There is no shortage of "khushkaba" (dry) land in upland Baluchistan, so it should be practical to prepare catchment areas on currently unutilized land.

Introducing Range Plants in Baluchistan

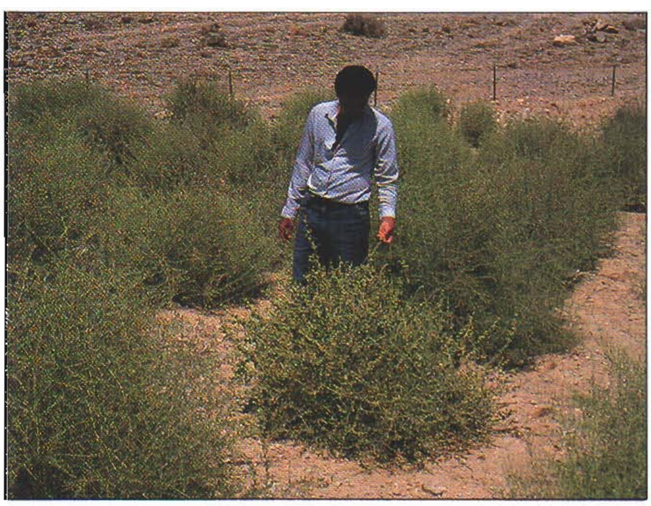
In the harsh environments of upland Baluchistan, the ranges have become degraded, and the spectrum of plant species has been depleted. Experiments involved the introduction of weeping lovegrass (*Eragrostes curvula*), which remained green into November, by which time the dominant indigenous grasses, *Chrysopogon aucheri* and *Cymbopogon jawarancusa*, were almost completely dried and dormant.

Even more interesting results were obtained with four-wing saltbush (*Atriplex canescens*), which was introduced at Zarchi and Tomagh. One irrigation at planting was enough to ensure almost 100% establishment of the transplants in these harsh upland environments. A trial planting for a forage reserve at Tomagh has demonstrated the productivity potential of four-wing saltbush when it is grown under favorable soil-moisture conditions. Six months after planting most of the shrubs were at least 1.5 m tall, and the stand was producing useable forage at an estimated 6,000 kg (dry matter)/ha.

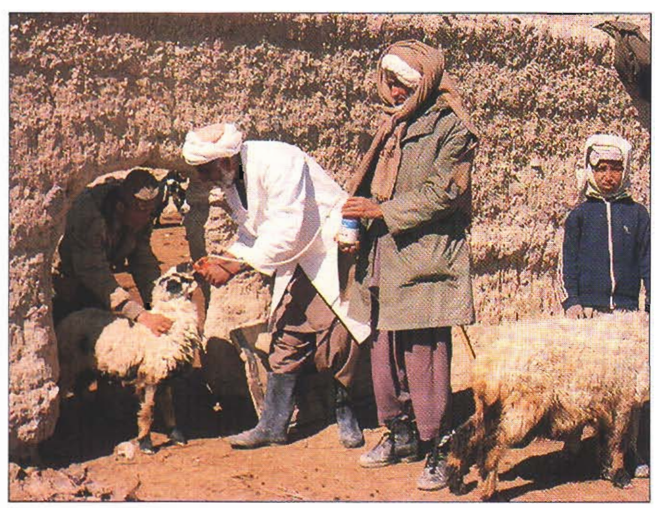
Sheep Parasites in Baluchistan

In a survey in the Kovak Valley, internal parasites were found in 100% of the sheep sampled. The incidence for tick infestation was 35%, and 23% for sheep scab. A more extensive survey included parts of the four major sheep- producing districts in the province. Almost 80% of the 340 sheep sampled in this survey were infested with internal parasites, and some of them carried six different species.

In cooperation with veterinarians of the Government of Baluchistan, a study was conducted at Zarchi to compare the efficacy of two anthelminthics for the control of internal parasites. Ewes of Baluchi sheep treated with oxfendazole revealed no eggs or larvae, but levamisole was less effective, reducing eggs by 91% and larvae by 71%



A four-wing saltbush plantation at Tomagh, Baluchistan, in August 1988.

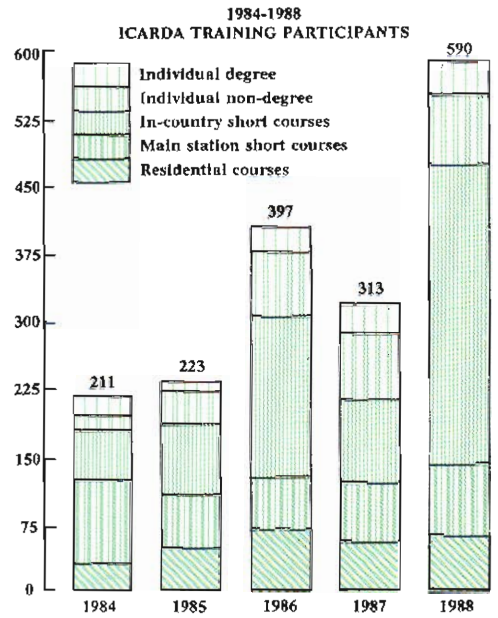


Treating sheep for internal parasites at Zarchi, Baluchistan.

Training

The total number of research scientists, technicians, and extensionists participating in the Center's training activities surged to a record enrollment of 590. The significant increase occurred in the category of in-country/sub-regional courses in which 337 participants were enrolled. Main station enrollments of 273 participants showed a slight increase over the 1987 figure of 239 participants (Fig. 21).

As in the past, most participants came from countries of West Asia and North Africa (Table 27), In 1987/88, however, ICARDA welcomed the first-ever participants from Malaysia, Nigeria, and Zimbabwe for specialized short-course training at headquarters; from Mexico for residential training, and from Peru, Bolivia, and Venezuela for a short course in food legume improvement. This year, 68 of the participants were women with the highest representation in graduate degree training.



Note: Some of the short courses scheduled for 1987 could not be held, hence the shortfall in the total number of participants.

Fig. 21. ICARDA training participants, 1984-88.

Table 27. Country participation in ICARDA training (1978-1988).

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Total
Latin America and the Caribbean												
Argentina	-	-	-	-	-	-	-	1	-	-	-	1
Bolivia	-	-	-	-	-	-	-	-	-	-	4	4
Chile	-	1	-	1	-	1	-	-	-	-	-	3
Colombia	-	-	-	-	-	-	-	-	-	1	6	7
Ecuador	-	-	-	-	-	-	-	-	-	1	5	6
Mexico	-	-	-	-	-	-	-	-	-	-	2	2
Peru	-	-	-	-	-	-	-	-	-	-	3	3
Venezuela	-	-	-	-	-	-	-	-	-	-	2	2
Total	-	1	-	1	-	1	-	1	-	2	22	28
Sub-Saharan Africa												
Djibouti	-	-	-	-	-	3	-	-	-	-	-	3
Ethiopia	-	3	-	1	-	2	1	6	27	38	67	145
Kenya	-	-	-	-	-	-	2	-	-	-	-	2
Nigeria	-	-	-	-	-	-	-	-	-	-	1	1
Rwanda	-	-	-	-	1	-	-	-	-	-	-	1
Somalia	-	-	2	-	-	1	1	1	1	-	1	7
Tanzania	-	-	-	-	-	1	-	1	-	-	-	2
Zimbabwe	-	-	-	-	-	-	-	-	-	-	1	1
Total	-	3	2	1	1	7	4	8	28	38	70	162

North Africa and Near East												
Algeria	1	4	3	3	2	-	3	1	45	63	16	141
Bahrain	-	-	-	-	1	-	-	-	-	-	-	1
Cyprus	-	4	1	-	1	-	1	1	1	-	-	9
Egypt	4	1	-	7	5	31	20	5	33	13	85	204
Iran	2	-	-	-	2	1	5	9	10	2	5	36
Iraq	-	5	-	-	1	-	2	2	7	1	-	18
Jordan	2	4	4	1	4	5	7	2	14	16	20	79
Kuwait	-	-	-	-	-	-	-	-	-	1	1	2
Lebanon	3	1	-	-	3	1	3	4	4	1	-	20
Libya	1	1	-	-	-	3	9	-	3	-	-	17
Morocco	-	4	5	1	30	-	27	62	36	12	82	259
Oman	-	2	-	-	-	-	-	-	-	1	2	5
Qatar	-	-	-	-	-	-	1	-	-	-	-	1
Sudan	-	2	7	12	4	13	8	13	29	25	15	128
Saudi Arabia	-	-	2	-	-	-	1	2	1	-	46	52
Syria	10	16	8	19	41	41	70	53	55	72	67	452
Tunisia	-	3	5	2	11	13	6	9	37	20	39	145
Turkey	2	2	7	-	-	-	-	4	57	11	36	119
Yemen AR	-	2	-	-	-	2	3	4	11	4	41	67
Yemen PDR	-	1	2	2	2	3	4	5	3	5	6	33
UA Emirates	-	-	-	-	-	-	-	-	-	1	-	1
Total	25	52	44	47	107	113	170	176	346	248	461	1789
Asia and the Pacific												
Afghanistan	-	4	3	-	4	1	-	-	1	-	-	13
Bangladesh	-	3	2	1	-	-	2	1	1	-	1	11
Peoples' Republic of China	-	-	-	1	-	-	3	2	4	3	6	19
India	1	2	1	1	-	-	1	1	1	3	3	14
Malaysia	-	-	-	-	-	-	-	-	-	-	1	1
Nepal	-	-	-	-	-	-	-	1	-	1	1	3
Pakistan	-	-	3	2	5	4	20	28	7	4	6	79
Total 1 9	9	5	9	5	26	33	14	11	18	1		
Industrialized Countries												
France	-	-	-	-	1	-	-	-	-	-	-	1
Germany FR	-	-	-	-	5	1	1	1	5	8	12	33
Greece	-	-	-	-	1	-	-	-	-	1	-	2
Netherlands	-	-	-	1	-	-	-	2	2	2	2	9
Spain	-	-	-	-	1	1	1	-	2	2	2	9
United Kingdom	-	1	-	-	-	-	-	2	-	1	3	7
United States	-	-	-	-	-	-	1	-	-	-	-	1
Total	-	1	-	1	8	2	3	5	9	14	19	62
Grand total	26	66	55	55	125	128	203	223	397	313	590	2181

The formal training courses are listed, with other ICARDA events, in the overall calendar, Appendix 5.

Core funding supported 9,924 person days of training participation, compared to 14,773 person days supported by non-core funding. The special project grant of the Ford Foundation was the major funding source in support of graduate research training of candidates at national universities in the region, with particular emphasis on the training of women in agricultural research. The continuing grant (restricted core) of the Arab Fund for Economic and Social Development was the major source of ICARDA funding support for Arab participants. Additional funding support was provided by AOAD, UNDP, USAID, FAO, GTZ, IFDC, EC, IDRC, OPEC Fund and various bilateral donor projects to meet specific national program or project staff needs.

During late 1988, a Training Followup Study was initiated through the efforts of the designated country collaborators in the 10 countries of the study sample. An external consultant worked with the Training Coordination Committee (TCC) in the design and planning of the study, scheduled for completion by mid-1989.

Information Dissemination

ICARDA considers information dissemination an important and integral part of its activities. During the course of its strategic planning in 1987/88, the Center emphasized the need to accelerate the pace of sharing with NARSs the knowledge that has matured and is ready for use. A Publication Committee was established to develop a policy that would facilitate the selective dissemination of information to the various audiences of ICARDA in appropriate formats in English, Arabic, and French, as applicable.

Apart from regular publications including the Annual Report, the three newsletters -- FABIS, LENS, and RACHIS -- and seminar and workshop proceedings, over 80 journal articles were processed for submission and several publications, addressed to young scientists and extension workers in WANA, were produced (see Appendix 3).

A notable event was the visit of a producer from the BBC World Service and the broadcast of one entire program on ICARDA, as well as several shorter items in English and Arabic.

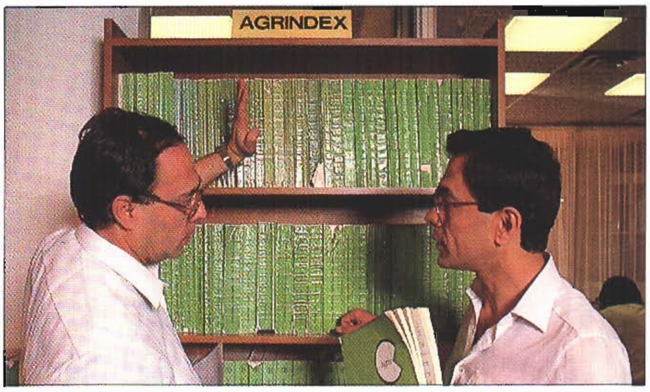
In June, ICARDA participated in the first meeting of the CGIAR's Public Awareness Association, which was held at CIMMYT. The Center recognizes that there will be a continued public debate about the policy issues surrounding international agricultural research and, like the other Centers, it must be prepared to account for its activities, not only to the scientific and donor communities, but also to a lay public that is becoming increasingly concerned with the global issues of population and food, and conservation of the environment.

At a meeting of IARC information personnel held at ICRISAT, ICARDA was designated as the "lead center" to solicit the cooperation of libraries participating in AGLINET (the Agricultural Library Network) to serve as depositories of all CG-Center publications and offer access to them under normal inter-library loan and photocopying procedures. A positive response has already been received from the libraries of the Agricultural University, Wageningen, the Netherlands, and Agriculture Canada, Ontario. In this vein, ICARDA signed agreements of cooperation with the libraries of the Syrian Atomic Energy Commission, the Egyptian Documentation and Information Center for Agriculture, and the University of Aleppo.

The Faba Bean Information Service (FABIS) caught up the backlog in the publication of FABIS newsletter. It consolidated its bibliographic, question-and-answer, and document-delivery services. On the other hand, two issues of the Lentil Information Service (LENS) newsletter were combined to catch up the backlog. The information service on cereals, RACHIS, was maintained, and much of the backlog was cleared.

The Library placed emphasis on strengthening its collection of serials. This was partly in response to the decision taken in 1987 to participate in the CGIAR project aimed at producing a union list of serials holdings of the CG Centers. Input to this project was started by a consultant, and maintained after his departure, and priority was given to completing collections of the principal series that are published in West Asia and North Africa and that, in general, are unlikely to be collected at Centers other than ICARDA. Services based on the journal collections were extended, on an experimental basis, to some of the cooperating institutions in Syria.

During 1988, the Library also embarked on a training program, receiving a librarian from the Yemen Arab Republic and a documentalist from the Syrian National Agricultural Documentation Center. Relations with national AGRIS centers were further strengthened, particularly on the occasion of the Sixth AGRIS Technical Consultation, held at FAO in June.



The first trainee (right) in information management, from the Syrian National Agricultural Documentation Center, discusses the AGRIS activities of ICARDA with the Center's AGRIS/CARIS Liaison Officer.

At a CGIAR meeting convened at ILCA in October, ICARDA accepted the responsibility to assist other Centers in compiling information on the availability of suitable free-lance translators in the major languages, other than English, in which the IARCs produce their publications.

A list of graduate theses produced with ICARDA's assistance in 1988 is presented in Appendix 4.

Impact Assessment and Enhancement

The approach

In its impact assessment and enhancement, ICARDA endeavors to evaluate factors related to the acceptability of new technologies, and development of methods to promote and monitor the adoption and physical, biological, and social impact of technology at the farm and national levels. Experience indicates that many new or improved technologies have not yet reached farmers to the desired extent, particularly in the drier areas. ICARDA proposes to take concrete steps to gauge the economic and environmental impact of the introduced technology and, where possible, enhance benefits by specially targeting it towards farmers' needs and seeking appropriate changes in government policies. The Center recognizes the special advantage of partnership with NARSs in this area and will fully involve them in these studies. Although ICARDA's principal focus of improved and sustainable production is at the farm level, it is aware that national governments are often more concerned with the impact at the district and country levels. The implication of such considerations for the development of agricultural policies and the economic optimization of national resource allocation will be brought to light.

The Center has identified three key areas of research on impact assessment. First, methods are being developed for determining production impact through a combination of technology testing on farmers' fields and farm surveys of adoption as well as constraints faced by farmers. Second, ICARDA is concerned with the future interface between agricultural labor and changes in farming technology. Extensive regional overviews and country-specific studies on this issue have been under way, and some of these were reported last year (ICARDA Annual Report 1987, p. 40). Third, the Center recognizes the need to obtain a regional overview of production and policy trends to assist both in determining research priorities and assessing the actual and potential impact of new technology.

The following four important examples illustrate the progress that ICARDA has begun to make in its impact assessment and enhancement research.

Potential for Increased Wheat Production in the Sudan

Wheat cultivation has been practiced in the Sudan from early times, especially in the northern part of the country. Due to population increase, urbanization, and rising incomes, wheat consumption in the country rose sharply from 10.5 kg/caput in 1960 to 26.0 kg/caput in 1980, and the same trend has continued in the 1980s. Currently, over 250,000 hectares are devoted to wheat, which meet only about 58% of the annual demand. The country imported about 270,000 tonnes annually during 1979-1981.

A commercial bread wheat variety in the CIMMYT/ICARDA-ARC field verification trials at Wad Medani. CIMMYT/ICARDA scientists (second and fourth from left) with their colleagues from ARC, Sudan, periodically evaluate all trials in the Project.

Practically all wheat in the Sudan is produced under irrigated conditions. Therefore, it is easier to bridge the gap between the actual and potential yield than under rainfed conditions, by removing the agronomic and economic constraints. Currently, poor seed stock, late sowing, poor land preparation, inadequate fertilizer application, moisture stress, weeds, delayed harvests, and poor marketing facilities are some of the major factors responsible for low wheat yields in the country.

In 1985, the Agricultural Research Corporation (ARC) of the Sudan, in collaboration with ICARDA, OPEC, and CIMMYT, launched a pilot project for improving wheat production. The ARC accepted the responsibility to verify research results under actual farmers' conditions, transfer improved technologies to farmers, and test the economic viability of improved production packages.

Over 200 farmers have participated since the project started. Using improved wheat varieties and recommended cultural practices, yields of up to 3600 kg/ha were achieved, over three times higher than the average yield obtained by neighboring farmers.

The economic analysis of the improved production packages showed that they were both highly profitable and stable. Most participating farmers attained a high marginal rate of return (200 to 500%). The project has also generated a wealth of scientific information for developing further recommendations.

Rapid Adoption of New Wheat Varieties

Sham 1, a new durum wheat variety, recently released in Syria, appears to have caught on with local farmers. This was revealed by a survey of 60 wheat farmers in northern Syria conducted during the winter of 1987/88.

