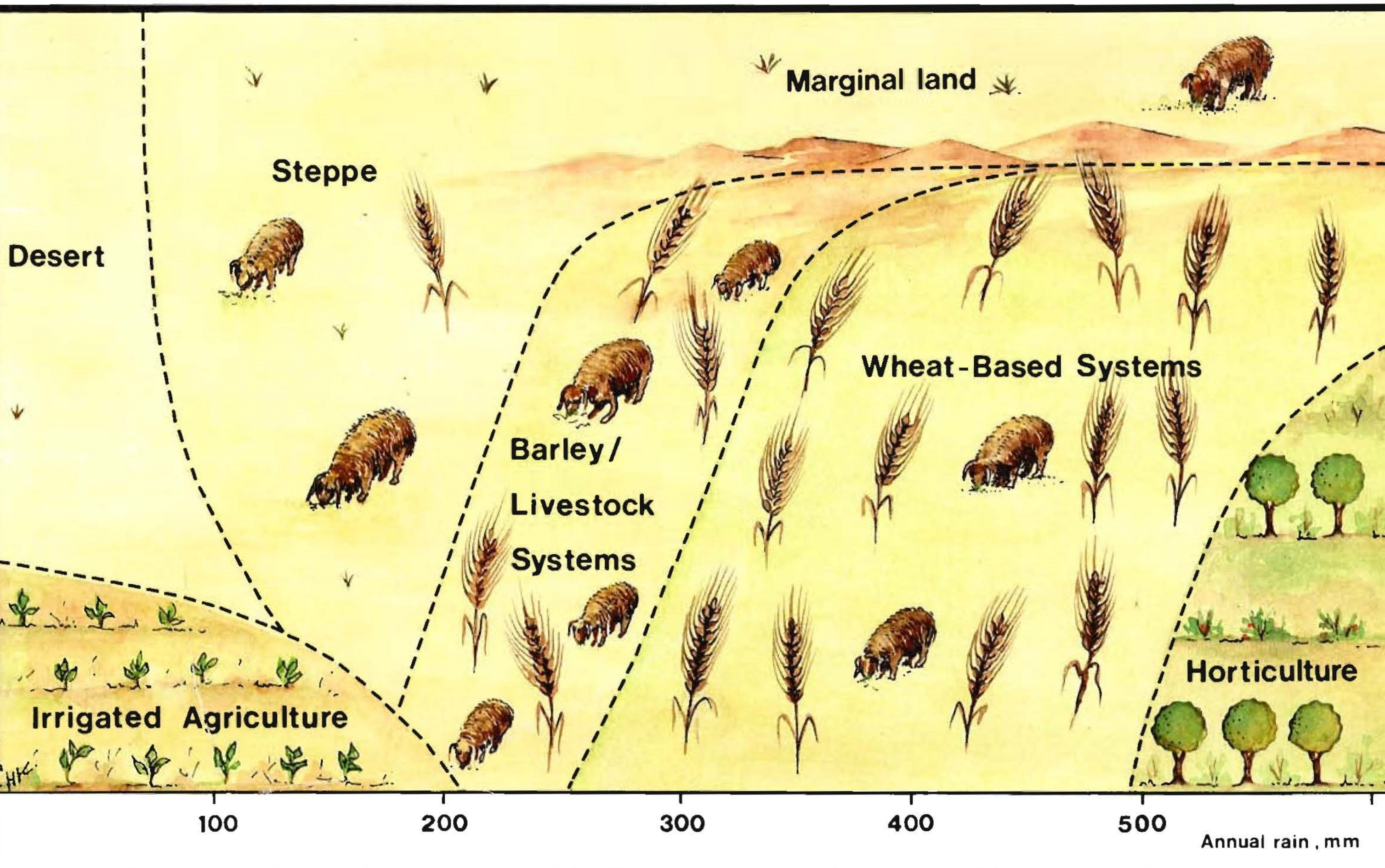
ICARDA Annual Report 1987



International Center for Agricultural Research in the Dry Areas

ICARDA
Annual Report
1987

International Center for Agricultural Research in the Dry Areas
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COVER: *Dominant agricultural systems of West Asia and North Africa.*

In its research programs, and now in the development of a strategic plan, ICARDA acts in relation to the farming systems that are practised where the climate provides moisture largely in the colder months, and where summers are hot and dry. Since national agricultural research programs are allocating much of their resources for systems appropriate to the higher end of the rainfall spectrum or under conditions of irrigation, ICARDA is gradually shifting its focus to the drier areas where livestock is particularly important. Much of the sloping land is marginal for cultivation, but can be improved to carry larger flocks. High-elevation areas are subject to more extreme stress, and need attention because of the large populations in these areas that depend on farming for their subsistence.

Contents

Dr Mohamed Nour addressing the staff of ICARDA at a farewell reception on the eve of his departure.

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 enhance and sustain food production and, 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, to achieve better and more consistent harvests, while conserving the natural resources that make this possible. 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 also supports an important ICARDA program on farm resource management.

Much of ICARDA's research is carried out on a farm of 948 hectares, at its headquarters at Tel Hadya, 30 km southwest of Aleppo. 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. A range of training programs are offered extending from residential courses for groups to advanced research opportunities for individuals. These efforts are reinforced by seminars, by publications (research reports, training materials and manuals for the application of techniques), and by specialized information services 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

It falls to me, as Acting Director General for the last months of 1987, to present this Annual Report to those interested in the work and progress of ICARDA. But I do so in all modesty, recognizing that, until September, the Center was fully under the command of the man who had been our Director General since 1981, Dr Mohamed A. Nour. At the end of that month, Dr Nour left ICARDA to become an Assistant Administrator of the United Nations Development Programme, and his departure was marked by many tributes for his long and dedicated service to the Center, as well as by expressions of confidence in the vitality that he was about to bring to his very important post in New York.

Dr Nour was not the only senior person to leave us. For eight months we were without a Deputy Director General for Research: fortunately, Dr Aart van Schoonhoven joined us in September. In August, Mr Edward Sayegh, the Financial Controller and Treasurer left after nine years of service.

The middle months of 1987 were also marked by other changes at ICARDA. The new buildings, which had been virtually completed in 1986, were occupied but not without problems, some of which are described elsewhere in this report. Now, with the problems largely overcome, the staff are able, for the first time, to work in a modern environment with all the required services. The older buildings have been adapted to new uses and effectively complement the new facilities.

One of the new uses for old buildings involves the rehabilitation of the area with precision climate-control that was formerly occupied by the computers and the staff of Computing Services. This space has been reallocated for a modest effort in biotechnology, aimed particularly to accelerate the breeding work needed for crop improvement. There are biotechnology techniques that appear to offer immediate gains for our research in plant breeding, and we seek to profit from them, either through cooperation with advanced institutions in industrialized countries or in our own facilities. This is a pragmatic approach, and our modest investment in new facilities should be seen as a reinforcement of our applied research, and not as a shift into basic research for its own sake.

West Asia and North Africa form a vast region with more than 20 countries. It is the national institutions of these countries that bear the responsibility for demonstrating the results of research and for providing extension service to their farmers. ICARDA cooperates as far as possible but, in so doing, it must not compromise the role set down in its Charter, which established the Center as a body to give leadership in research. Inevitably, we are in a position to offer somewhat more cooperation to our host country than to most of the others and, to the degree that we can contribute to Syria's efforts in agricultural development, this is often to mutual advantage: the discipline of putting research into application can provide a healthy feedback to the research itself.

In general, however, we know that any effort we can spare for development work must be targetted to key issues of regional significance. Thus, for example, since weaknesses in seed-production facilities are a constraint on the introduction and adoption of improved crops, we are happy to be managing a Special Project that provides training and advice in seed-production technologies for national institutions in the region. Again, this exemplifies a pragmatic application of ICARDA's experience without implying a major reorientation of our principal activities.

Elsewhere in this report, we take note that 1987 was a year in which we devoted considerable efforts to the development of a long-term strategic plan and preparations for the external program and management reviews that will take place in 1988. I believe that our decisions on biotechnology and our work on seed production demonstrate that, while our core program will continue to be centred in the mainstream of applied research, we have the flexibility to seize new opportunities and to respond to priority needs. The same two items also illustrate that we are not prisoners of our existing organizational structure. The biotechnology laboratory will be a common resource and a point of convergence for all scientists, whether concerned with cereals, or legumes, or livestock. The seed-production effort is a similar across-the-board activity which draws on the accumulated knowledge of all research programs.

One of the principal themes of this year's Annual Report is 'networks', and readers will notice that, in several of the items in the *Highlights* sections, we describe an informal and specialized network set up among a group of scientists to deal with a problem of common interest. Perhaps in the long run, these loose, overlapping structures that provide for a sharing of work within groups of committed individuals will prove more effective than more formal efforts that would require coordinated planning and long-term institutional commitments.

Nevertheless, even the informal networks can function only within the framework of agreements that provide for the unimpeded movement of personnel, and the exchange of equipment, materials and seed. During 1987, we signed new such agreements with the Ministries of Agriculture of Egypt and Iran. Altogether we now have agreements with 13 countries of the region, which means virtually all those that have a significant rainfed sector in their agricultural economies. Typically, each of these agreements sets the modalities for cooperation between ICARDA and the principal national institution charged with responsibility for agricultural research. With many of the countries, there is an annual meeting at which we and our partners agree on a workplan for the coming season, and the relationship is reinforced by exchange of visits as the work proceeds.

The set of agreements also include all those countries of the region that have large populations actively engaged in agriculture at elevations over 1000 m. One of our *Highlights* describes a conference in Ankara at which plans were made to set up interlocking networks for research related to the very different needs of these areas. This gives us considerable satisfaction, recalling the original concepts of the founders of ICARDA, who envisaged three broad zones of action: one in the more-favored, often coastal areas, one in the dry areas of low or intermediate elevation, and another for the very special, and hitherto neglected, case of agriculture on the high plateaux and in intermontane valleys.

During 1987, agreements were also signed with two universities: Khartoum and Alexandria. These, and earlier agreements with other universities have several purposes including, of course, cooperation between ICARDA staff and university faculty for research either in our facilities or at the university itself. But another important aspect is that the agreements provide for graduate students to do their thesis research at ICARDA while receiving their degrees from the university. Our engagement in such activities, while it may put a heavy burden on the time of our senior staff, is to respond to new priorities in our overall training program. The large numbers that appear in Table 9 reflect our concentration over the years on providing courses, either at Tel Hadya or in particular countries, for groups of participants, mostly persons working at a relatively junior level in national research institutions. Without abandoning this type of training, we are shifting a somewhat larger fraction of our resources into advanced training for individuals, including those who are candidates for academic degrees.

In December, ICARDA joined with the Food and Agriculture Organisation of the United Nations (FAO) and with the International Service for National Agricultural Research (ISNAR) to sponsor the second general conference of the Association of Agricultural Research Institutions in the Near East and North Africa (AARINENA). The conference was held in Nicosia, Cyprus, where the participants elected officers, selected a permanent location for the Association's headquarters, and drew up a program of work for the next two years. ICARDA welcomes this development: we would like to see AARINENA become a strong regional organization with its own mechanisms for organizing cooperation in agricultural research. As in the past, we shall seek the advice of the heads of individual national research programs, but we now also look forward to having, in AARINENA, an interlocutor that can speak for the agricultural research needs of the region as a whole.

