ICARDA Annual Report 1986

International Center for Agricultural Research in the Dry Areas

ICARDA
Annual Report
1986

International Center for Agricultural Research in the Dry Areas

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Cover: ICARDA's New Headquarters.

Located at Tel Hadya, 30 km from Aleppo, Syria, these buildings provide 10 500 m^2 for laboratries, offices, conference facilities, computer and library

Contents

An Introduction to ICARDA

The International Center for Agricultural Research in the Dry Areas (ICARDA) was established in 1977 and is governed by an independent Board of Trustees. Based at Aleppo, Syria, it is one of thirteen centers supported by the Consultative Group on International Agricultural Research (CGIAR), which is a consortium of donor governments and agencies.

The CGIAR seeks to increase agricultural production but, at the same time, to improve social and economic conditions for people living in developing countries; hence it supports the kind of research that will help small farmers, even those with inadequate resources, to achieve better harvests. In setting up ICARDA, the CGIAR was addressing the problems of developing countries in West Asia and North Africa. In fact, ICARDA focuses its efforts on areas having a dry summer and where precipitation in winter ranges from 200 to 600 mm.

In terms of crops, ICARDA has been given 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 CGIAR has also supported an important ICARDA program on farming systems.

Much of ICARDA's research is carried out at its headquarters at Tel Hadya, 30 km southwest of Aleppo, on a farm of 948 hectares. ICARDA also manages other sites where it tests material under a variety of agro-ecological 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 of the region. Particularly important activities are under way at various locations in Syria and Jordan, at Quetta in Pakistan, in Morocco, Algeria and Tunisia, and with Egypt, Ethiopia and Sudan in the Nile Valley.

The results of the 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 ICARDA provides. These efforts are reinforced by seminars, by publications (research reports, training materials and manuals for the application of techniques), and by specialized information services operating in close association with ICARDA's senior scientists.

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

Several exciting developments took place in 1986, the tenth year of ICARDA's existence. It was largely a year of introspection, when we sought to consolidate our activities and to define new thrusts in the light of what we have learned during the last decade. Fortunately, we found ourselves increasingly close to national research systems, and hence to the means for achieving our goals: to increase food production and to improve the economic well-being of people in the region. Our success in establishing a strong and viable network in the region is demonstrated by the fact that several national research systems are now providing germplasm, information and assistance to each other and, at the same time, participating in our research and training programs more actively than ever before. We broke new ground in collaboration with several countries of the region, particularly with Algeria, Ethiopia, Iraq, Morocco, and Turkey, and with some countries beyond the region, notably China.

The payoff from the ICARDA-supplied germplasm is evident from the new varieties that several countries have released, or will release in the near future; these are reported in the pages that follow. Increased efforts were made to strengthen the research capabilities of the scientists in the region through a wide range of training courses described and listed in this report. ICARDA now receives more requests for training than it can accommodate.

These developments are enabling national research systems to take over down-stream activities, while ICARDA moves upstream toward the basic and strategic research for which national systems have little of the necessary expertise and facilities.

Having established good credibility in the region, ICARDA is extending its vision to more distant countries to fulfil its international responsibilities: on faba bean and barley in China; on barley in India, the Andean region, and Latin America; and in areas of mutual interest in Spain and Portugal. A Soviet scientist spent 6 months at ICARDA to study the prospects for future collaboration. Cooperation with centers of excellence in developed countries was further strengthened, particularly in biotechnology which is now receiving increased attention. A well-targeted proposal, which includes some low-risk, cost-effective techniques of biotechnology, has been developed to fit into the on-going programs. We hope this will make ICARDA's programs more efficient and will accelerate the pace of technology transfer.

In 1986, ICARDA's interest in high-elevation research increased considerably. Eight of the countries in the region (Afghanistan, Algeria, Iran, Iraq, Morocco, Pakistan, Turkey, and Yemen Arab Republic) have significant areas at high elevation (1000 meters and above). In the past, these areas have received little attention from researchers, and productivity is low. Research has been carried out in the high-elevation areas of Morocco, Pakistan and, more recently, Ethiopia, but in 1986 we took a closer look at our work in a broader perspective and developed a sharply focused proposal to cover the entire region. This proposal will be discussed at an international workshop in Turkey in July 1987. We are anticipating that some other Asian countries (China, Nepal, India) will also join our research network for high-elevation areas.

The other happy development in 1986 was that our new building complex at Tel Hadya was nearing completion. The ICARDA staff are eagerly looking forward to moving to the new offices and laboratories. We have no doubt that the move to the new buildings will greatly improve our efficiency, as it will bring all research programs and support services under one roof.

Fragile ecosystems as they are in the ICARDA region, I would like to report on the weather conditions that the crops had to face during the 1985/86 growing season. The season did not get under way until the second half of December. The 40 mm of rain that had fallen earlier made almost no contribution to crop moisture supply. However, the moist period that started in December lasted to mid-February, with rainfall above the long-term average. This created favorable conditions for the establishment and early growth of crops. A pronounced dry spell followed from mid-February to the second half of March and coincided with the stem-elongation phase for cereals and the preflowering phase for food legumes. A dry spell during these phases can be expected only once in six to ten years. Rainfall then remained below average until the end of the season when some showers interfered with harvest. Details are given in Appendix 9.

The worst frost came in December, before crops were established, and thus did not cause any damage. Another frost in January caused only minor damage. During the remainder of the season, temperatures were rather mild and the number of frost days fell considerably short of the average, not only at Tel Hadya, but at all other ICARDA sites in Syria. Compared with the previous year, the weather in 1985/86 was thus more clement, and this was reflected in crop performance and yields.

The 1985/86 season permitted us to produce large quantities of seed from the many cultivars that were being tested for desirable traits. These stocks of seed will be useful, not only for ICARDA's own future research, but will also enable us to provide breeding material to our partners in national research systems throughout the region.

If we review the results of the last 10 years, it becomes clear that 'stress' is the key constraint. The ultimate success of ICARDA's efforts therefore lies in developing cultivars tolerant/resistant to various abiotic and biotic stresses: drought, heat, cold, diseases and pests being the major ones. ICARDA is developing a package of technology that should reduce the risks caused by these stresses and enable resource-poor farmers to sustain crop and animal production at an optimum rather than at the maximum level. Of necessity, such a package will be designed to make the best use of soil and water – the two vital resources for crop production – and will thus conserve the natural environment and maintain the sustainability of dryland farming.

There are clear signs that national governments are showing more interest in agricultural research, and that they would like to earmark more resources to this sector. Unfortunately, however, this awareness coincides with a period when falling oil prices have caused even oil-rich countries to cut their development expenditures, and when some of the donors are reviewing their commitments to dryland agricultural research, perhaps because of the slow pace of progress. But research in fragile ecosystems is a complex and difficult task. There are no short cuts, and social and economic factors complicate dryland agriculture even more. Nonetheless, there is sound evidence that investments in ICARDA are beginning to pay off, and the years ahead could see considerable improvement in the living conditions of the rural population in the region. We sincerely hope that our donors will continue to maintain their interest and will provide greater encouragement in our endeavors to achieve ICARDA's goals.

Readers will notice that this 1986 Annual Report is different from those in the recent past. In the last several years, our Annual Report gave, in one comprehensive volume, a detailed account of the research that had been conducted and the results that had been obtained. It was addressed primarily to scientists, and was supplemented by a publication called *Research Highlights*, which provided a more easily digestible account, but again focussed on the more scientific aspects of our work. The production of these two annual publications took a substantial amount of time and resources, on the part of both scientists and editors, particularly because the reports grew bigger from year to year with the growth in ICARDA's programs. We needed to find a new solution that would be more economic and yet still meet our obligations to report to our constituencies: both the scientific constituency and the constituency of government officials and donors who support our work.

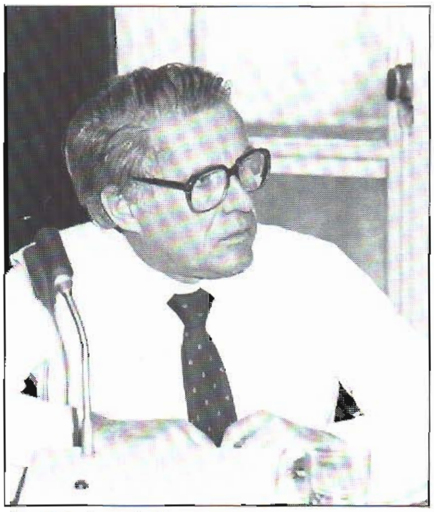
For 1986, we have prepared a series of detailed annual reports, one for each of our major programs, and each targeted to its appropriate scientific audience. These were all published and distributed by May 1987, and they are identified in the appropriate chapters of this publication. *Research Highlights* has been abandoned, although many of its features will be found here. But, for the first time in an Annual Report, we have attempted to put the work of one year in a longer perspective and to present it in a way that will be interesting for the lay reader. We are not sure that we have succeeded, but we hope that our several constituencies will find this new report useful. We regret that, in the process of changeover from the former system, the production of this report was delayed. Next year, the Annual Report should appear more promptly and, meanwhile, we would welcome comments and suggestions on how it may be improved.

The ICARDA family joins me in expressing our gratitude to our donors for their continued support to ICARDA; to our host country, the Syrian Arab Republic, for its uninterrupted and excellent hospitality to ICARDA; to our colleagues in national research systems for their active participation and genuine interest in our programs; to centers of excellence in developed countries, with whom we have collaborative projects, for sharing their knowledge and expertise with us; and to our Board of Trustees for their generous counsel and guidance.

I congratulate the ICARDA staff for their dedicated work during 1986, and wish them greater success in their efforts in the future.

Mohamed A. Nour
Director General

Board of Trustees



Dr Ekkehard Clemens

Dr Sten Ebbersten

Dr Jose Ignacio Cubero

Dr Ekkehard Clemens (Federal Republic of Germany), who had been a member of the Board since 1980 and its chairman since 1985 retired after the Annual Meeting in May 1986. Dr Sten Ebbersten (Sweden) also retired at the same time, having served as a Trustee since 1980. Tributes were paid to both of them for their many contributions to the development of ICARDA. Dr Jose Ignacio Cubero (Spain) was appointed as the Board's new chairman.

The *Guest of the Year* for 1986 was Professor J.R. (Jim) McWilliam, a founder-member of the Board from 1977-1982. Currently, Dr McWilliam serves as the first Director of the Australian Center for International Agricultural Research (ACIAR), established in 1982. Formerly he was Head of the Department of Agronomy and Soil Science at the University of New England in New South Wales, Australia. The subject of his address at the meeting of the Board was "CGIAR, A Strategy for the Future: Implications for ICARDA".

Two new members were elected in 1986. At the end of the year, the membership of the Board was as follows:

Dr Jose Ignacio Cubero
(Chairman, from May 1986)
Escuela Tecnica Superior de Ingenieros Agronomos
Cordoba, Spain

Dr Mustapha Lasram
(Vice Chairman, from May 1985)
Institut National de Recherche Agronomique de Tunisie (INRAT)
Ariana, Tunisia

Miss Naima Al-Shayji
Ministry of Planning
Kuwait

Mr Kenneth Anthony
Consultant in Tropical Agricultural Research
Oxted, Surrey, UK

Dr Joseph Haraoui
Agricultural Research Institute
Fanar, Lebanon

Dr Ch.Muhammed Anwar Khan
Pakistan Agricultural Research Council (PARC)
Islamabad, Pakistan

Mr Hamid Merei
Deputy Minister of State for Planning Affairs
Damascus, Syria

Mr Hasan Su'ud Nabulsi
Jordan Cooperative Organization
Amman, Jordan

* Elected in 1986

The following meetings took place

20 to 24 January	Aleppo	Program Committee
6 to 7 March	London	Executive Committee
5 to 8 May	Aleppo	Full Board
10 to 11 November	Stockholm	Executive Committee

ICARDA Trustees and Staff at Tel Hadya, May 1986.

Resources for Research and Training

The International Center for Agricultural Research in the Dry Areas (ICARDA) employs several means to fulfill its responsibilities for research and training:

- It carries out research and conducts training programs employing its own staff and facilities; it welcomes guest researchers and graduate students to use these facilities.
- It provides seeds and technologies, and it collaborates with national institutions in West Asia and North Africa to plan and carry out research in their facilities and on farmers' fields, as well as to conduct training courses appropriate to national needs.
- It works with advanced institutions in industrialized countries to apply highly developed research methods to some of the problems of the ICARDA region.
- It cooperates with other Centers in the CGIAR system on matters of common interest.

In 1986, the several activities were consolidated, and some new initiatives were launched. This chapter contains a commentary on the evolution of ICARDA's resources: its staff, budget and facilities.

Staff

Staff is the essential resource for achievement in research, and ICARDA is proud of the quality of the staff that it has built up over the past ten years. During 1986, we experienced difficulties and delays in the recruitment of international staff, in part perhaps because of prevailing perceptions about the political situation in some parts of the region. Fortunately, the staff in place do not appear to feel that insecurity, and ICARDA retained almost all the senior staff that were with us at the end of 1985. Indeed there was a net increase of seven.

However, a major loss did come with the departure of Dr Peter Goldsworthy (United Kingdom) who had served as Deputy Director General - Research since 1981. We are pleased that Dr Goldsworthy remains with the CGIAR system, and his ICARDA colleagues look forward to working with him in his new position at ISNAR.

Dr Peter Cooper (United Kingdom) returned to his position as Program Leader, Farming Systems after a sabbatical year at the University of Reading. Similarly the Financial Controller and Treasurer, Mr Edward Sayegh (Lebanon) returned after a sabbatical year at the University of London. Appointments included those of Mr Samir El-Fayoumi (Egypt) as Senior Administrator, and Mr John Woolston (Canada) as Program Leader, Scientific and Technical Information.

Table 1. Staff of ICARDA at various locations.

		International professional	Regional professional	Other staff
Syria:	Aleppo-Tel Hadya	48	30	527
	Damascus	–	–	7
	Lattakia	1	–	4
Ethiopia:	Addis Ababa	1	–	–
Egypt:	Cairo	1	–	6
Italy:	Perugia	–	–	1
	Viterbo	–	–	2
Jordan:	Amman	–	–	1
Lebanon:	Beirut	–	–	7
	Terbol	–	–	29
Mexico:	CIMMYT	1	–	–
Morocco:	Rabat	2	–	–
Pakistan:	Quetta	4	–	–
Tunisia:	Tunis	2	–	4
TOTALS	(1986)	60	30	588
TOTALS	(1985)	53	26	565
Increase		7	4	23

Table 1 shows the overall staff situation, and it includes those persons that are on contracts for projects that are specially funded for a determined duration. The senior staff are listed in Appendix 6. Vacancies did remain at the end of the year, but the trend is positive. Regional staff and staff recruited in the host country are making ever-increasing contributions as they gain in experience and scientific maturity.

Finances

In 1986, ICARDA operated on funds totalling 19 324 000 United States dollars, about half a million dollars less than in 1985. This decrease was due to the completion of most of the first phase of the building of ICARDA's permanent headquarters and a consequent reduction in contributions needed from donors for capital expenditures. Financial accounts and the Auditors' Statement are shown in the Appendices 4 and 5, and the contributions of individual donors are listed in Table 2.

In addition to the regular operations funded out of its core budget, ICARDA received 2 084 000 USD from various donors as contributions to the cost of 14 Special Projects. These are listed in Appendix 1, and key developments are described in the Chapter *Cooperative Research Programs*.

Table 2. Sources of funds for ICARDA's core programs and capital requirements (thousand USD).

Arab Fund	341*	Netherlands	486
Australia	443	Norway	417
Austria	175	OPEC	122*
Canada	719	Spain	100
China	50	Sweden	482
Denmark	181	UNDP	300*
Ford Foundation	150	United Kingdom	780
France	178*	USAID	5 600
Germany (BRD)	1 821*	CGIAR Stabilization Mechanism	200
IBRD (World Bank)	4 500	Earned Income	1 102
IDRC	309*		
Italy	868*		19 324

* Part or all of these amounts were provided for specified activities ("restricted core")

The only major shift in donor support during the year was that of the German contribution from "core" to "restricted core". Starting in 1985, ICARDA had been required by the CGIAR's Technical Advisory Committee to take a fresh look at its research on food legumes in relation to global priorities for agricultural development. Were these crops of sufficient priority to merit continuation of this component of the Center's work? This issue is further discussed in the Chapter on *Food Legumes*, but the Federal Republic of Germany, which was impressed by the need to continue the work on faba bean, lentil and dry pea, asked that its donation be devoted to these crops and, at the same time, more than doubled its contribution, from 668000 USD to 1821000 USD.

Permanent headquarters

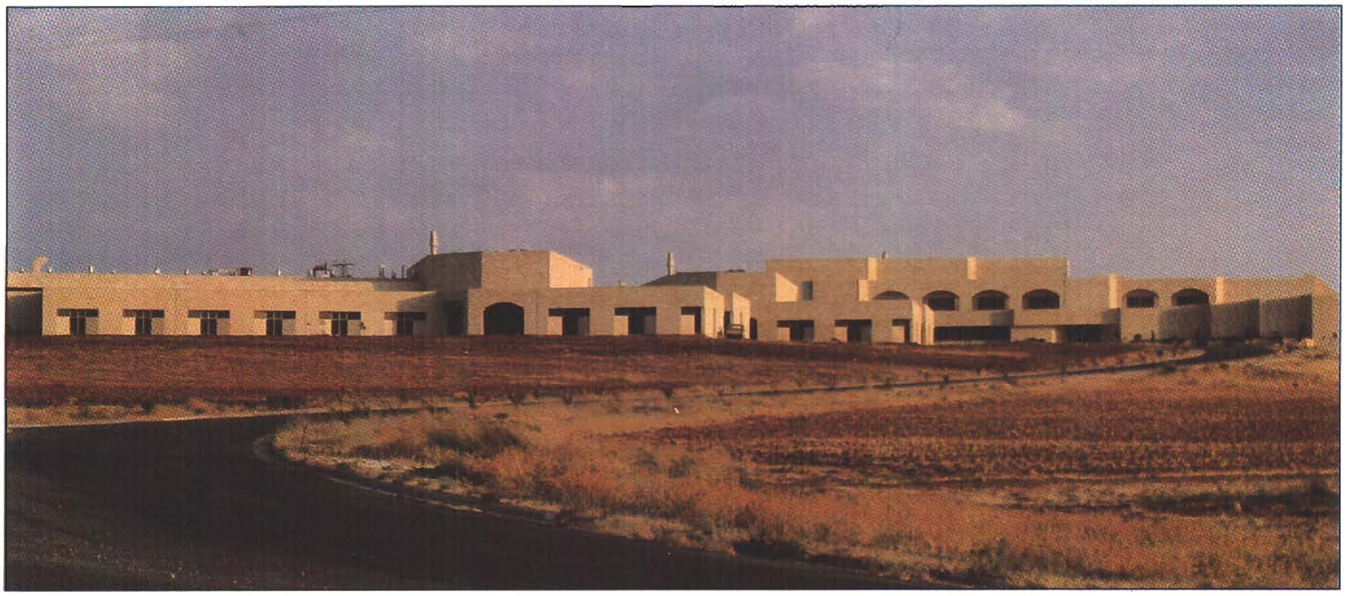
ICARDA's headquarters and its principal research site are at Tel Hadya, 30 km southwest of Aleppo on a farm of 948 ha that was donated by the Government of Syria in 1977. Until now, work has been conducted in temporary facilities but, in October, ground was broken for the construction of a permanent complex involving two laboratories, each of about 2750 m^2, and a building of 5000 m^2 for training and communications. In September and October 1982, ICARDA accepted delivery of the laboratories from the contractor, and expects to receive the third building in May 1987.

The buildings have a low profile adhering closely to the contours of the hill (Tel) on which they are situated. The architects, Giffels Associates Limited of Toronto, Canada, deliberately set out to design structures that would harmonize from the outside both with the site and with the traditional features of buildings in the Aleppo region. Thus the complex is characterized by arched openings and slotted windows, and the reinforced-concrete structures are faced with local limestone.

The buildings are designed to conserve energy, as they need both heating in winter and air-conditioning in summer. Windows are shaded from the sun in summer; roofs and walls are well insulated.

The construction was contracted to Milihouse, the major parastatal construction company in Syria. Total costs will amount to about 11 million USD, and ICARDA gratefully acknowledges the major contributions of the OPEC Fund for International Development and the International Fund for Agricultural Development (IFAD).

At the end of the year, work was under way to install services in the laboratories and to begin furnishing. In so doing, ICARDA was implementing plans that had been carefully prepared over a period of years to ensure that best advantage is taken of modern concepts in laboratory design. The planning was entrusted to Dr. Phil Williams of the Canadian Grain Commission (Winnipeg, Manitoba) who has been associated with ICARDA since the earliest days and who, in the role of consultant, has spent a



ICARDA's new headquarters.

A laboratory in the new headquarters

significant part of each year in Aleppo. In the two buildings, there are 23 distinct laboratories identified with 14 disciplines.

In the layout of the laboratories, careful attention has been given to the relations between different functions and disciplines and, although internal access doors are provided to facilitate anticipated movements of people and materials, this has been accomplished while preserving the integrity of those rooms where sterile material will be handled.

A wide range of services are available, including three-phase power, gas, pure demineralized water, compressed air, on-line vacuum, and low-temperature (5°C) storage areas. Benches are at different heights (77 cm or 90 cm) according to whether the work will more likely be carried out by persons sitting or standing, and similar thought has been given to other furnishings.

The year 1986 also saw the start of construction, on the same site, of a separate building to house the Genetic Resources Program. Generously financed by the Government of Italy, this building will provide about 800 m² of laboratory space and a 300-m² cold room for the long-term storage of germplasm.

The design and construction of the building is under the supervision of Prof. Ing. A. Bianchi of the Instituto di Construzioni Rurali della Universita di Bari, and the work itself is being managed by ICARDA with private subcontractors.

The farms

Apart from its main facilities at Tel Hadya, ICARDA manages other research sites in both Syria and Lebanon. In Syria, the Khanasser site was closed after the 1985/86 season, having been replaced by the one at Ghrerife, which had been started the previous year. In Lebanon, the Kfardane site was re-opened after having been closed for several years. The locations and principal features of all sites are presented in Table 3.

ICARDA needs to test crop varieties and farming practices throughout the range of agroclimatic conditions that are to be found in West Asia and North Africa, and this range is reasonably well represented at the sites in Syria and Lebanon. The spread in average rainfall is clearly indicated in the Table, but the different sites also provide different types of soil. That at Tel Hadya, luvisol, is typical of vast areas of the region but, at Breda, the soil is aridosol and, at Jindiress, it is vertisol. Because of their elevations, the Lebanese sites are distinctly cooler: on the other hand, at Lattakia, which is virtually on the coast, moisture is abundant, and it is at this site that research is conducted on those diseases that are promoted by humid conditions.

At the main site, Tel Hadya, there are tens of thousands of plots which, after the experiments of one year, must be cleaned and made ready for the experiments of the next year. Research that involves between-year comparisons would be invalidated if soil conditions were allowed to fluctuate. Tillage, crop residues and weeds are among the many factors that need to be kept under control.

Indeed, the management of experimental farms is a discipline in its own right and, after years of observations and tests, new techniques of tillage and seed-bed preparation were introduced in 1986. For example, after a

ICARDA's main experiment station is on a site of 948 ha at Tel Hadya, 30 km from Aleppo, Syria

Table 3. ICARDA sites in Syria and Lebanon.

Site	Distance from Aleppo	Area	Approximate Elevation	Average annual precipitation
	km, direction	ha	m	mm
Syria				
Tel Hadya	30 S.W.	944	320	330
Bouider	55 S.	35	360	180
Khanasser	70 S.E	10	335	225
Ghrerife	40 S.	2	320	250
Breda	35 S.	76	300	280
Jindiress	45 N.W.	10	220	470
Lattakia	150 S.W.	5	25	785
Lebanon				
Kfardane	270 S.S.W.	50	950	430
Terbol	290 S.S.W.	39	1080	600

cereal crop, the soil is now inverted, thus plowing under seeds that may have fallen before or during the harvest. Such seeds would interfere with the next year's experiments if they were allowed to remain near the surface and germinate in the following season. The new procedure replaces one that called for a summer irrigation to germinate the seeds - and then let them die in the heat and drought - and thus it conserves water. It may also help control soil-borne diseases.