Of the 33 farmers who had heard of ICARDA's Sham 1, released in 1984 by the General Organization of Seed Multiplication (GOSM) of the Syrian Ministry of Agriculture and Agrarian Reform, eight had already tried it and six of them were continuing to grow it. Another eight farmers expressed an interest in growing Sham 1 in the next season, if seed was available. A further nine farmers said they would like to try it in small plots, while eight said they would be interested in seeing it grown in someone else's field before trying it on their own.

The majority of the 27 farmers who indicated no interest in adopting Sham 1 had never heard of it and had no desire to try a new variety: cultivating a new variety can be risky, they thought. They said they had never seen their neighbors grow this variety, that they were unfamiliar with it, and that they did not know how to obtain its seed. Most of these points can be remedied through extension activities of the national program in coordination with its Seed Organization.

The adoption of Sham 1 by 10% of the wheat farmers surveyed within only three years of its release, and the widespread interest of other farmers in the variety, is a mark of success for the Syrian national program. ICARDA is very pleased to have been a partner in this achievement.

Over half of the farmers in the survey reported that they were currently using a bread wheat variety they called "Mexibak". That the high-yielding variety Mexipak has become a household word among Syrian wheat farmers is a credit to ICARDA's sister center CIMMYT, which was responsible for its development. The surveyed farmers referred to the problem of shattering in this variety, yet they favor Mexipak over other cultivars.

Introducing Faba Bean in New Areas in the Sudan

Faba bean is the most important food legume in the Sudan. For large sectors of the population, especially low-income groups in urban areas, it is a stable component in the diet and a vital source of protein. In addition, faba bean is an important source of income to farmers growing the crop. As the Sudan's population continues to increase, demand for faba bean has been rising continuously. Local faba bean production, however, has not increased at the same rate. As a result, the country is often compelled to import significant amounts of relatively expensive faba bean to bridge the widening gap between increasing demand and the variable supply.

Faba bean is traditionally grown along the Nile on farms occupying a narrow strip in the northern region of the Sudan where cultivable land is limited and irrigation water expensive. To meet the ever increasing demand for faba bean, vertical as well as horizontal expansion has been sought.

An important aspect of horizontal expansion has been the identification of areas in the Gezira,

Sham-1, a durum wheat variety recently released in Syria, has been adopted by 10% of the farmers surveyed in 1988.

Field demonstration of faba bean production technology in the Gezira scheme has led to the expansion of this crop to non-traditional areas, south of Khartoum, in the Sudan.

Rahad, and New Halfa government schemes where land and water resources are available. Introduction of faba bean in these schemes would add a highly needed component, a winter legume, to the cropping system.

Research has been undertaken to introduce faba bean in the cropping systems of the new areas south of Khartoum. Technologies developed were tested in a series of on-farm trials (Table 28) spanning many sites.

The number of farmers participating in a pilot/demonstration program during the last three seasons has increased rapidly. In the Gezira scheme, for example, the number rose from 3 to 84. Seed yields have been very encouraging, and the potential exists to obtain even higher yields. One of the farmers in the program realized a record

Table 28. Seed yield and net returns from Faba Bean Pilot Production/ Demonstration Plots in new areas in the Sudan.

Location	Year	Average grain yield (kg/ha)	Net returns (LS/ha)*
Gezira	1985/86	2000	4325
	1986/87	2200	3972
	1987/88	1800	3931
Rahad	1985/86	1200	2114
	1986/87	1100	1757
	1987/88	1000	-
New Halfa	1985/86	1000	1092
	1986/87	900	402
	1987/88	1200	-

* LS = Sudanese pounds.

yield of 4200 kg/ha in the 1986/87 season. Net revenues from the crop were many times higher than those from the most profitable field crop currently cultivated.

Economic evaluation and survey of production were carried out to determine the impact of widespread introduction of faba bean in Gezira and to provide both quantitative and qualitative information. A total of 120 farmers, 120 retailers, and 200 consumers were interviewed to assess local reaction. The results (Table 29) confirmed the profitability of faba bean over all crops grown by tenants in the Gezira scheme.

Table 29. Profitability of faba bean compared to other crops in the Gezira scheme (1987/88).

Crop	Total cost (LS/ha)*	Total revenue	Net (LS/ha)
Faba bean	1985	5916	3931
Cotton	2495	3101	607
Wheat	769	1269	499
Groundnut	697	1427	730
Sorghum	539	1241	702

* LS = Sudanese Pounds.

All farmers interviewed expressed an interest in taking up faba bean cultivation. The majority considered most of the faba bean cultural practices as easy or easier to carry out than those for other crops. Of the farmers surveyed, some encountered problems of inferior seed quality. All retailers sold the crop at prices comparable with those in the traditional areas.

In addition to the farmers involved in the demonstration trials, there were many who adopted the package and have grown the cultivar BF 2/2. More new cultivars are at the seed multiplication stage. The management of the Gezira scheme has been impressed by the response of the farmers and has decided to provide the necessary services to back up farmers' adoption of the new crop. The scheme management estimates that if each farmer grew one acre (0.45 ha) of faba bean, a target of 160,000 additional hectares could be easily reached. This would double the area currently under faba bean in the country.

Certain factors, however, may affect the adoption rate. These include the leafminer pest, seed quality, weed control, high temperature stress, and wilt and root rot diseases. Research has already begun to find solutions to these problems. Research to control the leafminer includes an insecticide (Danitol-S) and three tolerant lines. Three effective and economic herbicides have been identified to control weeds. Breeding efforts are under way to release varieties adaptable to local climatic conditions. Characteristics include early flowering and maturity, heat tolerance, and high yields, among others.

The systems approach to problem solving has been fully accepted and used by the teams of researchers, extension specialists, and farmers involved.

A Tool for Fertilizer Policy Analysis

ICARDA economists and agronomists have developed a framework which may be used by national programs for balancing crop-by-crop responses to nitrogen (N) and phosphorus (P) fertilizers in various production zones against options for exporting domestically produced fertilizer or importing further supplies. This framework is of particular interest to ICARDA because it addresses the need felt by many countries in West Asia and North Africa for an objective means of considering the potentials of farming in the dryland, lower rainfall areas compared with that in the higher rainfall and irrigated areas.

The framework makes use of response functions that indicate the expected yield for different combinations of N and P per hectare. These are estimated for the average year, based on agronomic trials, for each main crop in each main production zone. Use of average-year response is justified because fertilizer allocation decisions must be made in advance of the cropping season, before it is possible to predict the season's growing conditions for each crop/zone.

The framework defines a sample of N and P combinations or points which cover the economic range of each response function, and calculates the expected yield (Y) at each of these points. These N, P, Y data are then incorporated in a linear programming matrix which allows the national allocation to be defined in a simpler form: competition among elementary fertilizer-use points across crops.

Amounts of domestically produced N and P are entered as constraints in the matrix, while options to export N and P provide reserve (world) prices below which marginal values of crop production will not encourage fertilizer use. Options to import fertilizers to relieve shortfalls in domestically manufactured N and P are also included in the matrix. The objective which is maximized by the framework is the sum of all crop values and export sales of N and P, minus the costs of imported N and P.

Alternative fertilizer policies studied include:

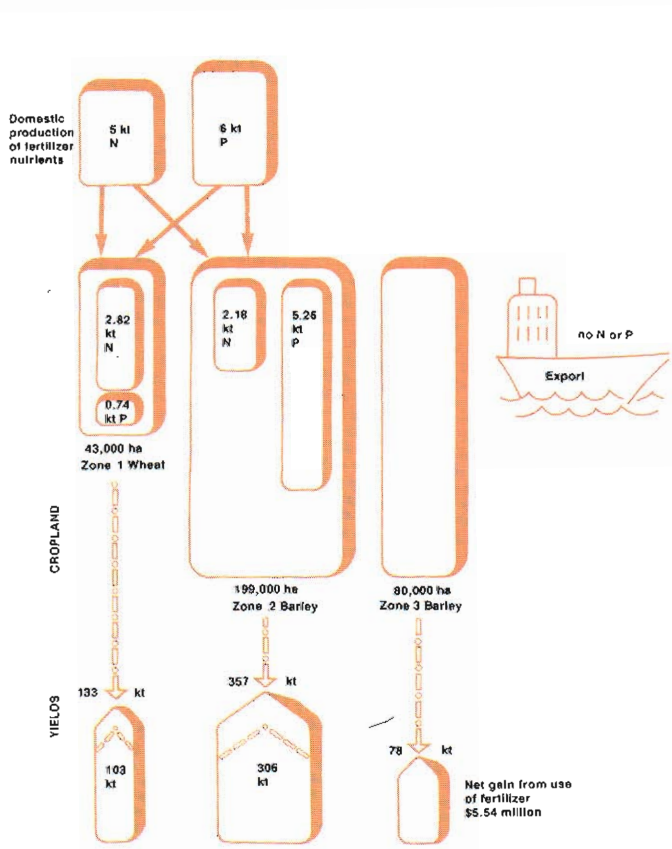
(1) blocking allocations to the driest crop/zone in favor of higher rainfall zones,
(2) blocking imports of fertilizers, and
(3) allowing allocations to all crop/zones and allowing imports to fill domestic N and P manufacturing shortfalls.

Results suggest that the best benefits are reaped through an open policy of allowing fertilizers for any crop area according to values of marginal responses, exporting any surplus domestically manufactured N and P where remaining values of marginal yield response are below export prices, and of filling N and P production gaps with imports to the point where values of marginal crop yields equal the import price.

The poorest economic performance results from restrictive policies of blocking imports or stopping allocations to one of the crop areas.

An example of allocation of N and P fertilizer to wheat and barley in a hypothetical country with three agroecological zones, Zone 1 (>350 mm rainfall), Zone 2 (250-350 mm), and Zone 3 (200-250 mm) is illustrated in Fig. 22. Response functions generated by ICARDA from over 100 on-farm wheat and barley trials are used. In Fig. 22a, domestic production is limited to 5000 tonnes of N and 6000 tonnes of P_2O_5, no imports are allowed, and no fertilizer is allowed for Zone 3. In the second scenario, Fig. 22b, domestic fertilizer production remains at the same levels, but imports are allowed and fertilizer can also be allocated to Zone 3.

Four years of collaborative on-farm research with the Syrian Soils Directorate has demonstrated substantial responses of barley to both N and P fertilizers even in very dry areas (less than 200 mm rainfall).



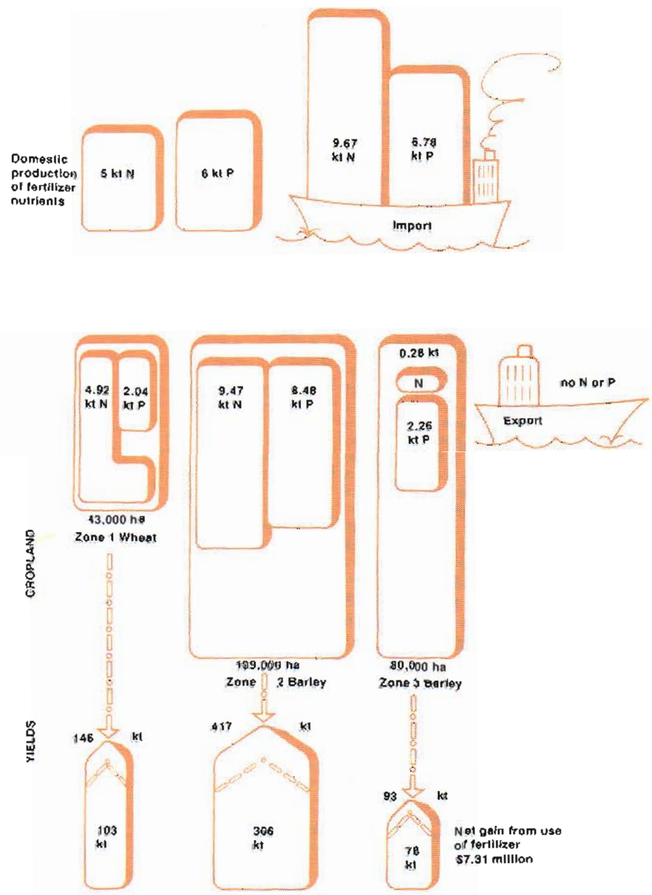


Fig. 22. (a) Optimal allocations of domestically produced N and P among Zone 1 wheat, Zone 2 barley and exports, given a policy that none may go to Zone 3 and no imports of fertilizer are allowed.

Fig. 22. (b) Optimal allocations of imported and domestically produced N and P among Zone 1 wheat, Zone 2 barley, Zone 3 barley and exports.

The open policy illustrated by the second scenario (Fig. 22b) increases the net benefits of fertilizer use from US$5.54 million to US$7.31 million.

Paradoxically, under open policies the framework may be replaced by simpler field-by-field optimizations. The framework is most useful where governments decide, for their own reasons, against completely open policies and, within the national constraints they define, wish to economically optimize the allocation of limited amounts of fertilizers among crops/zones. The above model is also a tool for governments wishing to evaluate alternative policy options.

ICARDA must engage in a dialogue with national policy makers around West Asia and North Africa on issues of research priorities, infrastructures, and institutions for the provision of farm inputs and services in the dry areas. The fertilizer allocation framework has a place in some of these dialogues where productivity of both traditional and improved plant cultivars is limited in the dry areas due to low soil fertility.

Factors Affecting the Adoption and Impact of Supplemental Irrigation in Syria

Three years of on-farm research and surveys revealed an escalating interest in supplemental irrigation (SI) both at official and individual levels in Syria, and a considerable impact in terms of fallow elimination, higher cropping intensity, yield, income, and living standards. Lower unemployment and reduced migration of rural communities were also observed.

Major constraints affecting SI adoption are: uncertainty about the establishment of wells; very limited supply of water from government irrigation schemes for SI; and shortage of pumps and other irrigation equipment. Factors affecting SI impact on farm productivity are: improper land preparation for irrigation, delayed sowing, and improper timing and supply of water and other capital inputs and operations.

However, the potential for adoption and impact of SI is considerable. More than 65% of the total rainfed area is located in zones 1 and 2 (good agroclimatic conditions), only 33% of total water resources of the country are already utilized, and current irrigation efficiency is low (40%). Recent government policies strongly support SI, and potential increases in wheat production would be about 0.75-1.5 million tonnes if only 25-50% of rainfed wheat area was supplementally irrigated and a yield level of 4500 kg/ha was obtained.

Supplemental irrigation of wheat in on-farm trials has produced much higher and more stable yields than those from the plots that did not receive supplemental irrigation.

Outreach Activities

Irrespective of how suitably the Syrian test-bed is located in WANA, it cannot meet the specific requirements of such an agroecologically diverse region. It is, however, beyond ICARDA's resources to establish new stations to serve the full range. Its approach to meeting the needs of the region is through a chain of regional programs representing the major agroecological zones. In this, ICARDA's role is essentially that of a catalyst, working with the NARSs to encourage sharing of information and experience, offer training, promote innovation, provide germplasm, and, where possible, help target resources from donor agencies. Much of ICARDA's outreach activities are carried out with special project funding (see Appendix 6).

ICARDA is developing regional programs and networks as an integral part of its research effort in partnership with NARSs. A regional program has three essential components: (i) identification of research priorities and generation of new scientific information, (ii) development and validation of improved and appropriate technologies, and (iii) technology demonstration to, and its adoption, by farmers.

The main cooperators in research and training among the NARSs are the national agricultural research institutions mainly run by, or under the overall supervision of ministries of agriculture. Agricultural departments in universities are becoming increasingly involved in applied research and their partnership with ICARDA is growing further. Other branches of NARSs have also been receiving increased attention. These include the seed multiplication services which are crucial to the availability of new germplasm to farmers; the extension services which participate in on-farm research and training activities; and, not least, policy-making departments whose decisions critically influence the economic climate and the opportunities for the spread of innovations.

An up-to-date list of varieties released by NARSs through cooperative activities with ICARDA is presented in Appendix 2.

During 1988, ICARDA continued setting up six regional research and training programs based on the commonalities of geography, ecology, and constraints to production (Fig. 23). These programs will link scientists both within countries and within the region. They are intended to promote leadership at the national and regional levels; engender cooperation in solving problems common to a group of countries; acquire, pool, and optimize the use of scarce resources; and encourage self-reliance. The six programs, briefly described below, will integrate the current activities and resources and will have strong components of training and information dissemination.

1. **The Highland Program**. The major highlands of WANA are in two distinct masses: one in the East, covering Turkey, Iraq, Afghanistan, and Pakistan; the other, in the West, covering the Algerian - Moroccan Atlas range. Highland work is being developed first in the eastern part.

   The second phase of the USAID-supported AZR Project in Pakistan, which will concentrate on range management and water harvesting, will be an important component of the highland work.

2. **The Arabian Peninsula Regional Program.** The overall objective of this Program will be to narrow the widening gap between production and demand of ICARDA-mandated commodities, particularly wheat and barley, and to develop cooperative research and training.

3. **The West Asia Lowland Program.** This Program will cover Jordan, Syria, Lebanon, Iraq, southern Turkey, and Cyprus, and will be operated from Jordan. It will promote regional cooperation in research, training, and information dissemination.

4. **The Nile Valley Regional Program.** This expanded Program in which Egypt, the Sudan, and Ethiopia share research and training to improve the productivity of wheat, lentil, chickpea, and faba bean will become operational in 1989. CIMMYT is also expected to participate in this as well as the Arabian Peninsula Program.

5. **The North Africa Regional Program.** This Program serves Libya, Tunisia, Algeria, and Morocco. The objective is to strengthen research and technology transfer to increase barley, food legume, and livestock production. A sub-component of this Program will be the regional work on faba bean, likely to be based in Morocco.