In November, the Board of Trustees announced the selection of the next Director General, Dr Nasrat Fadda, a scientist with an outstanding record in agricultural research, development and administration. He made a week-long visit in December to become better acquainted with the Center and its staff and, as the year ended, we were looking forward to his assuming his responsibilities in March 1988.

So, at the end of my short term as Acting Director General, I want to take the opportunity to express my heartfelt thanks to all those who helped me to discharge that function. Particularly, of course, to the Trustees and staff; but, at the same time, I acknowledge the benevolent cooperation of the Government of Syria, and the helpful advice that I received from colleagues within the CGIAR system and from the donors - without whose faith in the Center, none of this would be possible.

G. Jan Koopman
Acting Director General

Board of Trustees

The year 1987 was one that saw unusually intense participation of the Trustees in the affairs of the Center. At the regular April meeting of the whole Board, Dr Mohamed Nour informed the Trustees that he would be resigning from his position as Director General, and the Board set up a Search Committee to look for a successor.

At the end of August, the Executive Committee met in Aleppo and appointed Ir G. Jan Koopman - who had, himself, been a member of the founding Board of Trustees - as Acting Director General. The Executive Committee also set up another Selection Committee, this one to search for a new Financial Controller and Treasurer to replace Mr Edward Sayegh.

Early in October, the Board's Committee on the Strategic Plan held an intensive two-day meeting during which they shared ideas with management and the scientific staff and furthered the process of developing a long-range plan that will be presented to the External Program Review in May 1988.

Meanwhile, the Selection Committee had been interviewing candidates for the position of Director General. It met later in October and prepared the recommendation that it was to submit to an extraordinary meeting of the whole Board in November. At that meeting, the Board announced its selection of Dr Nasrat Fadda to be the new Director General and its expectation that he would assume his functions in March 1988. The whole Board also reviewed the work of the Committee on the Strategic Plan.

Earlier in the year, the Trustees' work had been proceeding normally. The Program Committee had met in Khartoum and, in addition to its usual in-depth review of the scientific program, had endorsed a proposal to restructure the Farming Systems Program and to rename it as the Farm Resource Management Program.

At the full Board meeting in April, the Trustees honored Dr Harry S. Darling as their *Guest of the Year*. Dr Darling had been the first Director General of ICARDA, serving from 1977 until he was succeeded by Dr Nour in 1981. He now lives in retirement in the United Kingdom.

Three Trustees came to the end of their terms of office in 1987: Mr Kenneth Anthony who had been appointed in March 1982; Dr Ralph A. Fischer, who had been a Trustee since November 1981, and Chairman of the Program Committee since 1985; and Dr Mustapha Lasram who had been appointed in November 1981 and had served as Vice-Chairman of the Board since 1985. Dr Enrico Porceddu was elected as the new Chairman of the Program Committee, and Mr Hasan Su'ud Nabulsi as the new Vice-Chairman of the Board.

Three new members were elected, and 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

Mr Hasan Su'ud Nabulsi
(Vice Chairman, from April 1987)
Jordan Cooperative Organization
Amman, Jordan

Miss Naima Al-Shayji
Ministry of Planning
Kuwait

Dr Alfred Philippe Conesa
Institut National de Recherche Agronomique (INRA)
Montpellier, France

Dr Nazmi Demir
Ministry of Agriculture, Forestry and Rural Affairs
Ankara, Turkey

Dr Hoceine Faraj*
Institut National de la Recherche Agronomique (INRA)
Rabat, Morocco

Dr Carl Gotsch
Stanford University
Stanford, California, USA

Dr Norman Halse*
Director General
Dept of Agriculture
South Perth, Australia

Dr Joseph Haraoui
Agricultural Research Institute
Fanar, Lebanon

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

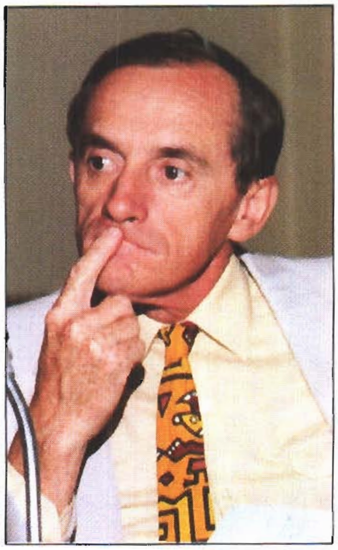
Dr Gerard Ouellette*
Ottawa
Ontario, Canada

Dr Enrico Porceddu
Institute of Agricultural Biology
University of Tuscia
Viterbo, Italy

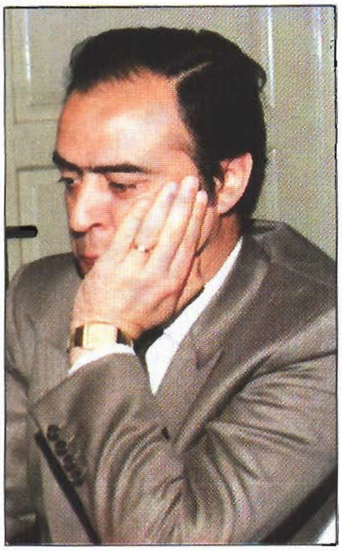
Prof Alexander Poulovassilis
Agricultural College of Athens
Athens, Greece

Harry S. Darling

Kenneth Anthony



Ralph A. Fischer



Mustapha Lasram

Prof Dr Ir Roelof Rabbinge
Agricultural University
Wageningen, Netherlands

Dr Hassan Saoud
Deputy Minister of Agriculture and Agrarian Reform
Damascus, Syria

Ir G. Jan Koopman (ex officio)
Acting Director General
ICARDA
Aleppo, Syria

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* Elected in 1987

The following meetings took place:

January 26-30	Khartoum SD	Program Committee
March 4-5	Sevilla ES	Executive Committee
April 26-29	Aleppo SY	Full Board
August 27-28	Aleppo SY	Executive Committee
October 20-23	Washington US	Search Committee for Director General
November 9-12	Aleppo SY	Full Board

Resources for Research and Training

At the most basic level, the resources available to ICARDA are the funds provided by the donors. Inevitably, in an organization that is eleven years old, much of the budget is committed for the salaries of staff and for the operation of facilities that are already in place. However, good management requires that a significant component remains available for new capital expenditures and to shape program activities according to changing needs and priorities. In the commitment of resources, a balance must be struck between that which maintains a capacity to act and that which can be devoted to specific actions in their own right. In last year's annual report, we listed the types of activity in which ICARDA is engaged, and this list is repeated below because it represents an enduring description of the means we employ to reach our objectives; but there is an evolution in the topics to which our resources are applied as we identify improved strategies for research and as the national agricultural research programs develop new strengths and capacities. To discharge its responsibilities, ICARDA:

- Carries out research and conducts training programs employing its own staff and facilities; welcomes guest researchers and graduate students to use these facilities.

- Provides genetic material and technologies, and 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.

- Works with advanced institutions in industrialized countries to apply highly developed research methods to some of the problems of the ICARDA region.

- Cooperates with other Centers in the CGIAR system on matters of common interest.

The combination of continuity with flexibility is partly assured by the mechanisms by which donors provide their support. The greater part comes as contributions to our "core" budget, but an increasing fraction (now more than 10%) comes for the support of "special projects" which exploit ICARDA's capacities and accumulated experience, but which do not represent a commitment beyond the duration of the funding. These special projects are particularly useful for cooperative activities with national programs, where an ICARDA involvement may be needed for a few years, but for which the national programs will themselves be responsible once the immediate objectives have been fulfilled.

Staff

Table 1 shows the numbers of staff employed on December 31. The departures of the Director General and of the Financial Controller and Treasurer have already been noted in the *Foreword*, as well as the arrival of the new Deputy Director General for Research. Dr Mohan Saxena, Leader of the Food Legume Improvement Program, was granted sabbatical leave, which he is spending with the International Atomic Energy Agency. Dr K.B. Singh was appointed Acting Leader in Dr Saxena's absence.

There were no major organizational changes affecting the scientific programs, but the Director of Administration, who had been appointed late in 1986, re-organized the units that are reporting to him. Several were consolidated in a Physical Plant Department, and Dr P. Jegatheeswaran, a mechanical engineer, was appointed as Department Head.

Table 1. Staff of ICARDA at various locations on December 31, 1987

		International professional	Regional professional	Other staff	Totals
Syria	Aleppo-Tel Hadya	46	48	549	643
	Damascus	-	-	7	7
	Lattakia	1	-	4	5
Ethiopia	Addis Ababa	1	-	-	1
Egypt	Cairo	1	-	6	7
Italy	Perugia	-	-	3	3
	Viterbo	-	-	2	2
Jordan	Amman	-	-	1	1
Lebanon	Beirut	-	1	6	7
	Terbol	-	-	27	27
Mexico	CIMMYT	1	-	-	1
Morocco	Rabat	3	-	2	5
Pakistan	Quetta	5	-	1	6
Tunisia	Tunis	2	-	4	6
TOTALS (1987)		60	49	612	721
TOTALS (1986)		60	30	588	678
Increase		-	19	24	43

Finances

During 1987, the CGIAR asked all Centers to adopt a uniform accounting policy and to use standarized formats for their financial statements. The presentation in this annual report is made, therefore, on a somewhat different basis from those in previous years.

In particular, the new policy affects the reporting of revenue from donors' grants for particular activities within the core program ("restricted core") and for special projects. In the past, these amounts were reported in the year for which they had been pledged. The new policy requires such grants to be reported only to the extent that monies were actually expended within the amounts pledged.

To enable comparisons to be made with previous years, the records for those years have now been adjusted to reflect the new policy and to apply the new format. The 1987 statements, with adjusted 1986 figures for comparison, are given in Appendix 4.

During 1987, ICARDA operated its core activities on funds totalling 24.577 million USD, which compares with 23.852 million in 1986. The sources of these funds are given in summary form in Table 2. In addition to the funds applied to its core activities, ICARDA received contributions totalling 2.677 million USD for support of 18 special projects. These are listed in Appendix 1.

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

Arab Fund	370[a]	Netherlands	554
Australia	246	Norway	433
Austria	175	OPEC	115[a]
Canada	783	Spain	155
China	30	Sweden	541
Denmark	244	UNDP	338[a]
Ford Foundation	210	United Kingdom	910
France	189[a]	USAID	4 763[a]
Germany (BRD)	1 827[a]	Locally generated fund	3 042[b]
IBRD (World Bank)	4 800	Earned Income	2 197[c]
IDRC	273[a]		
Italy	2 382[a]		
			24 577

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

[b] During 1987, Syrian law permitted ICARDA to import Syrian currency purchased outside the country; for accounting, the domestic rates-of-exchange are used and the difference is credited on this line.

[c] This amount is largely made up of gains in the USD equivalent of accounts in German marks and British pounds.