An invasion of voles (*Microtus socialis*) provided a new challenge to the farm managers at Tel Hadya. The rodents came in numbers that had never been seen before and, since one colony can eat the crop on 10-15 m², their arrival endangered the whole program of experiments that had been planned. To meet this emergency, poison was placed in the rodents' holes over the entire farm, and the farm managers are now looking for less labor-intensive methods to use in the future.

Not all of the farm is needed in every year, and the remainder is normally planted with barley, which is then harvested and sold on the local market. On 40 ha in 1986, the average yield was 3000 kg/ha, and some standard varieties, planted on 1.5-ha plots, yielded as much as 5400 kg/ha. These yields are far more than those obtained by local farmers on adjacent lands, and a new agronomic study was started to find the reasons for this achievement.

The computers

Agricultural researchers will always need fields in which to conduct their experiments but, in the last few years, they have adopted powerful methodologies for planning these experiments and for analyzing the results. The science of computers, wedded to that of biometrics, now enable an agricultural researcher to design experiments that will be more likely to reveal what he needs to observe, and then to state his conclusions with greater confidence.

At ICARDA, such concepts are no longer novel. Year by year, the partnership between biological science and computing science becomes increasingly intimate. That trend will necessarily continue as the Center moves into new areas of basic and strategic research.

ICARDA's Computing Services are based on a centralized complex of VAX equipment, but with a web of connections reaching out to terminals that are located in the researchers' own laboratories and offices. Service is also provided to Syrian national agricultural research institutions, whose scientists bring their data to Tel Hadya for computation and analysis. For these activities, the most important set of programs is one developed jointly by ICARDA and ICRISAT, and is known as CRISP (Crops Research Integrated Statistical Package). During 1986, a new statistical module was added to CRISP, and other features were enhanced. Some 45 new persons were trained in its use, representing a cross-section of the various scientific disciplines within ICARDA, as well as individuals from national programs.

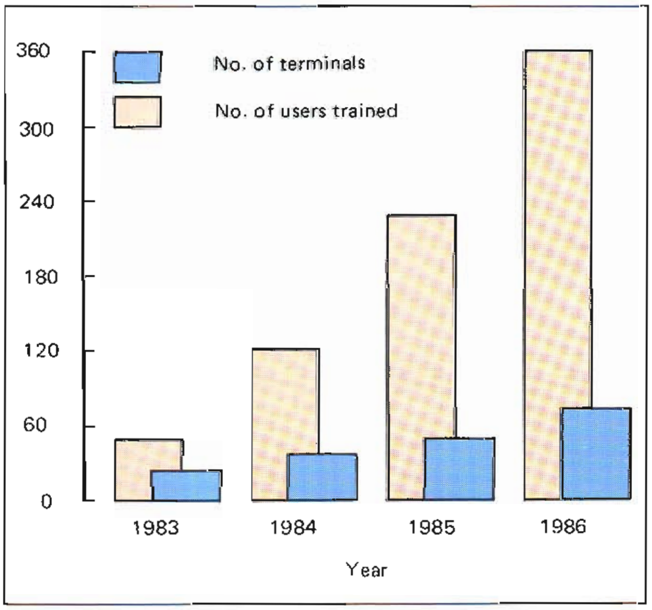


Figure 1. Growth in the use of computer resources at ICARDA, 1983-86.

ICADET is another set of programs developed at ICARDA, and this is for the management of data bases, both numerical and textual. During 1986,many enhancements were made to these programs, and 55 new users were trained.

The ICADET programs are used for many different purposes. For example, they are employed to handle large collections of rainfall and evaporation data collected from a variety of locations. During 1986, a module was added that permits the analysis of these data to generate a report on the water stresses to which crops are subjected.

Another ICADET-managed data base is ICARDA's composite mailing-list, which contains about 5 000 addresses. The enhancements introduced now permit much more rapid sorting of these addresses into preferred sequences.

CERINT, which is based on ICADET, is designed to help cereal breeders to trace the inheritance of traits, both retroactively to identify responsible parents, and predictively, to forecast the possible outcome of future crossings.

During 1986 a new, ICARDA-produced typesetting package was brought into operation. ICASET receives texts that have been prepared and corrected in the computer's word-processing facilities and permits the typesetter to choose from a variety of fonts as that text is being composed for output on a laser-printer. The new facility was employed for a number of important publications that were issued during the year, including the annual report for 1985.

Computing Services also supports administrative and financial applications. Improvements were made to existing modules, such as those for budget preparation, general ledger, payroll, and stock control, and a new module was completed for maintaining records of staff leave.

Cooperative Research Programs

In carrying out its responsibilities, ICARDA cooperates with its host country, Syria, with other countries in the region, and with industrialized countries throughout the world. In 1986, staff travelled extensively in the region to maintain existing cooperative projects and to develop new ones. Several new initiatives were launched.

Host country

Cooperation with Syria remained especially close in 1986. The Annual Coordination Meeting, held at Aleppo in early October, was the fifth in the series and was graced by the presence of His Excellency, the Minister of Agriculture and Agrarian Reform. These meetings involve the research directors of all the Ministry's research stations in the country. During the year, more than 200 joint breeding, agronomy, pathology and other research trials were carried out at more than 15 different research stations in Syria. In addition, more than 100 variety verification trials for promising cereals, food legumes, pasture and forage lines were conducted on farmers' fields in various agro-ecological zones. Indeed, many of ICARDA's research projects have at least a component that is carried out in cooperation with Syrian researchers, and the results are reflected in the chapters on *Core Research Programs*. In addition, about 70 of the Ministry's scientists received training at ICARDA during 1986, either in formal courses or through attendance at workshops and conferences.

– *For a detailed scientific account in Arabic (with English summary), request* COLLABORATIVE RESEARCH AND TRAINING PROGRAM: ANNUAL REPORT FOR 1985/86 SEASON, *publication* ICARDA-116 Ar,En.

Other countries in the region

New agreements for cooperation were signed during 1986 with the Ministries of Agriculture of three countries: Algeria, Iraq and Morocco. These official agreements are intended to facilitate the exchange of scientists and technicians, as well as crop varieties, publications and information. They establish mechanisms by which ICARDA offers the advice and cooperation of its researchers, improved seeds and plant material, and access to advanced training courses. For their part, the countries establish a framework for cooperative research to be carried out at their own research stations, provide a legal basis for the movement of equipment and plant material, and accord privileges to ICARDA personnel similar to those that are enjoyed by agencies of the United Nations.

In Rabat, the Institut National de Recherche Agronomique provided space for two ICARDA scientists who

Turkish and ICARDA scientists examine performance of new chickpea lines at Diyarbakır, Turkey

will cooperate with the national program in Morocco as well as in neighboring countries. A grant from the World Bank permitted a staff member to be posted to Addis Ababa to work with the Ethiopian Institute of Agricultural Research on highland pulses. The first formal coordination meeting was held with ICARDA's research partners in Turkey. Workshops and training courses were organized in Egypt, Jordan, Morocco, Pakistan, Sudan, Syria, Tunisia and Turkey.

In 1986, 446 shipments of seeds were dispatched by ICARDA to 68 countries; some 40% of these went to recipients in the ICARDA region.

Nile Valley Project

The Nile Valley Project (NVP) is a major item in ICARDA's program. It started in 1979 with both Egypt and Sudan, and was expanded to include Ethiopia in 1985. Its central objective is to improve the production of faba bean, and it has been financed throughout by the International Fund for Agricultural Development. In June 1986, ICARDA and IFAD signed an agreement to extend the project until December and, to compensate for a phased reduction of IFAD funding, the Government of Italy made a generous contribution. The project has become a model for other activities and, in 1985, OPEC began support for a wheat improvement program to be carried out in Sudan using many of the methods that had been pioneered in the Nile Valley Project.

The importance of faba bean is discussed in the *Food Legumes* chapter of this report, but nowhere is the crop more important than in the three participating countries. In Egypt and Sudan, faba bean is grown under irrigation during the winter months, but in Ethiopia the main producing areas are at high elevation where rainfall is assured.

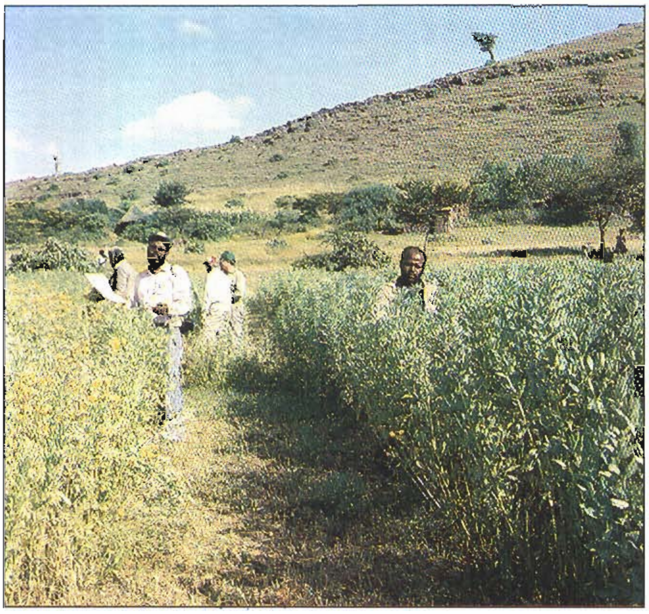
Cooperation and the exchange of experience are maintained through joint planning processes that culminate in an annual coordination meeting. The seventh such meeting took place in Addis Ababa in September 1986, at which His Excellency, the Minister of Agriculture of Ethiopia called for further cooperation and the development of more comprehensive systems of food security.

Previous research, much of it in cooperation with farmers, has led to the recommendation of particular "packages" for use in particular areas. Depending on the problems and potential of the area, a package may involve a disease-resistant cultivar, a method of seed-bed preparation, a recommended irrigation regime, fertilizer and herbicide. The package for an area largely infested by the parasitic weed, *Orobanche* (broomrape) is not the same as one for an area where, for example, this weed is absent, but another problem, such as water scarcity, is the dominant constraint.

In 1986, demonstrations of such packages were conducted, in cooperation with farmers, in all three countries. Yields and profitabilities were assessed and shown to be superior to those achieved by neighboring farmers who were using either traditional or only partially improved practices (Table 4). Efforts were continued, with the national extension and production authorities, to help ensure that farmers have access to the superior technologies, as well as the inputs necessary for their implementation.

Table 4. Increase in faba bean yields obtained in demonstration trials on farmers' fields (1986).

Location	Trial type	Yield increase kg/ha
EGYPT		
El-Minia	Pilot Demonstration	420
	Orobanche Control Demonstration	1790
Fayoum	Pilot Demonstration	790
Kafr El-Sheikh	*Orobanche* Control Demonstration	1910
SUDAN		
Sayal Scheme	Pilot Production	454-1574
ETHIOPIA		
Ada district	Faba Bean Production Package	824
Wolmera district	Faba Bean Production Package	700



Scientists visiting on-farm trails of the NVP in Ethiopia.

Back-up research is conducted at national research stations with the cooperation and advice of ICARDA scientists. Much of this is related to genetic improvement and the incorporation of pest and disease resistance into cultivars that already have other desirable characteristics. A major effort was continued in Ethiopia to enrich the spectrum of genetic diversity that exists in the highlands, and to select lines that have potential for further exploitation. But agronomic practices are also studied and, for example, in Egypt, much attention is given to development of effective but economic systems of weed control.

An important component of the project is aimed at finding methods to control infestations of bruchids, which damage and destroy much of the faba-bean crop after it is harvested. When farmers can safely store their produce, they benefit from higher after-season prices, and the consuming public is better assured of a continued supply.

At Selaim Besin in Sudan's Northern province, 1986 was the second year of an effort to demonstrate the value of disinfecting stores and then fumigating faba bean with aluminum phosphide. But an independent entrepreneur had already recognized the advantages and began offering this service to farmers. Close to 1000 tonnes were treated.

At the end of the 1985/86 season, similar packages were demonstrated at Zeidab, Aliab and Shendi in the Nile province. Untreated neighboring stores had an average infestation of about 14%, and economic analysis showed that, based on September prices, bruchid control gave a net benefit of 379 SDP/tonne.

In fact, however, farmers traditionally store their faba bean in jute sacks stacked on the ground, and bruchid infestation is rapid. Two alternatives were studied. One involved lining the sacks with polythene and fumigating with aluminum phosphide. Averaging the results at three different locations showed that, while produce in untreated sacks was subject to a 23% infestation, there was virtually none in the treated sacks, and the net benefit of this treatment would be 625 SDP/tonne.

At Selaim and Hudeiba, faba bean was stored underground in pits. This also eliminated infestation, and the economic analyses showed net benefits of 542 SDP/tonne at Selaim and 870 SDP/tonne at Hudeiba.

With the support of IFAD, Italy and other donors, ICARDA looks forward to an expansion of its work in the Nile Valley and expects to develop a full-fledged program that will include cereals, as well as food legumes other than faba bean.

– *For a more detailed scientific account, see pp 223-234 of* FOOD LEGUME IMPROVEMENT PROGRAM: ANNUAL REPORT FOR 1986, *publication* ICARDA-109 En.

Tunisia

ICARDA has been working with the Institut National de la Recherche Agronomique de Tunisie (INRAT) for the last six years; it maintains an office in Tunis, and has stationed international and other staff with INRAT to ensure close cooperation in joint research activities. Some work, especially on plant diseases, has been done with the Institut National Agronomique de Tunis (INAT), and ICARDA has also cooperated with the Office des Cereales in the processes of evaluation that lead to the release of new varieties.

The cooperation can be considered as having three main components: cereals, food legumes and farming systems. In 1986, the second and third components were partly supported by funding from the International Development Research Centre of Canada.

The 1985/86 growing season was characterized by a severe drought, which cut national cereal production to only 600 000 tonnes, about half the ten-year average. However, this same drought enabled researchers to identify lines that demonstrated a high tolerance and that filled grain despite having received only 100-150 mm of effective rain. Although foliar diseases were less apparent under these dry conditions, the pathologists were still able to pursue their search for multiple disease resistance.

With the Office des Cereales, final evaluations were underway for the anticipated early release of three new varieties: a durum wheat which is well adapted to more favored zones or those with supplementary irrigation; a bread wheat which has a good yield and stiff straw; and a high-yielding barley.

In April, the cereal work was reviewed by a committee that expressed its satisfaction with the progress that had been made during the years of cooperation with ICARDA. According to its report, "a viable barley improvement program is in place and operating" and "there are a strong pathology support program for all cereals, and an adequate training program for personnel." As a result, it was decided, that the time had come to recall the ICARDA barley breeder/pathologist who had been stationed at INRAT. ICARDA remains a partner in planning cooperative research projects and continues to provide training and germplasm, but the conduct of the research is now entirely in the hands of the Tunisian scientists.

A similar decision was taken for the food-legume program, and ICARDA's support is now provided from Aleppo. Certainly, Tunisia has developed a strong multidisciplinary program for the improvement of faba bean, lentil and chickpea under a range of agro-climatic conditions. Research continued during 1986, and some details are given in the *Food Legumes* chapter of this report; however, the highlight of the year was a series of decisions to release, as new cultivars, three chickpea and two lentil genotypes that had been developed in the joint program.

Two of the chickpea genotypes were specially developed for sowing in the winter months, so they can profit from the moisture that is available in that season. Of necessity, both are fairly resistant to ascochyta blight. One yields very well, and has medium-size seeds. The other yields about as well as local checks, but it stands high and is suitable for mechanical harvesting; its seeds are small, and hence will be used mainly in pastries and coffee-blending; unfortunately, it is very susceptible to wilt and cannot be grown in areas affected by this disease.

The two lentil genotypes yield slightly better than local checks, but the main purpose of their release is to widen the range available in Tunisia and reduce the hazards of genetic vulnerability. One has small seeds, but of appealing color, and it is free of any major disease problem, although it is susceptible to lodging. The other originated in Syria and has seeds that are larger than those previously available in Tunisia.

Farming systems research in the Goubellat area of Tunisia focuses on technologies that would suit small farmers.

The farming-systems component of the program is more recent, and on-site support by ICARDA staff will continue until it is more fully developed. The work centers in the Goubellat district, 80 km southwest of Tunis, where rainfall is moderate (450 mm long-term average), and the plains are surrounded by hills where the soils are shallow and unproductive. Farm size is highly variable, and off-farm employment is often needed to supplement family incomes.

The farming involves cereals (wheat and barley) and livestock (sheep and cattle). In surveys over the last three years, the farms have been categorized, and a number of representative farms have been selected for more detailed socio-economic and agronomic monitoring.

For sheep, the annual feeding cycle involves wheat stubble, barley grain and straw, and the highly productive weeds that grow on land left fallow. On-farm research is attempting to develop strategies for improving cereal production, including the green-grazing of barley in early spring, as well the replacement of weedy fallow by nutritious forage crops or self-regenerating annual pastures.

Although ICARDA's direct engagement in Tunisian agricultural research was reduced in 1986, this reflected our respect for the maturity of the national research program, and we look forward to continued fruitful cooperation in the future.

Baluchistan (Pakistan)

Starting in 1985, the United States Agency for International Development (AID) together with the Pakistan Agricultural Research Council (PARC) have been supporting a major project to strengthen the Arid Zone Research Institute (AZRI), which is located at Quetta, and to build a research program aimed at improving agricultural production in the harsh dry environments found at high elevation through much of Baluchistan.

The AID assistance is provided through the Management of Agricultural Research and Technology (MART) project, with ICARDA as the main contractor. In its turn, ICARDA has sub-contracted Colorado State University for the services of a specialist in livestock and rangeland management. This set of institutional relations is, for convenience, usually known as the MART/AZRI project.

During 1985, PARC appointed a Director and a Deputy Director for AZRI, the buildings were repaired, services were brought into use, an animal nutrition unit was commissioned, and a research flock of 300 sheep and goats was purchased. Staff moved into a colony of 24 housing units, and took delivery of 16 vehicles. An important program was started for training AZRI's present and future staff, as well as those from the provincial research agencies in Baluchistan.

ICARDA's international team of scientists was brought to full strength. It now includes specialists in rangeland/livestock management, germplasm evaluation, agronomy, farming systems, and extension and communication.

Close relations were established with provincial organizations in Baluchistan. Originally the project was to have the use of a large tract in the Maslakh range, 30 km from Quetta. Unfortunately, since this is an isolated area close to the border with Afghanistan and where hostile incursions occur, the plan had to be abandoned for security reasons. Sites for the range-livestock work were identified and developed at Zarchi in Kalat District and at Tomagh in Loralai District. For germplasm evaluation, facilities were made available at the Agriculture Research Institute at Sariab.

Research at Tomagh includes socio-economic studies of agro- pastoral systems.

The northern upland section of Baluchistan consists of a series of inhospitable mountain ridges separated by narrow valleys. Even the valley bottoms have an elevation from 1000 to 2000 m. Rainfall averages 200 to 300 mm. The growing season is usually less than 90 days. Sheep, goats and camels are reared and, where slope and soil permit, wheat is grown with minimum inputs. Where summer rain can be channeled on to dammed fields, yields are somewhat better, but normally they average only 200 to 600 kg/ha, and crops fail three or four years out of ten.

In the extremely cold winter months, livestock cannot be supported on the rangeland, and the farmers drive their animals down to lower altitudes in Baluchistan and neighboring provinces.

The first year of crop research was disappointing because of adverse weather and the fact that many of the experiments failed to produce a measurable yield. Cold weather came long before the first rain, and that which fell in February was not sustained. Nevertheless there were results of scientific interest, particularly the identification of cultivars capable of germinating and emerging at very low temperatures, and the performance of certain exotic forage legumes (*Vicia* spp.) which was remarkably good even under these adverse conditions.

– *For a detailed scientific account, request* HIGH-ELEVATION RESEARCH IN PAKISTAN: THE MART/AZRI PROJECT: ANNUAL REPORT FOR 1986, *publication* ICARDA-110 En.

Seed production

Many countries in West Asia and North Africa now have mature programs for plant breeding and the scientific evaluation of genotypes. They have also set up authorities empowered to register varieties and to authorize their release. However, the exploitation of these resources is lagging far behind, and most farmers do not have access to the high-quality seeds that they will need if they are to upgrade their practices and increase the productivity of their farms. One survey indicated that, out of 20 countries, seven had developed effective seed-production and distribution facilities for wheat, but only one for barley, and none for the food and forage legumes. Investments in agricultural research are largely frustated if the benefits cannot be made available to farmers.

In 1985, the governments of the Netherlands and the Federal Republic of Germany agreed to provide special funding for the appointment of a Seed Production Specialist at ICARDA and for the initiation of a program that offers advisory services and training. Thus 1986 was the first full year of this very important activity and, inevitably, the specialist devoted a good part of his time to establishing contacts and assessing how the program could be structured to be of most benefit to the countries of the region.

At Tel Hadya, in close cooperation with the Cereal Improvement program, seed cleaning and testing facilities have been improved, partly to enhance ICARDA's capacity to multiply seed that is in great demand, but also to provide an operational base for training. Advice was given to the Agricultural Research Institute in Lebanon, which is working with private farmers and seed processors to multiply, clean and treat seeds that are then sold at a premium price.

In March, a course on seed production was held in Egypt with the cooperation of the Nile Valley Project and Egypt's Central Administration for Seed; it was attended by 81 participants from Egypt, Ethiopia and Sudan. In November, a course sponsored by FAO, was held in Aleppo with 21 participants from 11 countries.

A practical exercise in seed germination at the seed-production training course in Cairo, March 1986.

To conclude the year, a major workshop was convened in Cairo with the support of the Commission of European Communities. It brought together seed-production specialists from both sides of the Mediterranean in an attempt to identify the constraints that hamper the development of seed production and distribution systems. The participants addressed questions of seed supply for small farmers, the role of private and semi-private organizations in a national context, the need to build up facilities for producing high-quality seeds for food, forage and pasture legumes, and the all-important question of training. The recommendations of this workshop will be highly influential in setting the future directions of the project.

Collaboration with more industrialized countries

To strengthen its collaboration with countries that have advanced research facilities, ICARDA signed formal agreements for collaboration with both France and India. The French agreement was signed by the chief executives of three institutions that have major responsibilities for research on agriculture in developing countries, INRA, CIRAD and ORSTOM, and special provisions are made for joint actions with ICARDA and the national programs of countries in West Asia and North Africa. The Indian agreement is with the Indian Council for Agricultural Research and provides a legal framework for bilateral research cooperation.

ICARDA now participates in about forty cooperative research projects with advanced institutions in Europe and North America: they are listed in Appendix 2. These projects give ICARDA access to researchers with specialized talents and to equipment that is available only in such centers of excellence, and about half of the projects relate to upstream research that may be characterized as "biotechnology". Discussions were initiated during 1986 with the Soviet Union, which seconded a scientist to Aleppo to study the prospects for future collaboration. For several years, Japan has generously seconded an animal scientist to work at ICARDA on livestock improvement and, during 1986, there were intensive discussions about the possibilities for future Japanese cooperation on a wide range of topics of interest to ICARDA.

Collaboration with other CGIAR Centers

ICARDA's closest relationships are with CIMMYT for wheat and barley improvement, and with ICRISAT for chickpea improvement; these activities are discussed in greater detail in the chapter on *Core Research Programs*. There is close technical cooperation with IBPGR on the germplasm collections, their classification and description. During 1986, ICARDA undertook to participate in a project managed by the CGIAR secretariat, which aims at preserving the past publications of all the Centers and their dissemination as a collection, probably on optical disks accessible through microcomputers. But the relations with all the Centers are intimate, for the exchange of experience on both technical and management issues.

Collaboration within the CGIAR system, and the initiatives of ICARDA's farming-systems scientists, led to an Inter-Center workshop on Agricultural Environments: Characterization, Classification and Mapping, which was held at FAO in April. Several centers face a common problem: ''good'' varieties are not necessarily good in all environments. Specially-adapted varieties must be developed for harsh climates and adverse soil conditions. Breeders must specify the range of agro-ecological conditions for which a particular variety is best suited, and maps are needed to show the zones in which the different conditions prevail. To produce a useful zoning system would require a large effort, and the workshop was a first move by the Centers to determine the way in which this might be done.