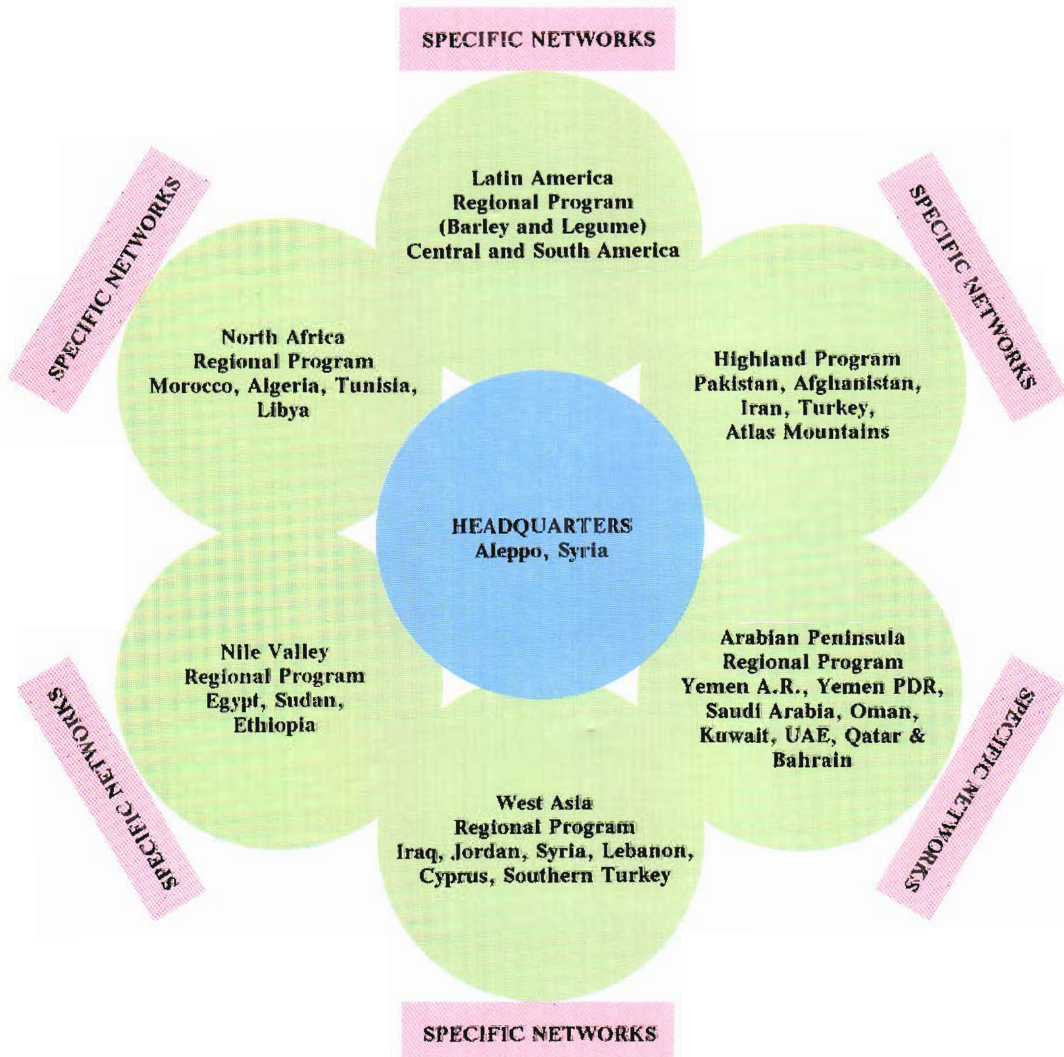


Fig. 23. Proposed Regional Programs and Networks (some of them already in place).

6. **The Latin America Regional Program.** This Program will be based on the existing Latin America Barley Program, supported by an ICARDA scientist working from CIMMYT, Mexico. The possibility of expanding it to cover food legumes is being considered with ICRISAT.

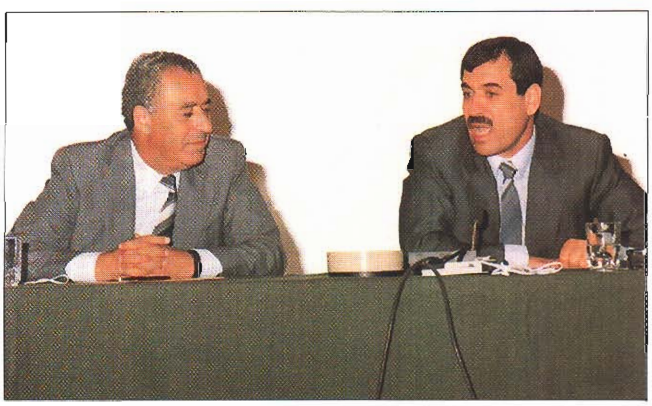
Commodity and Discipline-oriented Networks

While regional program activities will emphasize interdisciplinary collaboration on a broader scale between neighboring countries, specific problem-oriented networks will operate both across and within the sub-regional programs. These networks will be built around a commodity or a discipline and have the objectives of bringing together scientists working within the same or different countries, fostering a two-way flow of information between national scientists and ICARDA, and extending ICARDA's technologies to appropriate scientists. Examples of such networks, already in place, are presented in Appendix 7.

The outreach activities of ICARDA during 1987/88 are reported in detail in the Program Reports for 1988, published separately (see Publications List, Appendix 3). What follows here is a summary of major developments.

Syria

The cooperative program with Syria took a further step ahead in 1987/88. The on-going cooperative programs with the Ministry of Agriculture and Agrarian Reform, including the Directorate of Extension and three Syrian universities (Damascus, Aleppo, and Tishreen), were expanded to other Syrian organizations and institutes: the Atomic Energy Commission, the Department of Meteorology, and the General Institute of Agricultural Mechanization. New agreements were signed and work plans developed for implementation with the Universities of Aleppo and Tishreen, emphasizing training, exchange of scientific information and materials, participation in scientific meetings, and joint research experimentation.



Mr Mohamed Ghabbash (right), Minister of Agriculture, the Syrian Arab Republic, makes a point to Dr Nasrat Fadda, DG, during the opening session of the Seventh Coordination Meeting between Syria and ICARDA, held in Aleppo.

The most significant feature of the cooperative program in 1987/88 was the active participation of farmers in the joint on-farm trials. The Seventh Annual Coordination Meeting, held at Tel Hadya in October 1988, was opened by the Minister of Agriculture who confirmed the strong support of the Government of the Syrian Arab Republic to the development of agricultural research, commended the work and achievements of the cooperative program, and emphasized the importance of linkages between extension, research, and training to accelerate the transfer of technology to farmers. The Minister also commended the release of new varieties of cereals and food legumes through the efforts of the cooperative program (see Appendix 2).

The meeting reviewed the results of the 1987/88 season and developed a work plan for 1988/89 to cover several important aspects of crop improvement: on-farm trials, breeding for stress tolerance and resistance to diseases and insect pests, winter sowing of chickpea, lentil varieties for mechanical harvesting, pasture and forage crop improvement, supplemental irrigation of wheat, fertilizer use on wheat and barley, and collection, preservation, and utilization of genetic resources.

North Africa

Various activities with a regional, Maghreb-countries perspective were carried out during the 1987/88 cropping season. Examples of these are the regional in-country training course conducted at Meknes, Morocco, for food legume experimentation and extension; the in-country training course on crossing techniques in food legumes at Beja, Tunisia; the North Africa in-country training course on methods of farm surveys in Tunis; and the survey of Hessian fly infestation in Tunisia and Morocco, and of cereal diseases in Morocco.

The cereal traveling workshop in Morocco with participants from three institutions each of Tunisia and Morocco, as well as the food legume disease and insect survey in Morocco and Algeria, are examples of ICARDA's current role in North Africa in bringing together researchers from the Maghreb countries and from different institutes within each country.

An international workshop on the role of legumes in the farming systems of Mediterranean areas was organized in Tunis, and attended by participants from 17 countries.

A regional research and technology transfer project to increase barley, food legume, and livestock production in North Africa was developed and submitted to IFAD and the Italian Government for financial support. Similarly, a Maghreb project on cereal and food legume diseases, their surveillance and germplasm enhancement, was submitted to UNDP for possible support.

ICARDA's coordination meetings with Algeria, Morocco, and Tunisia were held in September 1988. The research results of the 1987/88 crop season were reviewed and work plans for the 1988/89 season developed.

High Elevation Research in Pakistan

In the MART/AZR project at the Arid Zone Research Institute in Pakistan, research efforts continued on improving the sustained production of small ruminants in upland Baluchistan. Production of sheep and goats is the principal dryland agricultural activity in the continental Mediterranean climatic zone in Pakistan and is of major economic importance in the Province of Baluchistan.

Since 1955, there has been a very rapid increase in the number of sheep and goats in Baluchistan (7% per year). Now there are more than 18 million head, representing approximately 40% of the total number of small ruminants in Pakistan.

The following major production constraints have been identified:

(a) Acute feed shortages resulting from poor rangeland productivity due to overgrazing and the lack of alternative feed sources from forage crops and food crop residues;

(b) Poor flock management, particularly of the newborn; and

(c) Severe problems of mortality and morbidity resulting from diseases, parasites, and poor livestock management.

Dr Jose-Ignacio Cubero (fourth from right), Chairman, BOT, along with senior staff of ICARDA and national program scientists, inspecting the MART/AZR project trials in Baluchistan.

Studies on the potential for improvement of range forage resources revealed that fourwing saltbush introduction gave most encouraging results as did furrow plantings of weeping lovegrass. Preliminary results from long-term grazing studies on native grasses suggested that vegetation recovery from overgrazed land would be very slow if improved grazing management practices were not introduced.

The results of improved livestock management studies on sheep indicated that a fertility and weaning rate of close to 100% is possible in local Harnai ewes receiving good general nutritional and health management in contrast to average rates in Baluchistan that do not exceed 60%.

One possible contributory factor to low fertility rate has been identified through an extensive survey of the internal parasitic load of sheep in four major producing areas in upland Baluchistan: of the sheep sampled, 80% were infested and some animals carried as many as six different species of parasites.

In agronomic and germplasm evaluation experiments designed to increase animal feed resources from marginal crop lands, in-field water redistribution treatments were effectively the only ones to prevent crop grain production failure. Seasonal rainfall was very low at all sites, generally less than 150 mm in the 12-month period, and in consequence, forage yields were also low.

Conventional agronomic interventions to the cropping system, such as use of fertilizers, herbicides, insecticides and improved varieties, were largely ineffective. However, selections of improved germplasm from previous years, such as Arabi Abiad (barley), *Vicia villosa* ssp. *dasycarpa* 683 and *V. ervilia* 2542 (forage legumes), and ILL 5720 and ILL 5665 (lentils), showed encouraging performance in relation to local controls.

In studies examining social organization and communication patterns in rural communities, that were designed to assist in the formulation of strategies for effective agricultural extension of AZRI-generated technologies, the results indicated the following:

(a) Social organization in villages of Baluchistan is structured along kinship lines and communication patterns follow suit;

(b) The boundaries of each community, if defined by tribal ties, also mark the boundaries of communication networks;

(c) Access to mass media is somewhat limited in village communities and is restricted essentially to radio; and

(d) The access of dryland farmers to extension services is almost non-existent.

Nile Valley Project

The Ninth Annual Coordination Meeting was held in September in Cairo, under the patronage of the Deputy Prime Minister and Minister of Agriculture and Land Reclamation, Egypt. Senior government officials and scientists from Egypt, Sudan, and Ethiopia, as well as representatives of the donor agencies including IFAD, Ford Foundation, EC, and the Italian Government, participated in the meeting.

The meeting reviewed the progress of the Project since it was established in 1979. It was clear from the reports of the participants that the Project had succeeded as a viable and flexible model of cooperation between the national governments, their scientists, the donor agencies, the CGIAR, and, above all, the farmers. This multi-disciplinary, multi-institutional, problem-oriented model in research and development has already been adopted for other crops in Egypt, Sudan, and Ethiopia, and plans are under way for its adoption in the Maghreb and Mashreq countries for major food crops.

The success of the project has stimulated the interest of the participating countries, ICARDA, and others involved to expand it to a new Nile Valley Regional Program on Cool Season Cereals and Food Legumes. The new Nile Valley Regional Program will be launched in January 1989. The new Program will have a much wider focus and target areas. Partnership will be expanded to include CIMMYT in wheat research. Funding for most of the components has already been assured by SAREC of Sweden for Ethiopia; the Government of the Netherlands for the Sudan; and the EC for the Arab Republic of Egypt.

The Arabian Peninsula

ICARDA's outreach activities in the Arabian Peninsula started with a generous support from the Arab Fund for Economic and Social Development (AFESD) in early 1988. The main objectives of this effort are to strengthen wheat and barley research and training in the Arabian Peninsula and to bridge the gap between production and consumption of these major crops in this region.

The countries participating in this effort are the Yemen Arab Republic (YAR), the People's Democratic Republic of Yemen (PDRY), Saudi Arabia, Kuwait, Qatar, Bahrain, the Sultanate of Oman, and the United Arab Emirates. The biotic and abiotic constraints to production in these countries are similar to those as elsewhere in WANA. The most important constraints to wheat and barley production in this region are heat, drought, salinity, weeds, pests and diseases, and lack of well-trained staff.

ICARDA started its activities in the Arabian Peninsula in 1987/88 in a moderate manner. Priorities were allocated to the Yemen Arab Republic, Saudi Arabia, Kuwait, and the People's Democratic Republic of Yemen. Two specialized training courses were organized in the Yemen Arab Republic. The first was on "Seed Technology" (13-31 March) and involved 23 participants from the YAR, and the second was on "Techniques of Cereal Improvement" (23-27 October) and involved 15 participants from the YAR, PDRY, and the Sultanate of Oman. From 2 to 12 April, another in-country training course on "Identification, Diagnosis and Control of Wheat and Barley Diseases" was organized in Saudi Arabia with 42 participants. Scientists from the Cereal Improvement Program of ICARDA also participated in the Symposium on Agricultural Research Network for the Gulf Countries Council (GCC), organized in Kuwait during 17-19 October. Several other scientists and technicians from the Arabian Peninsula were trained at ICARDA in Aleppo in different disciplines: Saudi Arabia (4), Yemen Arab Republic (5), People's Democratic Republic of Yemen (3), the Sultanate of Oman (1), and Kuwait (1).

Mr Mukbel Ahmed Mukbel (third from right), Deputy Minister of Agriculture and Fisheries, YAR, opened the First Regional Coordination Meeting of barley and wheat scientists of the Arabian Peninsula, in Sana'a, Oct 1988.

Wheat and barley germplasm and nurseries were provided to most countries of the region and special arrangements were made with the YAR for developing a barley nursery to be tested at two locations (Dhamar and Al-Bon). Selection will be made for earliness, agronomic value, and drought and disease tolerance. The best lines will be further tested on large scale in farmers' fields and will be demonstrated for possible release to Yemeni farmers.

In 1987/88, three bread wheat varieties were released in the YAR: Aziz (Seri 82), Mukhtar (Veery 07), and Dhumran (Alondra). These new varieties were identified by the Agricultural Research Authority (ARC) of the YAR and ICARDA, and are expected to replace the local bread wheat variety Maarib 1 which is susceptible to stem rust. A varietal description booklet on the local and improved wheat and barley cultivars grown in the YAR was also produced by ICARDA. Similar booklets will be produced for other countries in the region.

The First Regional Coordination Meeting for barley and wheat scientists in the Arabian Peninsula was held in Sana'a, YAR, 18-20 October. Scientists from the YAR, PDRY, Saudi Arabia, and Kuwait, and invited specialists from Egypt and the Sudan participated in the meeting along with representatives from AFESD, ICARDA, and CIMMYT. Representatives from FAO, UNDP, GTZ, and USDA also participated in the opening session.

The meeting reviewed the research and training activities in the participating countries and discussed the objectives, organization, and implementation of the program. A work plan for 1988/89 was developed. Each country nominated a national coordinator, and a Steering Committee for the program was formed. The meeting requested ICARDA to appoint a full-time Regional Coordinator and to host the Second Annual Coordination Meeting for the program at its headquarters in Aleppo, in late August or early September 1989.

New Partnerships

In 1987/88, ICARDA expanded its cooperative work within the region and beyond. Agreements of cooperation were signed with the All Union Academy of Agricultural Sciences of the Soviet Union; the Agricultural and Natural Research Organization of the Ministry of Agriculture, Islamic Republic of Iran; the Government of Nepal; the Tropical Agricultural Research Center (TARC) of Japan; the Alemaya University of Agriculture, Ethiopia; University of Hohenheim, Germany; the International Center for Mediterranean Agronomic Studies (CIHEAM), France, and USSR. Nearer home, a tripartite agreement was signed with ACSAD and the Steppe and Range Directorate of the Ministry of Agriculture, Syrian Arab Republic. As stated earlier, ICARDA's agreements with the Aleppo and Tishreen Universities were renewed. An up-to-date list of agreements is presented in Appendix 8.

Resources for Research and Training

Finances

ICARDA's core activities are funded by its generous donors. During 1988, the Center operated its core activities on funds totalling 23.105 million USD, slightly below the funding level of 24.577 million USD in 1987. The sources of these funds are summarized in Table 30.

Table 30. Sources of funds for ICARDA's core programs and capital requirements (thousand USD), 1988.

Arab Fund	354[a]	Netherlands	567
Australia	266	Norway	472
Austria	175	OPEC	50[a]
Canada	851	Spain	155
China	30	Sweden	600
Denmark	277	UNDP	300
Ford Foundation	120	United Kingdom	982
France	194[a]	USAID	4,591[a]
Germany (BRD)	1,935[a]	Locally generated revenue	5,083[b]
IBRD (World Bank)	4,800	Earned income	144[c]
IDRC	127[a]		
Italy	1,032		
		Total	23,105

[a] Part or all of these amounts were provided for specified activities ("restricted core").

[b] Syrian law permitted ICARDA to import Syrian currency purchased outside the country; for accounting, the domestic rates of exchange are used and the difference is credited to this source of revenue.

[c] Net of investment income and losses on transactions in other foreign currencies.

In addition, ICARDA received 2.813 million USD support for 28 special projects (see Appendix 6). The special projects exploit ICARDA's capacities and accumulated experience, but do not represent a commitment beyond the duration of the funding. These projects are particularly useful for cooperative activities with national programs, where an ICARDA involvement may be needed for a few years, but for which the national programs will themselves be responsible once the immediate objectives have been fulfilled.

Staff

During the year, the following senior staff joined ICARDA: Dr Nasrat R. Fadda, Director General; Mr Muhannad Ismail, Financial Controller and Treasurer; Dr Philip Lashermes, Biotechnologist; and Dr Michael van Slageren, Genetic Resources Scientist. Dr A.B. Damania, who was already on ICARDA staff as Durum Germplasm Scientist, took over as Wheat Germplasm Specialist. Drs Euan Thomson (PFLP), Willie Erskine (FLIP), and Mohammed Tahir (CIP) proceeded on sabbatical leave. The following senior staff left ICARDA during 1988: Ir. J.G. Koopman, Deputy Director General (International Cooperation); Dr Kutlu Somel, Agricultural Economist; Dr Joseph Nagy, Farming Systems Specialist/Agricultural Economist; Dr Dennis Tully, Anthropologist. Dr M.P. Haware, Pathologist, seconded to ICARDA from ICRISAT, returned to ICRISAT. A list of senior staff as of 31 December 1988 is given in Appendix 13, and a summary of the list is presented in Table 31.

Table 31. Staff of ICARDA at various locations on 31 December 1988.