The buildings

In last year's Annual Report, a report was presented on the new buildings that had been completed at ICARDA's headquarters site at Tel Hadya. Most of the finishing and furnishing took place during 1987. By mid-summer, occupation was virtually complete, and the staff that had been working in Aleppo were accommodated in either the new or the old buildings at Tel Hadya.

ICARDA's new headquarters at Tel Hadya.

The major facility in Aleppo had been a large mansion rented from a private owner. However, by the time ICARDA was ready to move out, the Governorate of Aleppo had purchased the mansion, together with two other villas and land on which a sports complex had been developed. The Governorate offered to make the entire site available to ICARDA on a long-term lease and with permission to make alterations and additions. This provided the opportunity for us to take the mansion as new premises for the International School which, until then, had been housed in very cramped quarters (see Appendix 11). The two villas on the site were re-furbished as guesthouses, allowing us to vacate the old guesthouses which were far from any ICARDA office. And the staff has now formed a Sports Committee which is setting up a program to use the facilities that were acquired with the land.

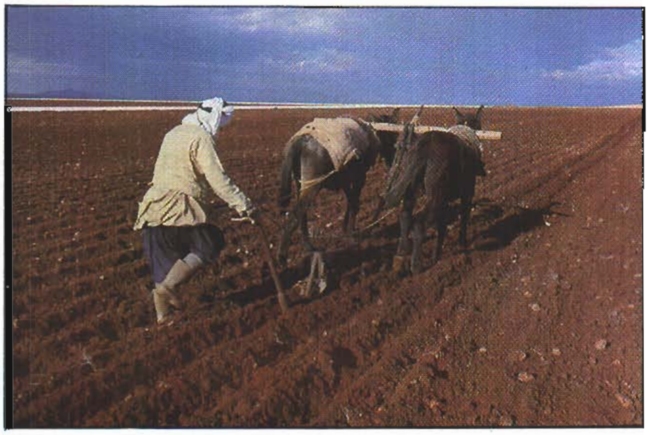
The completion of the main headquarters did not end all construction at Tel Hadya. Work continued on the Genetic Resources Building, which was already well under way in 1986; however, serious delays were experienced in the on-site delivery of essential materials for this building, which will contain 600 m^3 dedicated to cold storage, and completion is not now foreseen until late in 1988.

Ground was broken for an extensive new array of double-layer plastic greenhouses. These have a span of 8.5 m, and a total useable floor area of 4335 m^2, of which 2040 m^2 will be concreted. The houses are manufactured by a French company, and the erection which began in October 1987 is scheduled to be finished by April 1988. Total cost is estimated at 500 000 USD.

The suppliers are working to specifications that require that humidity be maintained at up to 70% and temperature down to 25°C even in mid-summer. To achieve this, the houses will have their own independent electricity supply with a stand-by generator, and self-contained water facilities for the evaporative cooling systems. Plastic windbrakes are used to reduce the impact of hot winds in summer and cold winds in winter.

Artificial lighting and irrigation systems are provided, so that a range of year-round growing conditions can be

Greenhouses under construction.



Local farmers broadcast seed over ridges and then, as in this photograph, split the ridges to cover the seed.

simulated for research projects that are already at an advanced stage of planning. These are built on the experience that ICARDA has had in the much smaller greenhouse facilities currently available. Tissue culture will be included for the first time in the breeding work, which altogether will occupy much of the total space. However space will also be dedicated to physiology and agronomy work, to pathology and entomology.

The farms

ICARDA operates six sites in Syria and two in Lebanon. This permits the Center to carry out its experiments and test crop varieties under a range of agroclimatic conditions typical of those that prevail in West Asia and North Africa. Data on each site - location, elevation, area, soil, average precipitation - were given in last year's Annual Report; and the month-by-month precipitation at most of the sites during 1986/87 is recorded in Appendix 13 of this report. The 1986/87 season was unusual in many respects: good early rains were followed by a long spell of cold and drought, but then a relatively mild period that enabled the crops to recover at Tel Hadya. However, there were some complete failures at drier sites. Overall, 1986/87 proved to be a satisfactory year for seed multiplication at Tel Hadya, but the unusual conditions also made it useful for the observance of stress phenomena.

The 1987/88 season also began mild and with considerable early rain. The problem with voles (*Microtus socialis*), which gave considerable trouble at the outset of the 1986/87 season, was not encountered this year. We are not sure of the reasons for the sharp decline in population, although it may be that these rodents are unable to construct their nest burrows when the soil is water-logged. At Tel Hadya, fertilizer spreaders were used to distribute poison bait in ditches as a precautionary measure.

Each year brings its particular problems for the farm managers and, entering the 1987/88 season, there was high incidence of the parasitic weed, *Orobanche,* which attacks all the food legumes, as well as some of the forage legumes. ICARDA's research on *Orobanche* is presented later in this report, and the item includes a discussion of possible means of control. On an experimental farm, control is essential for, otherwise, it becomes almost impossible to make scientific intercomparisons of different practices and varieties.

Strong action is planned to prevent this year's *Orobanche* from seeding. The spikes will be collected in plastic bags and incinerated. However, this will not eliminate the infestation, as many more dormant seeds lie in the soil and could germinate in later years. One possibility is to make a very deep plowing to bury the seeds below the depths where they can germinate but, if this technique is applied, deep plowing should not be done again on the same fields, perhaps for as long as 15 years, because of the long period of viability of *Orobanche* seeds.

In last year's Annual Report, it was noted that ICARDA sowed barley on the land at Tel Hadya that is not needed for experiments. We recorded that ICARDA was getting greater yields than local farmers outside the fence, and that we proposed to do an agronomic study to determine the reasons.

Farmers broadcast barley over ridges, and then split the ridges to cover the seed. ICARDA has been drilling seed, and has progressively reduced row spacing, now to 10 cm. In 1986/87, we also simulated farmers' practices and compared the results. With early planting in dry soil, drilled seed gave 4 180 kg/ha, and simulated farmers' practices gave 3 423 kg/ha. No firm conclusions should be drawn from the results of one year but, tentatively, the difference can be attributed to the irregularity of the emergence of seedlings from broadcast seed and the late establishment of ground cover; early ground cover promotes water-use efficiency. At least in years when there is no severe climatic stress, there may well be advantage in having a consistent sowing depth and a more uniform spacing of plants.

An item in this report, *Tillage and Stubble Management*, describes ICARDA's interest in studying the practices of stubble retention and zero tillage as means for combatting soil erosion. Some such work has already begun on half-hectare plots at Tel Hadya, and may help resolve discussions on whether or not any kind of soil preparation is useful before the introduction of the regime. European experience points to the dangers of using heavy equipment on fields subject to zero tillage, but the sub-surface compaction seen in European clays may prove not to be a problem in the soils characteristic of this region: here the soils swell up when wet, and there is a seasonal cycle of natural disruptions.

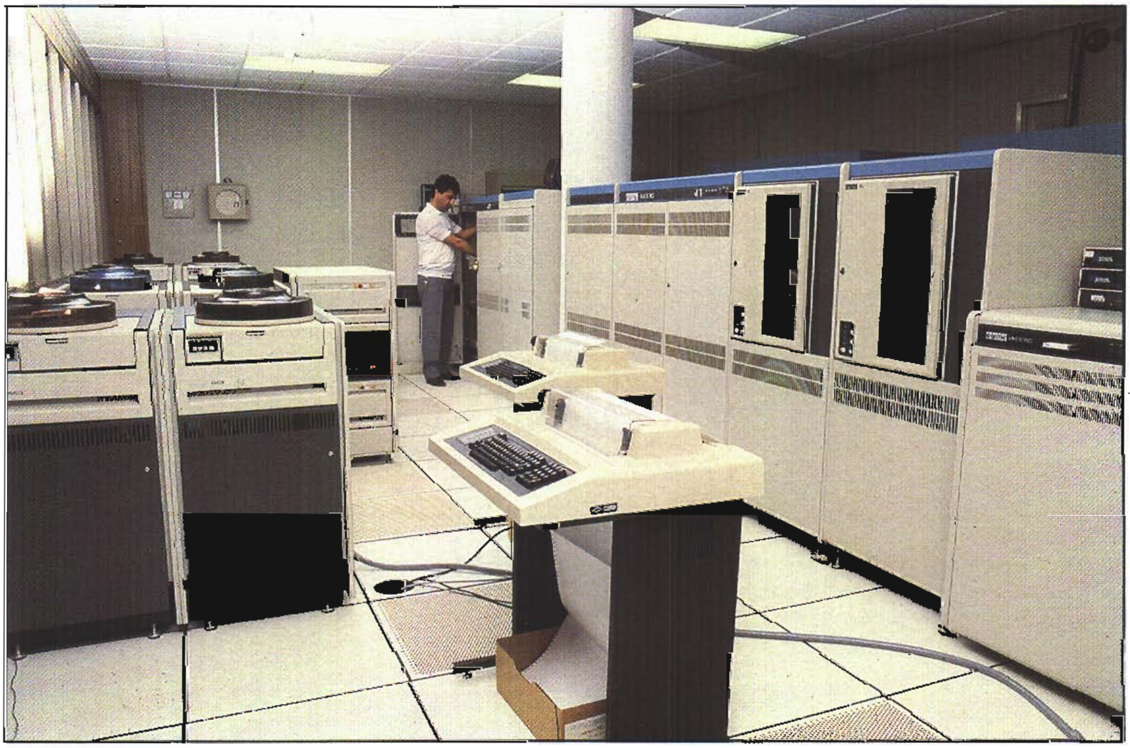
An important event of 1987 was the convening of a regional conference in collaboration with the International Association on Mechanization of Field Experiments (IAMFE). This took place in May and brought 66 participants from 20 different countries. It was attended by managers of experimental farms, agricultural researchers, and equipment designers and manufacturers. At the end of the conference, a special seminar was held on the mechanization of lentil and chickpea harvests. The proceedings have been published by ICARDA, and they represent a significant accumulation of relevant experience as well as research in progress. The manufacturers that demonstrated equipment during the conference have donated some of their machines to ICARDA and, indeed, these make a useful addition to the modern equipment available for managing the experimental plots at Tel Hadya.

The computers

For Computing Services, a pivotal event of the year was the move into ICARDA's permanent headquarters: the planning that preceded the move, the temporary connections to maintain service as users progressively transferred to locations remote from the old center, the adaptations needed in the new building, the phased moves of the computer equipment itself, and the preparations for expanded service once the new location had been occupied.

ICARDA's principal equipment is made up of two VAX-11/780, one VAX-11/750, and one PDP-11. The small machine was previously located in Aleppo, and the three large ones in temporary facilities at Tel Hadya. Unlike those who operate computers at institutions in industrialized countries and who can call on a wide range of specialized services to back up their work, the ICARDA team must rely very much on its own skills. Here, there are no customer engineers making regular visits, no classes to which staff can be registered for training, no agents to negotiate procurement licences, and - the case in point - no engineering teams with specialized knowledge of computer removals.