Core Research Programs

Forage legumes replace fallow

For hundreds of years, farmers in the drier areas of West Asia and North Africa have practised rotations that leave land fallow for a year after it has been cropped, usually to barley. The farmers know that the fallow helps to restore fertility, and ICARDA's studies have indeed confirmed that the soil contains more available nutrients, particularly nitrogen, after a fallow than it did after the last crop. Also the farmers believe, and our studies have shown, that in years of good rainfall, fallow stores some moisture that can be used by a crop in the succeeding year. The amount carried over is more significant in cool high-elevation areas, like the Anatolian plateau, but in low-lying areas, it is seldom more than 10% of the rain that fell; however, even this may be important, especially if the next year is a dry one.

Those farmers who continue to devote much of their land to fallow are doing so because they believe that to grow any crop would depress the barley yield in the following year.

In northern Syria, however, this traditional practice is gradually giving way, and many farmers are now growing barley every year on the same fields. As is often the case with mono-cropping, yields decline but, for the farmer who needs to feed his sheep, continuous barley is still economically attractive and, at least for a few years, it responds well to fertilizer.

Other means of feeding sheep are diminishing. Constrained by population pressures and over-grazing, many farmers now get little benefit from common pastures on hills and steppeland.

For eight years, ICARDA has been looking for ways to replace fallow with a productive crop other than barley. Forage legumes, especially common vetch, *Vicia sativa*, and chickling vetch, *Lathyrus sativus*, have been seen as the more promising species. Through rhizobia action on their root systems, these plants obtain much of the nitrogen that they need, and they make efficient use of rainfall. When grazed in spring, they provide excellent nourishment for lambs or lactating ewes, or they may be harvested as grain and straw to provide feed in autumn or winter.

Since this work has involved cooperation between two of ICARDA's core programs, Farming Systems and Pasture, Forage and Livestock, it is presented here as a separate chapter.

Breda is a village about 40 km from Aleppo, and it is the site of one of ICARDA's smaller experiment stations. Rainfall is about 280 mm, and the local farmers produce barley and sheep. Their cash income comes from the sale of sheep products and, for feed, they mainly use the barley grain and straw. Their land is cropped to barley, either continuously or in rotation with fallow.

For the last three years, ICARDA has carried out a series of on-farm trials aimed at finding out whether, for these resource-poor farmers, the forage crops could provide an effective and profitable alternative to fallow in rotation with barley.

Trials on farmers' fields are complemented by experiments under more exacting control at ICARDA's Breda station. Here, fallow in the foreground, legumes in the center, and continuous barley in the distance.

The trials were conducted on up to 8 farms each year, with one area on each farm sown to common vetch and another to chickling vetch. The areas (about 0.5 ha each) were separated by a 10-m fallow strip, and half of each plot was fertilized with 50 kg P_2O_5/ha. The forages were either grazed while still green by lactating ewes or lambs, or they were allowed to mature and were then harvested for grain and straw. Hay-making was not attempted as it would have involved technologies beyond the experience of the local farmers.

When the plots were used for grazing, the stocking rates were high and, because the yield of herbage is small, the sheep were consuming these forages for only about 30 days. Despite this, as shown in Fig. 2, ewes maintained as good a milk yield, and lambs as good a growth rate, as others that were grazing freely on native pastures.

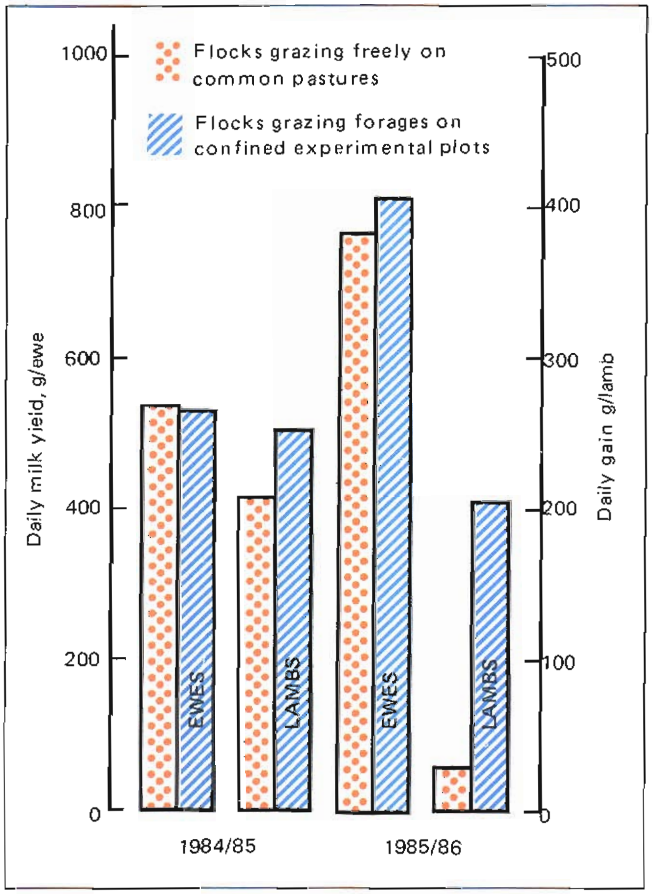


Figure 2. Productivity of farm flocks.

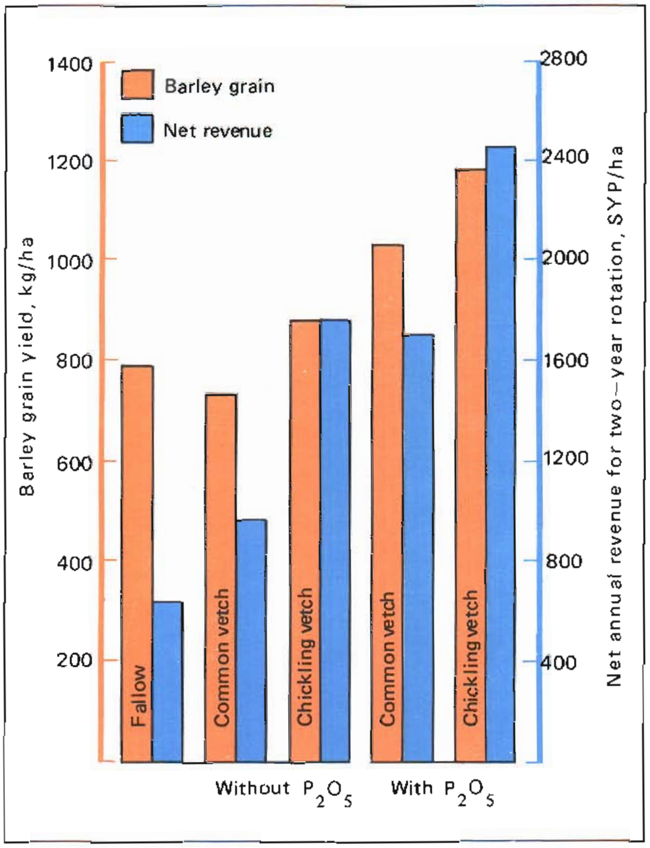


Figure 3. Forages contrasted with fallow: barley grain yields in the following year, and the net revenue per year of the two-year rotation.

When left to maturity, the seed and straw yields of both vetches were found to have been much increased by phosphate. In all situations, common vetch and chickling vetch had about the same straw yield, but chickling vetch produced much more seed than did common vetch. Indeed, farmers showed a clear preference for chickling vetch, and its better performance may have been due to its better resistance to sitona weevil, whose larvae attack the nitrogen-fixing root nodules.

As shown in Fig. 3, the yield of barley, both grain and straw, was as good after an unfertilized forage crop as it was after fallow. This result is very important, because it demonstrates that, contrary to what farmers had suspected, a forage crop does not diminish the productivity of barley in following year. It is also clear that, when the forage is fertilized with phosphate, enough remains in the soil to give a substantial boost to barley production in the following year

Based on the products harvested in the two years of each rotation, Fig. 3 also shows the relative profitability of the various combinations. Sowing common vetch on land that would otherwise have been left fallow gave a 50% increase in net revenue, even when no phosphate was applied. Common vetch with phosphate, or chickling vetch without, more than doubled the profitability – while chickling vetch plus phosphate was more than three times as profitable as barley/fallow without phosphate.

While, because of losses during harvest, actual net revenues from grain and straw will probably be lower than those shown in Fig. 3, the cooperating farmers have demonstrated that they can obtain substantial benefits by adopting chickling vetch as an alternative to fallow in dry areas like that around Breda.

In parallel work, the barley rotation with chickling vetch also demonstrated that it could compete with continuous barley that is well fertilized with nitrogen, both of these practices giving a high net revenue and a high rate of return on investment. Now, after three years, we feel confident that the introduction of forage crops will substantially increase feed supply and hence farm income. The work also has implications for our future research. We intend to make an effort to secure genetic improvement in chickling vetch; there will be more emphasis on grain and straw production and less hay-making; herbage yield will be assessed, but with grazing in mind and will take account of palatability; we will probably shift the emphasis of our forage research more in favour of the drier zones.

– *For more detailed scientific accounts of this work, see pp 62-71 of* PASTURE, FORAGE AND LIVESTOCK PROGRAM; ANNUAL REPORT FOR 1986, *publication* ICARDA-111 En *and pp 31-76* of FARMING SYSTEMS PROGRAM: ANNUAL REPORT FOR 1986, *publication* ICARDA-108 En.

Pasture, Forage and Livestock

Since its formation, this program has sought to find ways to improve sheep production in the dry areas of West Asia and North Africa. It is not involved in sheep-breeding, but it is concerned with questions of nutrition and husbandry, and it centres its research on the improvement of grazing resources and the on-farm production of feed. To structure its research, it identifies two dominant situations: one, in more favourable agroclimatic areas, where the farmers grow barley or wheat as well as raising sheep, and the other, often on marginal land, where shepherding is the sole, or principal activity.

For the first of these situations, the work has concentrated on efforts to find pasture or forage plants that would be more productive than fallow when employed in rotation with cereals. In the previous chapter of this report, we described how, in drier areas, farmers can profit by sowing forage legumes in the year intervening between barley crops. Later in this chapter, we shall describe how self-regenerating legumes can be employed in somewhat wetter areas, and again we find that they are more profitable than fallow.

For the second situation, we see great possibilities of improving the productivity of the so-called marginal areas which, for our purposes, are defined as those lands that receive at least 200 mm of rain, but which are too rocky, too steep, or with soil too shallow to permit cultivation.

Replacing fallow with self-regenerating pasture legumes

The idea of using annual pasture legumes to replace fallow in cereal/fallow rotations originated in southern Australia. There, pastures provide nutritious grazing throughout the year, replenish soil fertility and provide a break between cereal crops that helps control disease. In the 30 years since it was introduced, the ley farming system, as this practice is called, has increased livestock numbers by up to four times and has doubled cereal yields.

The main advantage of annual pastures over annual forages is that, if appropriate legumes are chosen, there is no need to re-sow them after the initial year: these species can regenerate themselves because their seeds will remain dormant in the soil during cereal years unlike, for example, those of the vetches. Not only does this save farmers the expense of re-sowing, but it allows a much higher rate of re-seeding than farmers could afford, and it results in rapid establishment of the pasture and a much longer grazing period.

Ideally, farmers introduce livestock to the pastures in early winter: since annual legumes are prostrate and many weed species are erect, this is also a good way of controlling weeds.

In the second year the farmer waits until the autumn rains and then, after weeds germinate, he prepares a seed bed and sows his cereal. Most of the legume seed produced in the previous year remains dormant because of its impermeable seedcoat: tillage must be shallow to allow plants to emerge in the third year.

Medic pasture regenerates after seeds have lain dormant during a cereal crop.

Success of the system depends upon several factors. Because the major feed requirements come in autumn and winter, when temperature and light intensity are low, rapid pasture growth and resistance to frost are important attributes. Enough material must be produced to provide summer grazing, with enough seed falling for dense re-generation. These seeds must resist germination in the crop year and germinate promptly two years later. Finally, the pasture must fulfill its role as a source of nitrogen and, in association with rhizobia, make available enough nitrogen from the air for its own requirements and, as much as possible, for those of the cereal to follow.

Attempts to introduce the ley farming system to West Asia and North Africa began in the 1960s. Claims of success (though unsupported by published data) have been made in parts of North Africa, especially Libya, but elsewhere there have been problems. Reasons given for the many failures that have occurred have included lack of legume species adapted to the regional environment;

poor nodulation of the legumes (nodulation by rhizobia needed for nitrogen-fixing); and inappropriate management practices, especially grazing management and tillage. Most critics also imply that research has been inadequate.

The importance of rhizobia

If the ley-farming system is to succeed, we need to find effective pasture legumes and be sure that they are matched by strains of rhizobia capable of nodulating their root systems. In previous years, we have reported on our work with medics (*Medicago* spp.), first those brought from Australia, and then the native medics, particularly *M. rigidula*, which proved to be much better adapted to the harsh winters of northern Syria.

Rhizobia exist in the soils where legumes grow and, in the past, it was often assumed that, because medics are native to West Asia, appropriate strains would always be available. This assumption was proved to be false when, several years ago, a diligent search was made at ICARDA's Breda station, and the rhizobia responsible for inoculating medics (*R. meliloti*) could not be detected at all. The explanation probably resides in the fact that, before the advent of modern agriculture, farmers treated medics as weeds, and both they and their matching rhizobia were eradicated from large areas.

To ensure that effective rhizobia will be available, pasture-legume seed is often sown with an inoculum that has been mixed with peat. We followed this practice and inoculated our *M. rigidula* sowings with recommended strains obtained from Australian collections. Nodules formed and, at first, we believed that these strains were effective. This year, however, we started to employ a sophisticated technique (antibiotic resistance) to identify what strain had actually produced each root nodule. In more than 90% of the nodules, it was not the rhizobia with which the seeds had been inoculated, but indigenous strains that, on these occasions, were available in the soil.

Preparing a rhizobia inoculum.

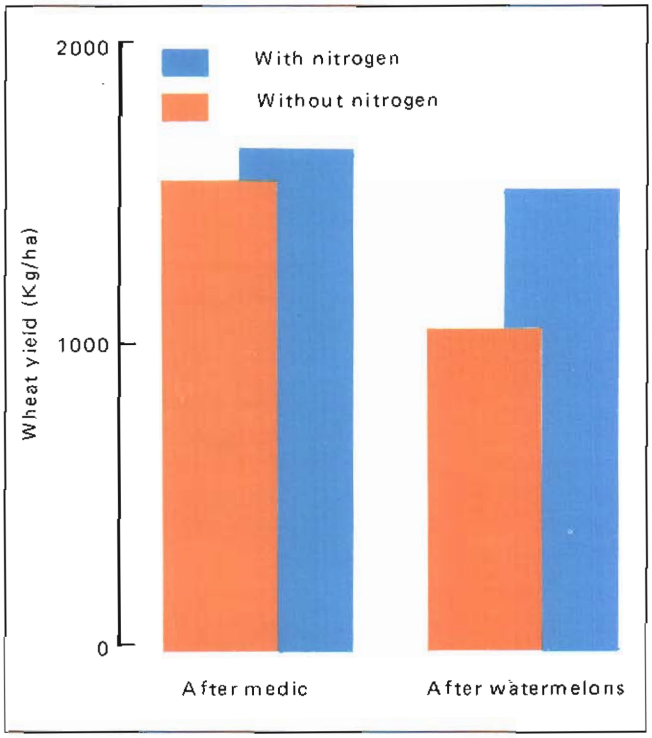


Figure 4. Yields are augmented when a wheat crop follows a medic rotation, whether or not nitrogen was applied.

The plant/rhizobia/environment interactions are exceedingly complex and, in addition to *M. rigidula*, we are also working with *M. rotata*, *M. noeana*, and *M. polymorpha*. In an effort to better understand the interactions, we have isolated rhizobia from 94 soil samples collected from both arable and non-arable areas in various parts of Syria. By using these to inoculate seeds of the several species, and then planting the seeds at different sites, we have ranked the response of each medic to each isolate. The new knowledge should lead to much more efficient matching of rhizobia with indigenous medic species, and to the development of better techniques for inoculation.

ICARDA's attempts to adapt ley farming have led to the establishment of 13 on-farm experiments in Syria. The purpose is to permit farmers to evolve their own versions of ley farming, which will be more appropriate than the original system based on farming practices in southern Australia. Such work involves a three-way collaboration between the farmers, the Ministry of Agriculture and Agrarian Reform, and ICARDA scientists.

One result has been analogous to the finding, presented in the previous chapter, that a forage rotation does not reduce barley yields, as farmers had feared it would. Many farmers similarly feared that producing wheat crops after medic pastures might also reduce yields: again ICARDA's on-farm research has shown that this is not so (Fig. 4). Wheat after medic produces as much as wheat after watermelons, a common crop rotation in Syria. However, the need for nitrogen fertilizer in the wheat/watermelon rotation was replaced by a need for herbicide to control weeds.

Improving marginal lands

Thirty percent or more of the lands in the region of ICARDA's responsibility can be classified as marginal, and thus by definition non-arable. Until 1983/84, ICARDA's research on these lands was confined to studies of the productivity of perennial grasses. While the studies did reveal some potential among certain Mediterranean grasses, we concluded that they were unlikely to be productive on unmanaged land and poor soil, and that efforts should be concentrated on improving the management of these lands as a whole. For this much more basic information was needed.

Studies were designed to obtain information on the soil, climate, and existing plant resources of marginal lands. Annual legumes were collected from 207 sites throughout Syria, identifying the species, estimating their populations, and describing the climate and soils at each site from which they were collected.

This survey has provided much valuable information, although its analysis is still at a preliminary stage. For example, one proposed management tool for improving marginal land is the application of phosphate to remedy a suspected phosphorus deficiency. The survey showed that, while phosphorus deficiency is widespread on marginal land, it occurs acutely on only about 25% of sampled sites, though up to 60% of the sites may respond to phosphate. The deficiency was not related to either climate or soil type; so, before phosphate can be recommended for any particular site, a soil test for phosphorus would be needed.

The survey also gave evidence of reasonably good potential for improvement, because soil fertility, in chemical terms, was found to be higher on marginal land than on adjacent arable land. For example, near Breda, the organic-matter content of marginal land was 3.2%, almost three times that of adjacent arable land (1.1%). The problem, of course, is to exploit this fertility.

Table 5. Genera collected from 207 marginal land sites.

Genus	Number of species	Number of accessions
Anthyllis	1	8
Astragalus	9	204
Biserrula	1	7
Coronilla	2	28
Hippocrepis	1	48
Hymenocarpis	1	74
Lathyrus	3	24
Lens	1	5
Medicago	23	531
Onobrychis	4	107
Ornithopus	1	9
Pisum	1	2
Scorpiurus	1	42
Securigera	1	7
Trifolium	34	775
Trigonella	9	179
Vicia	4	55
Total	97	2105

The diversity of legumes found was great (Table 5), and they constitute a valuable resource for improving both marginal and arable land. In many cases, the populations were so varied as to suggest that less genetic erosion had taken place than had previously been estimated.

Marginal land in the dry areas

Adamy is a small Syrian village on the boundary between the cereal zone and the steppe. The land is marginal because the average rainfall is only 200 mm, and it is used mostly for grazing. However, farmers do occasionally grow cereals, particularly if they are encouraged by early rains. We believe it is this cultivation that is the main cause of desertification, and abandoned fields are a common sight. Either these fields remain as bare ground for several years, or they become covered with unpalatable weeds.

Studies carried out in cooperation with the Ministry of Agriculture and Agrarian Reform compared land that was open for grazing with other land which had been protected for two to several years after it had been planted with shrubs (*Atriplex* spp.). Grasses were dominant in winter, comprising more than 96% of the vegetation. By April, however, grass varied from 30 to 70%, while weeds (species other than grasses and legumes) had gained importance, especially in the grazed area. Herbage yield depended strongly on the plant population in January (Fig. 5).

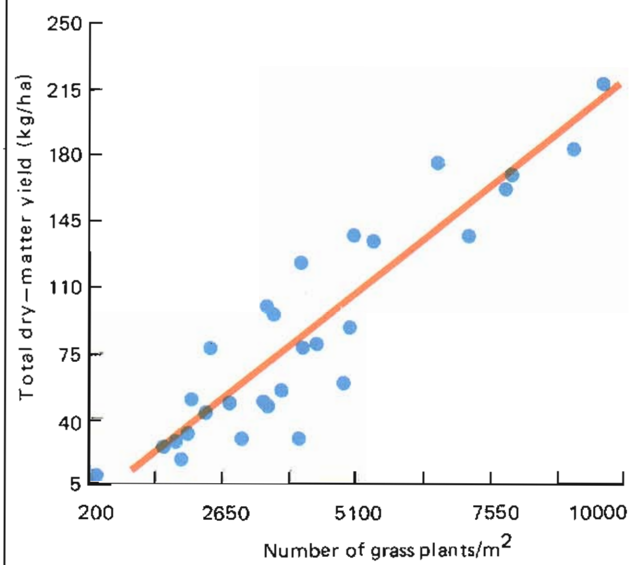


Figure 5. The population of plants in January determines the herbage yield for the whole season.

Protected areas had 3 to 9 times more plants than unprotected areas, and these differences were reflected in yield. Usually, the advantage peaked after two years' protection and then began to diminish. It seems that the *Atriplex* shrubs when fully grown might compete with and replace the herbaceous cover, even in the absence of grazing.

Even one year of protection from grazing substantially benefits seed yield. The number of seeds found inside protecting cages was almost double what was produced outside, and seed mass was also greater. Total seed yield after two years' protection was four times that under open grazing and, after five years, was still double.

The study has shown that many of our findings in higher-rainfall marginal lands also apply at Adamy: for example that yield depends on plant number, that grazing depresses seed production, and that primary productivity is very low. One important difference, however, is the lack of legumes. If we are to depend on pasture legumes in these dry areas, it seems likely that sowing will be necessary. It will be a formidable task to select adapted species, develop appropriate establishment techniques and devise suitable grazing systems.

Breeding forage crops to use in cereal/forage rotations

Widely adapted cultivars will be needed if we are to see any broad extension of the practice of using forage crops to replace fallow. At present, while varieties are available in most local markets, there are few officially registered cultivars whose performance is known and that can be widely recommended.

The process of selecting for wide adaptation involves several steps. First, a large number of accessions are screened in nursery rows; second, they are evaluated in microplots and advanced yield experiments; and finally, they must be tested at a variety of sites representative of the agroclimatic regions for which they are intended. Disease screening is conducted at all stages, and the palatability of the more promising lines is monitored.

An important new objective is to search for resistance to root-knot nematodes (*Meloidogyne artiella*) in vetches, and cyst nematodes (*Heterodera rosii*) in peas. These nematodes are also a problem for ICARDA's Food Legumes program.

In 1984/85 (the first year in which nematode screening was conducted), 30 accessions of three vetch species (common vetch, Narbon vetch and woollypod vetch) were classified as tolerant of the root-knot nematode. The screening was conducted in the field so the results may have been affected by local variations in the nematode population. It was therefore decided to repeat the screening, both in the original field - which is being maintained for screening work - and in a greenhouse.

For the greenhouse screening, the soil was artificially infected with 20 000 eggs/kg. The results confirmed that woollypod vetch is highly resistant under both field and greenhouse conditions. Narbon vetch and 13 of the 28 common vetches showed tolerance, while 15 of the common vetches failed to repeat their performance of the previous year.

With peas, the greenhouse screening did not reveal any selections which could be classified as resistant to cyst nematode, although there are five accessions that have repeatedly shown some tolerance both in the field and under artificial conditions. Chickling vetches (*Lathyrus sativus* and *L. ochrus*) are also attacked by cyst nematodes, and screening has identified several accessions of *L. ochrus* that are resistant or tolerant.