Location		International professional	Regional professional	Other staff	Total
Syria	Aleppo-Tel Hadya	51	44	512	607
	Damascus	-	-	7	7
	Lattakia	1	-	2	3
Ethiopia	Addis Ababa	1	-	-	1
Egypt	Cairo	1	-	6	7
Italy	Perugia	-	-	6	6
	Viterbo	-	-	2	2
Jordan	Amman	-	-	1	1
Lebanon	Beirut	-	1	6	7
	Terbol	-	-	27	27
Mexico	CIMMYT	1	-	-	1
Morocco	Rabat	3	-	2	5
Pakistan	Quetta	4	-	1	5
Tunisia	Tunis	2	-	3	5
Totals (1988)		64	45	575	684
Totals (1987)		60	49	612	721
Increase/Decrease		4	-4	-37	-37

The Farms

ICARDA operates six sites in Syria and two in Lebanon (Table 32). These sites represent a variety of agroclimatic conditions, typical of those prevailing in West Asia and North Africa.

Table 32. 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	944	284	350
Bouider	35°41'N	37°10'E	35	268	210
Ghrerife	35°50'N	37°15'E	2	320	280
Breda	35°56'N	37°10'E	76	300	280
Jindiress	30°24'N	36°44'E	10	210	470
Lattakia	35°26'N	35°57'E	5	60	930
LEBANON					
Terbol	33°49'N	35°59'E	39	890	600
Kfardane	34°01'N	36°03'E	50	1080	430

The 1987/88 season began with early rainfall at Tel Hadya as well as other sites, and developed into the wettest season since the early 1940s. At Tel Hadya, a total of 504 mm rainfall, compared to an average of 348 mm, was received. The season not only started with early rainfall but also continued to be wet, leaving only the month of July without precipitation. The monthly rainfall data for ICARDA sites for the 1987/88 season are presented in Appendix 1.

The early rains caused early germination of the 1987/88 crops and consequently increased the occurrence of the parasitic weed, *Orobanche*. Some parts of the fields were so heavily infested that they had to be abandoned and the crop burnt. This prevented the spread of the seeds with the harvested material and also destroyed a small proportion of the weed seed lying on the surface.

A new, strong mouldboard plough arrived in mid-1988 and was used for preparing the 1988/89 field trials to compare the effect of 45-50 cm deep ploughing with that of 30 cm ploughing, and with non-inversing tine implement tillage, 15-18 cm deep.

In 1987/88, the comparison of barley planting techniques (farmers' practice versus two machine-planting methods) was not conclusive: there was widespread lodging of the crop so no clear advantage of either technique was visible. The trial will therefore be repeated in 1988/89. However, on a 10-ha field, the variety Early Russian Apam (released in Tunisia as "Fayez"), planted with a seeder on 10-cm row spacing, yielded an average of over 6000 kg/ha.

For seed-bed preparation and planting the use of low ground pressure tires (either twin or enormous balloon tires), was increased to achieve the minimum possible ground pressure during seed-bed preparation and planting operations. The next step is to include spraying operations.

For the first time a 5-ha field was planted with five varieties of oilseed rape (*Brassica napus*) to evaluate the potential of this crop for vegetable oil production. The Syrian Industrial Company for Vegetable Oil agreed to use the produce for their tests. Oilseed rape has advantages over sunflowers and soybeans, the two crops used in Syria for oil production, in its lower water requirement, and also in leading to a better soil structure for the following field crop.

The new greenhouses, announced in last year's Annual Report, are now gradually being occupied, although the temperature control is not yet working to the desired specifications.

Training of ICARDA staff in the use of agricultural machinery was started in 1988. It is proposed to develop these training activities into more formal courses in the coming years.

The Laboratories

In 1988, a new laboratory was established for research on *Orobanche*, bringing the total number of laboratories in use at ICARDA to 41. Over 20 disciplines are represented, including agronomy, biotechnology, cereal quality, cytology, entomology, flour milling, baking, forage quality, Kjeldahl protein-testing, legume quality, microbiology, nematology, Orobanche studies, pathology, physiology, sample preparation, seed health, seed production technology, soil chemistry, soil hydrology and virology.

The Computers

Hardware Upgrade

Introduction of microcomputers for data analysis and office automation was a major event in 1988. Over 30 microcomputers were installed across the research programs and administrative units. The mainframe systems will revert to the role of maintaining the growing large-scale databases including those for pooled research management and administrative data.

ICARDA proposes to develop an internal Center-wide computer network in 1989. The essential characteristics of the network will be its increased reliance on local CPUs, in the form of single-user microcomputers and multi-user departmental computers, connected with the mainframe systems and with each other.

The center-wide introduction of microcomputers has greatly accelerated the pace of work in both scientific and administrative areas.

A Microcomputer Software Library comprising both statistical and office automation packages has been established. Evaluation of these packages was started in 1988 and will continue in 1989.

The stand-by VAX-11/780 computer system was powered up and put into operation. This additional computer system with more terminal lines and disk storage capacity has almost doubled the hardware facilities to meet the ever increasing computing need of the Center. In addition, two Uninterrupted Power Supply (UPS) units were installed in the research laboratories.

Software Development

Statistics and Experiment Aids

The biometric support to the research programs at ICARDA has involved four major statistical packages: SPSS-X, CRISP, BMDP, and SHAZAM. The major modifications in CRISP, carried out in 1988, were:

1. Addition of a module COMGEN, to perform the genetic analysis of Scaling Tests as defined by Mather (1949)[1] and the Joint Scaling Test devised by Cavalli (1952)[2].
2. Addition of a module, RCBPOL, to perform the combined analysis of data from several trials in an RCB design conducted at the same location in a given year.
3. Addition of a path coefficient analysis module, PATHCO.
4. Addition of a module LATPOL, which analyzes data from a group of trials in Latin Square Design.
5. Addition of a utility module, LSRBOK, to produce fieldbooks on a laser printer.
6. The analyses programs for RCB, Augmented RBD or Lattice design experiments were modified to store the Treatment Means and other statistics in an output data file.
7. Addition of the probability of significance level for computed F and T statistics in all analysis modules.

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(1) Mather, K. (1949). Biometrical Genetics (1st Edn). Methuen, London.

(2) Cavalli, L.L. (1952). An Analysis of Linkage in Quantitative Inheritance, Quantitative Inheritance, pp. 135-44, HMSO, London.

Administrative Applications

In 1988, the following three additional application components were added to MAS (Management, Accounting and Information System):

1. The Fixed Assets Register
2. Workshop Management and Control System
3. Order Entry System

Fixed Assets Register

The Fixed Assets Register was developed to enable accurate determination of the assets in ICARDA's inventories, as well as their location. ICARDA's inventories comprise a central store under the management of Purchasing and Supplies Department, vehicles assigned for business and personal use to senior staff, and housing assets.

The subsystem enables the entry of records related to individual fixed items under the diverse categories of such items. Financial and statistical components enable the summarization of the fixed assets holdings.

Workshop Management and Control System

A new subsystem, MAINSYS, for Engineering Workshops Maintenance, was developed to assist the management of a number of workshops, such as Vehicle Maintenance Workshop, Mechanical Engineering Workshop, Electrical Engineering Workshop, Electronics Engineering Workshop, Agricultural Machinery Workshop, Metal Fabrication Workshop, and others.

The system consists of two major modules: Equipment Management and Control and Equipment Utilization. The first component relates to the day-to-day activities in a maintenance workshop, whereas the second relates to the exploitation of resources.

Order Entry System

The newly developed Order Entry System will enable the Purchase and Supplies Department to manage and control purchase requests raised by the responsibility centers, purchase orders issued to the suppliers, follow-up of the orders through the status indicators, and goods released from the customs authority and received in the central store. The Supplier File subsystem and the Stock Control subsystem in MAS are used by the Order Entry system.

Additionally, a number of revisions related to the file structure and reporting modules in both Payroll Subsystem and the General Ledger Subsystem took place in 1988, to accommodate the growth in ICARDA's financial activities.

Graphic Facility -- ICAGRAF

Development of a new graphic software, ICAGRAF, was completed to provide a complete graphics facility for improved data presentation. What distinguishes ICAGRAF from other softwares is the use of certified routines for the mathematical treatment of data and its ability to deal with various stochastic and other parameters, reflecting and indicating the validity of data. ICAGRAF permits the user to select from a range of colors, shades, markers, line styles, and hardware/software area-fillings.

The interface to ICAGRAF is through a set of interactive commands or through catalogued commands in a file. The often-needed parameters can be established at the startup time with a startup file.

Training and User Support

Providing instruction to the institute's scientific, administrative, and secretarial staff on software and system orientation is a major activity of Computer Services. The Computer Services staff devote over 40% of their work time to training and user-support activities. Table 33 gives a measure of training and user-support activities in 1988.

Table 33. Computer training and user-support activities in 1988.

Software	No. of research staff	No. of administrative staff	Total
Document Preparation	40	15	55
Database Management	20	10	30
Management Accounting and Information	-	10	10
Statistical Packages	70	3	73
Graphic Facility	15	5	20
System Orientation	30	10	40

In addition, Computer Services also trained the scientific staff of NARSs. At INRAT, Tunisia, a PDP-11 minicomputer was installed. Instruction was provided to INRAT staff on statistical packages CRISP, SPSS-11 and on SATURN wordprocessing package.

A three-day training course on CRISP statistical package was organized at the Agriculture Research Institute, Nicosia, Cyprus; and a four-day workshop was conducted at Jordan University of Science and Technology, Ramtha, Jordan, on CRISP and ICADET.

Appendixes

Contents

Appendix 1

Precipitation (mm) in 1987/88.

	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	TOTAL
SYRIA													
Tel Hadya													
1987/88 season	1.4	71.0	45.7	74.4	84.7	97.4	92.6	29.4	2.6	4.4	0.0	0.6	504.2
Long-term average (10s.)	0.5	26.3	44.9	55.9	68.1	56.2	47.1	31.7	14.3	3.7	0.0	0.1	348.7
% of long-term average	280	270	102	133	124	173	197	93	18	119	n/a	1000	145
**Bouider*													
1987/88 season	0.6	69.9	37.2	44.6	80.2	77.8	41.0	25.4	5.2	3.8	0.0	0.0	385.7
Long-term average (16s.)	1.5	13.9	21.0	35.9	43.5	38.6	27.2	20.1	10.2	0.7	0.2	0.0	212.8
% of long-term average	40	502	177	124	184	201	151	126	51	543	0	n/a	181
**Ghrerife*													
1987/88 season	0.0	102.0	33.8	38.7	76.2	88.6	71.6	19.6	7.0	4.2	0.0	0.0	441.7
Breda													
1987/88 season	0.0	68.2	36.4	41.0	85.6	82.4	65.6	19.4	9.8	6.4	0.0	0.0	414.8
Long-term average (30s.)	1.4	13.2	29.5	52.2	48.8	39.0	33.4	33.6	15.8	1.6	0.2	0.0	268.7
% of long-term average	0.0	517	123	79	175	211	196	58	62	400	0	n/a	154
Jindiress													
1987/88 season	0.0	117.4	65.7	85.0	100.8	78.2	167.1	71.8	22.5	6.4	0.0	0.0	714.9
Long-term average (29s.)	1.3	28.4	52.0	98.6	92.2	75.9	65.9	44.9	19.4	3.3	0.0	0.9	482.8
% of long-term average	0	413	126	86	109	103	254	160	116	194	n/a	0	148
***Lattakia*	-	-	-	-	-	-	-	-	-	-	-	-	-
LEBANON													
**Terbol*													
1987/88 season	0.0	22.4	52.4	164.7	153.4	113.2	187.2	8.2	7.0	0.0	0.0	0.0	708.6
***Kfardane*	-	-	-	-	-	-	-	-	-	-	-	-	-

* Long-term average not available.
** Data not available.

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 31.

For complete meteorological reports, including temperatures, request publication ICARDA-139 En. (Meteorological reports for ICARDA experiment stations in Syria: 1987/88 season, 152 pp. 1989.)

Appendix 2

Cereal and Food Legume Varieties Released by National Programs

Country	Year of Release	Variety
Barley		
Algeria	1987	Harmal
China	1986	Gobernadora
Cyprus	1980	Kantara
Ethiopia	1981	BSH 15
	1984	BSH 42
	1985	Ardu
Iran	1986	Aras
Jordan	1984	Rum (6-row)
Mexico	1986	Mona/Mzq/DL71
Morocco	1984	Asni
		Tamellat
		Tissa
	1988	Tessaout
		Aglou
		Rihane
Nepal	1987	Bonus
Pakistan	1985	Jau-83
	1987	Jau-87
	1987	Frontier 87
Peru	1987	Una 87
		Nana 87
Portugal	1982	Sereia
	1983	CE 8302
Qatar	1982	Gulf
	1983	Harma
Saudi Arabia	1985	Gusto
Spain	1987	Rihane
Syria	1987	Furat 1113
Thailand	1987	Semang 1 IBON 48
		Semang 2 IBON 42
Tunisia	1985	Taj
		Faiz
		Roho
	1987	Rihane"S"
Yemen AR	1986	Arafat
		Beecher
Durum Wheat		
Algeria	1982	ZB S FG'S'/LUKS GO
	1984	Timgad
	1986	Sahl
		Waha
Cyprus	1982	Mesoaria
	1984	Karpasia
Egypt	1979	Sohag I
	1988	Sohag II
		Beni Suef
Greece	1982	Selas
	1983	Sapfo
	1984	Skiti
	1985	Samos
		Syros
Jordan	1988	Korifla = Petra
		Sham 1 = Maru
		N-432 = Amra
		Stork = ACSAD 75
Lebanon	1987	Belikh 2
Libya	1985	Marjawi
		Ghuodwa
		Zorda
		Baraka
		Qara
		Fazan
Morocco	1984	Marzak
Pakistan	1985	Wadhanak
Portugal	1983	Celta
		Timpanas
	1984	Castico
	1985	Heluio
Saudi Arabia	1987	Sham 1
Spain	1983	Mexa
	1985	Nuna
Syria	1984	Sham 1
	1987	Sham 3
		Bohouth 5
Tunisia	1987	Razzak
Turkey	1984	Susf bird
	1985	Balcili
Bread Wheat		
Algeria	1982	Setif 82
		HD 1220
Egypt	1982	Giza 160
	1988	Sakha 92
		Giza 162
		Giza 163
		Giza 164
Ethiopia	1984	Dashen
		Batu
		Gara
Greece	1983	Louros
		Pinios
		Arachthos

Iran	1986	Golestan
		Azadi
	1988	Darab
		Saludan
		Quds
Jordan	1988	Nasma = Jubeiha
		L88 = Rabba
Libya	1985	Zellaf
		Sheba
		Germa
Morocco	1984	Jouda
		Merchouche
Pakistan	1986	Sutlej 86
Portugal	1986	LIZ 1
		LIZ 2
Sudan	1985	Debeira
	1987	Wadi El Neel
Syria	1984	Sham 2
	1986	Sham 4
	1987	Bohouth 4
Tunisia	1987	Byrsa
Yemen AR	1983	Marib 1
	1987	Mukhtar
	1988	Aziz
		Dhumran
Yemen PDR	1983	Ahgaf
	1988	SW/83/2

Kabuli Chickpea[1]

Algeria	1988	ILC 482
		ILC 3279
Cyprus	1984	Yialousa (ILC 3279)
	1987	Kyrenia (ILC 464)
France	1988	TS 1009
		TS 1502
Italy	1987	Califfo (ILC 72)
		Sultano (ILC 3279)
Morocco	1987	ILC 195
		ILC 482
	1985	Fardan (ILC 72)
		Zegri (ILC 200)
		Almena (ILC 2548)
		Alcazaba (ILC 2555)
		Atalaya (ILC 200)
	1987	Shendi
Oman	1988	ILC 237
Syria	1982/86	Ghab 1 (ILC 482)
	1986	Ghab 2 (ILC 3279)
Tunisia	1986	Chetoui (ILC 3279)
		Kassab (FLIP 83-46C)
		Amdoun 1 (Be-sel-81-48)
Turkey	1986	ILC 195
		ILC 482

Lentil

Algeria	1987	Syrie 229
	1988	Balkan 755
		ILL 4400
Ecuador	1987	INIAP-406 (FLIP 84-94L)
Ethiopia	1984	ILL 358
Lebanon	1988	Talya 2
Syria	1987	Idleb 1 (78S 26002)
Tunisia	1986	Neir (ILL 4400)
		Nefza (ILL 4606)
Turkey	1987	Firat'87 (75kf 36062)

Faba bean

Iran	1986	Barkat (ILC 1268)

Appendix 3

Publications

Articles in scientific journals

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Keatinge, J.D.H., N. Chapanian, and M.C. Saxena. Effect of improved management of legumes in a legume-cereal rotation on field estimates of crop nitrogen uptake and symbiotic nitrogen fixation in northern Syria. Journal of Agricultural Science (Cambridge) 110(3): 651-659.

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Makkouk, K.M., L. Bos, O.I. Azzam, S. Koumari, and A. Rizkallah. Survey of viruses affecting faba bean in six Arab countries. Arab Journal of Plant Protection 6(1): 53-61. (Arabic summary).

Makkouk, K.M., L. Katul, and A. Rizkallah. A simple procedure for the purification and antiserum production of bean yellow mosaic virus. Journal of Phytopathology 122(1): 89-93.

Matar, A.E., S. Garabed, S. Rihawi, and A. Mazid. A comparison of four soil test procedures for determination of available phosphorus in calcareous soils of the Mediterranean region. Communications in Soil Science and Plant Analysis 19(2): 127-140.

Singh, K.B., W. Erskine, L.D. Robertson, H. Nakkoul, and P.C. Williams. Influence of pretreatment on cooking quality parameters of dry food legumes. Journal of Food Science and Agricultural Chemistry 44: 135-142.

Skaf, J.S., K.M. Makkouk, F.M. Azmeh, and W.F. Al-Kassis. Aphid transmission, distribution, and serotyping of barley yellow dwarf virus (BYDV) in Syria. Arab Journal of Plant Protection 6: 97-105. (In Arabic, English summary).

Thomson, E.F. and F.A. Bahhady. A note on the effect of live-weight at mating on fertility of Awassi ewes in semi-arid North-West Syria. Animal Production 47: 505-508.

Thomson, E.F. and G. Orita. Seasonal prevalence of *Proto-strongylid* and *Dictyocaulus* species of lungworms in Awassi sheep in Northwest Syria. Tropical Animal Health and Production 20: 187-190.

di Vito, N., N. Greco, K.B. Singh, and M.C. Saxena. Response of chickpea germplasm lines to *Heterodera ciceri* attack. Nematologia Mediterranea 16: 17-18.

Williams, P.C., F. Jaby el-Haramein, G. Ortiz-Fereira, and J.P. Srivastava. Preliminary observations on the determination of wheat strength by near-infrared reflectance. Cereal Chemistry 65(2): 109-114.

Williams, P.C., F. Jaby el-Haramein, W. Nelson, and J.P. Srivastava. Evaluation of wheat quality for the baking of Syrian-type two-layered flat breads. Journal of Cereal Science 7(2): 195-207.

Magazine articles about ICARDA

Alam Attijarat. ICARDA celebrates spring field days in Syria. June 1988, pp.9.