The permanent headquarters had been designed some seven or eight years before it was ready for occupancy. Prime space had been reserved for the computer center, but not sufficient for present needs, and a variety of problems became apparent as the building neared completion. For example, a system of metal trays needed to be installed



The new computer room at Tel Hadya.

over the ceiling of the computer room to catch any spill that might result from a rupture in the air-conditioning system. This protection is now supplemented by temperature and humidity monitors that are capable of automatically sounding alarms and shutting down the center if it is at risk.

The research scientists were the first to move into the new buildings. They did so while they were still needing to use the computers to analyse the results of their 1986/87 experiments. The maximum distance from the old computer center was 1.7 km and, until the computers could be moved, terminal access was provided through back-to-back linedriver-multiplexers operating over three spans in series. For several months, users were served at 1200 baud, instead of the 2400 baud to which they had become accustomed.

Now, with the move complete, ICARDA has begun to implement plans for a long-awaited expansion of its computer facilities. Figure 1 illustrates the planned networking of central computers, departmental computers, and local personal systems (PS). For this, the necessary equipment was ordered and, despite delays in the granting of export licences, as well as local clearances, it is expected to be in operation soon. The total installation will become one of the largest and most intensively used in the region.

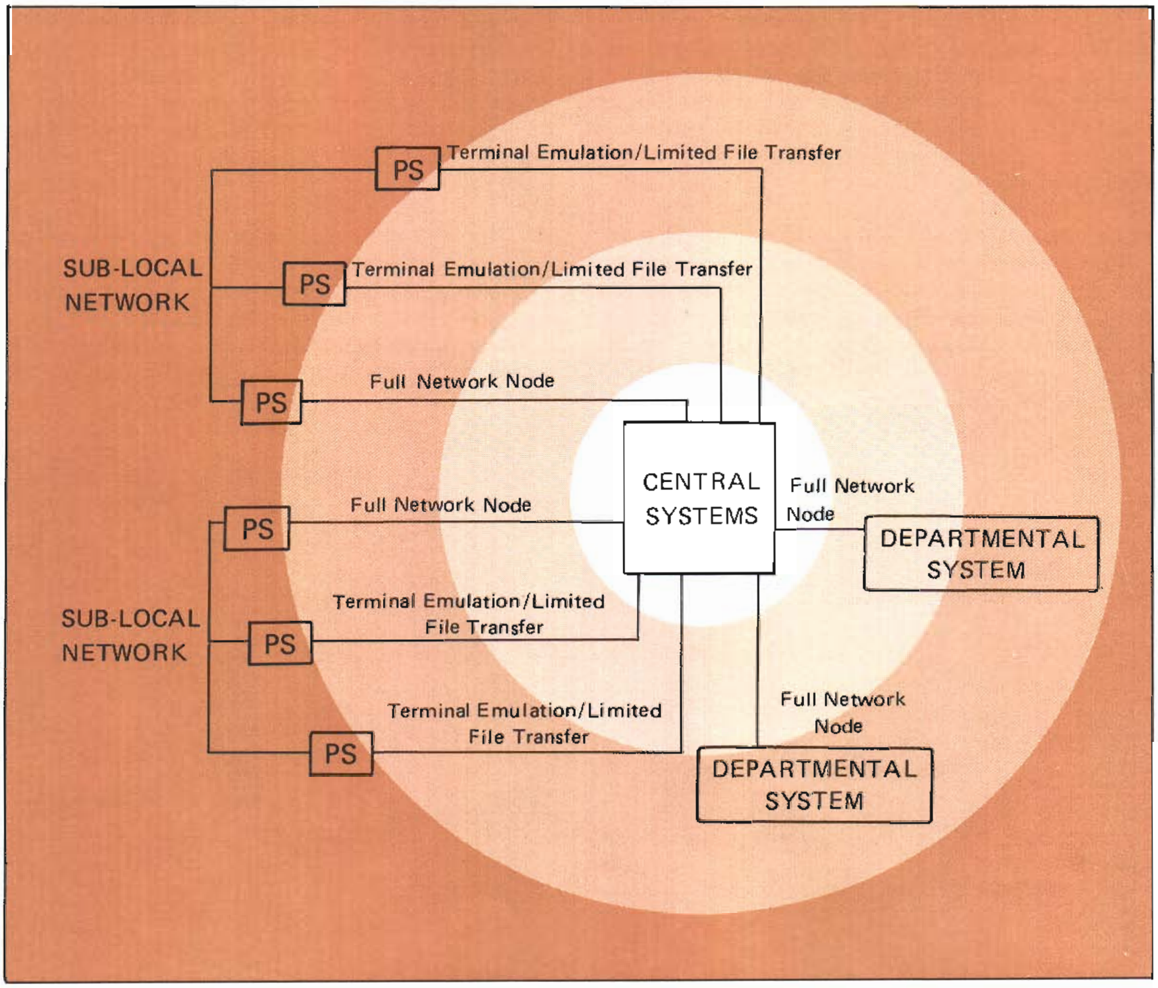


Figure 1. Schematic diagram of ICARDA net participating CPUs. (PS = personal system; number of CPUs not representative).

Developments in Research Programs

The year 1987 was one in which the researchers of ICARDA made an intensive effort to re-think their long-term strategies and to forecast their activities for the next 10-15 years. This process had begun with a series of meetings near the end of 1986 and was hastened by the prospect of the external reviews to be carried out in May-June 1988. The process is embodied in the development of a draft Strategic Plan which takes account of forecasts of future agricultural production and food requirements, the knowledge that ICARDA has acquired in its past work, the identification of those problems that might be overcome by further research, and consultations with national research organizations in West Asia and North Africa.

ICARDA's Strategic Plan will be completed and issued in 1988. Meanwhile, all research programs of ICARDA have developed forward plans at least at the conceptual level, and statements are presented in their individual annual reports. These reports, which are published separately, are available as follows:

Farm Resource Management Program: annual report for 1987, 218 pp., publication ICARDA-131 En

Pasture, Forage and Livestock Program: annual report for 1987, 288 pp., publication ICARDA-129 En

Cereal Improvement Program: annual report for 1987, 206 pp., publication ICARDA-132 En

Food Legume Improvement Program: annual report for 1987, 264 pp., publication ICARDA-134 En

Genetic Resources Program: annual report for 1987, 57 pp., publication ICARDA-133 En

High-Elevation Research in Pakistan: the MART/AZR project: annual report for 1987, 103 pp., publication ICARDA-127 En

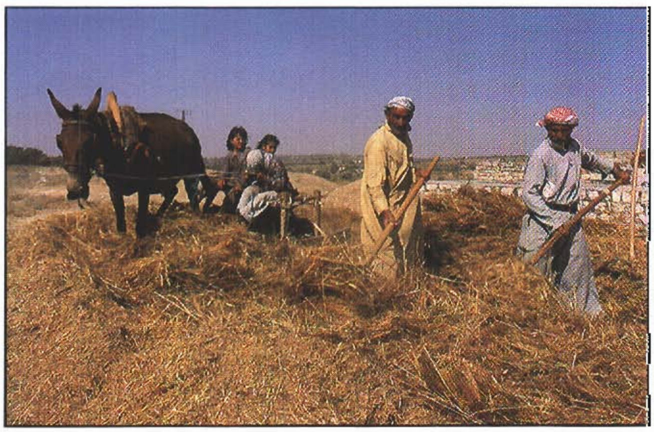
Readers interested in detailed scientific accounts of ICARDA's work in particular areas are invited to request these reports. In the remainder of this chapter, brief statements on major trends and new orientations are made. In the *Highlights* sections that follow, ICARDA's scientific work is illustrated by presenting accounts of particular research efforts. These cover only a small fraction of all the work of 1987, but they have been selected because of their possible more general interest, or because a specific action had come to a certain maturity in the course of the last year.

The Program Committee of the Board of Trustees, at its meeting in Khartoum in February 1987, endorsed a proposal to restructure the former Farming Systems Program and to rename it as the *Farm Resource Management Program.* This change reflected a new focusing of the Program's activities and a recognition that the old name had suggested - wrongly - that the research was following an academic orientation.

Rainfed arable land in West Asia and North Africa (which, for ICARDA, includes Pakistan, Afghanistan and Ethiopia) amounts to about 155 million hectares between the 200- and 600-mm isohyets. In most of this area, production is constrained by meager resources at the farm level: rainfall coming only in winter, and subject to major irregularities within the season and from year to year; relatively infertile soils, often shallow, sloping and stony; an unfavorable economic environment, at least partly due to the small size of the farms and the need for each farmer to manage a cluster of activities to sustain a large family.

With major food and feed deficits forecast for the region in the forseeable future, the available resources must be husbanded to maximum benefit and, since the utilization of each is related to that of the others, a resource-focused research program must still be multidisciplinary and must still view the farm as a total system. The restructuring of the program retains these features, while putting a greater emphasis on the key resource constraints. Three major components have been defined:

Management of Soil, Water and Crop Nutrients. Research in this area seeks to identify technologies that will optimize the efficiency of use and the conservation of these resources. The objective is to work with national research programs and to develop recommendations, principally those that would be offered for application on farms but also, where needed, as policy considerations for governments.



These labor-intensive farming practices are giving way to mechanization, and ICARDA is stepping-up its research on the social consequences.

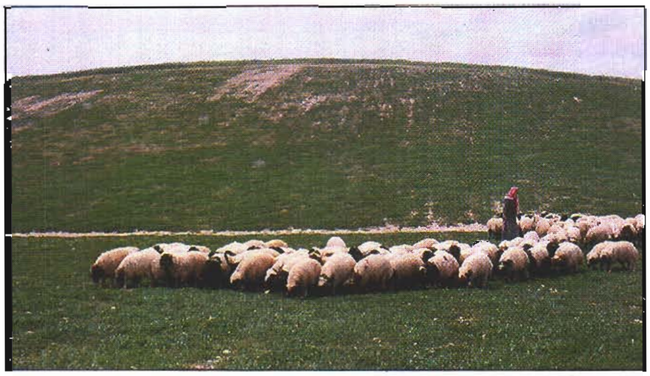
Agroecological Characterization. Given the diversity of agroecological situations in the region, no single technology, nor any single set of recommendations, is likely to be of general validity. Technologies must be targetted, because any one may be effective only for zones with a particular range of soil and climate. Hence, as indicated in last year's report, ICARDA is working with other international agricultural research centers to characterize different environments and to define their geographic extent. This will make it possible for national authorities to adopt a technology, or consider a policy, for application in the areas for which it is appropriate.

Adoption and Impact of New Technologies. It has long been recognized that the products of agricultural research are not always adopted by farmers or by governments and that, when they are, there may be unexpected social or economic consequences. To ensure that ICARDA's research remains relevant, and that the development of technologies is carried out in full knowledge of their potential impact, we will strengthen what has been a small capacity in the socioeconomic sciences. Even more than in the past, ICARDA will factor the social and economic aspects into its studies of alternative technologies.

The studies that led to the definition of the new objectives and activities of the Program were started in 1985 and they carried on into 1986 and 1987; the conclusions are now being integrated into the Strategic Plan.