Other highlights in 1986

- A protein supplement of cottonseed meal was found to be as good as soybean meal for fattening lambs. In Syria, cottonseed meal is half the price of soybean meal, and it does not need to be imported.
- Ewes that were fed concentrates and also allowed to graze on marginal land produced more milk than those that received only concentrates – even when the rations supposedly met all their nutritional requirements.
- It can be highly profitable to put ewes on a diet of straw and concentrate. The best-fed ewes produced about 140 kg of milk during a lactation.

- *For a detailed scientific account, request* PASTURE, FORAGE AND LIVESTOCK PROGRAM ANNUAL REPORT FOR 1986, *publication* ICARDA-111 En.

Farming Systems

In the agricultural economies of West Asia and North Africa, wheat and barley have complementary roles. Wheat is grown for human consumption, barley largely for animal feed. Less drought-resistant than barley, most wheat is grown in areas with more than 350 mm mean annual rainfall. Barley predominates in drier areas (200-350 mm rainfall).

In the past, wheat has received much the larger share of the human and financial resources of national research programs but, in recent years, ICARDA has given special attention to farming systems based on barley and livestock for the drier areas. The relevance of these efforts is underlined by projections to the year 2000 made by the International Food Policy Research Institute (IFPRI). These show that the gap between supply and demand for wheat is likely to level off, but that for feed grains like barley will continue to rise steeply.

In the barley-livestock system, farmers obtain the greater part of their income from the livestock, mostly sheep. That income is almost invariably low and, as a group, these farmers are among the poorest in the region. Their environment is harsh, and its limited resources are under pressure from increasing population. Little researched, the system, its problems and potential, are still poorly understood.

ICARDA has been working in the barley areas of Syria for nearly 10 years. It has shown that yields are small, not simply because there is little rain, but because poor soil fertility prevents efficient use of the rain that does fall. On many farmers' fields, only 15% of the rain is used by the crop, while the remainder is lost as evaporation from the surface of the soil. Lack of phosphate is the most widespread cause of poor fertility, but this can be corrected, and barley yields can be much increased by applying phosphate fertilizer. In good years, and where barley is grown as a continuous crop (as opposed to the traditional 2-year barley/fallow rotation), nitrogen also produces a response that is important and can be economic.

Nevertheless, many poorer farmers cannot afford fertilizer without financial assistance. So, over the last few years, ICARDA has cooperated with the Syrian Soils Directorate in a set of barley trials to determine precisely how production and profits would increase if farmers had fertilizer available. For ICARDA, this work also provided an opportunity to test and improve its methods for on-farm trials. It is hoped that the experience will also be of value in planning research for barley-producing areas in other countries.

Fertilizers on barley in Syria

In 1985/86, we carried out 22 two-replicate trials placing four levels of nitrogen and phosphorus on Arabi Aswad barley in farmers' fields in Hama, Aleppo, Raqqa and Al-Hassakeh provinces. Grain and straw production were both significantly increased by phosphate fertilizer at 21 sites and by nitrogen fertilizer at 11 sites (Fig. 6). Compared with control experiments when no fertilizer was applied, the most intensive phosphate applications, 90 kg/ha, increased grain yields by from 170 to 1170 kg/ha (mean 540 kg/ha) and straw yields by from 100 to 1590 kg/ha (mean 800 kg/ha); similarly, the most intensive nitrogen applications, 60 kg/ha, increased grain yields by from 0 to 1060 kg/ha (mean 190 kg/ha) and straw yields by from 0 to 1330 kg/ha (mean 410 kg/ha). Even where rainfall was only 147 mm and the soil was very shallow (at Jebsh-el-Dgherat in Al-Hassakeh province), phosphate doubled total dry-matter production from 800 to 1600 kg/ha.

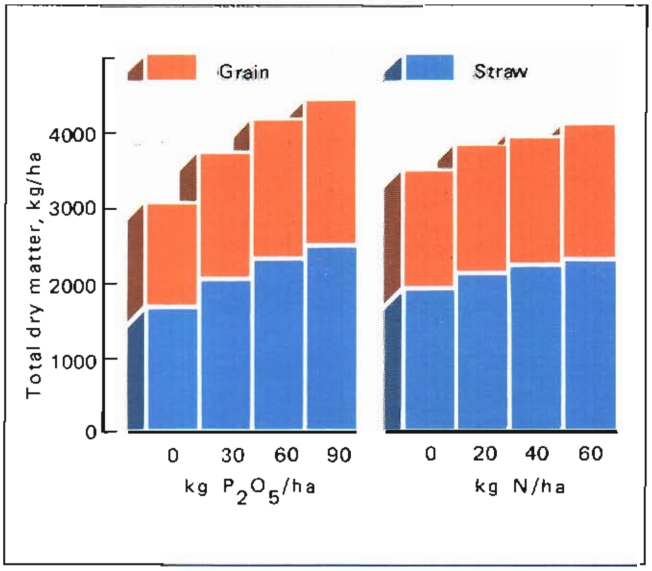


Figure 6. Mean yield responses of barley to phosphate and nitrogen fertilizer in twenty-two on-farm trials.

Economic analysis showed that the best results came from using the two fertilizers together. Nitrogen without phosphate gave little or no net revenue, and phosphate by itself was only moderately profitable; but, with phosphate and nitrogen together, the rate of return on investment could exceed 100 per cent.

At Tel Zatar, as elsewhere, barley plots fertilized with phosphate (left) gave dramatic increases in early growth as well as ultimate grain yield.

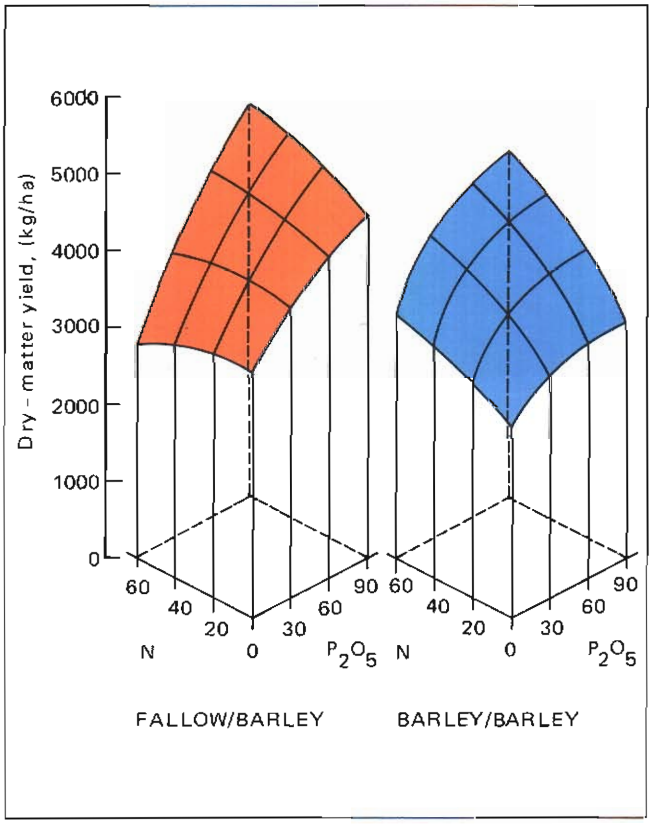


Figure 7. Six paired trials: fitted surfaces show effects of nitrogen and phosphate fertilizer on barley following fallow, as compared with barley following barley.

The opportunity was taken to compare the response of barley on fields that had been fallowed in the previous year with that on fields where barley was being grown for the second year in a row. There were six paired comparisons, the fields in a pair being adjacent to each other. When not fertilized, fields that had produced barley in the previous year did not do as well as those that had been fallow. However, fields that were producing barley for a second year showed a much stronger response to nitrogen (Fig. 7), and this to a degree that could not be explained merely by the difference in available nitrogen in the soil at planting time.

Farmers explain their interest in using fertilizer.

During the 1984/85 season, socio-economic researchers visited 37 farmers associated with 11 experimental sites. The farmers were those collaborating with the project, others from the same village, and others from neighboring villages. One purpose was to find out what farmers thought of the trials and to discover what problems they might have in obtaining and applying fertilizer. Another was to get a better understanding of their practices and economic conditions in order to assess whether it would be feasible for them to adopt the use of fertilizer.

All farmers reported that the trials were interesting, useful and successful. Within a year the number of farmers using fertilizer increased from 11 to 35 per cent of those monitored. Another 35% of farmers indicated they would like to use fertilizer but faced problems: of these, the most important were lack of money or credit, and fertilizer not being available.

Recently, as a result of the trials, the Syrian Government has approved the use of fertilizer by farmers in dry areas and is providing credit for its purchase. The potential impact of this decision is considerable. Even with a set of very conservative assumptions about management practices and the rate of adoption, fertilizer could increase the production of barley grain in Syria by about 160000 tonnes.

Whole-farm analyses

Farmers operating in the barley-livestock areas of Syria manage, with mixed success, to nourish sheep by a combination of grazing (common native pastures, cereal crops and stubbles, and other crop residues) and hand-feeding (grains, straws and purchased supplements, such as cottonseed cake and wheat bran). Thus, barley crops may be sold, grazed directly or hand-fed. Lamb sales are the chief source of revenue, followed by sales of milk products (cheese, yoghurt and ghee) and cull ewes.

A farmer may want to shift to higher-input cropping, such as a fertilized barley/forage-legume rotation, and thus increase the size of his flock, but he must first consider a complex set of cost factors, as well as the nutrition requirements of his sheep. ICARDA researchers are studying the interactions inherent in the combined management of crops, livestock and native pasture by farmers in different areas.

Such studies are facilitated by a standard method of farm management research, called linear programming. This allows simultaneous, quantitative consideration of known relationships and constraints within a particular farming system, and is useful for indicating how management practices can be optimized.

One example, using results from experimental flocks and crop rotations at Tel Hadya, with 1985 prices, compared traditional barley/fallow with a high-input barley/vetch rotation on 10 ha of farmland, and assumed that another 10 ha of native pasture was available. With the shift to the high-input rotation, the calculated economically optimum number of ewes increased from 20 to 57, and whole-farm profits rose from 6200 SYP to 14800 SYP. Optimum use of the vetch included some hay production for winter feed and some grazing of vetch pasture in spring. The increase in the amount and quality of available feed, due to the vetch crop, allowed more complete use of barley stubbles.

Such whole-farm analyses allow the integration of experimental results, survey data and historical or anticipated future price levels in predictions of how new farm technologies will balance or change farming systems. This is an essential step in anticipating the impacts of new technologies and for identifying directions of research which are likely to be most fruitful.

Herbicides enhance food-legume production

Both lentil and chickpea are important crops in the wetter areas of Syria, but yields are low and variable, and farmers' profits are declining. Farmers usually sow lentils several weeks after the rains have started so that they can kill germinated weeds during the sowing process. In trials that were managed jointly with farmers at 20 locations in Syria, we sowed as soon as the rain started, but with an application of herbicide (cyenazyne plus pronamide) and a dressing of carbofuran to control sitona weevils and the damage they cause to nitrogen-fixing root nodules. For the lentil crop, this combination of treatments resulted in large and consistent increases in yield and an average increase in net revenue of over 1500 SYP/ha.

Similarly, winter sowing of chickpea together with herbicide (turbutryne + pronamide) resulted in large increases in yields and an average increase in net revenue of over 2500 SYP/ha. Both these sets of results are encouraging, but must be viewed with some caution. Experience has shown that the increased yield and profit associated with improved legume production practices can be highly variable from year to year and between locations. Future work must identify the causes for this variability and shape recommendations that will give consistent benefits to farmers.

Supplemental irrigation

In rainfed agriculture, yields vary from year to year, largely because of differences in rainfall. Increasingly, wherever they have access to water, farmers are applying small amounts of irrigation to supplement and stabilize the supply of water for crop growth. However, the costs associated with supplemental irrigation can be large, and careful consideration of how much water to apply and when to apply it is necessary to achieve maximum economic benefit. Economic surveys in northern Syria have indicated that the net income of farmers using supplemental irrigation was 3 to 10 times greater than that of comparable farmers who did not have access to water and needed to rely wholly on rainfall.

Wheat is the crop that is most often considered for supplemental irrigation. At one on-farm trial in a dry area, where normally only barley can be grown, wheat yields were increased by more than 3000 kg/ha when the season's rainfall (220 mm) was supplemented with 120 mm of irrigation.

Currently, in conjunction with FAO, we are conducting a regional survey to quantify the existing benefits that are being derived from supplemental irrigation and to assess the potential for the future.

– *For a detailed scientific account, request* FARMING SYSTEMS PROGRAM: ANNUAL REPORT FOR 1986, *publication* ICARDA-10 En.

Cereals

ICARDA has a global responsibility for research on the improvement of barley and, with CIMMYT, a joint regional responsibility for the improvement of bread wheat and durum wheat. ICARDA's target areas for cereal improvement are those with low to moderate rainfall (200-600 mm), as well as those at elevations above 1000 m and with a Mediterranean-continental climate.

Per-capita cereal consumption in West Asia and North Africa is greater than anywhere else in the world, yet domestic production cannot keep up with demand. As a result, cereals continue to be imported at an increasing rate, causing depletion of the currency reserves of many countries in the area.

ICARDA assists national programs in their efforts to increase and stabilize winter cereal production in rainfed areas, particularly those where abiotic and biotic stresses severely affect productivity. To the extent that these efforts succeed, they improve the quality of life of vast populations that depend on barley/livestock or other cereal-based farming systems. Within our program, each project has a commodity focus with multidisciplinary research and training in agronomy, crop physiology, pathology, entomology, grain quality, germplasm development and transfer of technology, all integrated into a strong team approach.

Highlights

Table 6 shows barley and wheat varieties that have been released in partnership with national programs, ICARDA, and CIMMYT.

Table 6. Cereal varieties released.

Country	Year of release	Variety
Barley		
Cyprus	1980	Kantara (Roho)
Tunisia	1985	Taj (WI 2198)
	1985	Roho
	1985	Faiz (ER/Apam)
	1986	Rihane 'S'
Qatar	1982	Gulf (Aut/Aths)
	1983	Harmal
China	1986	Gobernadora
Mexico	1986	Mona/Mzq/DL71
Jordan	1984	Rum (6-row)
A.R.Yemen	1986	Arafat (Arrivat x LD8)
	1986	Beecher
Ethiopia	1981	BSH15
	1984	BSH 42
	1985	ARDU
Iran	1986	Aras (Aramir)
Morocco	1984	Asni
	1984	Tamellat
	1984	Tissa
Pakistan	1983	Jau-83.
Portugal	1982	Sereia (Arivat/Norvegvesa).
	1983	CE 8302 (Ribeka/Union).
Saudi Arabia	1985	Gusto.
Durum wheat		
Cyprus	1982	Mesoaria (Anhiga'S' x Volunteer)
	1984	Karpasia (Sham 1)
Egypt	1979	Sohag (Stork'S')
Morocco	1984	Marzak (E12-BD11)
Libya	1985	Marjawi
	1985	Stork
	1985	Ghoudwa (Cimaron sari/Bursa)
	1985	Zorda (Gdo 469/AA)
	1985	Baraka
	1985	Qara (Fg/Bo)
	1985	Fazan (D-25)
Portugal	1983	Celta (Sham 1)
Syria	1984	Sham 1
Algeria	1986	Sahl
	1986	Waha
	1982	ZB X FG 'S'/LUKS GO
	1984	Timgad
Tunisia	1986	21563-AA'S' x Fg'S'/ Dm 69-331
Greece	1982	Selas (GR-09673)
	1983	Sapfo
	1984	Skiti (Sahl)
	1985	Samos
	1985	Syros (Sham 1)
Bread wheat		
Iran	1984	Golestan (Alondra 'S')
	–	Azadi
Libya	1985	Zellaf
	1985	Sheba
	1985	Germa
Morocco	1984	Jouda (Kal x Bb)
	1984	Merchouche
PDR Yemen	1983	Ahgaf (S 311 x Norteno)
Sudan	1982	Debeira (HD 2172)
Syria	1982	Sham 2
	1986	Sham 4
Tunisia	1986	Snb 'S'
Egypt	1980	Sakha 61
	1980	Sakha 69
	1982	Giza 160
A.R.Yemen	1983	Marib 1
Algeria	1982	Setif 82
	1982	HD 1220
Ethiopia	1984	Dashen
	1984	Batu
	1984	Gara
Greece	1983	Louros
	1983	Pinios
	1983	Arachthos
Portugal	1986	LIZ 1
	1986	LIZ 2

Durum lines Sebou and Kourifla are under consideration for release in Syria. Kourifla is adapted to dry areas and possesses improved gluten strength, and it is also being considered for release in Jordan and Cyprus.

Morocco, Tunisia, and the Arab Republic of Yemen invited ICARDA scientists to review their barley and wheat research and production activities with the objective of developing more efficient and cost-effective programs, and to recommend priorities.

Training was geared to strengthen the capacities of national programs through specialized short courses, degree training, individual training, and residential in-country training. More visits to ICARDA by senior national scientists are helping to promote greater interaction between ICARDA and national programs.

During 1985/86, considerable progress was made in refining breeding strategies for barley, durum wheat and bread wheat in the rainfed areas. Results show that genotypes selected under less than 250 mm of rainfall, as well as under moderate rainfall, performed better under drought stress and in moderate rainfall areas than did barley or wheat genotypes selected in stress-free environments.

The utilization of the variability in landraces has been shown to be useful in improving barley yield in harsher environments. Some barley genotypes with improved agronomy yielded over 2000 kg/ha in areas with less than 250-mm rainfall, against the farmers' average of 500 kg/ha.

Wild germplasm and primitive forms of wheat and barley were collected in Jordan for use in breeding programs.

The durum wheat improvement project provided national programs with germplasm developed to meet their specific needs. Through multilocation field tests, genetic stocks possessing frost tolerance and earliness, drought and heat tolerance, septoria and common bunt resistance, and high yields were identified. Several durum wheat entries gave grain yields larger than those of local checks in on-farm trials conducted by national programs.

The bread wheat improvement project has identified parent lines with desirable genes for yield, disease resistance, and nutritional and industrial quality. They were screened for frost, heat and drought tolerance, at several field locations in advanced yield trials. New sources of genetic variability were identified by the introduction and recycling of materials from national programs in West Asia and North Africa.

In the high-elevation cereal research project, three disease-resistant, high-yielding lines were identified at Tehran, Iran. Genes for high grain protein, disease resistance (yellow rust), and cold tolerance have been transferred into *T. durum* from *T. turgidum* var. *dicoccoides* through interspecific hybridization.

Tests carried out in collaboration with the Grain Research Laboratory, Winnipeg, Canada, on semolinas and malts verified the ranking of durum wheat and barley genotypes made at ICARDA's cereal quality laboratory on the basis of simple tests (e.g. SDS sedimentation, kernel characteristics and saccharifying activity) used for early-generation screening. As a result of ICARDA's cereal-quality training, a network of cereal technologists is developing in the region. Future plans include the exchange of reference samples and interlaboratory collaboration.

ICARDA distributed more genetic stocks and segregating populations to national programs than in past years. Programs with less resources and manpower received only selected advanced lines. Emphasis was placed on developing germplasm to meet specific agroclimatic conditions. Over 1400 sets of international barley, durum wheat and bread wheat nurseries were dispatched to 115 national cooperators at their request. National programs were encouraged to use the ICARDA International System to test their most advanced lines throughout the region and beyond.

Physiology/agronomy studies have shown that deep sowing, close row spacing and early planting promote barley production. Factors associated with grain yield included slow leaf senescence, leaf rolling during early growth, greater number of heads/m^2, and early-stage prostrate growth. Other studies pointed out that different improvement strategies should be used for each cereal species.

The cereal pathology project is now screening for eight major cereal diseases, including covered smut and the barley yellow dwarf virus (BYDV). BYDV screening was conducted at Tel Hadya using artificial inoculation with aphids infected with the PAV strain of BYDV. In addition, lines from Mexico are being screened for BYDV at Tel Hadya, with selected lines from ICARDA being screened at Quebec. The development of germplasm pools for sources of resistance has been improved. Four such pools (yellow rust, *Septoria tritici* blotch, common bunt in wheat, and scald in barley) are now available to breeders.

Entomological research at Tel Hadya identified one barley line, four durum wheat lines, and two bread wheat lines with resistance to wheat-stem sawfly. Only one bar-



Diseases and insect pests cause severe losses to cereal crops. These pictures show infection by yellow rust (left), common bunt (right) and Suni bug (middle).

ley line possessed moderate resistance to aphid infestation. Analyses of past results revealed that currently measured plant variables do not explain the variation observed in insect infestation.

Barley

In view of the significance of barley in the drier areas, the barley improvement project receives the largest allocation of resources. The work for 250-400 mm rainfall areas has produced higher-yielding, disease-resistant barley lines, and several varieties have been released by national programs. During the last two years, the new thrust for improving barley for areas with less than 300 mm rainfall has shown excellent results. The use of the bulk-pedigree method and the multilocation testing of early segregating populations has indicated that: (1) selection in the presence of stress is possible and is more efficient than selection in the absence of stress, and (2) different morphophysiological plant architectures are needed to maximize yields in stress and in non-stress environments. The evaluation and utilization of barley landraces has led to the identification of lines capable of producing better grain yields than the existing cultivars under moisture, nutrient and temperature stress. Mixtures of selected lines are being tested in different environments to compare their yields with those of pure lines. Evaluation of the *H. spontaneum* collection resulted in the identification of a number of useful accessions. Crosses between *H. spontaneum* and *H. vulgare* that performed well in very dry conditions (200 mm) were identified and will be further improved through backcrossing. As part of the project to develop new material for high-elevation environments, more attention will be given to germplasm for areas with long cold winters and a short, often dry, spring.

High priority is given to disease resistance, particularly to scald, barley stripe, powdery mildew, covered smut, BYDV and net blotch. Development of germplasm pools for sources of resistance to specific diseases and their improvement to ensure reasonable resistance to other diseases is receiving increased attention Also in-

Evidence accumulates to support the thesis that genotypes selected in very dry areas (less than 250 mm rainfall) can confront drought more successfully than those selected in favorable environments. Tadmor, a pure-line barley identified through direct selection from a Syrian landrace under severe stress, has been consistently excelling the local cultivar on farmers' fields in these very dry areas.

depth study of specific diseases is now a component of barley pathology. A collaborative project with Montana State University, funded by USAID, is concentrating on strengthening the research capabilities of national programs in barley pathology. This joint project strives to develop a network of national, university and international research teams aimed at developing high-yielding barley cultivars with broad-based resistance to major diseases. This includes studying and collecting resistance sources; establishing nurseries and planting them in "hot spots"; and developing barley disease screening centers in national programs so they can take over responsibility for virulence studies. Also, work on resistance to the principal insect pests of the region, particularly wheat-stem sawfly, aphids, suni bug and Hessian fly, will be continued through sub-regional collaborative projects between ICARDA, national programs and institutions in developed countries.

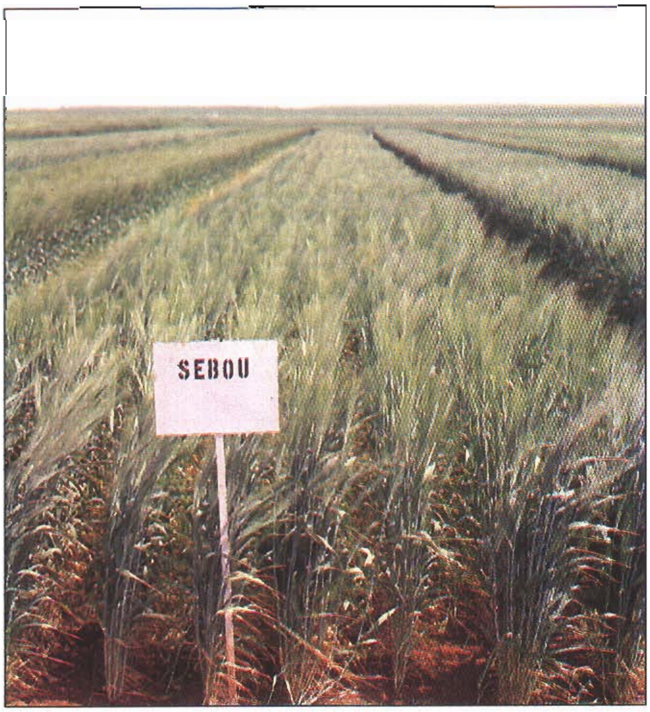
The Cereals program has increased its efforts to develop barley germplasm for specific target areas in West Asia and North Africa. In the future, it will work towards fulfilling its global responsibility for barley: in the Indian sub-continent, sub-saharan Africa, the Far East and the Andean region. Developing lines and cultivars suited to Latin America is the primary objective of ICARDA's breeder posted at CIMMYT, Mexico, in the joint CIMMYT/ICARDA barley improvement project.