Bendki, Joyce. Nile Valley Project to boost faba bean production in Egypt and Sudan. Alam Attijarat, Sept 88, 23(9). pp. 10-13.

Burton, Randy. Drought resistant wheat shows potential. Star-phoenix, Aug 1988, pp. D5.

Canora Courier. Saskatoon researchers studying drought tolerance in wheat. July 1988, pp. 5.

Humbolt Journal. U of S studies wheat drought tolerance. Aug 1988, pp. A6.

Kindersley Clarion. U of S working on drought tolerant wheat. July 1988, pp. 1B.

Platform. The Dutch/German seed production project at ICARDA (in Dutch). Nov. 1988, pp. 7-9.

The Sun, Swift Current. Primitive grains genetic treasures. July 1988, pp. 9.

Contributions to conferences

February

New Delhi IN. International Congress of Plant Physiology

Acevedo, E., P. Perez-Marco, and E. van Oosterom. Physiology of wheat and barley in stressed rainfed Mediterranean environments.

Silim, S.N. and M.C. Saxena. Comparison of dry matter accumulation, partitioning and yield in determinate and indeterminate faba beans (*Vicia faba* L.)

Srivastava, J.P. Physiological approach to winter cereal improvement for dryland farming systems.

March

Sana'a YE. Seed Production in the Arabian Peninsula

Van Gastel, A.J.G. ICARDA and seed program development.

April

Alexandria EG. Workshop for Evaluation of Farm Resource Management in the Northwest Coast of Egypt.

El-Naggar, S., E.R. Perrier, and M.E. Shykhoun. Evaluation of farm resource management in the northwest coast of Egypt.

Perrier, E.R. Discussion of suggested research proposals.

Washington DC US. USDA Conference on Strengthening Collaboration in Biotechnology

Makkouk, K.M., D.P. Beck, and M. Diekmann. Applications of immuno and DNA hybridization diagnostics in research at ICARDA.

May

Foggia IT. Third International Symposium on Durum Wheat

Nachit, M.M., H. Ketata and S.K. Yau. Breeding durum wheat for stress environments of the Mediterranean region.

Muscle Shoals US. IFDC/UNDP Conference on Fertilizer Sector Development and Agricultural Production for Countries of the Middle East and North Africa

Cooper, P.J.M., M. Jones. H. Harris, and A. Matar. Agro-ecological constraints to crop production in West Asia and North Africa, and their impact on fertilizer use.

June

Braunschweig DE. Third International Symposium on Genetic Aspects of Plant Mineral Nutrition

Damania, A.B. and J.P. Srivastava. Genetic resources for optimal input technology - ICARDA's perspectives.

Saxena, M.C., R.S. Malhotra, and K.B. Singh. Iron deficiency in chickpea in the Mediterranean region and its control through host-plant resistance and nutrient application.

Cairo EG. Workshop on Small Ruminant Research and Development in the Near East

Russi, L., M. Pagnotta, A.E. Osman, and F. Bahhady. Use of Syrian marginal land for fat-tailed sheep production.

Tekirdag TR. First International Sunn Pest Symposium

Miller, R.H. Past, present and future status of sunn pest research at ICARDA.

Tilburg NE. Technology Development and Changing Seed Supply System

van Gastel, A.J.G. Stimulating and development of national seed production organizations in West Asia and North Africa: ICARDA and seed program development.

van Gastel, A.J.G. Seed programs in the African, Caribbean and Pacific countries.

Tune DK. CTA Seminar on Seed Pathology for ACP countries

Diekmann, M. Seed health measures at International Agricultural Research Centers.

Tunis TN. Workshop on the Role of Legumes in the Farming Systems of Mediterranean Areas

Erskine, W., P.S. Cocks, M. Pala, T. Nordblom, and E.F. Thomson. Use of on-farm research as a method of extending legume production in Mediterranean farming systems.

Jones, M.J. Role of forage legumes in rotation with cereals in Mediterranean areas.

Osman, A.E., M. Falcinelli, P.S. Cocks, L. Russi, and M. Pagnotta. The role of legumes in improving marginal lands.

Wagga Wagga AU. Ninth Australian Plant Breeding Conference

Yau, S.K. and N. Thurling. Genotypic variation in mechanisms of nitrogen uptake in spring rape (*Brassica napus* L.)

July

Cambridge GB. VII International Wheat Genetics Symposium

Damania, A.B., M. Tahir, and B.H. Somaroo. Improvement of durum wheat proteins utilizing wild gene resources of *Triticum dicoccoides* Koern at ICARDA.

Inagaki, M.N. Three steps in producing doubled haploids of wheat through the bulbosum technique.

Nachit, M.M. and A. Ouassou. Association of yield potential drought tolerance and stability of yield in *Triticum turgidum* var. durum.

Ortiz-Ferrara, G. and M. Deghais. Modified bulk, a selection method for enhancing disease resistance and adaptation in rainfed wheat.

Srivastava, J.P., A.B. Damania, and L. Pecetti. Landraces, primitive forms and wild progenitors of durum wheat--their use in dryland agriculture.

Tahir, M. Characteristics of cultivated landraces and improved varieties of wheat (*T. aestivum* L.) in high altitude areas.

Yilmaz, B. and M. Tahir. Genetic diversity in Ahlat wheats.

Giessen DE. Symposium on Tropical Pastures and Feed Resources

Cocks, P.S. Strategies for improving feed resources in West Asia and North Africa and their potential impact.

Vancouver CA. 18th International Congress of Entomology

Miller, R.H. Entomology in West Asia and North Africa: a subregional approach.

Weigand, S. and M. Pala. Economic damage of *Sitona* weevil (Coleoptera: CurculioNidae) in lentils.

Zaragoza ES. Conference on Present Status and Future Prospects of Chickpea Crop Production and Improvement in the Mediterranean countries

Cleyet-Marel, J.C., R. Di Bonito, and D.P. Beck. Chickpea and its root-nodule bacteria: implications of their relationships for legume inoculation and biological nitrogen fixation.

Haware, M.P. Fusarium wilt and other important diseases of chickpea in the Mediterranean area.

Saxena, M.C. Status of chickpea in the Mediterranean basin.

Singh, K.B. Winter chickpea, problems and potentials in the Mediterranean region.

Singh, K.B. Prospects of developing new genetic material and breeding methodology for chickpea improvement.

Solh, M.B. and M. Pala. Weed control in chickpea.

Weigand, S. Insect pests of chickpea in the Mediterranean area and possibilities for resistance.

August

Amarillo Texas US. International Symposium on Dryland Agriculture

Cocks, P.S. Constraints to developing ley farming systems in West Asia and North Africa.

Harris, H.C., W. Goebel, T.L. Nordblom and M. J. Jones. Defining the impact of variable weather on agricultural production and the design of new technology.

Jones, M.J., A.E. Matar, M. Pala, and P.J.M. Cooper. Fertilizer strategies for rainfed agriculture in West Asia and North Africa. Cereals in Syria: A Case Study.

Karaca, M., M. Guler, N. Durutan, M. Pala and I. Unver. The effect of different tillage systems on wheat.

Keatinge, J.D.H. and D.J. Rees. An analysis of precipitation and air temperature records in the Quetta valley, Pakistan. The implications for potential improvement in agricultural productivity.

Matar, A.E. Prediction of barley response to N and P fertilization using N and P-soil tests (poster presentation).

Papastylianou, I., and M.J. Jones. Replacement of fallow in the rainfed areas of the Mediterranean region (poster presentation).

Perrier, E.R. Water capture schemes for dryland farming.

Srivastava, J.P., R.H. Miller and J.A.G. van Leur. Biotic stresses in dryland cereal production: the ICARDA perspective.

Kyoto JP. International Symposium on Crop Losses Due to Diseases Outbreaks in the Tropics and Countermeasure

Mamluk, O.F., M.P. Haware, K.M. Makkouk and S. Hanounik. Occurrences, losses, and control of important cereal and food legume diseases in West Asia and North Africa.

Kyoto JP. V International Congress of Plant Pathology

Mamluk, O.F. and M. Nachit. Performance and reaction of some durum wheat genotypes against different isolates of common bunt (*Tilletia foetida* and *T. caries*).

Makkouk, K.M. and L. Bos. Broad bean mottle virus: identification, host range, serology and occurrence on faba bean (*Vicia faba*) in West Asia and North Africa.

September

Amman JO. Rainfed Field Crops and Farming Systems in Jordan and the Neighboring Countries

El-Dehni, E.R. Perrier, and A.B. Salkini. Moisture conservation using supplemental irrigation on spring wheat.

El-Naggar, S., and E.R. Perrier. Rainfed farming systems on the Northwest coast of Egypt.

Nachit, M.M. Breeding durum wheat for dryland.

Amman JO. Third Regional Workshop on Soil Test Calibration

Jones, M.J., and A.E. Matar. Note on the long-term effects of rotation and fertilization treatments on soil phosphorus and carbon status in dry areas.

Matar, A.E. Descriptive model for prediction of residual phosphorus in soil after phosphate fertilization.

Pala, M. and A.E. Matar. Effect of rate and method of phosphate placement on wheat production.

Somel, K., A.E. Matar, and K. El-Hajj. Pooled analysis of barley fertilizer trials in Northern Syria.

Nairobi KE. IBPGR/UNDP/IITA. Workshop on Plant Genetic Resources in Africa

Holly, L., M. Solh, and M. Kamel. Food legume germplasm evaluation and utilization with special reference to Moroccan chickpea landraces.

S. Margherita Ligure IT. Advanced Technology for Increased Agricultural Production: Actual Situation, Future Prospects and Concrete Possibilities of Applications in the Developing Countries

Ceccarelli, S. Increasing productivity in unfavorable conditions: philosophies, strategies, methodologies.

October

Cairo EG. Fertilizer and Agriculture Sector

Matar, A.E. Fertilizer use in the dry areas with special reference to soil test calibration.

Kuwait KT. Workshop on Agricultural Networks for the Countries of the Gulf Cooperative Council

Ketata, H., M.H. Ibrahim, and A.E. Osman. Challenges facing agricultural research in the Arab region with emphasis on GCC countries.

Rome IT. IFAD Consultation on the Sustainability of Small Farms

Cocks, P.S. The sustainability of small farms in West Asia and North Africa.

San Diego, CA. US. 73rd Annual Conference of the American Association of Cereal Chemists

Tahir, M., P.C. Williams, F. Jaby El-Haramein, A. Sayegh, and J.P. Srivastava. Influence of interspecific crossing on quality of durum-type wheats (poster presentation).

November

Adana TR. International Seminar on Farming Systems Research

Cocks, P.S. Introducing pasture legumes to farming systems in North Syria: A Case Study.

Cooper, P.J.M., and T.L. Nordblom. Farming systems research in practice.

Jones, M.J. and A. Mazid. Fertilizer use on barley in the dry areas of Syria. A Case Study.

Damascus SY. 28th Science Week

Matar, A.E. Effect of rate and method of phosphate placement on yield production of durum wheat under the Mediterranean climate.

Rihawi, S. The feeding value of barley straw as influenced by variety and supplementation with either barley grain or cottonseed cake.

Touma, M. Grazing management of a medic system.

December

Al-Ain AE. Third Arab Congress of Plant Protection

Bellar, M. Screening forage vetches, peas, and chicklings for foliar diseases.

Makkouk, K.M., L. Bos, and S. Kumari. Broad bean wilt virus: host range, purification, serology, transmission characteristics and occurrence in West Asia and North Africa.

Makkouk, K.M., S. Kumari, and W. Ghulam. Luteoviruses affecting cereals and food legumes in West Asia and North Africa.

Miller, R.H. and S. El-Masri. Plant spacing effects on wheat stem sawfly resistance.

Anahein, CA. US. Conference of the American Society of Agronomy

Beck, D.P. and K.B. Singh. Interaction between chickpea cultivars and *Rhizobium* strains for nodulation and nitrogen fixation.

Kuala Lumpur MY. Symposium on Germplasm Introduction and Quarantine Procedures

Diekmann, M. Germplasm exchange and related seed health measures at ICARDA.

Publications sponsored by ICARDA

Beck, D. and L.A. Materon (editors). Nitrogen fixation by legumes in Mediterranean agriculture. Proceeding of a workshop .... [Aleppo SY 1986-04-14 to 17]. (Dordrecht NL: Martinus Nijhoff, ISBN 90-247-3624-2, AGRIS 88-082470). 250 NLG.

Nordblom, Thomas, L., Awad el Karim Hamid Ahmed, and Gordon, R. Potts (redacteurs). Methodes de la recherche applicables aux essais zootechniques en ferme: compte rendu de l'atelier tenu a Alep (Syrie) [Alep SY 1985-03-25 au 28], 337 pp. (Ottawa CA: Centre de Recherches pour le Developpement International, publication IDRC-242f, ISBN 0-88936-469-9). Egalement disponible en anglais (1985) et en arabe (1987).

Summerfield, R.J. (editor). World crops: cool season food legumes. A global perspective of the problems and prospects for crop improvement in pea, lentil, faba bean and chickpea. Proceedings of an International conference [Spokane US 1986-07-06 to 11] 1179 pp. (Dordrecht NL: Kluwer Academic Publishers, ISBN 90-247-3641-2).

Thomson, E.F. and F.S. Thomson (editors). Increasing small ruminant productivity in semi-arid areas. Proceedings of a workshop [Aleppo SY 1987-11-30 to 12-03], 296 pp. (Dordrecht NL: Kluwer Academic Publishers, ISBN 0-89838-386-2).

Publications produced at ICARDA

ICARDA-119 Ar, En Cocks, P.S., E.F. Thomson, K. Somel, and A. Abd El-Moneim. Degradation and rehabilitation of agricultural land in North Syria. 38 pp.

ICARDA-120 En Matar, Abdallah, P.N. Soltanpour and Amy Chouinard (editors). Soil test calibration in West Asia and North Africa: Proceedings of the second regional workshop, Ankara, Turkey, 1-6 September 1987. 118 pp.

ICARDA-123 Fr Amelioration des legumineuses alimentaires en Afrique du Nord. Synthese des travaux du stage de formation, Tunis, 13-20 Avril 1986. 122 pp.

ICARDA-124 En van Gastel, A.J.G. and J. Kerley (editors). Quality seed production: papers presented at the seed technology course, Cairo, Egypt, 15-30 March 1986. 185 pp.

ICARDA-125 En Abdelnour, Mireille. Meteorological reports for ICARDA experiment stations in Syria: 1986/87 season. 150 pp.

ICARDA-126 Ar El Sebae Ahmed, Samir (editor). Practical seed production: proceedings of the training course on seed production technology held at Aleppo, Syria, 15-26 February 1987. 195 pp.

ICARDA-127 En High elevation research in Pakistan: the MART/AZR project annual report. 103 pp.

ICARDA-128 En Somel, Kutlu. Food and agriculture in West Asia and North Africa: projections to 2000. 28 pp. (also Ar, 23 pp.)

ICARDA-129 En Pasture, forage and livestock program: annual report 1987. 288 pp.

ICARDA-130 En Verification and adoption of improved wheat production technology in farmers' fields in the Sudan: proceedings of the second national wheat coordination meeting, 20-22 July 1987, Wad Medani, Sudan. 42 pp.

ICARDA-131 En Farm resource management program: annual report 1987. 218 pp.

ICARDA-132 En Cereal improvement program: annual report 1987. 206 pp.

ICARDA-133 En Genetic resources program: annual report 1987. 57 pp.

ICARDA-134 En Food legume improvement program: annual report 1987. 264 pp.

ICARDA-135 En Saxena, M.C., R.A. Sikora, and J.P. Srivastava (editors). Nematodes parasitic to cereals and legumes in temperate semi-arid regions: proceedings of a workshop held at Larnaca, Cyprus, 1-5 March 1987. 217 pp.

ICARDA-136 En Srivastava, J.P., M.C. Saxena, S. Varma, and M. Tahir (editors). Winter cereals and food legumes in mountainous areas: proceedings of an international symposium on problems and prospects of winter cereals and food legumes production in the high-elevation areas of West Asia, Southeast Asia, and North Africa, 6-10 July 1987, Ankara, Turkey. 317 pp.

ICARDA-137 Fr Cours de formation sur les legumineuses alimentaires: experimentation et vulgarisation. Synthese des travaux, Meknes, Maroc, 7-12 mars 1988. 116 pp.

Technical manuals

14 (Rev.1) En Williams, Phil, Fouad Jaby El-Haramein, Hani Nakkoul and Safouh Rihawi. Crop quality evaluation methods and guidelines. 145 pp.

Periodicals

Faba bean in AGRIS Vol 3 1987 (Cumulation), 53 pp., Vol 4 1988, no. 1, 22 pp., no. 2, 21 pp., no. 3, 29 pp.

FABIS Newsletter. no. 18, 44 pp., no. 19, 36 pp., no. 20, 56 pp., no. 21, 52 pp.

LENS Newsletter. Vol 13, no. 2, 45 pp., Vol 14, no. 1/2, 38 pp., Vol 15, no. 1, 52 pp.

Lentil in AGRIS. Vol 1 1975-1985, 66 pp., Vol 2 1986-87, 41 pp.

RACHIS Newsletter.Vol 6, no. 1, En, 59 pp., Ar, 59 pp., Vol 6, no. 2, En, 64 pp., Ar, 68 pp.

Other publications

Annual report for the regional barley yield trials and observation nurseries, 1986/87, 215 pp.

Annual report for the regional bread wheat yield trials and observation nurseries, 1986/87. 163 pp.

Annual report for the regional durum wheat yield trials and observation nurseries. 1986/87. 204 pp.

Barley germplasm catalog Part II 1988. 221 pp.

Checklist: books, reports and journals published outside ICARDA 1973-88. 12 pp.

Chickpea pathology progress report 1987/88. 36 pp.

Faba bean germplasm catalog: pure line collection. 140 pp.

Faba bean pathology progress report 1986/87. 150 pp.

ICARDA Annual Report 1987, 76 pp. (En), 80 pp. (Ar).

International cereal nurseries 1988/89: list of cooperators and distribution of nurseries. 40 pp.

International nursery report no. 10. Food legume nurseries 1985-1986. 525 pp.

Nile Valley Project on report on faba bean: report of the ninth annual coordination meeting, 19-22 September 1988, Cairo, Egypt. 59 pp.

MART/AZR project publications

Research report No. 16. Atiq-ur-Rehman, Kn., N.M. Khan, M. Asghar, and M.I. Sultani. Fourwing saltbush forage compared with conventional feeds for yearling sheep. 9 pp.

Research report No. 18. Atiq-ur-Rehman, Kn., M. Munir, and B.R. Khan. Incidence of internal parasites of sheep in upland districts of Baluchistan. 17 pp.