The *Pasture, Forage and Livestock Program* seeks to develop those components of farming systems that relate to livestock husbandry and to help ensure maximum returns to small farmers while, at the same time, safeguarding an essentially fragile environment. Much of its work applies to the crop rotations that will provide year-round feed for sheep, taking account of the seasonal fluctuations imposed by the lambing and fattening cycles, but it is also concerned with the use of marginal, often common, land for grazing. It studies livestock husbandry as an essential component of the total system. Because sheep become increasingly important as one moves to drier areas, there is a special concern for systems that can be applied where the mean annual precipitation is less than 350 mm.

A major component of the work relates to 'ley' farming, which involves a cereal in rotation with a pasture legume, typically one of the medics (*Medicago* spp.). The system depends on the fact that many of the medic seeds lie dormant in the soil while the cereal is cropped but they germinate in the second year to regenerate the pasture. In recent years, the Program has been studying this system in more-favored environments, where the cereal is wheat and the best medic has been *Medicago rigidula*. However, during 1987, more effort was devoted to drier areas where barley predominates, and it was found that *Medicago polymorpha*, which had been discarded on the basis of its performance at Tel Hadya, showed considerable promise. This seems to be due to the fact that, while appropriate strains of *Rhizobium* are not naturally present in the soil at Tel Hadya, they do exist in many of the drier areas where *Medicago polymorpha* is already established as a wild plant.



On-farm trials of ley farming with medics at the village of Tah, 60 km south of Aleppo, where the system is applied on hillsides as well as on the valley floor.

The Program also took its first major steps to carry its research into other countries of the region. A senior scientist was appointed to work with the ICARDA team attached to INRA in Morocco, where ley farming is already being put into practice along the Atlantic coast. So far, this development has been based on medic cultivars imported from Australia, but the new thrust will involve work with INRA to collect and characterize native medic ecotypes.

The other INRA, that of France, is associated with ICARDA in work that has started in Algeria in cooperation with ITGC and, particularly, its station at Sidi Bel Abbes. Here again, the research relates to ley farming, and it deals initially with on-farm trials aimed at the identification of appropriate medic species.

The *Cereals Program* further refined its strategies for developing lines of bread wheat, durum wheat and barley that will be well adapted to the environmental stresses that commonly occur in West Asia and North Africa. The stresses are manifold and vary greatly from year to year: cold and drought during the period of maximum growth, heat and moisture stress at the head-filling stage, outbreaks of disease, and fluctuating populations of pests.

Once again, during the 1986/87 season, it was demonstrated that lines selected for top performane in more-favored environments may often do less well than local checks under severe stress, but that lines selected for performance under stress can also do well when conditions are favorable.

The basic problem is that an attribute is not exhibited if it is not needed. In a well-favored environment, one cannot select either for drought resistance, or for year-to-year stability in yield under conditions of fluctuating stress - because there is simply no way of observing such attributes. Breeders have long recognized the underlying principle in their search for resistance to pests and diseases, and they select among genotypes that are actually exposed to these hazards, either in the laboratory or in the field. ICARDA is applying the same principle in its search for resistance to abiotic hazards. Much experimental evidence of the validity of the principle has now become available for all three cereal crops but, in this report, its application is illustrated by the results for barley, which is normally grown in drier areas and is thus most often exposed to drought.

In recent years, ICARDA barley breeders have made crosses between promising material and, starting with the F_2 generation, have sown the progeny from each cross in separate plots at several locations, typically at Bouider and Breda as well as Tel Hadya. Bouider and Breda suffer winters that are usually colder and drier than those at Tel Hadya.

At Bouider and Breda, some good heads are taken from the more promising plots, and these are then combined with seed from the best plants of the same cross in the plot at Tel Hadya. If a cross shows poor performance at the drier sites, its seed will not be collected at Tel Hadya, even if it did well there. The process is repeated in succeeding generations so that, by the time the material has become homozygous, it has demonstrated its capacity to perform under adverse and variable conditions over four or five different growing seasons (Figure 2).

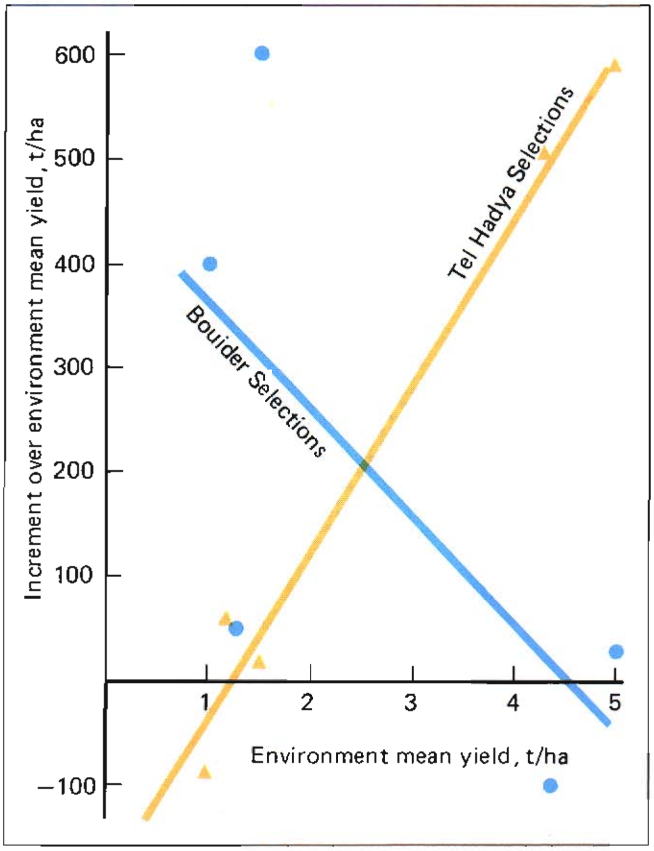


Figure 2. *Select under stress for performance under stress.* **Tel Hadya is a reasonably favored site with an average annual rainfall of 330 mm, whereas Bouider receives only 180 mm. Points on the scale** ***Environment mean yield*** **are obtained by taking the average yield of 155 barley genotypes in one season at one site; thus this scale can be read as an indicator that is inversely proportional to stress. Points on the scale** ***Increment over environment mean yield*** **are for selected genotypes in the same seasons at the same sites. The regression line labelled** ***Tel Hadya Selections*** **is based on the average yield of 29 genotypes that had been selected at Tel Hadya for performance superior to that of the local check** ***Arabi Abiad.*** **The regression line labelled** ***Bouider Selections*** **is based on the average yield of 15 genotypes selected at Bouider for performance superior to** ***Arabi Aswad.***

The basic principle consistently guides the breeding strategy for all three crops, and the results of its application are now reflected in the varieties that have more recently been released by national authorities (see Appendix 8). In 1984, for example, ICARDA provided Syria with 20 tonnes of seed for the introduction of Sham-1, a durum wheat. Since then, there has been an exponential increase in production, and the Syrian authorities distributed 9000 tonnes of Sham 1 seed to farmers for the 1986/87 season.

ICARDA believes that it now has a methodology that will secure the best adapted material from a given set of crosses. However, as long as the Center's goal is performance under stress, it needs to start crosses with material that has already demonstrated its capacity to produce even in the worst seasons. Clearly, the landraces have survived that test and, despite what may be poor performance in other respects, they are the survivors of a long process of Darwinian evolution influenced by both natural and human selection. The primitive forms, as well as the wild relatives of modern crops, carry genes for stress resistance, and the cereal breeding program aims to incorporate these and, where it may be necessary, to employ modern tissue culture techniques to do so.

CIMMYT scientists are stationed at ICARDA for joint research on the improvement of wheat: in this photo, a durum-wheat line that has been developed for commercial production in West Asia and North Africa.

For the *Food Legume Improvement Program,* 1987 was a year in which breeders were able to see fruits from their labors in previous years. New cultivars of kabuli chickpea were released in Cyprus, Italy, Morocco and Sudan (see Appendix 9). New cultivars of lentil were released in Ecuador, Syria and Turkey. In 1986, for the first time, a national authority (Iran) was reported to have formally released a faba bean cultivar developed from ICARDA's genetic stock.

Breeding for disease resistance has been, and continues to be, a major thrust in the total program. Ascochyta blight is an important disease of both chickpea and faba bean, and faba bean production is also much hindered by other fungal diseases, chocolate spot and rust. The item on winter-sown chickpea in the *Highlights* section of this report would not have been possible, had it not been for the development of cultivars resistant to ascochyta blight. Now, however, national programs have received germplasm with disease resistance and a broad spectrum of other qualities; increasingly, it is these national programs that are making selections based on criteria of local adaptability.

Faba bean is highly valued as a rotation crop with wheat in environments with adequate rainfall. ICARDA's station at Terbol in the Beka'a Valley of Lebanon has, for ten years, consistently provided facilities for research into the improvement of this crop.

Of course, while disease resistance has been a major goal, it is not the only one. Other items in the *Highlights* chapters describe the breeding of lentil to develop cultivars suitable for mechanical harvesting, and the breeding of faba bean for one of several physiological characteristics that promise basic improvements in the plant, thus making it better suited to modern agriculture.

As new cultivars are released, increasing attention is paid to those downstream constraints that might hinder their adoption and delay the benefits for both farmers and consumers. Seed multiplication is perhaps the most important of these constraints in many of the countries of the region, and research scientists are giving every possible support to the *Seed Production* project which is described later in this report. Where appropriate, ICARDA supplies breeder's seed to national organizations for further multiplication.

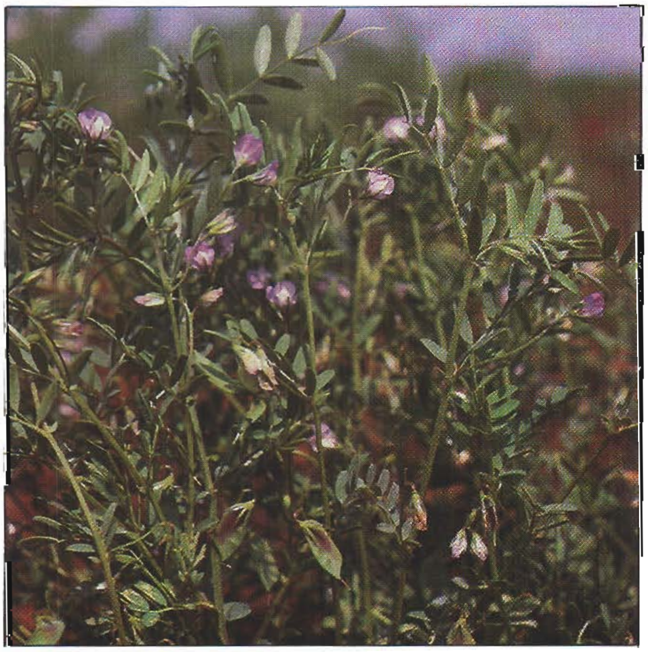
Increasingly, the *Food Legume Improvement Program* seeks to promote direct cooperation among the countries that have participated in the nursery network; as a result, a group of subnetworks is gradually taking shape. The most highly developed is that which involves the countries of the Nile Valley, and which has been growing in strength since 1979 when the Nile Valley Project was started to improve the production of faba bean. A looser subnetwork, involving Cyprus, Iraq, Jordan, Lebanon, Syria and southern Turkey, already involves some of these countries in providing seed to each other. Efforts at network building in the Maghreb began with the outstationing of an ICARDA scientist to Tunis in 1981. In South Asia, it is expected that the main links will be among India, Pakistan and Nepal and, for chickpea, this prospect is much strengthened by our association with ICRISAT which shares the responsibility. In Latin America, network building is mainly the responsibility of the Inter-American Institute for Agricultural Cooperation (IICA) with whom we coordinate our actions.