A collaborative project between Italian institutions and ICARDA to improve yield stability of barley in stress environments has been funded by the Italian Government. The activities of the project include basic and applied research on environmental stresses such as cold and drought.

Durum wheat

Durum wheat is grown on about 9 million hectares in West Asia and North Africa (about 45% of the total world area devoted to the crop). In Syria, Jordan, and North Africa, it accounts for about 70% of the total wheat area. Durum wheat is grown under drier conditions than bread wheat, and most of the crop is grown without irrigation. The joint ICARDA/CIMMYT durum improvement project places special emphasis on stabilizing yield and improving resistance to diseases and pests, without sacrificing grain quality. For the 300-500 mm rainfall areas, the project aims to develop germplasm and production technologies that would give dependable yields in poor years, but would also yield well in good years. It includes studies of parental materials for tolerance to specific stresses; hybridization of superior genotypes to combine desirable traits; selection under moderate stress; and evaluation of selected materials at carefully chosen sites that represent a range of stress environments.

In cooperation with national programs, special attention is given to selection for increased resistance to yellow rust, leaf rust, stem rust, septoria blotch and tan spot. Screening for resistance to common bunt, yellow rust, leaf rust, leaf rust, septoria blotch and BYDV is handled from the base program. Development of germplasm pools for sources of resistance to specific diseases is an important objective in cereal pathology. Selection for resistance to wheat-stem sawfly, suni bug, aphids and Hessian fly, is also receiving serious attention.



Sebou is a new high-yielding durum wheat variety which has attracted the interest of several countries. It has been released to farmers in Lebanon.

The durum wheat project has been successful in providing national programs with stable and high-yielding cultivars. The resistance of the new germplasm to the most prevalent diseases is greatly improved, particularly to yellow rust and *Septoria tritici*. The use of landraces, *dicoccoides* and wild relatives in the crossing programs, and selection of segregating populations at stress-specific sites has generated high-yielding cultivars with improved biotic and abiotic stress tolerance. Examples of successful varieties from such crosses are:

Crosses with landraces:

1. Omrabi (cross Jori with Haurani)
2. Kabir (cross Fg with Senator Cappelli)

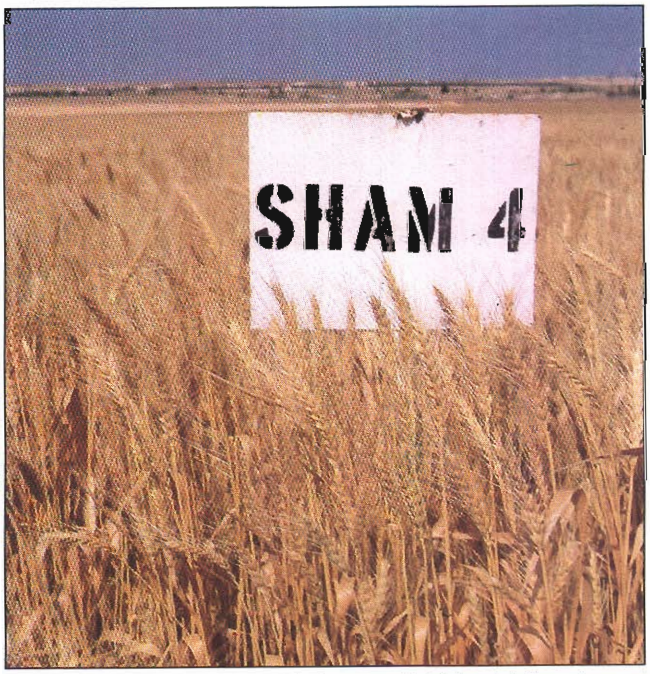
Crosses with wild relatives:

1. Sebou (cross Cr with *T. polonicum*)
2. Sahl (cross Cr with *T. dicoccum*)

In a joint program with the University of Hohenheim, breeding lines are screened for cold tolerance and photoperiod reaction. In cooperation with the University of Tuscia, Viterbo; the Institute of Germplasm, Bari; and ENEA in Italy, the Cereals and Genetic Resources programs at ICARDA have strengthened the work on the evaluation, documentation, and utilization of durum wheat landraces and wild relatives.

Bread wheat

Bread wheat is first among the food crops in the region. More than 65% of the crop is rainfed, and 50% of the area receives less than 400 mm. Therefore, the ICARDA/CIMMYT bread wheat improvement project concentrates on improving bread wheat for tolerance to drought, cold winters and hot spring and summer seasons. In cooperation with national programs, efforts are being made to speed the development of multiple disease resistance and adaptability to a wide range of environments. Increased attention is paid to improved resistance to foliar diseases (rusts, septoria) and others, such as common bunt and BYDV. Germplasm pools have been developed for sources of resistance to common bunt, yellow rust, and septoria blotch, and are now being extended to give reasonable resistance to other diseases. Screening and breeding efforts for resistance to wheat-stem sawfly, suni bug, aphids, and Hessian fly will be strengthened, and attention will continue to be given to the nutritional and industrial quality of grain.



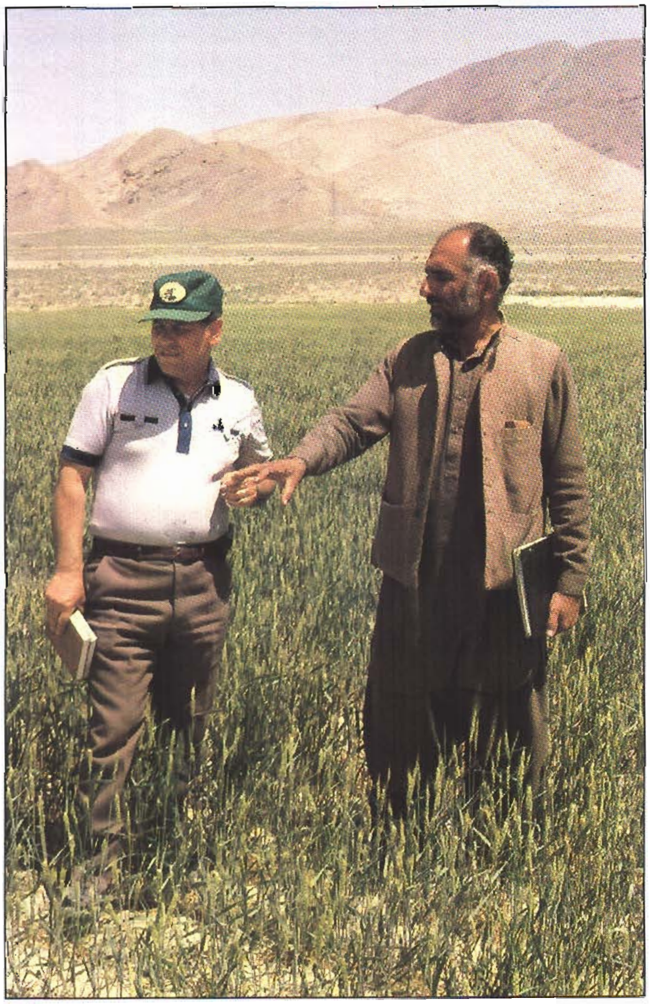
Sham 4 is a disease-resistant and high-yielding bread wheat variety with excellent grain quality. It was released to the farmers in Syria and Tunisia in 1986, and is under seed multiplication in Algeria, Morocco, Lebanon, and Turkey.

In international yield trials and observation nurseries, efforts are made to target the germplasm for low and moderate rainfall areas. These nurseries are sent to those areas for which the germplasm has been specially developed. In on-farm trials in cooperation with the Farm Resource Management program and with national programs, more attention will be paid to improving the agronomy of wheat production by applying known technology for control of weeds and use of fertilizers, etc.

Cereals for high-elevation environments

Seven countries in the ICARDA region have significant areas at high elevation (more than 1 000 m) with a Mediterranean continental climate. Although about one-half of the total wheat area in the region falls in this category, production per unit area is small (except in Turkey). Suitable genotypes and production technologies are not available. The varieties that are available are susceptible to diseases and to stresses such as cold, drought, and heat.

The project has two major components: first, germplasm development and testing; second, development of improved production technology in cooperation with national programs. One scientist at Tel Hadya, with the support of other breeders, develops the winter x winter and winter x spring type material. Early and advanced generations are then tested at suitable high-elevation locations in Pakistan, Morocco, Turkey, Iran and Syria.

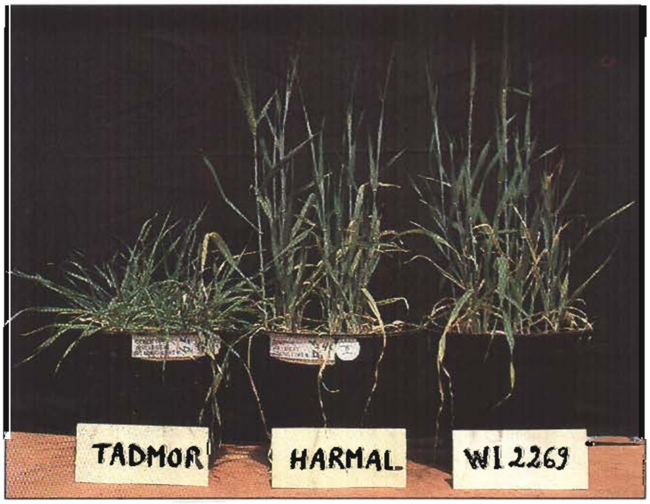


In Baluchistan, ICARDA and Pakistani scientists evaluate the performance of the germplasm specifically developed for high-elevation areas. Such germplasm is also simultaneously tested in the high-elevation areas of Turkey, Morocco, and Iran.

Attention is paid to screening the germplasm against the major diseases, i.e. yellow rust, common bunt and tan spot. Resistant germplasm for yellow rust and common bunt is now available, and screening for tan spot will be intensified. The germplasm developed has proved useful in large areas in the region, particularly in Iran, Pakistan, Eastern Turkey, and the Atlas Mountains in North Africa. The work currently accounts for 6% of the Cereals program budget, and will be stengthened.

Physiology/Agronomy

This component of the Cereals program aims to support the commodity projects in an interdisciplinary effort to generate well adapted, stable and responsive varieties. The 1985/86 season was devoted to understanding barley and wheat plant behavior under abiotic stresses prevalent in the Mediterranean environment. Some interesting results have been reported. The long-term targets of the project are to: (a) identify specific plant and crop attributes representing the traits that confer survival and productivity, (b) make comparisons between and within cereal species in terms of morphological and physiological attributes, and study the simulated effects of changing genetic parameters, (c) search for simple (integrative) parameters representing the physiological attributes that correlate with the plant and crop responses to stress in terms of yield, (d) demonstrate that enough genetic variability exists within cereal species to warrant plant selection and that selection and recombination with other characters is feasible, (e) develop appropriate agronomic practices based on the phenology of the crop, genotype characteristics and environmental conditions, and (f) provide training and transfer of technology methodologies to national programs.



Photothermal responses of flowering are useful for identifying genotypes appropriate for a given environment. Here, the genotype Tadmor did not flower when low-temperature requirements were not met.

Outreach activities

As a consequence of ICARDA's support over the years, several national cereal programs are changing from receiving to providing valuable germplasm, information and assistance to each other. For example, Cyprus is an important partner in identifying early-maturing barley and durum wheat lines for areas with mild winters and low rainfall; Egypt is taking a leadership role in identifying barley and wheat lines resistant to aphids; Morocco is developing Hessian-fly resistant cereal germplasm; and Tunisia recently supplied the barley variety Rihane to Algeria for on-farm demonstrations.

Syrian farmers present a plaque to ICARDA's cereal scientists in appreciation of the new or improved technologies that are now available to them.

Besides strengthening relations with individual countries, the Cereals program is active in the development of small networks based on sub-regions. These networks give leadership and responsibility to national programs and promote faster, closer collaboration. Such a network is starting in North Africa, comprising Algeria, Morocco, Tunisia and the Iberian peninsula. A similar network is being developed for the Nile Valley countries of Egypt, Sudan, and Ethiopia, while the Yemen Arab Republic and the People's Democratic Republic of Yemen may join at a later stage; and another such network is foreseen for Latin America. A network to cater to the needs of winter-habit barley and wheat is being considered for parts of Pakistan, Afghanistan, Iran, Turkey, Morocco and Algeria. Countries of West Asia growing spring-habit barley and wheat are being encouraged to form a network to handle their common production constraints.

Interaction with Turkey was strengthened during 1985/86. Winter-habit ICARDA barley and wheat germplasm have been planted in Ankara for evaluation of winter hardiness and possible suitability for other high-elevation areas. For the first time, land and other facilities were provided by the Central Anatolian Agricultural Research Institute. An International Conference co-sponsored by ICARDA and Turkey will be held in Ankara in July 1987 to promote a better understanding of the agroclimatic conditions and production constraints of the high-elevation areas, and to initiate a functional network. Interaction with Iraq, Yemen Arab Republic, Ethiopia, Portugal, Spain, Italy, France and Greece was strengthened during 1985/86.

In the 1985/86 season, a pilot project for the verification and adoption of improved wheat production technology by farmers was started in Sudan with financial support from the OPEC Fund. With financial and technical support from France, another project was started to increase production and strengthen research on cereal, food legume and forage crops in Algeria. Projects to strengthen research and production on barley and wheat in Ethiopia, Sudan and Egypt were developed for outside funding.

Collaborative arrangements were made with specialized institutions such as the Plant Breeding Institute, Cambridge, Reading University and the University of London with the support of ODA; with the University of Tuscia, Viterbo, and the University of Perugia with the support of the government of Italy; with Montana State University, the USDA, and Oregon State University with the support of AID; with the University of Cordoba and ETSIA, funded by Spain; and with INRA, Montpellier, funded by France.

Through developing collaborative projects with French and Japanese institutions, ICARDA plans to use biotechnological tools, such as haploid breeding using *H. bulbosum*, embryo rescue in wide crosses, and selection at the cellular level for some biotic and abiotic stresses. However, conventional breeding will continue as a mainstay.

A request from Morocco was answered by posting a senior cereal scientist to assist in coordinating the national cereal program in that country. He will also work in other North Africa countries as a regional cereal scientist. On the other hand, after six years of providing assistance to Tunisia in the establishment of a national barley improvement program, the cereal scientist assigned to the Tunisian program was withdrawn, as Tunisia's national capability is now well established.

During 1986, efforts on evaluation, documentation and utilization of primitive forms and landraces of barley and durum wheat were strengthened with financial support from the government of Italy. Several collections, identified for tolerance to drought, cold, heat, salinity and diseases, were provided to breeders and pathologists.

International nursery system

For 1986/87, 850 cereal germplasm nursery sets were sent out from Aleppo in response to specific requests from 91 cooperators in 44 countries, mainly in West Asia and North Africa.

The requests for specific-purpose nurseries have been increasing from national programs. In 1986, a large number of nurseries consisting of germplasm tolerant of abiotic and biotic stresses (drought, cold, salt, diseases) were sent to cooperators.

The Heat, Drought and Cold Tolerance Observation Nurseries were prepared and other trait-specific nurseries will be prepared, if requested by national programs. More early-generation germplasm and genetic stocks are supplied now than in the past.

For the first time, data received from cooperators were immediately analyzed and preliminary results conveyed to them. In-depth analysis of the data will also be carried out and reported, and newer tools to understand genotype x environment interaction will be employed.

– *For a detailed scientific account, request* CEREAL IMPROVEMENT PROGRAM: ANNUAL REPORT FOR 1986, *publication* ICARDA-112 En.

Food Legumes

Although faba bean, lentil and kabuli chickpea are of minor significance in global agricultural production and trade statistics, they are of immense value in the rainfed farming systems of the arid areas of West Asia and North Africa. Here these crops, taken together, are second only to cereals. They provide a source of inexpensive, high-quality protein in the diets of people (many of whom cannot afford adequate meat and dairy products), rich crop residues for animal feed, and a renewable source of fertilizer through their ability to fix nitrogen from the air. Indeed, they figure very importantly in crop rotations with cereals: without the legume option, land would need to be left in unproductive fallow, or artificial nitrogen fertilizer would need to be applied. Keeping the legume option in cereal-based farming systems, not only helps to maintain soil fertility, it also helps to break cycles of diseases, weeds and insect pests.

The three legumes originated in the region and, for centuries, they have been grown without any mechanism in place for achieving genetic improvement. This, in fact, is the chief reason why their productivity has been so low: the landraces have inherently poor yield potential, and they are susceptible to damage by diseases, insects, nematodes, and parasitic weeds, as well as to extremes of weather (cold, heat and drought).

Traditionally, the legumes are harvested by hand and, as labor costs increase, they have become less profitable for farmers. Lentil in particular is so costly to harvest that many farmers avoid planting it. By improving yields and by reducing the costs of harvesting, ICARDA seeks to restore the incentives and ensure that the legume/cereal system retains its role in dry-land agriculture.

Although it was challenged by the CGIAR's Technical Advisory Committee, ICARDA sees its food-legume breeding program as yielding results that could have a far-reaching impact. The prospects for faba bean are particularly interesting and, in the next few years, we may be seeing the first commercial hybrids. Winter-sowing of suitable cultivars of chickpea is already proving that it can result in a marked increase in production, and the development of cultivars of lentil suitable for mechanical harvesting may rescue an important crop from decline. These achievements are presented in greater detail in the following sections. As a result of the confidence demonstrated by the Federal Republic of Germany, ICARDA is now assured that these programs will continue for the next several years. By then, we expect to have put in place, for each of the three crops, a set of cultivars that will be adapted to the main agro-ecological situations in the region. We shall seek to transfer our breeding strategies to national institutions (indeed, a major training effort on faba-bean breeding was carried out in 1986) and to continue to provide parental stock. Thus, it should be possible to give farmers a long-term assurance that they can earn profit by retaining a legume year in their crop rotations.

Chickpea

Chickpea is the most important food legume in the ICARDA region: it accounts for 34% of total production, as against 18% for faba bean and 14% for lentil.

The kabuli chickpea, characterized by large beige seeds shaped like a ramshead, is the one for which ICARDA shares responsibility with ICRISAT. (The other, the desi chickpea, is ICRISAT's own responsibility). Chickpea is eaten mostly as a kind of paste made with sesame and olive oil and called *Hommos-bitehineh*, or in a fried form called *Falafel*. Both are used as sandwich fillings. It is also eaten as parched or roasted seeds and in soups.

Unlike lentil and faba bean, which are grown in winter, chickpea is grown in the spring in West Asia and North Africa. This is because it is susceptible to ascochyta blight, which is promoted by humid and moderately cold conditions. But it also means that the reproductive stage of chickpea falls in periods when rainfall is low and temperatures are high, and these conditions bring about low and unstable yields.

ICARDA scientists have now helped develop new cultivars of chickpea resistant to both ascochyta blight and cold, which, when sown in winter, produce between 50% and 100% more seed than spring-sown chickpea (Table 7). The higher yields are due to better utilization of moisture; a greater germination of the seeds planted (95% as against 75% for spring-sown); better nodulation of the roots, with almost 100% more atmospheric nitrogen fixed in winter than in spring; and less damage by insects and birds.

Table 7. Yields of winter- and spring-sown chickpea cultivars averaged over four locations in Tunisia, 1985/86.

	Planting season and yields, kg/ha		
Cultivars	Winter (early Dec.)	Intermediate (mid-Feb.)	Spring (early April)
FLIP81-56W	1635	1260	484
ILC 482	1868	1183	479
ILC 3279	1537	1164	409
Local check	1745	1248	517
Mean	1696	1214	472

Table 8. Food legume cultivars released.

Country	Cultivars released	Year of release	Specific features
Kabuli Chickpea			
Cyprus	Yialousa (ILC 3279)	1984	Tall
	Kyrenia (ILC 464)	1987	Large seeds
Syria	Ghab 1 (ILC 482)	1982/86	High yield, wide adaptation
	Ghab 2 (ILC 3279)	1986	Tall, cold tolerant
Spain	Fardan (ILC 72)	1985	Tall, high yield
	Zegri (ILC 200)	1985	Mid-tall, high yield
	Almena (ILC 2548)	1985	Tall, high yield
	Alcazaba (ILC 2555)	1985	Tall, high yield
	Atalaya (ILC 200)	1985	Mid-tall, high yield
Tunisia	ILC 3279	1986	Tall
	FLIP 83-46C	1986	Large seeds, high yield
	Be-sel-81-48	1986	Large seeds
Lentil			
Ethiopia	ILL 358	1984	Rust resistance
Tunisia	ILL 4400	1986	Large seeds, high yield
	ILL 4606	1986	Large seeds, high yield

A local cultivar (right) is killed by ascochyta blight when sown in winter, but ICARDA's cultivar, Ghab-2, is resistant to this disease.

The practice of winter-sowing is now rapidly spreading in the region, and the process has been hastened in four countries that have formally released cultivars that are selected from ICARDA nurseries. These are shown in Table 8. All except one of the chickpea shown in that Table were developed for winter-sowing; the one exception is Tunisia's Be-sel-81-48, which is resistant to fusarium wilt and was released for spring-sowing.

Other highlights in 1986

* Demonstration of the benefit to both winter- and spring-sown chickpea crops of supplemental irrigation during the reproductive phase of growth.

* Evaluation of many cultivars selected from ICARDA nurseries in on-farm trials or multi-location trials in Algeria, Cyprus, Egypt, France, Italy, Lebanon, Morocco, Oman, Pakistan, Syria, and Turkey.

* Development for the first time of very high-yielding, early-maturing and ascochyta-blight-resistant lines for spring sowing. These lines are also reasonably heat- and drought-tolerant.

* Development and distribution of lines with large seed size and tallness suitable for mechanical harvesting.

* Distribution of 497 sets of 11 types of nurseries to cooperators in 48 countries. Cooperation in the testing of kabuli chickpea has created perhaps the most extensive international network now in existence for any food legume. It is poised for making a major impact on production.

* With the screening of another 690 accessions, the total number of lines evaluated for resistance to ascochyta blight now exceeds 15 000. Several sources of location non-specific resistance have been identified and these are now being used in West Asia, North Africa, Europe, and the United States of America.

* Completion of a three-year study on yield loss due to ascochyta blight. No yield loss was observed in the resistant kabuli types, whereas in susceptible lines it reached up to 97%.

* Development of a herbicide package that can be safely recommended to farmers to control weeds that would otherwise heavily reduce the yield of winter-sown chickpea.

* Identification of a new cyst nematode infecting chickpea in Syria as *Heterodera ciceri* sp.n. Chickpea tolerates populations of *H. ciceri* <1 egg/cm^3 of soil, but yields are reduced by 50% when populations of the nematode reach 16 eggs/cm^3, and are completely lost at 64 eggs/cm^3.

Faba bean

The most important food legume throughout North Africa, faba bean is also the cheapest available source of protein. Millions of people in the Nile Valley begin each day with *ful*, a nourishing dish of stewed faba bean flavored with salt, oil and spices. Faba bean helps balance a cereal-based diet, and is sometimes mixed with vegetables to add variety and vitamins. The bean is eaten in both summer and winter, sometimes every day of the week, among urban low- and middle-income families. City-dwellers in Egypt eat about 9 kg a year, those in Sudan about 12 kg.

Faba bean is also an important cash crop for farmers: some Egyptians find 15-25% of their annual income from this source. In northern Sudan the crop is even more important to farmers, who sometimes receive 50% to 80% of their cash income from it.