Research report No. 20. M. Asif Masood, M. Afzal, J.G. Nagy, and S.M. Khan. Agricultural and related statistics of upland Baluchistan. 116 pp.

Research report No. 21. Ali, A., J.D.H. Keatinge, and B. Roidar Khan. Introduction, selection and evaluation of annual sown forage legumes under continental Mediterranean climatic conditions in Pakistan. 8 pp.

Research report No. 22. Aro, R.S., M.I. Sultani, and M. Asghar. Introduction to fourwing saltbush (Atriplex canescens) into degraded rangelands in upland Baluchistan. 9 pp.

Research report No. 23. Keatinge, J.D.H., B. Roidar Khan, D.J. Rees, R.S. Aro, and C. Talug. A strategic plan for the PARC Arid Zone Research Institute 1990-2000. 22 pp.

Nile Valley Regional Program (NVRP) publications

ICARDA/NVRP-DOC-001. Work Plan, Egypt 1988-1989. 21 pp.

ICARDA/NVRP-DOC-002. Work Plan, Sudan 1988-1989. 31 pp.

Appendix 4

Graduate Theses Produced with ICARDA's Assistance

Two graduate students earned doctorates on the basis of research that they carried out using ICARDA's facilities:

DE George-August-Universitaet Goettingen

Theodor Friedrich (DE). [Investigations of lentil harvest mechanization using the pulling principle in comparison with other lentil harvest methods in Syria]. (In German, English abstract). 141 p.

GB University of Sheffield

Munir Aziz Turk (JO). The growth of annual legume species in marginal rangelands in Syria with special reference to response to phosphate. 298 p.

Dr Turk, as an employee of ICARDA, also received financial support for his studies.

Eight others earned M.Sc. degrees or equivalent diplomas, largely for their research at ICARDA:

DE Justus-Liebig-Universitaet Giessen

Petra Engelhard (DE). [Development and control of *Orobanche crenata* on peas (*Pisum sativum*) in Syria]. ii + 102 p. (In German).

Stefan Kachelriess (DE). [*Orobanche* on *Vicia faba* and preferred methods for its control]. ii + 88 p. (In German).

DE Universitaet Hohenheim

Gerold Wyrwal (DE). [Studies of the population of seeds of *Orobanche* spp. in naturally infested areas and its interaction with crop plants]. xi + 95 p. (In German).

Sabine Mueller (DE). [The regeneration of medic pastures in a ley farming system and their value for sheep production in northern Syria]. 96 + xvi p. (In German, English summary, 22 p.).

LE American University of Beirut

Wajdi Aziz Birbari (LE). Assessment of chickpea returns in direct combine harvesting. 64 p.

SD University of Gezira, Wad Medani

Fuad Saeed Yousif (SD). Fababeans marketing and markets in Sudan. xx + 163 p.

SY Damascus University

interaction in relation to barley yellow dwarf virus affecting cereals, and bean leaf roll and bean yellow mosaic viruses affecting faba bean in Syria. 63 p. (Arabic translation, 96 p.).

SY University of Aleppo

Hassan Mohammed Dahrouj (YD). [The effect of sowing methods, seed rates and cultivars on yield and yield components of durum wheat crop]. 143 p. (In Arabic, English summary).

Mr Yousif, Mr Skaf, and Mr Dahrouj also received financial support from ICARDA and the theses supervisors were members of ICARDA's staff.

Three students received financial support for a doctoral degree:

EG Cairo University

Mounir Mohamed El-Hady Mohamed (EG). Diallel analysis of resistance to chocolate spot disease (*Botrytis fabae* Sard.) and other agronomic trials in faba bean (*Vicia faba* L.) 175 p. (Arabic summary).

FR Universite Paris VII

Moncef Ben Salem (TN). [Comparative study of several wheat varieties for drought resistance]. 386 p. (In French).

US Purdue University

Abdelmoneim Taha Ahmad (SD). An agricultural sector model for the northern region of Sudan to evaluate new faba beans technologies. 152 p.

and another three for a master's degree:

GB University College of Wales, Aberystwyth

Andreas Georghiou Kari (CY). Partial resistance of barley to *Rhynchosporium secalis*. 96 p.

GB University of Reading

Kemal Ali (ET). Biology of *Callosobruchus chinensis* (Coleoptera: Bruchidae) and varietal resistance in *Vicia faba*. 137 p.

JO University of Jordan, Amman

Jamal Morshed Abu-el-Enein (JO). Utilization of wild emmer (*Triticum turgidum*) var *dicoccoides* in improving cultivated durum wheat. 96 p.

Appendix 5

ICARDA Calendar 1988

January

10-28 Aleppo SY. Training course on effective use of fertilizer

18-21 Aleppo SY. Board of Trustees: extraordinary meeting of the Executive Committee and 15th meeting of the Program Committee

22 Aleppo SY. Board of Trustees: extraordinary meeting

February

1-2 Viterbo IT. Consultation with national programs on ICARDA's Strategic Plan

14-March 31 Aleppo SY. Residential training course on farming systems research and resource management

16-23 Aleppo SY. Training course on biometrical techniques for cereal breeders

26-27 Rome IT. Board of Trustees: second meeting of the Committee on the Strategic Plan

March

1-June 16 Aleppo SY. Residential training course on food legume improvement

1-June 16 Aleppo SY. Residential training course on cereal crop improvement

1-June 16 Aleppo SY. Residential training course on pasture, forage and livestock

6-12 Meknes MA. Training course on field experimentation techniques for food legumes (North Africa)

19-31 Dhamar YE. Training course on seed technology

15-28 Aleppo SY. Training course on cereal stress physiology

16-18 Sana'a YE. Workshop on seed production in the Arabian Peninsula

21-April 5 Aleppo SY. Training course on barley diseases and associated breeding methodologies

21-April 11 Aleppo SY. Training course on forage and range species germplasm

23-April 7 Aleppo SY. Training course on food legume disease methodologies

24-30 MA. Survey for food-legume diseases: phase I

April

2-12 Riyadh SA. Training course for identification, diagnosis and control of wheat and barley diseases

4-7 Alexandria EG. Workshop on evaluation of farm resource management in the Northwest coast of Egypt

7-8 Istanbul TR. Board of Trustees: 18th meeting of the Executive Committee

10 Aleppo SY. Presentation Day for students of Faculty of Agriculture, Damascus University

11-16 Beja TN. Training course on hybridization techniques for food legumes

11 Aleppo SY. Presentation Day for farmers of Sweda and Dera'a

12 Aleppo SY. Presentation Day for students of Aleppo University

13 Aleppo SY. Presentation Day for students of Tichreen University

14 Aleppo SY. Presentation Day for diplomats and government officials

18-21 Aleppo SY. Training course in cereal disease identification and scoring

18-20 Cairo EG. Workshop on seed certification

24-27 Sakha EG. Training course on seed certification

24-30 Aleppo SY. Training course on insect control in food legumes

26-May 6 MA. Survey for food-legume diseases: phase II

May

2-5 Aleppo SY. West Asian seminar on food legumes

3-29 SY. Disease survey for cereals

4-12 Aleppo SY. Training course on lentil harvest mechanization

8 Aleppo SY. Food Legumes Field Day

9-17 MA. Cereal travelling workshop for North Africa

9-20 Quito EC and Pasto CO. First international graduate training course on research and production for faba bean, lentil, sweet pea, and chickpea in the Andean region

10-14 Diyarbakir TR. Training course on food legume hybridization techniques

20-June 4 JO. JUST/ICARDA collection mission for wild relatives of wheat in lowland areas

23-28 DZ/MA. Disease survey and travelling workshop for cereals

23-June 10 Aleppo SY. Second external management and program reviews (EMR, EPR)

29-June 6 SY. MAAR/ICARDA collection mission for cultivated and wild barley in central and coastal areas

June

8 Aleppo SY. Board of Trustees: extraordinary meeting of the Executive Committee

9-12 Aleppo SY. Board of Trustees: 22nd meeting

9-13 SY. MAAR/ICARDA collection mission for durum wheat landraces in central areas

11-18 SY. MAAR/ICARDA collection mission for wild relatives of wheat in Sweida province

19-22 SY. MAAR/ICARDA collection mission for durum wheat landraces in Lattakia province

19-23 Aleppo SY. Workshop on barley and wheat growth simulation models

19-July 2 JO. JUST/ICARDA collection mission for wild relatives of wheat in mountainous areas

20-24 Tunis TN. Workshop on the role of legumes in the farming systems of the Mediterranean areas

20-29 Tunis TN. Training course on methods of farm surveys

July

3-17 SY. MAAR/ICARDA collection mission for food legumes in chickpea-growing areas

10-14 Aleppo SY. Workshop on agricultural labor and technological change in West Asia and North Africa

10-17 SY. MAAR/ICARDA collection mission for wild relatives of wheat in Idlib and Lattakia provinces

11-13 Zaragoza ES. Meeting on status and future prospects of chickpea crop production and improvement in Mediterranean countries

31-August 7 TR. Travelling workshop on food legumes in highland Turkey

August

29-September 4 ET. Nile Valley faba bean project: travelling workshop in Ethiopia

September

3-9 Amman JO. 3rd Regional workshop on soil test calibration

5-14 Holetta ET. Training course on methodologies for on-farm trials (Period 1)

10-12 Algiers DZ. Algeria-ICARDA coordination meeting

13-14 Tunis TN. Tunisia-ICARDA coordination meeting

19-24 Cairo EG. Nile Valley Project: 9th annual coordination meeting,

23-24 Cairo EG. First meeting on the Nile Valley Regional Program

26-27 Rabat MA. Morocco-ICARDA food legume coordination meeting

29 Caltagirone IT. Second meeting for the coordination of development of chickpea germplasm with combined resistance to ascochyta blight and fusarium wilt using wild and cultivated species

October

1-3 Aleppo SY. 7th annual coordination meeting with Syrian national program

3-4 Addis Ababa ET. Workshop on seed health and production

3-7 Holetta ET. Training course on methodologies for on-farm trials (Period 2)

5-16 Addis Ababa ET. Training course on seed health testing

9-10 Aleppo SY. Planning meeting of Cereal Improvement Program

10-12 Aleppo SY. Planning workshop for training follow-up study

12-13 Aleppo SY. Planning meeting of Food Legume Improvement Program

16-17 Aleppo SY. Planning meeting of Farm Resource Management Program

18 Aleppo SY. Planning meeting of Genetic Resources Unit

18-20 Sana'a YE. First coordination meeting of barley and wheat scientists in the Arabian Peninsula

19-20 Aleppo SY. Planning meeting of Pasture, Forage and Livestock Program

23-27 Sana'a YE. Training course on techniques of cereal improvement

31-November 4 Settat MA. Training course on agronomy trials

November

7-8 Washington US. Board of Trustees: 19th meeting of the Executive Committee

Appendix 6

Special Projects

During 1988, the following activities were in progress utilizing funds that various organizations had provided separately from ICARDA's core budget.

ANERA (American Near East Refugee Aid)

Seed Production Cooperative Project in Lebanon. This grant is for a period of one year beginning from July 1988 (5,000 USD in 1988).

AFESD (Arab Fund for Economic and Social Development)

Arabian Peninsula. Grant for strengthening barley and wheat research and training in the Nile Valley and Arabian Peninsula (37,000 USD in 1988).

Australia

Nitrogen Fixation. This grant is for measurement of symbiotic nitrogen-fixing capacity of populations of *Rhizobium meliloti* in Syrian Soils (10,000 USD in 1988).

DGIS (Directorate General for International Cooperation), the Netherlands and GTZ (German Agency for Technical Cooperation), Federal Republic of Germany

Seed Production. For a period of three years from 1985 and extended for a second phase of another three years, this project provides for the employment of a seed-production specialist and a program of work and training to enhance the capacities of national seed organizations (221,000 USD in 1988).

DGIS (Directorate General for International Cooperation), the Netherlands

Collection and Characterization of Wild Relatives of Wheat. This project funds a taxonomist at ICARDA in cooperation with the Laboratory for Plant Taxonomy and the Center for Genetic Resources in the Netherlands. The work centers on collection and characterization of wild relatives of wheat (178,000 USD in 1988).

Virology. This project funds a virologist at ICARDA and provides for cooperation with the Research Institute for Plant Protection (IPO) in the Netherlands and with the American University of Beirut, Lebanon. The work centers on virus diseases of cereals and food legumes (91,000 USD in 1988).

Ford Foundation

Agricultural Labor and Technological Change. This grant, now extended to December 1989, provides for the employment of a project coordinator at ICARDA and the preparation of regional and country reviews of the issues, as well as special case studies (68,000 USD in 1988).

Farming Systems Training. This grant, for 1986-88, is the third in a series that provides support for scientists from the region to conduct research in cooperation with ICARDA, and for workshops (71,000 USD in 1988).

Graduate Fellowships. This two-year grant is to extend ICARDA's own program of graduate fellowships (60,000 USD in 1988).

Post-Doctoral Fellowships. This grant is to support graduate and post-doctoral fellowships programs in agricultural research for Middle Eastern and North African Students, for a period of three years beginning from July 1988 (21,000 USD in 1988).

Supplementary Irrigation. The grant covers the cost of national consultants and their technical support (19,000 USD in 1988).

France

French Language Capability for ICARDA's Publication and Information Service. This project is intended to enable ICARDA to set up a publication program in French (34,000 USD in 1988).

IBRD (International Bank for Reconstruction and Development)

Food Legumes, Ethiopia. The arrangement provides for an ICARDA breeder/pathologist to be stationed with the Highland Pulses Program of the Ethiopian Institute for Agricultural Research (99,000 USD in 1988).

IDRC (International Development Research Centre, Canada)

Arabic Information Services. This grant provides for the recruitment of an English-Arabic translator and for the costs of producing an Arabic version of the *RACHIS Newsletter* (13,000 USD in 1988).

Consultant. This grant is to extend a consultancy for a period of five months beginning Jan 1988. The specialist was required to assist in collection and organization of relevant documents, prepare data and submit worksheets (6,000 USD in 1988).

Faba Bean Pathology. This project, for three years, 1985/86-1987/88, links ICARDA with the University of Manitoba for research on ascochyta blight and chocolate spot, as well as the training of scientists from Egypt and Morocco (3,000 USD in 1988).

Lentil Harvest Mechanization. This project, for three years, 1985-88, involves work in Algeria, Iraq, Jordan, Morocco, Syria and Turkey and included a training course at Tel Hadya (29,000 USD in 1988).

Mechanization and Rural Employment (Morocco). This project, agreed in November 1987, is to enable ICARDA to support studies at the Institut Agronomique et Veterinaire Hassan II (40,000 USD in 1988).

Rhizobia Carrier System. ICARDA and the University of Manitoba cooperate to develop production techniques for rhizobia and methods of inoculation of chickpea, particularly for areas where this crop is being newly introduced (13,000 USD in 1988).

Yellow Dwarf Virus. ICARDA cooperates with Laval University in Canada and the Instituto Nacional de Investigaciones Agropecurlas (INIA) in Chile to determine the extent of infection of this virus on barley in Morocco and Tunisia, and to screen cultivars for resistance (5,000 USD in 1988).

IFAD (International Fund for Agricultural Development) and Ministry of Foreign Affairs, Italy

Nile Valley Project. As explained in the text of this report, ICARDA works with Egypt, Ethiopia and Sudan for the improvement of faba-bean production (648,000 USD in 1988).

Italy

Development of Chickpea Germplasm with Combined Resistance to Ascochyta Blight and Fusarium Wilt Using Wild and Cultivated Species. This project in collaboration with Italian Institutes will be for a period of five years (1987-1991) and the main objectives are to survey, collect ascochyta blight disease samples, evaluate for resistance and develop high yield lines to both ascochyta blight and fusarium wilt (183,000 USD in 1988).

Enhancing Wheat Productivity in Stress Environments Utilizing Wild Progenitors and Primitive Forms. This is a five-year project in collaboration with the University of Tuscia, Italy, to study the genetic variability in the wild progenitors and primitive forms of wheat along with germplasm identification of wheat and training of regional scientists (138,000 USD in 1988).

NAR's Seminar. This one-time grant is to support the Center in organizing a National Agriculture Research Seminar in Italy (30,000 USD in 1988).

Near East Foundation

Fertilizer in Dryland Barley/Livestock Systems. This grant supports the joint program of ICARDA with the Soils Directorate of the Syrian Ministry of Agriculture and Agrarian Reform (62,000 USD in 1988).

OPEC (Organization of Petroleum Exporting Countries)

Wheat in Sudan. This project, which began in 1986, provides for the development of production technologies, using the Nile Valley Project as a model (69,000 USD in 1988).

Rockefeller Foundation

Social Science Research Fellowship with ICARDA's Farm Resource Management Program Project on the Adoption and Impact of Technology. The duration of this grant is for two years from Sept 1988 to Sept 1990 (8,000 USD in 1988).

USAID (United States Agency for International Development

MART/AZR Project, Baluchistan. ICARDA is contracted by USAID for a component of its Management of Agricultural Research and Technology (MART) project. This component is to strengthen Pakistan's Arid Zone Research Institute (AZRI) and involves an interdisciplinary team conducting research in harsh high-elevation environments (737,000 USD in 1988).