In sum, for food legumes, 1987 was an exciting year that gave ICARDA renewed confidence in its breeding strategies and also saw the development of greater self-reliance in the national programs that the Center seeks to serve.

The development, maintenance and exploitation of a very large genebank is the central responsibility of the *Genetic Resources Program*. As shown in the tables of Appendix 7, there are now some 85 000 accessions, and research institutions in many countries are calling for this material to use in their own crop improvement programs. Particular care is paid to the health of the seeds received and despatched, and one of the items in the *Highlights* chapters describes the work of the Seed Health Laboratory. A Virology Laboratory is also attached to the program and is actively engaged in surveying the incidence of viral diseases in West Asia and North Africa, as well as in developing techniques to detect viral contamination in plant material.

Some 25 ha of the Tel Hadya farm is reserved for the regeneration and multiplication of material from the genebank, and this offers the opportunity to characterize and evaluate the different accessions. Throughout 1987, the highest priority was given to preservation, documentation and evaluation. Nevertheless, ICARDA scientists joined with representatives of national programs and other organizations for collection missions in Egypt, Morocco and Syria. In these missions, special efforts were made to collect landraces from areas where crops are subjected to unusual stress, and where their survival clearly implies a genetic adaptation to such stress.

Over the years, but increasingly in 1987, breeders are showing interest, not only in the genetic diversity within crop species, but also the characters exhibited by progenitor species and wild relatives. West Asia was the evolutionary source of many of the crops of interest to ICARDA, and evidence of their cultivation enables archeologists to determine when man first began to practise agriculture. ICARDA's efforts to collect primitive material from the region is, therefore, of interest wherever plant breeders need to find new sources of genetic diversity for crops such as lentil, chickpea, wheat and barley.



Lens orientalis, the progenitor of Lens culinaris. Occasional hybrids still occur naturally.

Highlights - Agricultural Management

Tillage and stubble management

As indicated in the previous chapter, the re-structured Farm Resource Management Program emphasizes research on soil and water management, and conservation of the resources that are vital for producing the food needed now and by future generations. ICARDA has long maintained a modest program of research on these topics and we expect, as one component of our newly-reinforced effort, to carry out a review of the work that is being done by other institutions in West Asia and North Africa, particularly on soil erosion and the effect of different tillage practices.

Soil is a basic resource and, for all practical purposes, non-renewable. Within the region, tractors have become widely employed, and the tractor-pulled plows and harrows originally imported from Europe and North America are now manufactured locally. With increasing population, mechanical cultivation is spreading to marginal lands, often to fields that slope more steeply. There is abundant evidence of soil loss through water erosion, especially that caused by thunderstorms at the on-set of the rainy season after a hot, dry summer.

Research at ICARDA has shown that, except at times of intense rainfall, most of the rain does penetrate the soil. The type of tillage seems to have little effect on this, except on steep slopes where the direction of plowing is usually dictated by the configuration of small landholdings and, unfortunately, is often up-and-down the slope.

Typically, farmers begin with a deep primary tillage (20 - 30 cm). Later, they use a harrow or tyned implement for seedbed preparation. Often seed is broadcast, and the seedbed is then ridged so that the cropping pattern is in broad longitudinal bands.

With this practice, the controversial step is the deep primary tillage which, of course, is costly in fuel and time. Some believe it permits quick, deep penetration of rain, and thus the retention of moisture that plants may need to resist droughts late in the growing season. Others point to the evaporation losses that occur, especially when soil is inverted and exposed to sun and wind. There is much evidence that deep tillage, by burying weed seeds, serves to prevent their germination. But shallower tillage, which is less costly, may be just as effective both for weed control and for ensuring moisture penetration and retention.

Weeds are indeed a major problem, especially in North Africa where farmers value weedy fallow for grazing, and their management practices tend to maintain a supply of weed seeds. Repeatedly, herbicides (or, alternatively, hand-weeding in the case of legumes) have been shown to provide a positive economic return but, in terms of weed control, we have not so far been able to see any marked benefit of one tillage practice over another.

Many of the soils are self-mulching clays which are plastic when wet, and which crack extensively when they dry out. Such a surface, untilled and unprotected, loses water to evaporation, both from the cracks and through micropores: presumably, this is the reason why the owners of olive orchards keep the soil constantly tilled even when they grow nothing between the trees. The cereal-fallow rotations on the central Anatolian plateau (see item on *Agriculture at High Elevations*) employ a deep tillage in the spring of a fallow year, partly to bury grass seeds, but also to break up the surface and leave it rough. Then, at the end of the rainy season, farmers make a shallow till to leave a fine surface which reduces evaporation during the long, dry summer.

Such techniques are widely employed, but they probably do little to prevent wind erosion during the summer, or water erosion at the onset of the next season's rains. If stubble or other crop residues were left on the land after the harvest, would these reduce the erosion? To obtain protection throughout the period when the land is most vulnerable to erosion, the stubble would need to remain until the next year's crop is established; this implies zero tillage and the sowing of the next crop through the remaining stubble before or soon after the first rains.

Indeed, after a cereal crop, stubble is usually left and is then used for grazing during the summer but, since the practice of burning stubble is becoming more prevalent, perhaps more is being produced than can usefully be employed by livestock. Where tillage is not needed for weed control, and if stubble is as effective as tilling for hindering evaporation, then the farmer's balance sheet, as well as soil conservation, might be better served by his adopting techniques of stubble retention and zero tillage.

ICARDA has begun a more intensive series of studies aimed at determining the effectiveness of zero tillage, while recognizing that this would imply the introduction of sowing methods that are not now widely practised in the region. An important aspect of this research is to determine the relationship between zero tillage and moisture storage, both for this year's crop and as carry-over to the next.

Evidence is accumulating that, when land is continuously cropped to cereals, there is a progressive decline in yield that cannot be offset by applying more fertilizer. From the point of view of sustainability, the cereal/legume rotations are much more effective. So our studies of stubble retention and zero tillage must be set within the context of an overall farming system, which includes livestock, and must take account of effects, not only for the present year, but also for those that will follow.

Poorly structured soils are typical of the marginal lands into which agriculture spreads as demographic pressures increase. These soils tend to form a thick crust (left) which hinders the infiltration of water as well as the emergence of seedlings; heavy rains lead to devastating erosion (right). When stubble is left on such lands, it helps to provide a structure that attenuates these effects.

Burning stubble is becoming a more common practice (left) but, when properly applied, zero-tillage techniques permit the next season's crop to be sown into the stubble of the previous year (right, in this case lentil in wheat stubble).

Clearly, the goal is to develop technologies that are environmentally conservative and that farmers will be willing to adopt. Much of the needed research will be carried out in association with farmers on their own fields. For a given year, however, it is likely that a conservative technology will be less rewarding than an exploitive technology and, since many farmers and their families are living in poverty, this year's income matters more to them than an unquantifiable future benefit. This is not unlike the situation that existed, for example, in North America in the 1930s and, as in that case, the State may well need to offer incentives to balance farmers' present needs with the long-term interest of society as a whole.

Farming systems - Tunisia

Although the professional staff of ICARDA's office in Tunis is now reduced to two, we continue the cooperation with INRAT, INAT and the Office des Cereales that was set up some seven years ago. Appendixes 8 and 9 list the cereal and legume varieties that have been released as a result of this cooperation.

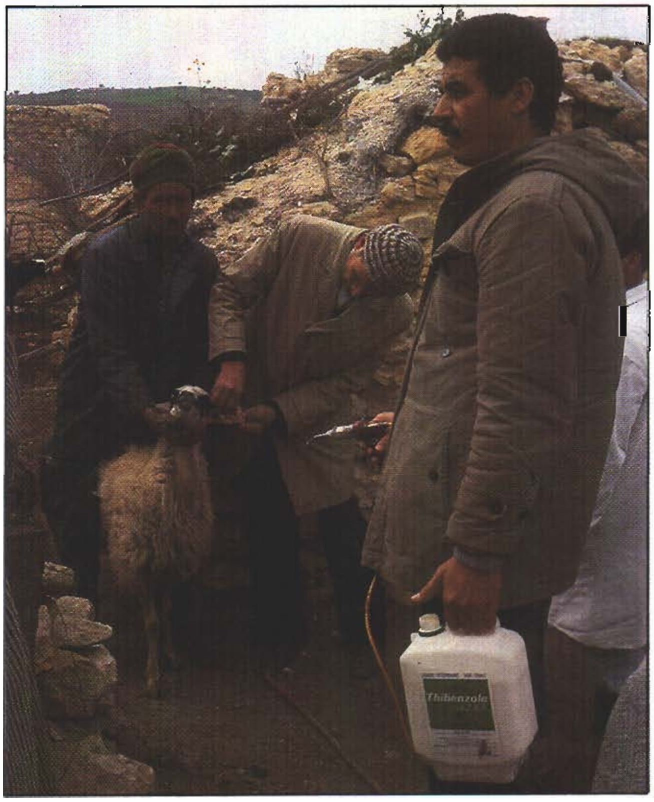
One of the two scientists in Tunis is especially concerned with farming systems: he works with INRAT and INAT and, since 1983, the joint research has received restricted-core funding from IDRC. In 1987, IDRC appointed a group of three consultants to make a detailed review of progress. They endorsed the importance of the work, recognizing that, in the project area, the farming systems involve complex interactions among three principal components: cereals, forage and livestock. Given that resources are limited, the review team recommended a sharper focus and a tightening of methodology. But it also expressed the belief that more resources should be found, and noted that the work provided a framework within which valuable and highly relevant training could be provided for Tunisian research professionals.

The research is centered at Goubellat, 80 km southwest of Tunis, in an area of moderate rainfall. Many small farmers now need to find off-farm employment to supplement their incomes but, in view of the proximity of a large urban population which is increasing its demand for animal products, there are good opportunities for economic returns from improved livestock production.

To illustrate the work, a research activity that was carried out in the 1986/87 season by scientists from INRAT and INAT is reported here. Data were obtained from 15 farmers who managed their flocks of sheep in the usual way, and from 10 farmers who applied an improved management package.

An important component of the package involved the removal of rams one month before mating was expected to begin. It is a curious fact that, in the absence of a ram, the oestrous cycles of the ewes tend to synchronize. Improved rams from INRAT were provided for mating and, as a result, 80% of the lambs were born within a span of a month. The lambing season was more prolonged in the check flocks, which were not exposed to the "ram effect" and which were thus less able to benefit from the peak season for grazing on native pasture.