Despite the importance of the crop over the past 3000 years, demand had outstripped supply by 1979. Once a profitable export, faba bean now has to be imported at double the local cost, and is not always available. In recent years, much of ICARDA's more applied research on faba bean has been carried out in the context of the Nile Valley project, and this was described in an earlier chapter. However, it is noteworthy that the work under this project has also identified germplasm that is significant for the more basic crop-improvement research. For example, lines have been developed that are resistant to prevalent diseases, such as chocolate spot in Egypt and root rot and viruses in Sudan, as well as a high-yielding cultivar tolerant to *Orobanche* (broomrape), a parasitic weed that can wipe out whole fields.

The basic research on faba bean that ICARDA has carried out is highly original, and for which national programs are not equipped. This research is aimed at turning the traditional crop into a new commercial one with profoundly different characteristics. For example, unlike European lines, which rely on insects for fertilization, some ICARDA lines are self-fertilizing. They can thus be used to produce genetically pure lines when grown in an insect-free environment, providing greater stability of yield. If genetically-pure lines can later be crossed with other lines, higher-yielding commercial hybrids might be developed — something that has so far proved impossible with European lines.

Pure lines of faba bean are developed in insect-free cages to prevent out-crossing.

ICARDA is also developing plants with physical characteristics that prevent them from lodging (falling over). These terminate in a flower at the top, which limits vegetative growth. They are 'determinate' types that offer the prospect of an entirely new kind of plant with more of its dry weight in seed and less of the inconsistency of yield that normal plants suffer because of excessive vegetative growth and flower- and seed-pod shedding.

Visiting scientist from China selects large-seeded determinate faba bean.

New plant types are also being developed with independent vascular supply to each flower pod, so that most flowers set and most pods remain on the plant until maturity. Crosses are being made between these plants and the new determinate types in order to combine the characteristics of the two.

In research on disease resistance, ICARDA's work has led to the development of lines, not found elsewhere, with stable resistance to multiple strains of chocolate spot. Such lines are now being used by breeders in Europe.

Other highlights in 1986

* Progress was made in incorporating the independent vascular supply trait and determinate growth habit into the same plant, and a capacity to produce larger seeds (up to 1.5 g/seed) was achieved, with consequent higher yield. Trials at Lattakia (a high-rainfall area such as is typical for faba-bean production) produced yields significantly better than those of local checks. We are confident that there are good prospects for commercial exploitation of these improved cultivars.

* The first year of on-farm trials of faba bean in Ethiopia showed that substantial increases in yield could be produced by introducing improved agronomic practices.

* Algeria, Egypt, Tunisia, and Yemen Arab Republic asked for larger quantities of seeds of several of the lines distributed to national programs, because of their superior performance. Faba bean breeders from Denmark, Egypt, Ethiopia, France, Tunisia, Turkey, and Yemen Arab Republic also asked for large numbers of breeding lines.

* With the evaluation of 840 pure-line accessions for 39 descriptors (traits), progress was made in compiling a faba bean germplasm catalog. ICARDA's pure-line collection is a unique source of variability for breeders worldwide. Several of these accessions have a high degree of auto-fertility and higher yield potential than the best adapted checks. The best yield was 7300 kg/ha against 6000 kg/ha for the best check.

* Resistance to chocolate spot, ascochyta blight and rust diseases was found in 118, 75 and 30 pure-line accessions, respectively. For the third consecutive year in three selections, from ICARDA crosses, multiple disease resistance was confirmed. Seeds of these will now be distributed to co-operating agencies.

No formally released faba-bean cultivars can yet be included in Table 8. With the problems of adaptability to different environments, and the marked tendency of faba bean to out-cross, the process of variety development takes significantly longer than for either chickpea or lentil. Nevertheless, ICARDA's early-generation lines are much in demand for enriching the germplasm available in landraces, and significant quantities of seed were sent to 13 countries in 1985/86.

Hand-harvesting and mechanical harvesting of lentil.

Lentil

One-third of the world's supply of lentil is grown in the region served by ICARDA. Yet, when ICARDA arrived on the scene, research was being done in only a few national programs. ICARDA has helped stimulate strong research thrusts in Turkey (the biggest exporter of the small red lentil), Jordan, Sudan, Algeria, Tunisia, Morocco, and Pakistan. It has also assembled the world's largest collection of lentil lines, all described and cataloged in a computer file.

ICARDA's interest in the crop stemmed from the fact that, despite its importance to the economy of the region, production was diminishing. The Center's research revealed that the reason was the practice of harvesting the crop by hand. Lentil-harvesting must be accomplished within an extremely short period -- 4 to 19 days depending on temperature. If that period is missed, the seeds are lost because the pods either fall or shatter. This means that laborers must be available when needed.

In recent years, labor has been hard to find and labor costs are so high that lentil production has been reduced. The simple back-breaking operation of hand-pulling the plants, which requires 15-29 person-days to harvest a hectare, has come to account for more than one-third of the entire market value of the crop.

If hand-harvesting is to be replaced by mechanical harvesting, the first requirement is to develop lentil cultivars that, without compromising yield, will stand straight and bear pods high enough from the ground for a machine to cut. The second requirement is to develop a machine that is compatible with existing farming practices.

ICARDA has produced lentil cultivars that meet the specification; and it has shown that harvesting can be done with cutter bars drawn by tractors, which many small farmers own. In 1986, on-farm tests were conducted in Syria with a harvesting package involving an improved cultivar and a double-knife cutter bar – and, in addition, a new sowing method using seed drills designed for a flat seed bed. To transfer this technology to national programs, a course on lentil harvest mechanization was held at Tel Hadya, with attendance from Algeria, Jordan, Syria, Tunisia, and Turkey.

New lentil cultivars derived from ICARDA lines (Table 8) can also produce more seed than older ones – up to 30% more. One cultivar released in Ethiopia is in fact yielding 50% more than the local landrace, and in addition is rust-resistant. The new cultivars also produce a larger quantity of good-quality straw, an important consideration because in very dry seasons the straw, when sold for animal feed, often brings more money to farmers than does the seed.

Other highlights in 1986

* A laboratory technique was perfected to screen lentil lines for tolerance/resistance to the parasitic weed, *Orobanche*, which causes substantial yield reductions in farmers' fields. The technique is now being used to screen germplasm in ICARDA's collection.

* Studies on control of *Orobanche* have revealed that covering wet soil with clear polyethylene during the summer months will kill dormant *Orobanche* seeds, so that they do not infest subsequent lentil crops sown in the autumn.

* In regional yield trials of large-seeded lentil cultivars in Syria, the highest-yielding ICARDA line (ILL 4354) produced a mean yield of 1648 kg/ha, which was 33% higher than the yield of the national check (1242 kg/ha). In the regional yield trial of small-seeded lentils, the best ICARDA entry (ILL 5858) gave a mean yield of 1601 kg/ha, compared to the national check's average of 1367 kg/ha. In on-farm tests, in which the best entries from the regional trials are included, the two ICARDA lines, 78S 3 and 76TA 8, yielded 1281 and 1243 kg/ha, respectively, compared to the overall yield of 993 kg/ha for the national check, Hurani 1.

– *For a detailed scientific account, request* FOOD LEGUME IMPROVEMENT PROGRAM: ANNUAL REPORT FOR 1986, *publication* ICARDA-108 En.

Genetic Resources

Plant breeding is at the heart of ICARDA's work and, if breeders are to succeed in their efforts to develop better varieties, they must have access to a great diversity of germplasm. Breeders look for desirable traits such as resistance to a disease, or a physiological characteristic that helps a plant to survive drought, and such traits are determined by the genes present in particular plants. In fact, however, the desirable genes may exist only in a small population of plants, and that population may be represented only in a remote geographic area. By constructing gene banks, we seek to gain access to a great variety of genes, thus enhancing the probability that the breeder will find what he needs.

The conservation of genetic resources is seen as an urgent task. As farmers adopt new and improved varieties, they discard land-races which, while they may not have been performing as well as the new varieties, may carry genes for desirable traits that will be sought in the future. Changes in land-use patterns and the introduction of modern farming systems tend to destroy the habitats of primitive plant forms and the wild relatives of important food crops. Again, unless these are collected and preserved, there is a danger that they will forever be lost from the gene pool.

In ICARDA's gene bank, we have collections for

Table 9. Germplasm collections at ICARDA in 1986.

Crop	Number of accessions				
	New	Total	In medium-term storage	To be multiplied	In long-term storage
Cereals					
Barley	304	15195	12624	500	
Durum wheat	784	19230	3000	8869	5475
Bread wheat	621	3219	1000	2219	
Wild relatives	1129	2885		2885	
Food legumes					
Lentil	231	6412	5581	752	
Chickpea	265	6185	5577	646	
Faba bean	66	3371	3305	3371	4958
Wild *Lens* spp.	89	190	111	190	
Wild *Cicer* spp.	10	40	22	30	
Forages					
Annual medics	334	3911	3911	175	
Pisum spp.	69	3299		3299	
Vicia spp.	623	3544	3204	1067	
Trifolium spp.	425	1212		1212	3221
Trigonella spp.	10	154		154	
Astragalus spp.	2	312		312	
Lathyrus spp.	384	932	838	469	
Total	5446	70091	39173	26150	13654

those species that are of most interest in our research. Each accession to the collection is described and evaluated, and may have as many as 26 descriptors to define its characteristics and properties. Altogether there are now 70091 accessions (Table 9), and the seeds that we need to store permanently are kept in sealed containers at -18°C. However, many of the items are designated as belonging to active collections, from which samples are drawn for distribution, and these are stored at 2°C and 20% relative humidity.

The Genetic Resources program collects, evaluates and distributes germplasm that is of interest to breeders throughout the region.

During 1986, missions to Pakistan, Syria and Turkey brought back a total of 2369 items to be added to the collections. In Pakistan, the expedition was carried out jointly with the Pakistan Agricultural Research Council (PARC) and concentrated on the collection of cereals from the more mountainous regions of Baluchistan and the northern provinces. The land-races present at high elevations are rapidly being displaced by new cultivars but, nevertheless, these landraces carry many of the genetic traits that are needed for performance under conditions of extreme climatic stress.

The mission in Syria was carried out jointly with scientists from the Ministry of Agriculture and Agrarian Reform and the University of Southampton, England. This work concentrated on food, forage and pasture legumes, and the opportunity was also taken to secure herbarium specimens for taxonomic purposes and to obtain samples of associated rhizobia.

In Turkey, the mission was conducted jointly with scientists from the Department of Agriculture of Western Australia, and it also focused on legumes, particularly those suitable for self-regenerating pastures.

Some 2977 entries were obtained from other genetic-resource collections, ensuring a total of 5346 new accessions in 1986.

Table 10. Germplasm samples distributed in 1985/86.

Country	Barley	Durum wheat	Chick-pea	Lentil	Faba bean	*Medicago* spp.	*Vicia* spp.	Other spp.
Argentina							21	83
Australia								13
Bangladesh			390	500				
Burundi								50
Egypt							33	
France			50			30		18
F.R. Germany			6					
Hungary								33
India	35			338	10	60		12
Iran						112	8	
Italy		6045				6		1
Morocco							25	
Pakistan			113			1	65	6
Saudi Arabia			5					
Syria						150	40	40
Tunisia		5567						
United Kingdom			47	50			119	
United States	660		6					97
Total	695	11612	617	888	10	359	311	353

The work of characterization and evaluation also continued, largely in cooperation with other ICARDA programs, but also in joint projects with Italian, Canadian and other scientists. During 1986, emphasis was placed on the evaluation of durum wheats, *Triticum turgidum* var. *dicocoides* and both cultivated and wild species of chickpea and lentil.

More than 4000 durum wheat entries were grown in the field and evaluated for 22 quantitative and qualitative traits, including resistance to three important diseases. One hundred lines, which had previously been screened for drought resistance in Canada, were tested not only at Tel Hadya, but also at Bouider and Breda. Since there were marked differences in the performance of the same cultivars at the different sites, we are increasingly convinced that multilocation testing is necessary when germplasm needs to be evaluated in depth, particularly for performance under stress.

The multiplication and evaluation of the entire collection of *Triticum turgidum* var. *dicoccoides* revealed that this wild species is endowed with considerable genetic diversity, and that there are traits, such as multiple disease resistance, of potential interest to breeders. The diversity within a population was shown to be often greater than that between different populations, indicating a need to collect and evaluate seed from single plants.

Recently acquired populations of cultivated chickpea were multiplied, but many of them will require segregating into sub-populations before they can be fully evaluated. Wild chickpeas were multiplied in a plastic house and checked for taxonomic identification. Enough seeds were obtained to permit evaluation in another year.

Cultivated lentils from several sources were multiplied and evaluated and, because of their performance, single plants were selected for possible immediate use in the breeding program. One group, based on Ethiopian and Pakistani entries produced a large number of seeds per plant; and another, based on Turkish entries, gave promisingly large seeds. All the available wild lentils were reproduced in a plastic house and were given a preliminary evaluation.

The collection and evaluation work must be justified by the present and future utilization of the germplasm in the collection. For the material to be used, it must be documented, rejuvenated and distributed. The year saw the publication of the first volume of the barley germplasm catalog which covers 8000 accessions and, in preparation for future catalogs, more than 250000 items of data (descriptors) were added to the computer files. Major segments of the collection were planted for rejuvenation and multiplication, including our entire holdings of the forage legumes in the *Vicia* and *Lathyrus* genera. Distribution is shown in Table 10.

The Seed Health Laboratory monitors all incoming and outgoing seed to ensure conformity with quarantine regulations and to prevent the inadvertent introduction of pests or diseases. It also monitors the isolation areas at Tel Hadya farm, where imported seeds are rejuvenated and multiplied. No exotic diseases were detected in 1986, though some foreign barley showed a high incidence of barley stripe, and some breadwheat showed a high incidence of loose smut. These observations confirm the need to maintain vigilant control on incoming as well as outgoing shipments. The Laboratory also conducts research on the effectiveness of pesticides and other treatments, and developed a method for detecting *Xanthomonas translucens* on wheat and barley.

The research activities of the Virology Laboratory are supported by funds from the Government of the Netherlands and are carried out in close association with the Dutch Institute of Plant Protection (IPO). Some of this work is also supported by the Lebanese Council for Scientific Research and is carried out at the American University of Beirut. In 1986, the survey for virus diseases on cereals and food legumes in Lebanon, Morocco, Syria and Tunisia was extended to cover Egypt and Sudan as well. The Laboratory also screens germplasm for resistance to virus diseases, and makes special efforts to assist the Seed Health Laboratory in preventing the transmission of seedborne diseases. At a workshop held in Aleppo, the first steps were taken to initiate cooperative research with virology laboratories in the region.

– *For a detailed scientific account, request* GENETIC RESOURCES PROGRAM: ANNUAL REPORT FOR 1986, *publication* ICARDA-113 En.

Training and Information

Training

The number of research scientists and technicians participating in Center training activities increased by 78% over that of the year before: 397 compared with 223 in 1985 (Fig. 8). At the beginning of 1986, plans had been made to receive 366, but national agricultural research programs made so many requests that an additional 31 trainees were accommodated. Of the total, 223 were in residence at the Center, while 174 were enrolled in collaborative courses throughout the region. Approximately 10% were women, a slightly higher proportion than in 1985.

As in the past, most participants came from countries of West Asia and North Africa (Table 11). The formal training courses are listed, with other ICARDA events, in the overall calendar, Appendix 3.

Seven training courses were held in collaboration with national institutions, as compared with five in 1985; this trend is expected to continue in 1987. Specialized, individual non-degree training has continued to be a priority in the Center's research programs, which helps provide qualified manpower for ICARDA's collaborative efforts with national research systems. ICARDA's graduate research training program, supported both by the Center's core funds and by the Ford Foundation, engaged eight post-graduate scholars in field research at Tel Hadya and in collaborative projects throughout the region in 1986. The number is expected to double between 1986 and 1987.

Both restricted-core and non-core funding increased in 1986. In addition to generous grants from the Arab Fund for Economic and Social Development for Arab-country participants, the Ford Foundation made a major financial commitment for support of graduate research training, particularly for women. In addition, a number of agencies provided support to meet the needs of specific national programs or bilateral projects. These included ADB, AOAD, DSE, FAO, GTZ, IDRC, IFAD, UNDP, and USAID.

A formal agreement was signed with the University of Khartoum for cooperation in training. Altogether, there are now six such agreements with universities in West Asia and North Africa, aimed primarily at postgraduate training.

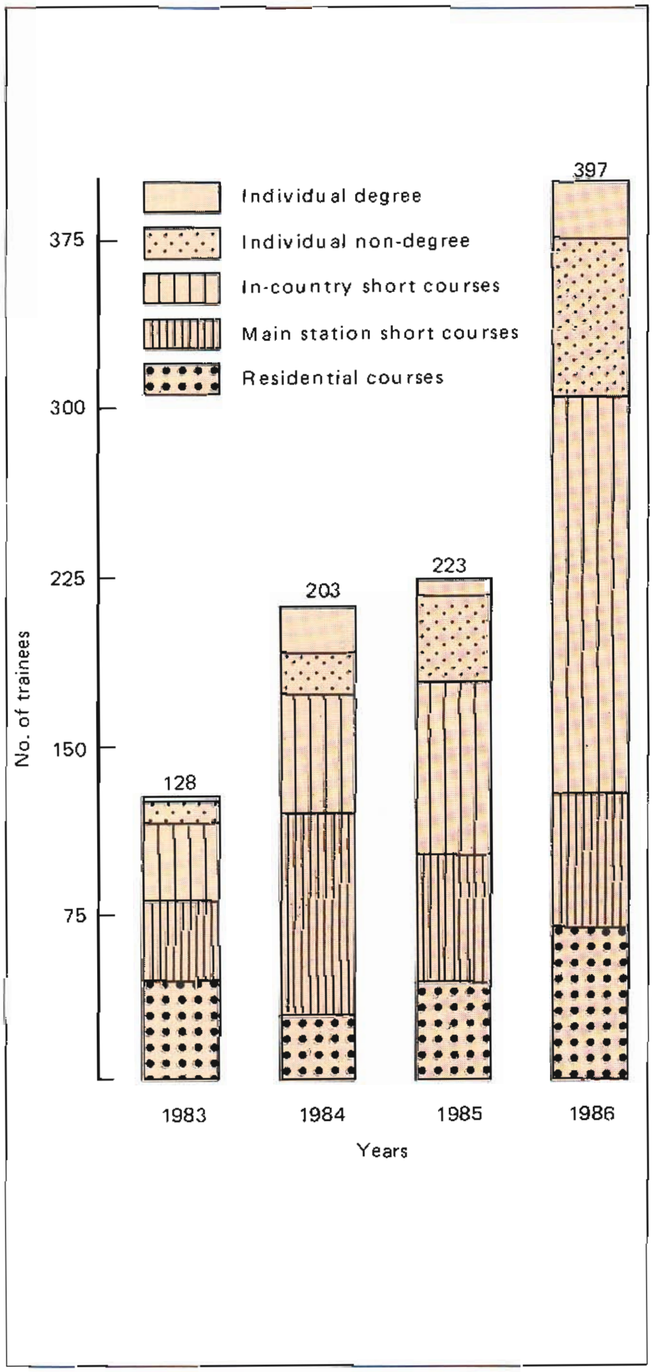


Figure 8. Training participation 1983-85.

Table 11. Country participation in ICARDA Training (1978-86)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	Total
West Asia and North Africa										
Afghanistan	–	4	3	–	4	1	–	–	1	13
Algeria	1	4	3	3	2	–	3	1	45	62
Bahrain	–	–	–	–	1	–	–	–	–	1
Cyprus	–	4	1	–	1	–	1	1	1	9
Djibouti	–	–	–	–	–	3	–	–	–	3
Egypt	4	1	–	7	5	31	20	5	33	106
Ethiopia	–	3	–	1	–	2	1	6	27	40
Iran	2	–	–	–	2	1	5	9	10	29
Iraq	–	5	–	–	1	–	2	2	7	17
Jordan	2	4	4	1	4	5	7	2	14	43
Lebanon	3	1	–	–	3	1	3	4	4	19
Libya	1	1	–	–	–	3	9	–	3	17
Morocco	–	4	5	1	30	–	27	62	36	165
Oman	–	2	–	–	–	–	–	–	–	2
Pakistan	–	–	3	2	5	4	20	28	7	69
Qatar	–	–	–	–	–	–	1	–	–	1
Sudan	–	2	7	12	4	13	8	13	29	88
Saudi Arabia	–	–	2	–	–	–	1	2	1	6
Syria	10	16	8	19	41	41	70	53	55	313
Tunisia	–	3	5	2	11	13	6	9	37	86
Turkey	2	2	7	–	–	–	–	4	57	72
Yemen A.R.	–	2	–	–	–	2	3	4	11	22
P.D.R.Yemen	–	1	2	2	2	3	4	5	3	22
Total	25	59	50	50	116	123	191	210	381	1205
Other developing countries										
Argentina	–	–	–	–	–	–	–	1	–	1
Bangladesh	–	3	2	1	–	–	2	1	1	10
Chile	–	1	–	1	–	1	–	–	–	3
China	–	–	–	1	–	–	3	2	4	10
India	1	2	1	1	–	–	1	1	1	8
Kenya	–	–	–	–	–	–	2	–	–	2
Nepal	–	–	–	–	–	–	–	1	–	1
Rwanda	–	–	–	–	1	–	–	–	–	1
Somalia	–	–	2	–	–	1	1	1	1	6
Tanzania	–	–	–	–	–	1	–	1	–	2
Total	1	6	5	4	1	3	9	8	7	44
More developed countries										
France	–	–	–	–	1	–	–	–	–	1
Greece	–	–	–	–	1	–	–	–	–	1
Netherlands	–	–	–	1	–	–	–	2	2	5
Spain	–	–	–	–	1	1	1	–	2	5
United Kingdom	–	1	–	–	–	–	–	2	–	3
United States	–	–	–	–	–	–	1	–	–	1
F.R.Germany	–	–	–	–	5	1	1	1	5	13
Total	–	1	–	1	8	2	3	5	9	29
Grand total	26	66	55	55	125	128	203	223	397	1278

Scientific and technical information

The former Communications and Documentation Unit was re-organized and given a new name: the Scientific and Technical Information Program. With this change, ICARDA expressed its intention to recruit scientists for more of the key positions, and to have its information activity carried out in closer cooperation with its research and training activities.

Recruitment was not as fast as had been hoped and, although some professional appointments were made very near the end of the year, two scientific positions remained unfilled. The full benefits of the re-organization can not become apparent until the program is fully staffed and until its several components, which are variously located at Aleppo and Tel Hadya, can be brought together.

Near the end of year, the IDRC renewed its grants for the information services on faba bean and lentil, and also extended its grant for the Arabic information service on barley and wheat. Preparations were made to enhance these services in 1987.

The Library cleared the backlog in its reporting of all ICARDA publications to the international information system AGRIS. A start was made in organizing our collections of reprints and reports so that AGRIS can be used as the index of these files. Through the generosity of FAO, several AGRIS computer searches were carried out on subjects identified by ICARDA scientists, and these also served to test the new procedures. A retrospective data base on ICARDA's journal publications was prepared, and a definitive list was published.

In the first half of the year, the publications program was slowed by the learning process involved in the transfer to computer typesetting. By the end of the year, the backlog had largely been cleared, although expansion in volume remains hindered by the shortage of trained typesetters. The English version of the Annual Report 1985 was typeset and printed in-house, though external typesetting was needed for the Arabic version.

New developments included the production and wide distribution of Executive Summaries for the Annual Report of 1985 and for this Annual Report. A new series of scientific reports was started: by incorporating a measure of standardization of format, cover design and color, it is hoped to streamline production processes and to achieve a product that is more immediately recognizable as ICARDA's. A refinement of the indexing of the 5 000 addresses in the computerized mailing list is making it easier to keep it up to date and has enabled the purging of many duplicates.

The one journalist on staff resigned early in the year and, though a replacement was appointed after a few months, there was an inevitable slowdown in public relations work. However, the audio-visual presentation on ICARDA was revised and brought up to date.

Appendix 1

Special Projects

During 1986, the following activities were in progress utilizing funds that various organizations had provided separately from ICARDA's core budget.

BMZ (Federal Ministry of Economic Cooperation), Federal Republic of Germany and DGIS (Directorate General for International Cooperation), the Netherlands

Seed Production. For a period of three years from 1985, 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 (160000 USD in 1986).