Appendix 7

Research Networks Coordinated by ICARDA

Title	Coordinator	Donor	Subject/objectives	Countries
Inoculation of pasture and forage legumes	L. Materon	Core funds	1. Identify need for inoculation of pasture and forage legumes. 2. Evaluate response to inoculation with introduced and native strains of *Rhizobium* spp. 3. Biological nitrogen fixation studies. 4. Training of national program scientists in WANA.	11, in WANA 5, outside WANA
Barley pathology	J.van Leur	USAID	Research on the epidemiology, virulence and resistance of pathogens of importance to barley cultivation in the ICARDA region.	7, in WANA
Durum germplasm evaluation	A.B. Damania and L. Pecetti	Italy	Following a Durum Germplasm Consultation meeting at Viterbo, Italy, a set of 200 selected accessions from the genetic resources collection was sent to national programs in 11 countries. The evaluators will score economically important agronomic and disease resistance characters at ecologically different locations in their own countries and report back to ICARDA. The pooled information will be provided to interested scientists and the germplasm recommended to breeders for use in their crossing programs. Very useful data have already been received from Ethiopia, Pakistan, Tunisia, and Canada.	6, in WANA 5, outside WANA
Barley, durum wheat, and bread wheat international nursery system	S.K.Yau	Core funds	Evaluation of the barley, durum wheat, and bread wheat advanced lines, parental lines and segregating populations developed by ICARDA and CIMMYT, and by national programs themselves.	50, worldwide
Screening wheat and barley for resistance to aphids	R. Miller	Egypt, EC, Sudan, Ethiopia, SAREC	Wheat and barley seedlings are screened against *Rhopalosiphum padi* and *Schizaphis graminum* in a laboratory in Egypt. Promising lines are then retested against natural populations of aphids in Upper Egypt and in the Sudan. Resistant germplasm is recommended to breeders in Egypt, Sudan, Ethiopia, and ICARDA.	Egypt Sudan Ethiopia
Screening wheat and barley for resistance to Hessian fly	R. Miller and M. Mekni	ICARDA/ MIAC	Differential nurseries containing the known resistance genes for Hessian fly are planted in six countries. Annual surveys are performed in the Maghreb countries. A training workshop, sponsored by ICARDA, MIAC,	Morocco Algeria Tunisia

			INRA, and INRAT, will be held in Morocco for trainees from North Africa. Germplasm is being exchanged.	
Integrated management of Suni bug (proposed)	R. Miller	Core funds	To develop integrated control practices for Suni bug, including resistant varieties, chemical and biological control.	6, in WANA
Biological nitrogen fixation in food legumes	D. Beck	IDRC (Chickpea only)	1) Evaluate the necessity for inoculation in chickpea, lentil, and faba bean. 2) Evaluate response to rhizobial inoculation with network strains. 3) Quantification of N fixed using ^{15}N to evaluate legume N input into farming systems.	9, in WANA
Nile Valley Faba bean Aphid Screening	S. Weigand	SAREC, EEC, DGIS	A joint screening program for host plant resistance to aphids in faba bean with the aphid screening laboratory at Giza Research Station, Egypt, serving as a center for screening faba bean lines from the three countries and ICARDA. Promising material based on its origin is field-tested by the respective national programs and finally a "regional aphid screening" nursery will be established and tested in the three countries.	Egypt Sudan Ethiopia
International Food Legume Testing Network	R.S. Malhotra	Core funds	The network provides for dissemination of genetic material and improved production and plant protection practices to the national program scientists for evaluation and use under their own agroecological conditions. It also permits multilocation testing of material developed by the national programs and assists in developing better understanding of genotype and environmental interaction as well as agroecological characterization of major food legume production areas.	52, worldwide
Soil Test Calibration	A. Matar	Core Funds, UNDP, IMPHOS	To standardize the methods of soil and plant analysis used in the WANA region and promote training and soil sample exchange. To evaluate the relationships between laboratory determination of soil fertility status and crop responses to the major plant nutrients, nitrogen and phosphorus. To establish procedures to integrate soil, climate and management to optimize fertilizer recommendations.	12, in WANA

Appendix 8

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.

1975-11-17 CHARTER of the International Center for Agricultural Research in the Dry Areas (En, Fr). Signed for IBRD, FAO, UNDP, and IDRC.

1976-06-08 Amendment to the Charter (En, Fr)

1976-06-28 Agreement with the Government of the SYRIAN ARAB REPUBLIC (Ar, En, Fr) to establish a Principal Station on Syrian territory.

1976-07-20 Agreement with the Imperial Government of IRAN (En, Fa) to establish a Principal Station on Iranian territory.

1977-07-06 Agreement with the Government of the Republic of the LEBANON (Ar, En) to permit operations on Lebanese territory.

1977-07-14 Agreement with the Government in the SYRIAN ARAB REPUBLIC (Ar, En) for the provision of lands.

Agreements for 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.

1977-10-27 with the Government of JORDAN (En)

1978-03-25 with the Agricultural Research Institute of LEBANON (En) for the provision of lands.

1978-03-29 with the Government of EGYPT (En)

1978-10-21 with the Government of the Democratic Republic of the SUDAN (Ar, En)

1979-02-05 with the Government of CYPRUS (En)

1980-03-11 with the Government of TUNISIA (Ar)

1980-03-19 with the PAKISTAN Agricultural Research Council (En)

1980-05-31 with the Government of EGYPT (Ar, En)

1981-09-16 avec le Ministere de l'Agriculture et de la Revolution Agraire de la REPUBLIQUE ALGERIENNE DEMOCRATIQUE ET POPULAIRE (Fr)

1985-01-18 with the Kingdom of MOROCCO (Ar)

1985-09-29 with the Ministry of Agriculture, Forestry and Rural Affairs of TURKEY (En)

1986-06-26 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)

1986-09-06 with the Government of IRAQ (Ar, En)

1986-10-08 avec la REPUBLIQUE ALGERIENNE DEMOCRATIQUE ET POPULAIRE (Fr)

1987-05-26 with the Ministry of Agriculture and Land Reclamation of the Arab Republic of EGYPT (En)

1987-09-01 with the Government of the Islamic Republic of IRAN (En)

1987-12-09 with the Government of the YEMEN ARAB REPUBLIC (Ar, En)

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

1981-10-30 avec l'Office de la Recherche Scientifique et Technique Outre-Mer ORSTOM-FRANCE (Fr)

1982-06-16 with the Consiglio Nazionale delle Richerche, CNR, ITALY (En, It)

1986-05-13 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)

1986-12-15 with the Indian Council for Agricultural Research, ICAR, INDIA (En, Hi)

1987-08-20 with the Chinese Academy of Agricultural Sciences, CAAS, CHINA (Ch, En)

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

1987-09-29 with the Tropical Agricultural Research Center, TARC, JAPAN (En)

1988-02-28 with the Institute of Plant Introduction and Genetic Resources, Sadovo, IPIGR, BULGARIA En

1988-08-02 with V.I Lenin All Union Academy of Agricultural Sciences-VASKHNIL-MOSCOW (En, Ru)

Agreements with international and regional organizations (not including agreements for specific work plans)

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

1980-04-05 with the International Fertilizer Development Center IFDC (En)

1982-04-05 with the Arab Organization for Agricultural Development, AOAD (Ar)

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

1987-05-05 with Winrock International Institute for Agricultural Development (En)

1987-09-15 with the Centro Internacional de Mejoramiento de Maiz y Trigo, CIMMYT (En)

1988-11-29 with the World Phosphate Institute, IMPHOS (En)

Agreements with universities

1978-10-21 with the University of Khartoum SD (Ar, En)

1985-09-15 with the University of Gizira SD (En)

1985-11-21 with Tishreen University SY (Ar)

1985-11-28 with the University of Tuscia IT (En)

1987-01-28 with the University of Khartoum SD (En)

1987-04-14 with North Carolina State University US (En)

1987-09-19 with the University of Alexandria EG (En)

1988-03-21 with the Jordan University of Science and Technology JO (En)

Appendix 9

The International School of Aleppo

Founded in 1977, the International School of Aleppo grew considerably in the 1987/88 school year. Originally intended to serve the children of ICARDA's senior staff, it is the only English-language school in Aleppo and, in recent years, non-ICARDA expatriate parents in Aleppo have also been allowed to enroll their children. As space becomes available, Syrian children are also accepted.

Only two years ago, the school had 95 students through grade 8. In 1986/87, grade 9 was added, and the number of students grew to 125. In 1987/88, with the addition of grade 10, the enrollment rose to 175.

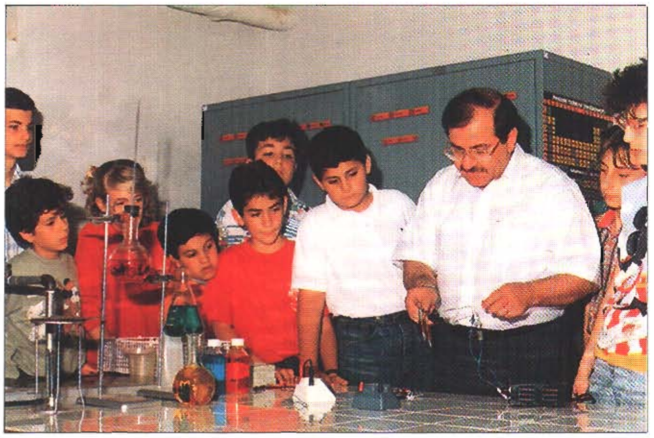
Two years ago, the school was in converted apartments. Last year it moved into what had been ICARDA's principal office building in Aleppo. In the current school year, an adjacent guest- house was converted for school use by grades 7-10; it also houses the computer laboratory and French room. The new campus has spacious grounds and playing fields for soccer, basketball, and tennis.

Plans have been developed for a new classroom wing to be built in the next two years to house the chemistry/biology laboratories and new classrooms for grades 11 and 12.

The staff has grown considerably. Currently, students are served by 15 full-time and 6 part-time specialist teachers. The pupil:teacher ratio averages 15:1 in every class. Personal attention to student growth and achievement is a hallmark of the school. Four teacher aides and two library aides assist students and teachers in enhanced learning.

A full program of English-as-a-Second-Language is provided. Computer studies are offered to all students in grades 1 through 10. Each week, all students receive instruction in art and music as well as physical education.

As the school develops its full high-school program, many grade-10 students are preparing for the examinations that lead to the International General Certificate in Secondary Education (IGCSE). In the next school year, an accreditation report will be written so that students may transfer to colleges and universities throughout the world.



ISA students at all levels are given individual attention to ensure their educational and personal development.

Dr George A. Dibs replaced Mr Dennis Sanderson as Principal in 1988. A management committee directs the development of school policies.

A Parent Advisory Committee has been established. It is composed of parent volunteers representing all grade levels. It meets once each month to hear reports and make suggestions for improvements. Many parents also volunteered to help classes and school programs during 1987/88.

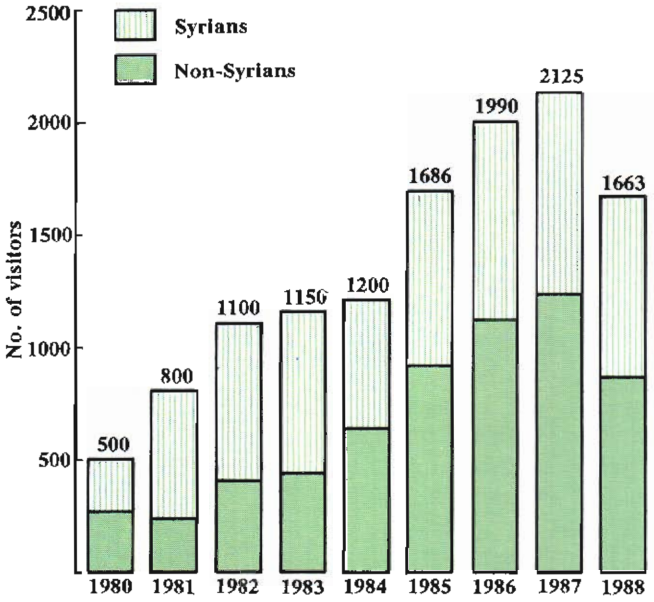
The school is growing rapidly in other ways. After-school activities now include sports, computers, science, journalism and music. Field trips to factories, museums and archaeological sites in Syria are regular features of the curriculum. The instruction materials are being upgraded as new programs and grades are established.

ICARDA also operates a small school in Baluchistan, Pakistan, for children of staff members working with the MART/AZR project.

Appendix 10

Visitors to ICARDA, Aleppo

During 1988, ICARDA received 1663 visitors: 57% of them came from Syria, and 43% from over 75 countries around the world, representing more than 300 national and international organizations, universities, and private institutions. As in past years, the peak month was April when crops were maturing and visitors could see the results of ICARDA's field experiments. In that month ICARDA organized its annual event of Presentation Days in which distinguished guests, including diplomats, donors, and officials of the Government of Syria, as well as farmers from different parts of the country participated.



Visitors to ICARDA, 1980-88

Appendix 11

Statement of Activity

For the Year Ended 31 December 1988 (x 000 USD)

	1988	1987
REVENUE		
Grants	20,191	21,515
Exchange gains	4,717	4,697
Investment income	963	954
Other income	47	88
	25,918	27,254
EXPENSES		
Research		
Farm resource management	2,049	1,883
Cereal improvement	2,568	2,467
Food legume improvement	2,579	2,559
Pasture, forage and livestock	1,868	1,645
	9,064	8,554
Research support	3,002	2,810
Cooperative programs	691	648
Training	644	603
Information	1,045	1,084
General administration	2,746	2,713
General operations	2,941	2,404
EMR/EPR	279	-
	20,412	18,816
Special projects	2,737	2,408
Capital expenditure	884	5,660
Special projects capital	76	269
	24,109	27,153
EXCESS OF REVENUE OVER EXPENSES	1,809	101
ALLOCATED TO		
Operating fund	-	906
Locally-generated fund	1,809	(805)
	1,809	101

Statement of Grant Revenue

For the Year Ended 31 December 1988
(x 000 USD)

	Current year grants	Funds received	Receivable 31 December 1988	(Advance) 31 December 1988
CORE UNRESTRICTED				
Australia	266	(266)	-	-
Austria	175	(350)	-	-
Canada	851	(851)	-	-
China	30	-	30	-
Denmark	277	(277)	-	-
Ford Foundation	120	-	-	(120)
International Bank for Reconstruction and Development (World Bank)	4,800	(4,800)	-	-
Italy	433	(948)	-	-
Netherlands	567	(567)	-	-
Norway	472	(472)	-	-
Spain	155	(155)	-	-
Sweden	600	(600)	-	-
United Kingdom	982	(982)	-	-
United States Agency for International Development	4,335	(4,335)	-	-
	14,063	(14,603)	30	(120)
CORE RESTRICTED				
Arab Fund for Economic and Social Development	354	-	354	-
France	194	(391)	-	(196)
Germany	1,935	(2,293)	-	(717)
International Development Research Centre	127	(250)	15	(95)
Italy	599	(1,198)	-	(692)
The OPEC Fund for International Development	50	(50)	-	-
United Nations Development Programme	300	-	475	-
United States Agency for International Development	256	(285)	-	(157)
Closed Projects	-	(1,046)	-	-
	3,815	(5,513)	844	(1,857)

	Current year grants	Funds received	Receivable 31 December 1988	(Advance) 31 December 1988
SPECIAL PROJECTS				
American Near East Refugee Aid	5	(10)	-	(5)
Arab Fund for Economic and Social Development	37	(183)	-	(146)
Australia	10	(11)	-	(1)
Ford Foundation	239	-	20	(179)
France	34	(70)	-	(36)
German Agency for Technical Cooperation	86	(217)	86	-
World Phosphate Institute	-	(10)	-	(10)
International Development Research Centre	109	(27)	22	(17)
Italy	351	(1,150)	-	(799)
Near East Foundation	62	(78)	-	(18)
Netherlands	319	(315)	158	(88)
Nile Valley Project	648	(1,000)	50	(46)
The OPEC Fund for International Development	69	(65)	35	-
Rockefeller Foundation	8	(33)	-	(25)
United States Agency for International Development	737	(835)	278	-
International Bank for Reconstruction and Development (World Bank)	99	(110)	37	-
Closed projects	-	(43)	15	-
Less: Provision for doubtful accounts	-	-	(80)	-
	2,813	(4,157)	621	(1,370)
Less: Refund to Stabilization Mechanism Fund	(500)	-	-	-
GRAND TOTAL	20,191	(24,273)	1,495	(3,347)

Appendix 12

Collaboration in Advanced Research

ICARDA received Special Project funding for some of its collaborative activities with advanced institutions in industrialized countries. Such items have already been 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 Atomic Energy Agency, Vienna, Austria
- Studies of biological nitrogen fixation in food and forage legumes, employing the isotope-dilution method with nitrogen-15

International Center for the Improvement of Maize and Wheat, Mexico
- Wheat and barley improvement: CIMMYT stations two wheat breeders at Aleppo and ICARDA stations a barley breeder in Mexico.

International Crops Research Institute for the Semi-Arid Tropics, Hyderabad, India.
- Chickpea improvement: ICRISAT stations a chickpea breeder at ICARDA.

Canada

Agriculture Canada and Laval University, Sainte Foy, Quebec
- Screening advanced ICARDA wheat and barley lines for resistance to barley yellow dwarf virus (BYDV)

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*

France

Institut National de la Recherche Agronomique 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 Paris South
- Haploid breeding and anther culture for cereal improvement

Federal Republic of Germany

University of Bonn
- Decline in cereal yield in continuous cropping systems
- Chocolate spot and ascochyta blight disease control in faba bean

University of Giessen
- Weed control and water-use efficiency in peas
- Control of *Orobanche* in food legumes

University of Gottingen
- Development of a lentil-pulling machine

University of Hohenheim
- Economics of irrigated food-legume production by small-holders in Sudan
- Economics of annual self-regenerating forage legumes to intensify livestock production in Syria
- Physiological factors as determinants of yield in durum wheat
- Improvement of nutrient-uptake efficiency in chickpea
- Influence of VA-Mycorrhiza on growth, nutrient and water relations in chickpea
- Integrated control of *Orobanche* spp. in food legumes
- Crossing faba-bean genotypes from Europe and West Asia to obtain wider adaptability

Italy

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

University of Perugia
- Inoculation of annual medics with *Rhizobium*
- 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; Germplasm Institute, Bari; and ENEA, Rome
- Evaluation and documentation of durum-wheat germplasm

University of Tuscia, Viterbo
- Enhancing wheat productivity in stress environments utilizing wild progenitors and primitive forms

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

Japan

Tropical Agriculture Research Center, Tskuba, Ibaraki
- Eco-physiological studies for improvement of high-yielding wheat varieties
- Haploid breeding in wheat using *Hordeum bulbosum*

Netherlands

DGIS: The Directorate General for International Cooperation, the Netherlands
- Agronomic characterization of germplasm collections on the basis of information on the environment in the regions of collection, and evaluation of data

Portugal

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

Spain

University of Cordoba
- Effect of environmental stresses on nitrogen fixation
- Developing Orobanche resistance in faba bean

University of Cordoba and INIA
- Barley stress physiology

University of Granada
- Isolation of VA-Mycorrhiza from forage legumes

United Kingdom

Plant Breeding Institute, Cambridge
- Characterization of barley genotypes
- Study of resistance of faba bean to *Botrytis fabae*

Overseas Development Natural Resources Institute, London
- Evaluating the nutritive value of straws for small ruminants

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 Reading
- Root studies of barley, wheat and chickpea
- Studies of the effects of photoperiod and temperature on the development of different genotypes of barley, lentil and faba bean
- Investigation of seed dormancy in plant populations on grazed marginal land

University of Sheffield
- Study of the response of annual legumes to phosphorus (i.e. legumes found in native pastures)

Wye College, University of London
- Studies on the quality of barley straw

United States

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

Appendix 13

Board of Trustees

Two new trustees joined the Board in 1988: Dr Winfried von Urff and Dr Gerard Ouellette. At the end of 1988, the membership of ICARDA's Board of Trustees was as follows:

Dr Jose-Ignacio Cubero
(Chairman, from May 1986)
Escuela Tecnica Superior de Ingenieros Agronomos
Cordoba, Spain

Mr Hasan Su'ud Nabulsi
(Vice-Chairman, from April 1987)
c/o ICARDA
Amman, Jordan

Miss Naima Al-Shayji
(Chairperson, Search Committee, from November 1987)
Ministry of Planning
Kuwait