In the improved package, old and non-productive ewes were culled, and sanitary treatments were provided. Sheep were vaccinated against enterotoxemia and were provided prophylaxis against gastrointestinal and pulmonary helminths; they were also given treatment, both curative and preventive, for external parasites. Over a 100 days starting at lambing time, each ewe was also fed 30 kg of commercial concentrate.



A Tunisian scientist collaborates with farmers to evaluate the impact of improved flock hygiene.

The management package significantly improved almost all measures of performance: fertility rate, prolificacy rate (number of lambs per 100 fertile ewes), and fecundity rate (number of lambs per 100 ewes in the flock). Abortion was reduced and, although there was no significant difference from the check flocks in lamb mortality, there was a significant increase in adult mortality which is difficult to explain. Weaning rate (weaned lambs per 100 ewes in the flock), which is an overall measure of productivity, was significantly increased - from 97.2 to 111.7.

The results of an economic analysis are shown in Table 3. The increased revenue from lamb sales can be attributed partly, of course, to the greater number of lambs, but also to their better finish and appearance. Overall, improved management required only a marginal increase in expenditure (4%) but it gave a 62% profit on the expenditure as compared with 37.5% for traditional management. The adoption of better management practices thus offers promise, not only of enhanced production, but also of a substantial increase in income for poor farmers.

Table 3. Economic analysis of improved flock management at Goubellat, Tunisia, TND/ewe.

	Checks (15 flocks)	Improved management (10 flocks)
COSTS		
Feed*	26.4	23.6
Labor	12.0	15.4
Treatment	0	1.0
Total	38.4	40.0
REVENUES		
Lambs	50.8	63.1
Wool	2.0	1.8
Total	52.8	64.9
NET REVENUE	14.4	24.9

* includes both pasture cost and concentrates; more pasture was needed for check flocks than for those receiving improved management and concentrates.

Economics of winter chickpea

As explained in last year's Annual Report, a major achievement of ICARDA's food-legume research has been the development of chickpea cultivars that are resistant both to cold and to ascochyta blight. These cultivars can be planted in winter to take maximum advantage of annual rainfall, and, typically, they show double the yield of traditional cultivars sown in the spring. With winter sowing, chickpea production can also be extended into new areas that are too dry for spring cultivation. Nine countries have formally released cultivars developed for winter growth (Appendix 9).

ICARDA also conducts agronomic trials to find appropriate technologies and to optimize yields. Indeed some of the first trials of winter-sown chickpea were made in the winter of 1976/77 before ICARDA occupied its Tel Hadya site and when, by courtesy of the University of Aleppo, it was using the University's site at Muslimieh. It was these early trials that set the priorities for the plant breeders, and indicated the importance of finding resistance to cold and ascochyta blight. Once progress had been made in the development of improved cultivars, the agronomic work was resumed.

In recent years, many of the trials have been carried out on farmers' fields: in Syria, for example, with the cooperation of the Ministry of Agriculture and Agrarian Reform. Typically on plots of 10 x 10 m, the trials are intended to assess the effects of different parameters, such as fertilizer, *Rhizobium* inoculation, planting techniques, and weeding techniques, and their relative significance in terms of the profit that a farmer makes from his crop. Although there is clear evidence that *Rhizobium* inoculation is of marked benefit where chickpea is sown in new areas, on land that has consistently been used for this crop, the biggest benefits come from finding appropriate weeding techniques.

Weeds are not normally a problem for spring-sown chickpea, since they are killed at the time of soil preparation. But they can seriously affect a winter-sown crop. Preemergence herbicides are effective in taking care of weeds, but economic analysis shows that two hand-weedings are more effective when labor is available and at the price that prevails in northern Syria. Since harvested weeds also provide feed to livestock, it is usually in the farmers' interest to follow this method.

With the release of the cultivars, Ghab-1 and Ghab-2 (both with tolerance to cold and ascochyta blight), the door was opened for the large-scale development of winter sowing practices in Syria. The Ministry of Agriculture and Agrarian Reform first needed to multiply the seed available and, in the winter of 1986/87, it entrusted part of this task to a group of farmers who were also growing spring chickpea. This provided the opportunity to do an economic analysis of the relative benefits of the two practices on larger areas, and the data used for compiling Figure 3 were obtained from nine farmers, each of whom had 1 to 12 hectares under chickpea. It is evident that the profit margins were substantial.

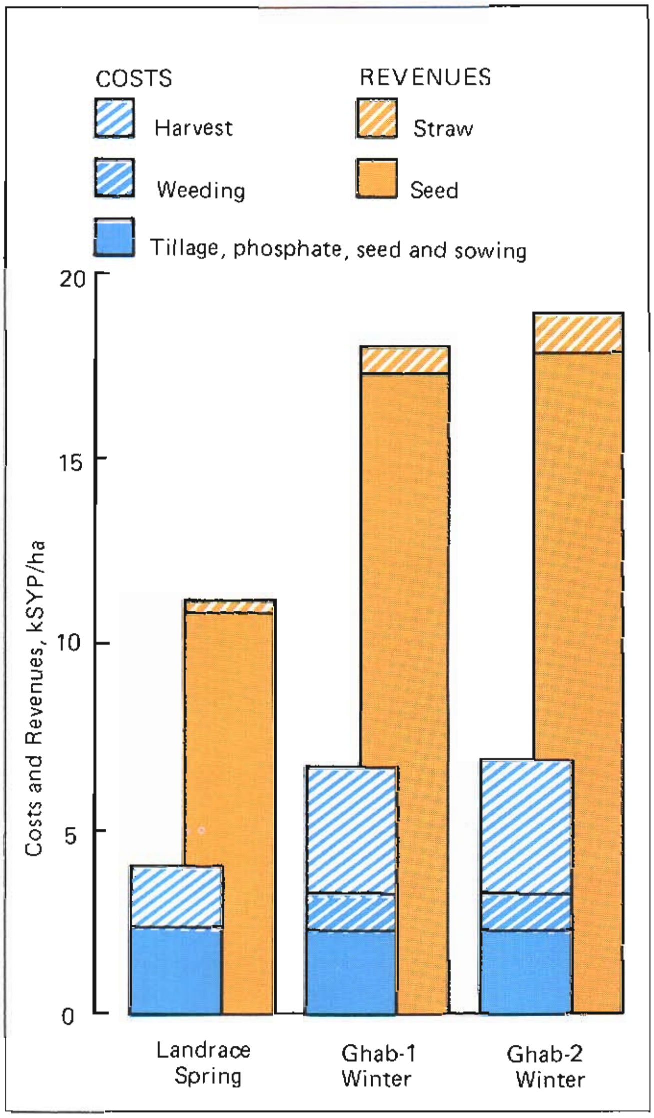
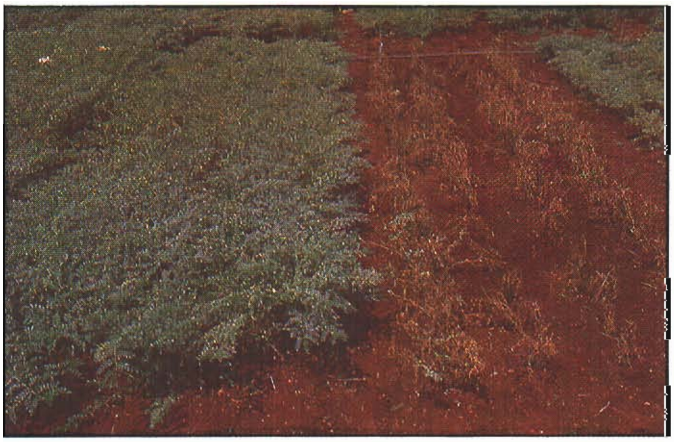
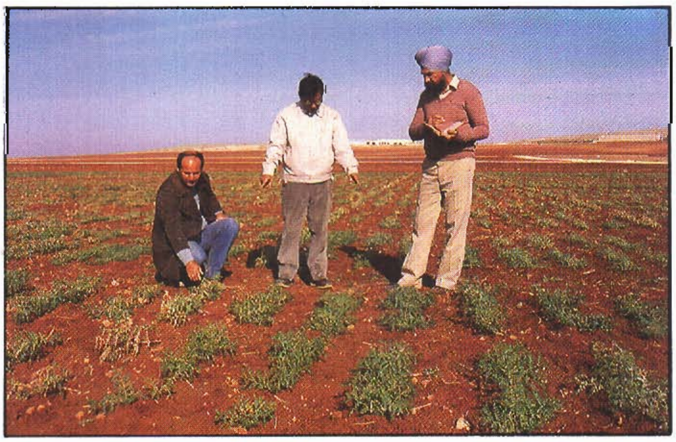


Figure 3. Chickpea cultivars sown in winter double the profit to Syrian farmers.





The key to the introduction of winter sowing of chickpea was the development of genotypes resistant to ascochyta blight (left) and cold (right).

One of the nine farmers collaborating with ICARDA staff in the economic study of his chickpea production.

With such favorable profit margins today, it is likely that many farmers would want to adopt the technology, and seed production could become a bottleneck. For 1987/88, Ghab 1 and Ghab 2 have been planted on 8 ha at Tel Hadya for the production of breeder's seed, while Syria's General Organization for Seed Multiplication has planted 28.5 tonnes for the production of certified seed. A substantial increase in Syrian chickpea production could therefore occur in the near future.

Other countries are also seeking to take early advantage of cultivars developed for winter sowing. Algeria imported six tonnes of Ghab 2 from Cyprus, and thirty tonnes of Ghab 1 and Ghab 2 from Syria. Turkey has indicated its interest in buying such seed as soon as supplies reach the international market. The first beneficiaries are likely to be those farmers who take immediate advantage of the new cultivars.

Orobanche - a continuing challenge

The *Orobanche* (broomrape) species are parasitic weeds that are serious obstacles to the production of both food and forage legumes. One *Orobanche* spike can produce several hundred thousand seeds that may be carried by the wind for many kilometers. Once in the soil, they can remain viable for up to a decade, and their germination is triggered by stimulants exuded by the roots of the host. In many areas of West Asia and North Africa, *Orobanche* infestations are becoming more intense from year to year and, where the incidence becomes high, it can wipe out a crop.

ICARDA has maintained a small basic research effort on *Orobanche*, in the early eighties in cooperation with the Agricultural University of the Netherlands, and more recently, with the University of Hohenheim in the Federal Republic of Germany. Considerable efforts in applied research have been carried out in the context of the Nile Valley Project. Although progress has been seen in particular situations, no generally applicable system of control is yet available to offer to farmers. This is an area in which more research is needed.