DGIS (Directorate General for International Cooperation), the Netherlands

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 (138000 USD in 1986).

Ford Foundation

Farming Systems Training. This grant, for 1986-87, is the third in a series that provides support for scientists from the region to do research in cooperation with ICARDA, and for workshops (75000 USD in 1986).

Agricultural Labor and Technological Change. This grant, for 1986-87, 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 (125000 USD in 1986).

IBRD (World Bank)

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 (115000 USD in 1986).

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* (23000 USD in 1986).

Faba Bean Pathology. This project, for three years, 1985-88, 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 (55000 USD in 1986).

Faba Bean Pollination. ICARDA works in cooperation with an entomologist at the University of Manitoba (20000 USD in 1986).

Lentil Haploid Culture. The University of Manitoba and ICARDA cooperate in developing an anther/pollen culture technique.

Lentil Harvest Mechanization. This project, for three years, 1985-88, involves work in Algeria, Irâq, Jordan, Morocco, Syria and Turkey and included a training course at Tel Hadya (59000 USD in 1986).

Survey of Forages. This project, which concluded in 1986, produced a state-of-the-art review of forage and pasture research in some countries of the ICARDA region.

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 (600000 USD from IFAD and 300000 USD from Italy in 1986).

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 (134000 USD in 1986).

USAID (United States Agency for International Development)

MART/AZRI 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 (280000 USD in 1986).

Appendix 2

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 1. 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 Board for Plant Genetic Resources, Rome, Italy

- Characterization of barley germplasm

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 and a chickpea pathologist at Aleppo

Canada

Canadian Grain Commission, Winnipeg

- Development of techniques for evaluating the quality of barley, durum wheat and food legumes

University of Saskatchewan, Saskatoon

- Collection, evaluation and conservation of barley, durum wheat and their wild relatives (carried out also with the collaboration of the University of Jordan)
- 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
- Evaluation of chickpea genotypes for winter sowing in southern Europe and North Africa

Institut national de la recherche agronomique, Dijon and Rennes

- Breeding faba bean for improved plant type, disease resistance and nutritional quality

Federal Republic of Germany

University of Bonn and University of Muenster

- Mechanism of resistance to ascochyta blight in chickpea

University of Giessen

- Weed control and water-use efficiency in peas

University of Goettingen

- 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
- Study of the photoperiod sensitivities of different durum wheats
- Improvement of nutrient-uptake efficiency in chickpea
- Phosphate fertilization and use of iron in food legumes
- 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

University of Kiel

- Screening for cold tolerance in faba bean

University of Munich

- Salt tolerance in wheat and barley

Italy

Institute of Nematology, Bari

- Studies of parasitic nematodes in food legumes

University of Naples

- Adaptation of faba bean in different parts of the Mediterranean region

University of Perugia

- Inoculation of annual medics with *Rhizobium*
- Increasing the productivity of marginal lands in western Syria

University of Tuscia, Viterbo

- Evaluation of durum wheat landraces and wild relatives

Netherlands

Agricultural University, Wageningen and Royal Tropical Institute, Amsterdam

- Screening food legumes for resistance to *Orobanche* spp.

Japan

Tropical Agriculture Research Center, Tskuba, Ibaraki

- Eco-physiological studies of cereals for their improvement and use in rainfed drylands

Portugal

Estacao Nacional de Melhoramento de Plantas, Elvas

- Screening cereals for resistance to rusts, scald and *Septoria*
- Adaptation of faba bean, lentil and kabuli chickpea to local conditions.

Spain

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*

Tropical Development and Research Institute, London

- Evaluating the nutritive value of hays and straws for small ruminants.

University College, London

- Development of metabolic index for drought stress in barley and durum wheat

University of Durham

- Evaluation of independent vascular supply in faba bean
- Basis for irrigation response and lodging differences in lentil genotypes

University of Reading

- Root studies of barley and chickpea
- Studies of the effects of photoperiod and temperature on the development of different genotypes of barley, lentil and faba bean
- Studies of the barriers to interspecific crossing in *Vicia*
- Studies of physiological variation with *Ascochyta rabiei* (also in cooperation with ICRISAT, India)
- Investigation of seed dormancy in plant populations on grazed marginal land
- Resistance to bruchids in faba bean

University of Sheffield

- Study of the response of annual legumes to phosphorus (i.e. legumes found in native patures)

United States

Kansas State University, Manhattan

- Identification and incorporation of Hessian-fly resistance in wheat and barley for North Africa (in cooperation with the Mid-America International Research Consortium (MIAC) and the Institut National de la Recherche Agronomique, Morocco)

Michigan State University, East Lansing and the International Fertilizer Development Center, Muscle Shoals, Alabama.

- Development of a weather-driven model for simulating growth in barley

Montana State University, Bozeman

- Research on barley disease and the incorporation of resistance into high-yielding varieties suitable for West Asia and North Africa. The University also cooperates with ICARDA in related training activities.

Oregon State University, Corvallis

- Research on wheat and barley improvement and dissemination; associated training with an important graduate program.

Appendix 3

ICARDA Calendar 1986

January

6-16 Shambat SD. Food legume crossing techniques in faba beans

7-14 Shambat SD. Cereal coordination meeting: Egypt/Sudan/Ethiopia

12-24 Aleppo SY. Training course on soil and plant analysis

18-23 Amman JO. ICARDA/USAID workshop on soil and water management

20-24 Aleppo SY. Board of Trustees: 13th meeting of the Program Committee

February

3-5 Aleppo SY. Meeting with the Ministry of Agriculture and Agrarian Reform on barley fertilization in Syria

24-28 Diyarbakir TK. Training course on cereal improvement strategy for rainfed areas

March

1-31 Aleppo SY. Residential training course on cereal crops improvement

2-June 19 Aleppo SY. Residential training course on food legumes

2-June 19 Aleppo SY. Residential training course on pasture, forage and livestock

2-28 Lattakia SY. Training course on disease epiphytotics in food legumes

6-7 London GB. Board of Trustees: Executive Committee

15-April 1 Cairo EG. Training course on seed production

15-April 5 Aleppo SY. Residential training course on farming systems research

15-April 7 Aleppo SY. Specialized training course on cereal pathology (with Montana State University)

16-April 4 Aleppo SY. Training course on barley disease methodology

24-28 Alata TK. Training course on economics in agricultural research

31-April 1 Aleppo SY. Virology workshop

April

7-10 Islamabad PK. Regional farming systems workshop

8-9 Aleppo SY. Presentation days for farmers

13-20 Tunis TN. Training course on food legumes production for North African region

14-17 Aleppo SY. ICARDA/UNDP workshop on biological nitrogen fixation

24 Aleppo SY. Presentation day for diplomats

29 Aleppo SY. Presentation day for Tichreen University

28-30 Tunis TN. Cereals travelling workshop

May

2-5 Rabat MA. CIMMYT/ICARDA/USAID internatinal wheat conference

3-4 Aleppo SY. Presentation days for donors

5-8 Aleppo SY. 19th meeting of Board of Trustees

10-23 Aleppo SY. Training course on lentil harvest mechanization

11-13 Aleppo SY. Meeting with Syrian scientists on breeding strategies for cereals and food legumes

15-June 5 TK/SY. Food legumes travelling workshop

June

16-20 Montpellier FR. INRA/ICARDA seminar on investigating strategies for breeding wheat

16-25 Meknes MA. Training course on cereal on-farm verification

23-25 Aleppo SY. Workshop on soil test calibration

July

6-11 Spokane US. International conference on food legume research

August

3-5 Wad Medani SD. National co-ordination meeting for wheat research in the Sudan

September

20-28 Addis Ababa ET. VIIth Annual coordination meeting, Nile Valley Project

9-11 Tunis TN. IVth Annual coordination meeting, North Africa regional program

October

1-3 Aleppo SY. Vth Annual coordination meeting, Syrian national program

19-30 Aleppo SY. Training course on seed testing

25-30 Sidi Bel Abbes DZ. Training course on preparation and planting of experimental field plots

November

16-27 Aleppo SY. ICARDA-FAO training course on seed testing

10-11 Stockholm SE. Board of Trustees: Executive Committee

December

2-6 Ankara TK. Workshop for barley and wheat researchers working in high-altitude areas

16-18 Cairo EG. CEC-ICARDA workshop on seed production in and for the countries of the Mediterranean

Appendix 4

Statement of Accounts

GRANT INCOME FOR THE YEAR ENDED DECEMBER 31, 1986
(Amounts expressed in thousand U.S. Dollars)

CORE OPERATIONS UNRESTRICTED & CAPITAL	1986	1985
Australia	443	422
Austria	175	–
Canada	719	662
China	50	50
Denmark	181	97
Ford Foundation	150	185
Germany	–	668
IBRD	4 500	4 750
Italy	417	348
Netherlands	486	343
Norway	417	283
Saudi Arabia	–	600
Spain	100	100
Stabilization Mechanism Fund	200	500
Sweden	482	364
United Kingdom	780	622
USAID	5 275	5 300
	14 375	15 284
ALLOCATED TO – UNRESTRICTED	13 475	14 424
– CAPITAL	900	860
	14 375	15 284
RESTRICTED & CAPITAL		
Arab Fund	341	343
France	178	127
Germany – Faba beans & Lentil	1 588	–
– Dry peas	233	–
IDRC – Food Legumes – N. Africa	158	132
– Farming systems, Tunisia	151	117
IFAD – Buildings	–	500
Italy – Building (GRU)	–	313
– Forage	248	240
– Durum wheat	203	174
OPEC – Barley Development	122	162
– Buildings	–	596
UNDP – SWAN	–	200
– Transfer of technology	300	–
USAID – Barley diseases	325	160
	3 847	3 064
ALLOCATED TO – RESTRICTED	3 847	1 655
CAPITAL	–	1 409
	3 847	3 064
SPECIAL PROJECTS		
Germany/Netherlands – Seed Production	160	91
Ford Foundation		
– Farming System	75	75
– Factor constraints	125	125
IBRD – Ethiopia (FLIP)	115	–
IDRC – Arabic Dimension Services	23	20
– Faba bean insect pollination	20	13
– Lentil haploid culture	–	24
– Lentil harvest mechanization	59	50
– Manitoba, faba nean patholog	55	105
– Survey of forages	–	10
IFAD – Nile Valley Project	600	1 000
Italy – Nile Valley Project	300	–
Netherlands – Virologist	138	–
OPEC – Improved Wheat Technology/Sudan	134	49
USAID – AZRI (Baluchistan – Pakistan)	280	492
– Cereals/Jordan	–	45
	2 084	2 099

Statement of Accounts (Cont'd)

OPERATIONS FOR THE YEAR ENDED DECEMBER 31, 1986

(Amounts expressed in thousand U.S. Dollars)

		1986		1985
SOURCES OF FUNDS				
Operating grants				
– Core unrestricted	13 475		14 424	
– Core restricted	3 847		1 655	
		17 322		16 079
Capital grants				
– Core unrestricted	900		860	
– Core restricted	–		1 409	
		900		2 269
Earned income		1 102		1 585
Special projects		2 084		2 099
		21 408		22 032
APPLICATION OF FUNDS				
To core programs research				
– Integrated farming system	1 996		1 986	
– Cereals improvement	2 474		1 940	
– Food legumes improvement	2 199		1665	
– Forage improvement	1 612		1 451	
	8 281		7 042	
Research support	2 920		2 626	
– Training and communication	1 418		1 247	
Cooperative programs	630		374	
General administration	2 436		2 255	

		1986		1985
General operating costs	2 314		2 439	
	17 999		15 983	
To special projects	1 927		1 530	
	19 926		17 513	
To capital				
– Capital expenditures	1 820		3 734	
– Special projects capital	110		68	
		21 856		21 315
		(448)		717
Working capital/increase (decrease) of funds				
Working capital	(69)		71	
Restricted	(425)		145	
Special projects	46		501	
		(448)		717
Working capital/unexpended funds at beginning of year				
Working capital	1 915		1 844	
Restricted	2 047		1 902	
Special projects	1 151		650	
		5 113		4 396
Working capital/underexpended funds at end of year				
Working capital	1 846		1 915	
Restricted	1 622		2 047	
Special projects	1 197		1 151	
		4 665		5 113

Appendix 5

Arthur Andersen Mattar & Co.

آرثر أندرسن مَطَر وَشركاهم

Member of ARTHUR ANDERSEN & CO. عضو في

The Board of Trustees
The International Center for Agricultural
Research in the Dry Areas (ICARDA)
Aleppo - Syria

We have examined the balance sheet of The International Center for Agricultural Research in the Dry Areas (ICARDA) as of December 31, 1986, and the related statement of operations for the year then ended. Our examination was made in accordance with generally accepted auditing standards and, accordingly, included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the financial statements referred to above present fairly the financial position of the International Center for Agricultural Research in the Dry Areas (ICARDA) as of December 31, 1986, and their operations for the year then ended in conformity with accounting principles of the Consultative Group on International Agricultural Research described in Note 2, which basis has been consistently applied.

Our examination was made for the purpose of forming an opinion on the basic financial statements taken as a whole. The data on pages 14 to 16 are presented for purposes of additional analysis and are not a required part of the basic financial statements. This information has been subjected to the auditing procedures applied in our examination of the basic financial statements and, in our opinion, is fairly stated in all material respects in relation to the basic financial statements taken as a whole.

Arthur Andersen Mattar & Co

February 26, 1987
Beirut - Lebanon

Minkara Building - Clemenceau Street - P.O. Box 115075 - Beirut - Lebanon - Tel: 364642/3 - 371142 - Telex: 21015 MATTAR LE

بناية منقارة - شارع كليمنصو - صندوق البريد ١١٥٠٧٥ بيروت - لبنان - تلفون : ٣٦٤٦٤٢/٣ - ٣٧١١٤٢ - تلكس: مَطَر LE ٢١٠١٥

Appendix 6

Senior Staff 1986
SYRIA
Aleppo: Headquarters

Director General's Office

Dr. Mohamed A. Nour, Director General
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Mr. Bijan Chakraborty, Senior Programmer-Project Leader
Mr. Awad Awad, Senior Programmer
Mr. Bashir Bshara, Senior Programmer
Mr. Michael Sarkissian, Systems Engineer

Personnel

Ms. Leila Rashed, Personnel Officer

Farming Systems

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. Bakheit Saied, Senior Training Scientist
Dr. Kutlu Somel, Agricultural Economist
Dr. Dennis Tully, Anthropologist
Mr. Ahmad M. El-Ali, Weed Control
Dr. Wolfgang Goebel, Post-Doc. Fellow, Agro-Climatologist
Dr. Ulrich Marz, Visiting Scientist
Mr. Ahmad Mazid, Agricultural Economist
Mr. Abdul Bari Salkini, Agricultural Economist
Mr. Sobhi Dozom, Research Associate
Mr. Mahmoud Oglah, Research Associate

Cereal Crops Improvement

Dr. Jitendra P. Srivastava, Program Leader
Dr. Edmundo Acevedo, Physiologist/Agronomist
Dr. Salvatore Ceccarelli, Barley Breeder
Dr. Guillermo O. Ferrara, Bread Wheat Breeder (seconded from CIMMYT)
Dr. Habib Ketata, Senior Training Scientist
Dr. Omar Mamlouk, Plant Pathologist
Dr. Ross Miller, Cereal Entomologist
Dr. Miloudi Nachit, Durum Wheat Breeder (seconded from CIMMYT)
Dr. Mohammed Taher, Plant Breeder
Dr. A.B Damania, Durum Germplasm Scientist
Mr. Isam Nagi, Agronomist
Dr. S.K. Yau, International Nurseries Scientist
Mr. Joop van Leur, Barley Pathologist
Mr. Paulo Annichiarico, Research Associate
Ms. Loretta Dominici, Research Associate
Mr. Angelo Grottanelli, Research Associate
Mr. Luciano Pecetti, Research Associate

Food Legume Crops Improvement

Dr. Mohan C. Saxena, Program Leader/Agronomist-Physiologist
Dr. Douglas Beck, Food Legume Microbiologist
Dr. William Erskine, Lentil Breeder
Dr. Suzan Gerlach, Entomologist
Dr. M.P. Haware, Chickpea Pathologist (seconded from ICRISAT)
Dr. Mohamed Habib Ibrahim, Senior Training Scientist
Dr. Larry D. Robertson, Faba Bean Breeder
Dr. K.B. Singh, Chickpea Breeder (seconded from ICRISAT)
Dr. Akhlaq Hussein, Post-Doc. Fellow, Lentil Breeding
Dr. R.S. Malhotra, Post-Doc. Fellow, International Trials Scientist
Dr. Joahim Sauerborn, Post-Doc. Fellow, Orobanche
Dr. Mohamed El-Sherbeeny, Post-Doc. Fellow, Faba Bean Breeding
Dr. Said Nahdi Silim, Post-Doc. Fellow, Agronomy/Physiology
Dr. Franz Weigand, Post-Doc. Fellow, Pathology
Mr. Thomas Bambach, Visiting Research Associate
Mr. Eckhard George, Associate Expert
Mr. Stefan Schlingloff, Visiting Research Associate
Mr. Edwin Weber, Visiting Research Associate

Pasture, Forage, and Livestock Improvement

Dr. Philip S. Cocks, Program Leader/Pasture Ecologist
Dr. Ali Abdul Moneim Ali, Senior Training Scientist
Dr. Luis Materon, Microbiologist
Dr. Ahmed El-Tayeb Osman, Agronomist
Dr. Alan Smith, Grazing Management Specialist
Dr. Euan Thomson, Livestock Scientist
Mr. Faik Bahhady, Assistant Livestock Scientist
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Mr. Nerses Nersoyan, Research Associate
Mr. Mario Pagnotta, Research Associate
Mr. Safouh Rihawi, Research Associate
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Mr. Yassin Swedan, Assistant Training Scientist Fellow (UNDP)
Mr. Munir Turk, Research Associate
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Dr. Bhal Somaroo, Program Leader
Dr. Laszlo Holly, Genetic Resources Scientist
Dr. Khaled Makkouk, Plant Virologist
Dr. Yawooz Adham, Assistant GRP Scientist/Documentation Specialist
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Mr. Ohannes Kalou, Building & Maintenance Engineer
Mr. Haitham Midani, Officer-General Services

Station Development
Mr. Brian Tierney, Construction Manager
Mr. Issac Homsy, Civil Engineer
Mr. Khaldoun Wafaii, Civil Engineer

Purchasing & Supplies
Mr. Ramaswamy Seshadri, Manager
Ms. Dalal Haffar, Purchasing Officer
Mr. Ziad Muazzen, Stores Officer

International School of Aleppo
Mr. Denis Sanderson, Principal/Teacher
Ms. Jennifer Timme, Teacher
Ms. Christine Steer, Teacher

Damascus Office
Mr. Abdul Karim El-Ali, Administrative Officer

Lattakia
Dr. Salim Hanounik, Faba Bean Pathologist

ETHIOPIA
Addis Ababa

Dr. Surendra Beniwal, Food Legume Breeder/Pathologist

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Dr. Bhup Bhardwaj, Director of Administration & Operations, ICARDA/IFAD Nile Valley Project.

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Mr. Anwar Agha, Executive Manager/Senior Accountant

Terbol

Mr. Munir Sughayar, Engineer I-Station Operations

MEXICO
CIMMYT

Dr. Hugo Vivar, Barley Breeder

MOROCCO
Rabat

Dr. Mahmoud El-Solh, Food Legume Breeder
Dr. Mohamed S. Mekni, Cereals Scientist

PAKISTAN
Quetta

Dr. John D. Keatinge, Team Leader/Crop Physiologist
Dr. Richard Aro, Range Management/Livestock Specialist (seconded from Colorado State University)
Dr. Joseph Nagy, Farming Systems Specialist/Agricultural Economist
Dr. David J. Rees, Agronomist
Dr. Chemal Talug, Extension/Communications Specialist

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Tunis

Dr. Ahmed Kamel, ICARDA Representative/Cereal Pathologist
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Dr. Roger Peterson, Senior Biometrician
Mr. Mohammed Aziz Shoukry, Legal Advisor, Damascus
Dr. Hisham Talas, Medical Consultant
Dr. Philip Williams, Analytical Services

Appendix 7

Publications 1986

Articles in scientific journals

Abd El-Moneim, A.M. and P.S. Cocks. Adaptation of *Medicago rigidula* to a cereal-pasture rotation in north-west Syria. Journal of Agricultural Science (Cambridge) 107(1):179-186.

Anderson, W.K. Some relationships between plant population, yield components and grain yield of wheat in a Mediterranean Environment. Australian Journal of Agricultural Research 37(3): 219-233.

Baya's, B., W. Erskine, and L. Khoury. Survey of wilt damage on lentils in northwest Syria. Arab Journal of Plant Protection 4(2):119-118. (Arabic summary).

Erskine, W. and M.A. Choudhary. Variation between and within lentil landraces from Yemen Arab Republic. Euphytica 35(3): 695-700.

Greco, N., M. DiVito, M.V. Reddy, and M.C. Saxena. Effect of Mediterranean cultivated plants on the reproduction of *Heterodera ciceri*. Nematologia Mediterranea 14(2):193-200.

Hanounik, S.B. and N. Maliha. Horizontal and vertical resistance in *Vicia faba* to chocolate spot caused by *Botrytis fabae*. Plant Disease 70(8):770-773.

Hoshino, T. Constraints and present conditions of wheat and barley production in the ICARDA region. Nogyogijutsu 25:20-11 (In Japanese).

Hoshino, T. and M. Tahir. Breeding activities at ICARDA. Japanese Journal of Breeding 36:314-315 (In Japanese).

Hoshino, T. and M. Tahir. Primordia development and growth attributes of wheat cultivars in West Asia and North Africa. Japanese Journal of Breeding 36 (supp. 2)

Jaubert, Ronald. Perspectives d'ameliorations des systemes d'alimentation des troupeaux dans la zone orge-moutons (Syrie). Les Cahiers de la Recherche Developpement 11:17-23. (Resumes en anglais et espagnol).

Keatinge, J.D.H., M.D. Dennett, and J. Rodgers. The influence of precipitation regime on the crop management of dry areas in Northern Syria. Field Crops Research 13(3):239-249. (AGRIS 86-060188).

Osman, A.E. and N. Nersoyan. Effect of the proportion of species on the yield and quality of forage mixtures, and on the yield of barley in the following year. Experimental Agriculture 22(4):345-351 (Spanish summary).

Perrier, E.R. and L.P. Wilding. An evaluation of computational methods for field uniformity studies. Advances in Agronomy 39:265-312.

Robertson, Larry D. and Cesar Cardona. Studies on bee activity and outcrossing in increase plots of *Vicia faba* L. Field Crops Research 15(2):157-164.

Thomson, E.F., F.A. Bahaddy, A. Termanini, and M. Mokbel. Availability of home-produced wheat, milk products and meat to sheep-owning families at the cultivated margin of the NW Syrian steppe. Ecology of Food and Nutrition 19(2):113-121.

Magazine articles about ICARDA

Keen, Montague. An extra 100,000,000 sheep from the dry lands. Bigger and better sheep from more farm forage. Arab World Agribusiness 2(3):14-16.

Keen, Montague. Fabulous beans: bigger yields from 'poor man's meat'. Arab World Agribusiness 2(4):12-15 (Also in Arabic, pp 56-54).

Keen, Montague. Better cereals are spreading – slowly. Arab World Agribusiness 2(5):17-19.

Keen, Montague. Machines shatter legume yield records. Arab World Agribusiness 2(6):20-21.

Simarski, Lynn Teo. Mechanising the lentil harvest. Middle East Agribusiness 6(1):24-25.

Simarski, Lynn Teo. Breeding better legumes: faba beans, chickpeas, and lentils. The IDRC Reports 15(3):16-17 (also in Arabic edition 4:16-17).

Warg, Peter. Improving yields of the fava bean. Middle East Agribusiness 6(2):10.

Contribution to Conferences

January

Amman JO. Workshop on Soil, Water and Crop/Livestock Management Systems for Rainfed Agriculture in the Near East Region

Perrier, E.R. Small scale water harvesting techniques.

Tully, D. Rainfed farming systems of the Near East regions.