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Institut National de la Recherche Agronomique (INRA)
Montpellier, France

Dr Nazmi Demir
Ministry of Agriculture, Forestry and Rural Affairs
Ankara, Turkey

Dr Hoceine Faraj
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Stanford University
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Dr Norman Halse
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Department of Agriculture
South Perth, Australia

Dr Joseph Haraoui
Agricultural Research Institute
Fanar, Lebanon

Mr Hamid Merei
Deputy Minister of State for Planning Affairs
Damascus, Syria

Dr Gerard Ouellette
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Quebec, Canada

Dr Enrico Porceddu
(Chairman, Program Committee, from April 1987)
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University of Tuscia
Viterbo, Italy

Prof. Alexander Poulovassilis
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Prof. Dr Ir. Roelof Rabbinge
Agricultural University
Wageningen, the Netherlands

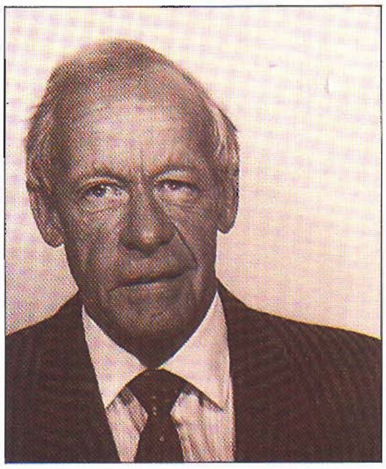
Dr Hasan Saoud
Deputy Minister of Agriculture and Agrarian Reform
Damascus, Syria

Dr Winfried von Urff
Technische Universitat Munchen
Freising-Weiherstephan
Federal Republic of Germany

Dr Nasrat R. Fadda
Director General (ex-officio)
ICARDA
Aleppo, Syria

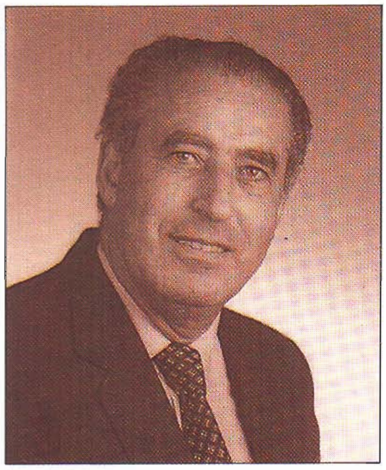
The following meetings were held during 1988:

January 18-21	15th Program Committee	Aleppo SY
January 18-21	Extraordinary, Executive Committee	Aleppo SY
January 22	Extraordinary, Board of Trustees	Aleppo SY
April 7-8	18th Executive Committee	Istanbul TR
June 8	Extraordinary, Executive Committee	Aleppo SY
June 9-12	22nd Board of Trustees	Aleppo SY
November 7-8	19th Executive Committee	Washington



Dr Gerard Ouellette

Dr Winfried von Urff



Dr Nasrat R. Fadda

Dr Gerard Ouellette, Canadian, was elected to the Board in June 1988. A soil scientist with post-doctoral experience in radio-isotopes, Dr Ouellette has had a long career devoted to agricultural research and development. Beginning his career as a research scientist with Agriculture Canada in 1950, he later joined Laval University, and there eventually became Associate Dean of the Faculty of Agriculture. His work at the University was complemented by deep involvement in the activities of the Canadian International Development Agency (CIDA). From 1975 to 1978 Dr Ouellette served as Agricultural Attache with the Canadian Embassy in Algiers, and then assumed the position of Chief, Agriculture Sector, Resources Branch, CIDA, which he occupied until 1985. Having conducted research and participated in development projects in several countries, Dr Ouellette is well acquainted with the challenges facing agricultural research in a variety of environments.

Dr von Urff, of the Federal Republic of Germany, currently Professor of Agricultural Policy at the Technical University of Munich's Faculty of Agriculture and Horticulture, has done extensive research and consultancy on development issues and projects in South America, Asia, Africa, and the Middle East. In April 1986 he participated in the External Program Review of the West Africa Rice Development Association (WARDA), and from 1982 to 1987 was an active member of the Technical Advisory Committee (TAC) of the CGIAR. Dr von Urff brings with him a wealth of experience and expertise in the field of agricultural development and, as a member of ICARDA's Board of Trustees and its Executive Committee, will undoubtedly play a significant role in the realization of the Center's mandate.

Dr Nasrat R. Fadda joined as the new Director General of ICARDA in March 1988. He graduated from the American University of Beirut and earned a Ph.D. in Botany from the University of London. During his long career of over 30 years in the Arab world and Africa, Dr Fadda has had several challenging responsibilities in diverse areas, including field research on rainfed crops, development of research stations, policy formulation, and advising governments. Before coming to ICARDA, he was Director of the Operations Department with the Arab Fund for Economic and Social Development.

Appendix 14

Senior Staff

(as of 31 December 1988)

SYRIA
Aleppo: Headquarters

Director General's Office

Dr Nasrat R. Fadda, Director General
Dr Aart van Schoonhoven, Deputy Director General (Research)
Dr J.P. Srivastava, Acting Deputy Director General (International Cooperation)
Mr Samir El-Fayoumi, Director of Administration
Ms Afaf Rashed, Administrative Assistant to the Board of Trustees

Government Liaison and Public Relations

Dr Adnan Shuman, Assistant Director General (Government Liaison)
Mr Ahmed Mousa El Ali, Public Relations Officer

International Cooperation

Dr Samir El-Sebae Ahmed, National Research Coordinator
Dr A.J.G. van Gastel, Seed Production Specialist

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Mr Muhannad Ismail, Financial Controller and Treasurer
Mr Suresh Sitaraman, Finance Officer, Financial Operations
Mr Mohamed K. Barmada, Finance Officer, Outreach
Mr Hany Galal, Finance Officer, Costing and Cost Control
Mr Suleiman Is-haak, Finance Officer, Cash Management
Mr Vijay Sridharan, Finance Officer, Financial Reporting
Mr Mohamed Samman, Pre-Audit and Control

Computer Services

Mr Khaled S. El-Bizri, Director
Mr Bijan Chakraborty, Senior Programmer/Project Leader
Mr Michael Sarkissian, Senior Systems Engineer
Mr Awad Awad, Senior Programmer
Mr C.K. Rao, Senior Programmer

Personnel

Ms Leila Rashed, Personnel Officer

Farm Resource Management Program

Dr Peter J. Cooper, Program Leader/Soil Physicist
Dr Hazel Harris, Soil Water Conservation Scientist
Dr Michael Jones, Barley-Based Systems Agronomist
Dr Abdullah Matar, Soil Chemist
Dr Thomas Nordblom, Agricultural Economist
Dr Mustafa Pala, Wheat-Based Systems Agronomist
Dr Eugene Perrier, Water Management Agronomist
Dr Mohamed Bakheit Saied, Senior Training Scientist
Dr Wolfgang Goebel, Post-Doc.Fellow/ Agroclimatologist
Dr Ammar Wahbi, On-Farm Agronomist-Barley/ Livestock Systems
Mr Ahmad Mazid, Agricultural Economist
Mr Abdul Bari Salkini, Agricultural Economist
Dr Richard Tutwiler, Visiting Scientist
Ms Meri Whitaker, Visiting Scientist
Mr Sobhi Dozom, Research Associate
Mr Mahmoud Oglah, Research Associate
Mr Ciro d'Acunzo, Associate Expert (seconded from FAO)

Cereal Improvement Program

Dr J. P. Srivastava, Program Leader/Breeder
Dr Edmundo Acevedo, Cereal Physiologist/Agronomist
Dr Salvatore Ceccarelli, Barley Breeder
Dr Ardeshir B. Damania, Wheat Germplasm Specialist
Dr Guillermo Ortiz-Ferrara, Bread-Wheat Breeder (seconded from CIMMYT)
Dr Habib Ketata, Senior Training Scientist
Dr Philippe Lasherme, Biotechnologist
Dr Omar Mamlouk, Plant Pathologist
Dr Ross Miller, Entomologist
Dr Miloudi Nachit, Durum Breeder (seconded from CIMMYT)
Dr Mohammed Tahir, Plant Breeder (on sabbatical)
Mr Joop van Leur, Barley Pathologist
Dr Masanori Inagaki, Senior Researcher (seconded from Japan)
Mr Issam Naji, Agronomist
Dr Sui K. Yau, International Nurseries Scientist
Dr Ahmad Zahour, Visiting Scientist
Dr Stefania Grando, Research Scientist
Mr Luciano Pecetti, Research Associate

Food Legume Improvement Program

Dr Mohan C. Saxena, Program Leader/Agronomist-Physiologist
Dr Douglas Beck, Food Legume Microbiologist

Dr William Erskine, Lentil Breeder (on sabbatical)
Dr Susanne Weigand, Entomologist
Dr Mohamed Habib Ibrahim, Senior Training Scientist
Dr Larry Robertson, Faba Bean Breeder
Dr K.B. Singh, Chickpea Breeder (seconded from ICRISAT)
Dr R. S. Malhotra, International Trials Scientist
Dr Franz Weigand, Post-Doc. Fellow, Pathology
Dr Karl H. Linke, Post-Doc. Fellow, Orobanche (seconded from Germany)
Dr Said Nahdi Silim, Post-Doc. Fellow, Agronomy/Physiology
Dr Oreib Tahhan, Post-Doc. Fellow, Agronomy/Entomology
Dr Geletu Begiga, Post-Doc. Fellow, Chickpea Breeding
Dr Mohamed El-Sherbeeny, Post-Doc. Fellow, Faba Bean Breeder
Mr Ihsan Ul-Haq, Assistant Training Scientist
Mr Thomas Bambach, Visiting Research Associate (seconded from Germany)
Mr Stefan Schlingloff, Visiting Research Associate
Mr Edwin Weber, Visiting Research Associate
Mr Bruno Ocampo, Research Associate

Pasture, Forage, and Livestock Improvement Program

Dr Philip S. Cocks, Program Leader/Pasture Ecologist
Dr Ali Mohamed Abd El Moneim, Senior Training Scientist
Dr Luis Materon, Microbiologist
Dr Ahmed el Tayeb Osman, Pasture Ecologist
Dr Alan Smith, Grazing Management Specialist
Dr Euan Thomson, Livestock Scientist (on sabbatical)
Mr Faik Bahhady, Assistant Livestock Scientist
Mr Hanna Sawmy Edo, Research Associate
Mr Nerses Nersoyan, Research Associate
Ms Silvia Lorenzetti, Research Associate
Mr Mario Pagnotta, Research Associate
Mr Safouh Rihawi, Research Associate
Mr Luigi Russi, Research Associate
Mr Munir Turk, Research Associate
Mrs Monika Zaklouta, Research Associate

Genetic Resources Program

Dr Khaled Makkouk, Acting Leader/Plant Virologist
Dr Laszlo Holly, Genetic Resources Scientist
Dr Michael van Slageren, Genetic Resources Scientist
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Mr Bilal Humeid, Research Associate
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Mr Bassam Hinnawi, Travel Officer

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Dr Juergen Diekmann, Farm Manager
Mr Ahmed Sheikh Bandar, Assistant Farm Manager
Mr Bahij Kawas, Senior Horticultural Supervisor

Physical Plant

Dr P. Jegatheeswaran, Chief Engineer
Mr Peter Eichhorn, Vehicle Workshop Engineer
Mr Ohannes Kalou, Building and Maintenance Engineer
Mr Farouk Jabri, Food and General Services Officer
Mr Khaldoun Wafaii, Civil Engineer
Mr Is-haq Homsy, Civil Engineer

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Mr Marwan Mallah, Administrative Officer

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Mr Ramaswamy Seshadri, Manager
Ms Dalal Haffar, Purchasing Officer
Mr Ziad Muazzen, Stores Officer

International School of Aleppo

Dr George Dibs, Principal
Ms Nida Kudsi, Deputy Principal/Teacher

Damascus

Mr Abdul Karim El-Ali, Administrative Officer

Lattakia

Dr Salim Hanounik, Faba Bean Pathologist

ETHIOPIA
Addis Ababa

Dr Surendra Beniwal, Food Legume Breeder/Pathologist

EGYPT
Cairo

Dr Bhup Bhardwaj, Director of Administration and Operations

LEBANON
Beirut

Mr Anwar Agha, Executive Manager/Senior Accountant

Terbol

Mr Munir Sughayyar, Engineer, Station Operations

MEXICO
CIMMYT

Dr Hugo Vivar, Barley Breeder

MOROCCO
Rabat

Dr Mahmoud El-Solh, Food Legume Breeder
Dr Mohamed S. Mekni, Cereal Scientist
Dr Philip Beale, Pasture, Forages, and Livestock Scientist

PAKISTAN
Quetta

Dr John D. Keatinge, Team Leader/Germplasm Evaluation Specialist
Dr Richard S. Aro, Range/Livestock Management Scientist (sub-contracted from Colorado State University)
Dr David J. Rees, Agronomist
Dr Cemal Talug, Extension/Communications Specialist

TUNISIA
Tunis

Dr Ahmed Kamel, ICARDA Representative/Cereal Pathologist
Dr Thomas Stilwell, Agronomist

CONSULTANTS

Dr Hisham Talas, Medical Consultant (Aleppo)
Mr Tarif Kayali, Legal Advisor (Aleppo)
Dr Edward Hanna, Legal Advisor (Beirut)
Dr Giro Orita, Veterinary Specialist (Aleppo)
Mrs S. Jegatheeswaran, Consulting Nurse (Aleppo)
Dr Philip Williams, Analytical Services (Canada)

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)
ANERA	American Near East Refugee Aid (USA)
AGLINET	Agricultural Library Network
AGRIS	International Information System for Agricultural Science and Technology (FAO, Italy)
AOAD	Arab Organization for Agricultural Development (Sudan)
ARC	Agricultural Research Corporation (Sudan)
AZRI	Arid Zone Research Institute (Pakistan)
BLRV	Bean Leaf-Roll Virus
BMDP	Biomedical Diagnostics Package
BYDV	Barley Yellow Dwarf Virus
CAAS	Chinese Academy of Agricultural Sciences (China)
CAS	Central Administration for Seed (Egypt)
CERES-N	Crop-Environment Resource Synthesis-Nitrogen
CG	Consultative Group
CGIAR	Consultative Group on International Agricultural Research (USA)
CIAT	Centro Internacional de Agricultura Tropical (Colombia)
CIDA	Canadian International Development Agency (Canada)
CIHEAM	International Center for Advanced Mediterranean Agronomic Studies (France)
CIP	Cereal Improvement Program (ICARDA)
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo (Mexico)
CNR	Consiglio Nazionale delle Richerche (Italy)
CPU	Central Processing Unit
CRISP	Crop Research Integrated Statistical Package
DGIS	Directorate General for International Cooperation (the Netherlands)
EC	European Community
EMR	External Management Review
ENEA	Ente Nazionale per l'Energia Nucleare e delle Energie Alternative (Italy)
EPR	External Program Review
FABIS	Faba Bean Information Service (managed by ICARDA)
FLIP	Food Legume Improvement Program (ICARDA)
FAO	Food and Agriculture Organisation of the United Nations (Italy)
FRMP	Farm Resource Management Program (ICARDA)
GCC	Gulf Cooperation Council (Saudi Arabia)
GOSM	General Organization of Seed Multiplication (Syria)
GTZ	German Agency for Technical Cooperation (West Germany)
IARCs	International Agricultural Research Centers
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 (India)
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)
IFDC	International Fertilizer Development Centre (USA)
IFLTP	International Food Legume Testing Program
IFPRI	International Food Policy Research Institute (USA)
ILCA	International Livestock Center for Africa (Ethiopia)
IMPHOS	Institut Mondial de Phosphate
INIA	Instituto Nacional de Investigaciones Agropecurlas (Chile)
INRA	Institut National de Recherche Agronomique (Morocco)
INRAT	Institut National de la Recherche Agronomique de Tunisie (Tunisia)
IPIGR	Institute of Plant Introduction and Genetic Resources (Bulgaria)
IPO	Research Institute for Plant Protection (the Netherlands)
ISBN	International Standard Book Number
ISSN	International Standard Serial Number
IVS	Independent Vascular Supply
JUST	Jordan University of Science and Technology (Jordan)
LDA	Lentil Dextrose Agar
LENS	Lentil News Service (managed by ICARDA and the University of Saskatchewan)
MART/	Management of Agricultural Research
AZR	and Technology/Arid-Zone Research project
MAS	Management Accounting and Information System
MIAC	MidAmerica International Agricultural Consortium
MSU	Mississippi State University (USA)
NARSs	National Agricultural Research Systems
NVRP	Nile Valley Regional Program
OPEC	Organization of Petroleum-Exporting Countries (Austria)
ORSTOM	Office de la Recherche Scientifique et Technique Outre-Mer (France)
PAGE	Polyacrylamide gel electrophoresis
PCA	Principal Component Analysis
PDRY	Peoples' Democratic Republic of Yemen
PFLP	Pasture, Forage and Livestock Program (ICARDA)
RoI	Rate of Ingestion
SAREC	Swedish Agency for Research Cooperation with Developing Countries (Sweden)
SDS	Sodium dodecyl sulphate
SIMTAG	Simulation of *Triticum aestivum* Genotypes
SMAAR	Syrian Ministry of Agriculture and Agrarian Reform (Syria)
SPSS	Statistical Package for Social Science
SYLICO	Syrian Lybian Company (Syria)

TAC	Technical Advisory Committee (FAO, Italy)
TCC	Training Coordination Committee
TARC	Tropical Agricultural Research Center (Japan)
UNDP	United Nations Development Programme (USA)
USAID	United States Agency for International Development (USA)
USDA	United States Department of Agriculture (USA)
WANA	West Asia and North Africa countries
WARDA	West Africa Rice Development Association (Ivory Coast)
YAR	Yemen Arab Republic

Units of measurement

^{o}C degree Celsius
cm centimeter
h hour
ha hectare
g gram
kg kilogram
km kilometer
m meter
mm millimeter
t tonne (1000 kg)

Languages

Ar Arabic
Ch Chinese
En English
Fa Farsi
Fr French
Hi Hindi
It Italian
Ru Russian

Countries

AE United Arab Emirates
AU Australia
BD Bangladesh
CA Canada
CY Cyprus
DE Federal Republic of Germany
DK Denmark
EG Egypt
ES Spain
ET Ethiopia
FR France
GB United Kingdom
IN India
IQ Iraq
IT Italy
JO Jordan
JP Japan
KE Kenya
KT Kuwait
LE Lebanon
MA Morocco
MY Malaysia
NL Netherlands
SD Sudan
SY Syria
TN Tunisia
TR Turkey
US United States
YD Peoples' Democratic republic of Yemen
YE Yemen Arab Republic

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