Wageningen NL. Workshop on Biology and Control of *Orobanche*

Sauerborn, J. and M.C. Saxena. A review on agronomy in relation to *Orobanche* problems in faba bean (*Vicia faba* L.).

February

Gainesville US. Conference on Gender Issues in Farming Systems Research and Extension

Rassam, A. and D. Tully. Gender-related aspects of agricultural labor in North-Western Syria.

Oeiras PT. 50 Aniversario da Estacao Agronomica Nacional. I. Jornades Portuguesas de Proteaginosas

Saxena, M.C. Improvement of chickpeas and faba beans.

Sexena, M.C. Utilization of food legumes for human consumption.

March

Canberra AU. Conference on Degradation and Rehabilitation of Agricultural Land

Cocks, P.S., E.F. Thomson, and K. Somel. Degradation and rehabilitation of agricultural land in north Syria.

Damascus SY. Second Arab Congress of Plant Protection

Azzam, O.I. and K.M. Makkouk. A survey of viruses affecting dry bean and cowpea in Lebanon.

Ballar, M. Survey of alfalfa diseases in the Ghouta of Damascus (1981, 1982 and 1985).

Baya'a, B., W. Erskine, and L. Khoury. Survey of wilt damage on lentils in N. Syria.

Dakermanji, A. and S. Kukula. Effects of fertilizer and herbicide on wheat production in farmers' fields.

Dozom, S. and M.K. Dermoch. Effect of tillage systems on the weed community in a two-course rotation (lentil-wheat).

Hanounik, S.B. and N.F. Maliha. Resistance in faba bean to ascochyta blight caused by *Ascochyta fabae*.

Katul, L. and K.M. Makkouk. Occurrence and serological relatedness of five cucurbit in Lebanon and Syria.

al-Mahdi, L. Some biological characteristics of the mole-rat *Spalax leucodon* and its control in North Syria.

Makkouk, K.M., L. Bos, O.I. Azzam, and S. Asaad. Identification of broad bean stain virus in faba bean and lentil in Lebanon and Syria and its serological detection in seeds.

Mamluk, O.F., A.M. Makki, and J.A.G. van Leur. Some morphological and biological aspects of the causal agents of common bunt (*Tilletia foetida* and *T. caries*) and screening for resistance to the disease.

Mamluk, O.F., J.A.G. van Leur, M. Nachit, and G.O. Ferrara. Screening wheat germplasm for resistance to *Septoria Tritici* blotch (*Mycosphaerelia graminicola*).

Masri, H. A greenhouse technique for screening faba bean (*Vicia faba* L.) for resistance to *Orobanche* spp.

April

Aleppo SY. Biological Nitrogen Fixation Workshop

Cocks, P.S. The role of pasture and forage legumes in livestock based farming systems.

Saxena, M.C. Role of food legumes in the Mediterranean.

Islamabad PK. Third ICARDA Regional Farming Systems Research Workshop

Keatinge, J.D.H. The systems approach in project planning and implementation-advantages, disadvantages and lessons learned by ICARDA in the MART Project at the Arid Zone Research Institute.

Somel, K.A., A. Matar, H. Harris, P. Cooper, A. Mazid, J.A. Karim, and K. El-Hajj. Fertilizer use on rainfed barley in Northern Syria.

Rome IT. Inter-Center Workshop on Agro-ecological Characterization, Classification and Mapping

Harris, H.C. and W. Goebel. Objectives, expectations and needs of the IARC's in the field of agro-ecological characterization.

Mulitze, D., R. Malhotra, and P. Goldsworthy. Relating production and environment: the international nursery networks.

Vibo Valentia IT. Convegno Incremento della Produttivita delle Risorce Agricole

Ceccarelli, S. Controllo genetico di meccanismi morfofisiologici di adattabilita a stress abiotici: l'esempio dll'orzo

May

Giessen DE. Tropentag 1986: Die Bedentung der Kleimen Wiederkauer zur Nutzung Marginarler Standorte in den Tropen und Subtropen.

Thomson, E.F. Feeding systems and sheep husbandry in the barley belt of Syria.

Gospar DE. Third International German Agricultural Society Symposium on Alternatives in Ruminant Livestock Production in Northern Africa and the Middle East

Bahhady, F.A. Optimum use of pasture by livestock.

Nairobi KE. International Drought Symposium on Food Grain Production in Semi-Arid Regions of Sub-Saharan Africa

Perrier, E.R. Adaptation of water management practices to rainfed agriculture on alfisols in the Sahel.

Rabat MA. Fourth International Wheat Conference

Nachit, M.M. and H. Ketata. Breeding strategy for improving durum wheat in Mediterranean rainfed areas.

Ortiz Ferrara, G. and D. Mulitze. Bread wheat breeding for the low rainfall non-irrigated areas of West Asia and North Africa.

Tahir, M. Evaluation and utilization of *Triticum turgidum* L. variety dicoccoides for the improvement of durum wheat.

June

Aleppo SY. Soil Test Calibration Workshop

Matar, A.E., J. Abdel Karim, and K. El-Hajj. Studies on response of cereals and food legumes to fertilization as related to nutrient soil tests in Syria.

Soltanpour, P.N. and A.E. Matar. Proposed guidelines for establishment of a regional network of soil test calibration study sites in limited rainfall areas.

Algier DZ. Seminaire National sur les Fourrages

Osman, A.E. and P.S. Cocks. Search for adapted medics to suit a ley farming system in West Asia and North Africa.

Radzikow PL. Symposium on Methods of Biochemical Evaluation of Germplasm Collections

Holly, L., Y.J. Adham, and B.H. Somaroo. Application of esterase isozymes electrophoresis in germplasm related research.

July

Aleppo SY. Agricultural Development Week in Aleppo City and Northern Syria

Jones, M.J., H. Harris, K. Somel, A. Matar, P. Cooper, A. Mazid, J.A. Karim, and K. El-Hajj. Fertilizer strategies for rainfed barley in the dry areas of Northern Syria.

Somaroo, B.H. and B.O. Humeid. Germplasm conservation in Syria and Arab countries.

Sowny, H. Introduction of medics into crop rotations (in Arabic).

Gottingen DE. Workshop in the CEC Programme of Coordination of Agricultural Research

Saxena, M.C., S.N. Silim, and M.V. Murinda. Build-up and partitioning of dry-matter and yield of faba bean genotypes of differing plant type.

Saxena, M.C., S.N. Silim, and M.V. Murinda. Effect of moisture supply and fertilizer application on the yield build-up of some contrasting faba bean genotypes.

Spokane US. International Food Legume Research on Pea, Lentil, Faba Bean and Chickpea

Bos, L., R.O. Hampton, and K.M. Makkouk. Viruses and virus diseases of pea, lentil, faba bean and chickpea.

Cooper, P., G. Campbell, P. Hebblethwaite, and N. Heath. Factors affecting water use efficiency in rainfed production of food legumes and their measurement.

Erskine, W., A. Nassib, and A. Telaye. Breeding for morphological traits.

Haddad, N.I., A.B. Salkini, P. Jegatheeswaran, and B.A. Snober. Methods of harvesting pulse crops.

Hawtin, G.C., F.J. Muehlbauer, A.E. Slinkard, and K.B. Singh. Current status of pulse crop improvement: an assessment of critical needs.

Makkouk, K.M., L. Bos, and O.I. Azzam. A preliminary survey of viruses affecting faba bean, lentils and chickpea in the Middle East and North Africa.

Malhotra, R.S. and L.D. Robertson. Phenotypic stability for seed yield and some other characters of elite faba bean cultivars.

Muehlbauer, F.J., J.B. Smithson, A.M. Nassib, L.D. Robertson, and R.J. Redden. Population improvement in pulse crops: an assessment of methods and techniques.

Nene, Y.L., S.B. Hanounik, S.H. Qureshi, and B. Sen. Fungal and bacterial foliar diseases.

Rheenen, H.A. van, D.A. Bond, W. Erskine, and B. Sharma. Future breeding strategies for pea, lentil, faba bean and chickpea.

Robertson, L.D. and S.N. Silim. Path coefficient analysis of yield and yield components in determinate lines of faba bean.

Saxena, M.C. and P.R. Goldsworthy. International programs – International Center for Agricultural Research in the Dry Areas (ICARDA).

Saxena, M.C., N.P. Saxena, and A.K. Mohamed. High temperature stress.

Singh, K.B. and M.V. Reddy. Genetics of resistance to ascochyta blight in chickpea.

Sydney AU. Microbiology in Action Symposium

Materon, L.A. and P.S. Cocks. Constraints to biological nitrogen fixation in ley farming systems designed for West Asia.

August

Bangor GB. Second British-Egyptian Conference on Animal and Poultry Production

Thomson, E.F., P.S. Cocks, and F. Bahhady. Improving feed resources: a key step towards expanding ruminant production in semi-arid North Africa and West Asia.

Hamburg DE. 13th Congress of the International Society of Soil Science.

Matar, A.E. Rate of phosphate immobilization of gypsoferous and calcareous soils and the comparative effects of phosphate on yields and nutrient composition.

September

Ghent BE. Conference of the Organization for Economic Cooperation and Development on Microbiological and Multipurpose Utilization of Lignocellulose

Capper, B.S. Genetic variation in the feeding value of straw.

Khonkaen TH. Food Legume Improvement for Asian Farming Systems

Beck, D.P. and R.J. Roughley. Biological nitrogen fixation as a limitation to food legume production in Asia.

Hanounik, S.B. and M.C. Saxena. Multiple disease resistance in faba beans.

Montpellier FR. Workshop on Genetic Resources and the Plant Breeder.

Srivastava, J.P. and A.B. Damania. Use of collections in cereal improvement in the semi-arid areas.

October

Amalfi IT. Meeting on Drought-Resistance in Plants: Genetic and Physiological Aspects

Saxena, M.C. Some studies on field screening of lentils for drought tolerance.

Ceccarelli, S. Breeding strategies to improve yield and yield stability of barley in drought-prone areas.

Neu-Ulm DE. 44. Internationalen Tagung Landtechnik

Jegatheeswaran, P. Probleme der Traktor-Elektronik beim Feleinsatz in semiariden Gebieten – Beispiel Syrien.

Rome IT. Expert Consultation on Rangeland Rehabilitation and Development in the Near East

Cocks, P.S. Selection of improved pasture and forage species at ICARDA.

Okayama JP. Fifth Barley Genetics Symposium

Ceccarelli, S. Tolerance to climatic stresses.

Jana, S., L.N. Pietrzak, M.I. Morris, and J.P. Srivastava. Genetic diversity in wild barley (*Hordeum spontaneum* Koch) populations of the fertile crescent.

Jaradat, T., A. Jaradat, S. Jana, and J.P. Srivastava. Diversity for quantitative characters in Jordanian landraces of barley.

Vivar, H.E., P. Burnett, and J. Bowman. Breeding barley for multiple disease resistance.

Toronto CA. 71st Annual Meeting, American Association of Cereal Chemists

Jaby El-Haramein, F., P.C. Williams, G. Ortiz Ferrara, and J.P. Srivastava. Factors affecting the experimental baking of two-layered Syrian flat breads.

Jaby El-Haramein, F., P.C. Williams, J.P. Srivastava, M.M. Nachit, and A. Sayegh. Selecting durum wheats on the basis of flat bread quality.

November

Lattakia SY. 26th Science Week

Bahhady, F.A. and E.F. Thomson. the use of cereal straw in sheep diets.

Cocks, P.S., E.F. Thomson, and A.M. Abd El-Moneim. Degradation and rehabilitation of agricultural land in North Syria.

Saxena, M.C. and S.N. Silim. The response of winter and spring sown chickpea to supplemental irrigation.

New Orleans US. ASA-CSSA-SSSA Annual Meetings

Perrier, E.R. and A.B. Salkini. Evaluation research for management planning in supplemental irrigation.

Pantacheru IN. International Consultants' Meeting on Research on Drought Problems in the Arid and Semi-arid Tropics

Perrier, E.R. Opportunities for the productive use of rainfall normally lost to cropping for temporal or spatial reasons.

Rome IT. Conference Relancio della Coltural del Cece (*Cicer arietinum* L.) in Italia: Problematiche e Prospettire

Singh, K.B. and M.C. Saxena. Chickpea genetic resources and their exploitation in the Mediterranean region.

December

Cairo EG. Second Conference of the African Association for Biological Nitrogen Fixation

Beck, D.P. and L.A. Materon. A program for optimizing response to inoculants.

Cairo EG. Seed production in and for Mediterranean countries

Cocks, P.S. The need for seed production of pasture and forage species.

Erskine, W., K.B. Singh, and L.D. Robertson. Seed production of food legumes in the Mediterranean area.

Ketata, H. and J.P. Srivastava. Seed production of cereals in Mediterranean countries: the role of ICARDA.

van Gastel, A.J.G. ICARDA's seed activities.

Chicago US. ASAE Annual Meetings

Perrier, E.R. Small scale water harvesting schemes: design criteria.

External publications sponsored by ICARDA

Nygaard, David F. and Peter L. Pellett (editors). Dry area agriculture, food science and human nutrition: proceedings of a workshop [Aleppo SY 1982-02-21 to 25] 372 pp. (New York US: Pergamon, ISBN 0-08-033996-4)

Faba bean abstracts. Vol. 7, nos. 1-4 (Slough GB: CAB International)

Lentil abstracts. No. 7 (Slough GB: CAB International)

ICARDA publications

Al Yuam. Vol. 6, no. 1: 4 pp. (Ar), 4 pp. (En); no. 2: 8 pp. (Ar), 8 pp. (En); no. 3: 12 pp. (Ar), 12 pp. (En).

Annual report for the regional barley yield trials and observation nurseries 1984-85. 177 pp. (En).

Annual report for the regional bread wheat yield trials and observation nurseries 1984-1985. 133 pp. (En).

Annual report for the regional durum wheat yield trials and observation nurseries 1984-85. 185 pp. (En).

Ascochyta blight resistance in chickpeas: Proceedings of a training course, Islamabad, Pakistan. 3 – 10 Mar 1984, PARC/ICARDA. Publication ICARDA-101 En: 123 pp.

Cereal improvement in dry areas: A report on the Tunisia cooperative cereal improvement project. Ministry of Agriculture, Republic of Tunisia/ICARDA. 81 pp. (En).

Cereal improvement program in Morocco: Review and recommendations. 14 pp. (En, Fr).

Cereal improvement program in Tunisia: Review and recommendations. 12 pp. (En, Fr).

Collaborative research and training program: Annual report for 1984-85 season. Syrian Arab Republic, Ministry of Agriculture and Agrarian Reform/ICARDA. 307 + XIX pp. (Ar, En).

Directory of faba bean and lentil research workers. 82 pp. (En).

FABIS Newsletters. No. 13: 44 pp., no. 14: 44 pp. (En).

Farming Systems Program: A summary view. 15 pp. (Ar), 15 pp. (En).

Food legume nurseries 1983-84. International Nursery Report no. 8: 261 pp. (En).

Forage conservation: Forage training course 1986. 57 pp. (En).

Forage feed evaluation and utilization: Forage training course 1986. 86 pp. (En).

ICARDA/IFAD Nile Valley Project on Faba Beans: Report of the sixth annual coordination meeting, 9-13 Sep 1985, Cairo, Egypt. 100 + vi pp. (En).

ICARDA annual report 1985. 420 pp. (Ar), 378 pp. (En). (AGRIS 87-9069).

ICARDA annual report for 1985: Executive summary. 12 pp. (En).

ICARDA in the news 1986. 58 pp. (Ar, En, Fr).

ICARDA research highlights 1985. 96 pp. (Ar), 96 pp. (En).

ICARDA's guide to Aleppo and its surroundings. (2nd ed.). 53 pp. (En).

Introduction to forage legumes. Technical Manual no. 13: 55 pp. (En).

Introduction to the international cereal nurseries system. 16 pp. (En). (AGRIS 86-051399).

LENS Newsletter. Vol. 12, no. 1: 42 pp.; no. 2: 54 pp. (En).

RACHIS Newsletters. Vol. 4, no. 1: 54 pp. (Ar); No. 2: 68 pp. (Ar). Vol. 5, no. 1: 60 pp. (En).

Third conspectus of genetic variation within *Vicia faba* (1986). 54 pp. (En).

Bernier, Claude C., Salim B. Hanounik, Mustafa M. Hussein, and Hosni A. Mohamed. Field manual of common faba bean diseases in the Nile Valley. Information Bulletin no. 3: 40 pp. (Ar).

el-Bizri, Khaled S. and Bijan Chakraborty. CRISP reference manual v.2.2. 150 pp. (En).

Cardona, Cesar, Ezzat Zaki Fam, Sadek I. Bishara, and Abdel Gadir Bushara. Field guide to major insect pests of faba bean in the Nile Valley. Information Bulletin no. 2: 60 pp. (Ar).

Mokbel, Mirella. Nutritional and dietary patterns in rural Syria: implications for ICARDA mandate crops. Research Report 18: 79 pp. (En).

Niks, Rients E. Bird life, The Hadya Research Station. 32 pp. (En).

Somaroo, B.H., Y.J. Adham, and M.S. Mekni. Barley germplasm catalog I 1986. 413 pp. (En). (AGRIS 87-011512).

Srivastava, J.P., G. Kashour, and S. Dutta. An annotated bibliography on durum wheat 1972-1984. 238 pp. (En).

Srivastava, J.P. and L.T. Simarski (eds.). Seed production technology. 287 pp. (En). (AGRIS 87-001784).

Williams, Phil, Fouad Jaby el-Haramein, Hani Nakkoul, and Safouh Rihawi. Crop quality evaluation methods and guidelines. Technical Manual no. 14: 142 pp. (En). (AGRIS 87-000099).

Appendix 8

Visitors to ICARDA, Aleppo

During 1986, ICARDA's Visitors' Services received 1 990 individuals. This averages more than five new visitors arriving every day but, in fact, the distribution is far from even through the year. The peak month was April with 689 visitors, with compares with only 36 in August. Many stay for periods of several days, and a few for months. ICARDA is usually responsible for providing accommodation and transport and, in doing so, it maintains two guesthouses, as well as apartments for trainees and visitors with families.

Of the visitors that came in 1986, 60% were from Syria itself. Other countries of West Asia and Noth Africa were represented by 24% of the visitors, but 16% came from more distant countries. Together they represented more than 40 universities, as well as 50 international, national and private organizations.

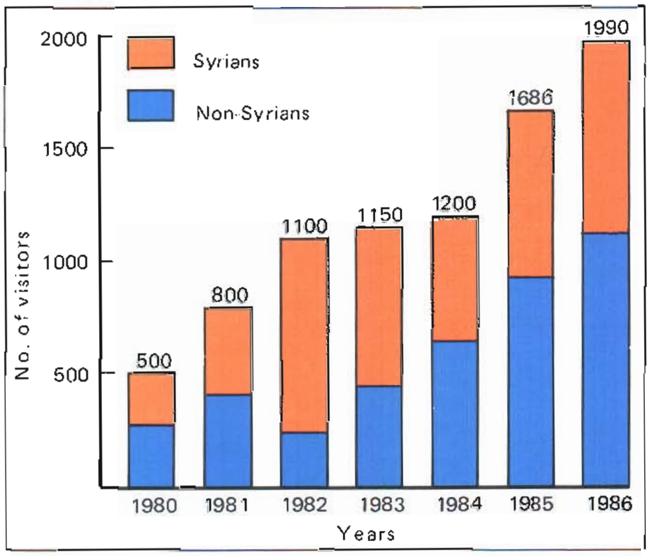

Figure 9. The rate at which ICARDA receives visitors has been increasing by about 25% per year.

Appendix 9

Precipitation in 1985/86 Season

ICARDA collects weather data for all its sites in Syria, except Lattakia where moisture is normally abundant. The table below shows precipitation by month, as well as the divergence from the long-term average

		OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	Season
TEL HADYA										
Total	mm	23.1	15.0	53.6	71.9	75.8	25.5	22.6	28.4	316
Divergence	%	+16	−68	−2	+14	+51	−35	−34	+65	−4
*BOUIDER										
Total	mm	5.6**	3.8	38.0	55.0	39.0	20.2	21.8	20.8	205**
KHANASSER										
Total	mm	23.4	13.4	42.6	45 6	36.4	17.6	22.2	12.4	214
Divergence	%	+333	−42	+13	+13	−5	−46	−22	−25	−5
*GHRERIFE										
Total	mm	8.2	3.8	48.4	49.2	44.2	27.6	20.8	37.6	240
BREDA										
Total	mm	17.0	4.4	37.2	57.7	57.6	19.0	15.0	10.4	218
Divergence	%	+25	−86	−36	+18	+48	−45	−57	−37	−22
JINDIRESS										
Total	mm	23.6	57.4	54.2	95.5	102.4	23.6	28.8	19.8	409
Divergence	%	−6	+11	−44	+7	+32	−60	−37	+1	−13

* Long-term average not available
** Incomplete data

Appendix 10

Glossary of Symbols and Acronyms

To avoid many repetitions of the names of units of measurement, as well as those of countries, currencies and languages, we have made use of the symbols recommended by the International Organization of Standardization (ISO). Those actually employed are:

Units of measurement

°C degrees Celsius
cm centimeter
ha hectare
g gram
kg kilogram
km kilometer
m meter
mm millimeter
t tonne (1000 kg)

Currencies

SDP Sudanese pound
SYP Syrian pound
USD United States dollar

Languages

Ar Arabic
En English
Fr French

Countries

AU Australia
BE Belgium
CA Canada
DE Germany (F.R.)
DZ Algeria
EG Egypt
ET Ethiopia
FR France
GB United Kingdom
IN India
IT Italy
JO Jordan
JP Japan
KE Kenya
MA Morocco
NL Netherlands
PL Poland
PK Pakistan
PT Portugal
SD Sudan
SE Sweden
SY Syria
TH Thailand
TK Turkey
TN Tunisia
US United States

The following are the acronyms employed in this report

ACIAR	Australian Center for International Agricultural Research
ADB	Asian Development Bank
AID	See USAID
AOAD	Arab Organization for Agricultural Development
AZRI	Arid Zone Research Institute (Quetta, Pakistan)
BMZ	Federal Ministry of Economic Cooperation (Federal Republic of Germany)
BYDV	Barley Yellow Dwarf Virus
CEC	Commission of the European Communities
CERINT	Small grains database management
CIMMYT	International Center for the Improvement of Maize and Wheat (Mexico)
CIRAD	Centre de Cooperation en Recherche pour le Developpement (France)
CGIAR	Consultative Group on International Agricultural Research
CRISP	Crops Research Integrated Statistical Package
CSIRO	Commonwealth Scientific and Industrial Research Organization (Australia)
DGIS	Directorate General for International Cooperation (Netherlands)
DSE	German Foundation for International Development
ENEA	Comitato Nazionale per la Ricerca e per lo Sviluppo dell'Energia Nucleare e delle Energie Alternative
ETSIA	Escuela Tecnica Superior de Ingenieros Agronomos, Spain
FAO	Food and Agriculture Organisation of the United Nations
GTZ	German Agency for Technical Cooperation
IBPGR	International Board for Plant Genetic Resources
IBRD	International Bank for Reconstruction and Development (World Bank)
ICADET	ICARDA Database Management Package
ICASET	ICARDA Typesetting Package
ICARDA	International Center for Agricultural Research in the Dry Areas
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics, India
IDRC	International Development Research Centre, Canada
IFAD	International Fund for Agricultural Development

IFPRI	International Food Policy Research Institute
INAT	Institut National Agronomique de Tunis
INRA	Institut National de la Recherche Agronomique
INRAT	Institut National de la Recherche Agronomique de Tunisie
IPO	Research Institute for Plant Protection, Netherlands
ISNAR	International Service for National Agricultural Research
MART	Management of Agricultural Research and Technology (project of USAID)
MIAC	Mid-America International Agricultural Consortium
NVP	Nile Valley Project
ODA	Overseas Development Administration, United Kingdom
OPEC	Organisation of Petroleum-Exporting Countries
ORSTOM	Institut Francais de Recherche Scientifique pour le Developpement en Cooperation
PARC	Pakistan Agricultural Research Council
SDS	Sodium dodecyl sulfate
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
USDA	United States Department of Agriculture

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