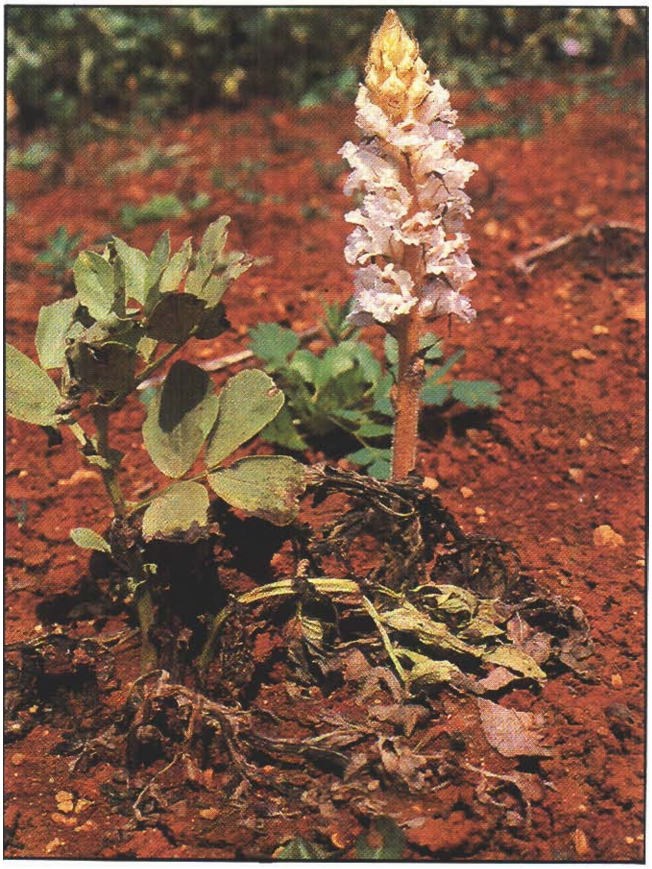
Among forage legumes, there is a wide range of susceptibility to *Orobanche*. Medics and *Lathyrus ochrus* are essentially immune, but the *Vicia* species (see section *Which vetch?*) demonstrate considerable variability. *Vicia villosa* ssp. *dasycarpa* and early-flowering genotypes of *Vicia sativa* itself are relatively tolerant, but *Vicia narbonensis*, taxonomically a close relative of faba bean, is highly susceptible. However, this variability offers the promise that, in part at least, the *Orobanche* problem can be attacked by genetic improvement.

Some faba-bean lines are known to be more tolerant of *Orobanche* infestations, and an Egyptian cultivar, Giza 402, has been widely adopted in the Nile Valley Project. But screening of food legumes for resistance has proved to be difficult except under carefully controlled conditions in a laboratory or greenhouse. Some lentil lines have been identified that take relatively few *Orobanche* attachments, but all such promising indications need subsequently to be confirmed in the field.

Chemical control has shown the best results so far. Much research has been done with Glyphosate, which is readily available and can also be used as a herbicide on other weeds. When properly applied to faba bean, in small quantities and at the best times, it acts as a systemic parasiticide, accumulating in the *Orobanche* tubercles and preventing the development of spikes. However, it is also toxic to the host, and the amount administered must be carefully tuned according to the degree to which the soil is contaminated with *Orobanche* seeds: for example, if the infestation is low, and only a few tubercles form on the roots of the host, there may be an inadequate 'sink' for the Glyphosate, and it will cause relatively more damage to the host. However, with just the right dose, Glyphosate can provide 100% control of *Orobanche* and even enhance the yield of faba bean.

Glyphosate is more toxic to lentil and chickpea than it is to faba bean, but a new chemical, Imazaquin, gives almost complete control of *Orobanche* at very low doses (only 10 to 20 g/ha) that can be tolerated by all these crops. Significant yield increases have already been observed, but more research is needed to optimize the amount and timing of application.

Orobanche tubercles developing on the roots of lentil.



A well developed Orobanche spike that is draining resources from its faba bean host.

If wet fields are covered by transparent polyethylene during the summer, the soil temperature becomes very high and, to a large degree, the seeds of *Orobanche* and other weeds, as well as nematodes, are killed off. Unfortunately, this technique is expensive (400-700 USD/ha) and cannot be recommended to poor farmers; it is, however, very useful in research, particularly where scientists need uncontaminated plots for their experiments.

Orobanche germination is correlated with temperature. If food legumes are planted while the soil is still warm (October-November), they may be subject to attack at an early stage of growth. Sowing in cold soil, say in mid-December, permits the legumes to get established before the soil temperature again rises to the level that permits *Orobanche* to germinate. At Hohenheim, careful studies are under way to identify the temperature and other conditions that determine when the seeds will germinate.

A combination of measures (e.g. chemical treatments, delayed sowing, less-susceptible cultivars) may prove to be more efficacious than any one of these alone. However, it remains a fact that the key to the best method of *Orobanche* control has not yet been found. These weeds have an extensive geographic range and, for example, some can be found even in the north of Scotland. But, in the intensive high-input agricultural systems of northern Europe, they pose no significant problem. More research is needed to understand the relationship of *Orobanche* infestation to soil conditions and cultural practices.

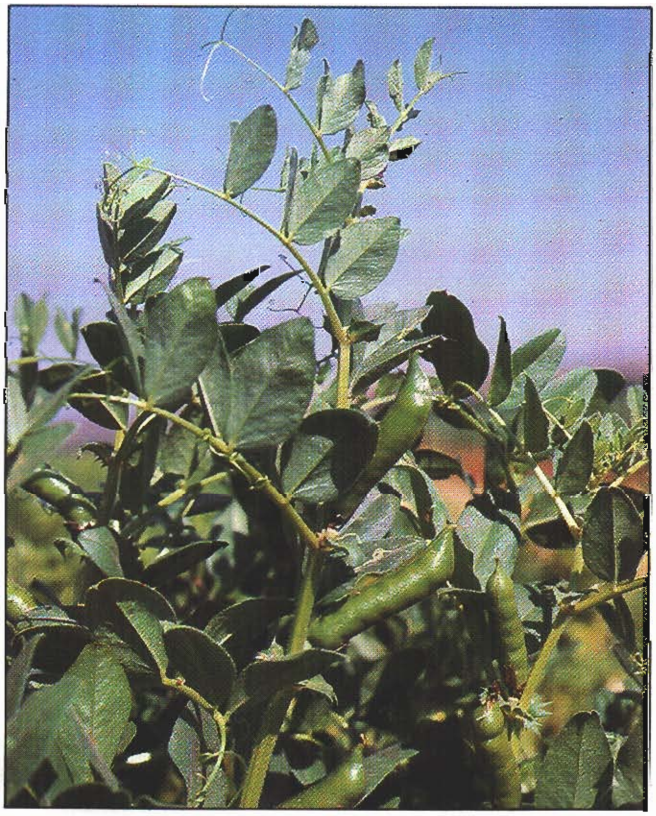
Which vetch?

The development of forage legumes as an economic alternative to fallow for use in rotation with barley was reported in the 1986 Annual Report of ICARDA. The legumes provide grazing for sheep and, because they fix nitrogen from the air, they improve the fertility of the soil for the next barley crop. The Report described experiments in dry areas with common vetch, *Vicia sativa*, and chickling, *Lathyrus sativus*, and explained that farmers preferred chickling.

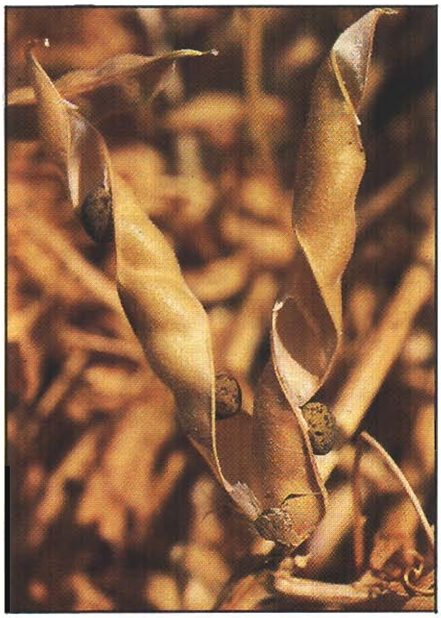
One of the constraints on the use of common vetch is that its pods tend to shatter on the plant, reducing the available yield and releasing seeds which germinate in the following season and become a weed in the barley field. To extend the possibilities for adoption of the legume/barley rotation, we need to identify a set of legumes, each with good agronomic performance and matched to one of the agroclimatic environments of the region.

In working towards this end, ICARDA has collected many species, both from the wild and from farmers' fields. These have been evaluated, and the more promising species and lines have been subjected to further research and, in some cases, to genetic improvement. Two species that rarely shatter their pods are woolly-pod vetch, *Vicia villosa* ssp. *dasycarpa* and Narbon vetch, *Vicia narbonensis*.

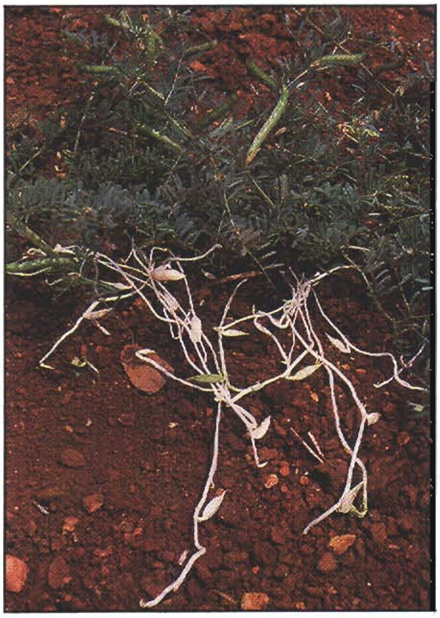
Woolly-pod vetch has a remarkably large yield of herbage, which can be grazed when green or harvested as hay.



Narbon vetch produces a high yield of biomass even under conditions too dry for common vetch.



Two genotypes of common vetch: the pods of the one on the left remain closed even when fully ripe.



Lateral growth and flowers of subterranean vetch were lifted from the soil for this photograph.

Some genotypes are cold- and drought-tolerant, as well as being resistant to cyst and root-knot nematodes. An economic analysis of experimental plantings under severe conditions at Quetta, Pakistan, indicated that farmers could make a bigger profit with woolly-pod vetch than with lentil. The margin was even greater where seeds were inoculated with an appropriate *Rhizobium*. The main problem with woolly-pod vetch is that it flowers late and the seed set is small under the conditions where it would be most suitable as a forage. If this vetch is to be more widely adopted, seed-production facilities will need to be established under favorable conditions, perhaps with irrigation.

Narbon vetch is even more drought-tolerant than woolly-pod vetch, and it is also a candidate to replace lentil where conditions are too dry for this crop to succeed. Narbon vetch can be considered a dual-purpose legume, in the sense that the product can be combined or threshed to give a high-quality straw as well as grain for animal, and even human, consumption. Seed production is not a problem. At ICARDA's Breda site (precipitation in 1986/87 was 245 mm), the best Narbon vetch genotype produced 1200 kg seed/ha, as against about 500 kg/ha for woolly-pod vetches.

Because of their non-shattering pods and resistance to stress, both woolly-pod vetch and Narbon vetch are attractive alternatives to common vetch, but the fact remains that they are not as palatable to sheep. The search among wild genotypes yielded some specimens of *Vicia sativa* with non-shattering pods, but these had very unfavorable agronomic characteristics. Fortunately, however, the gene for non-shattering pods is dominant. Crosses were made with genotypes having good agronomic qualities, and these are now in the F_3 generation. It is expected that careful selection will, by 1990, produce non-shattering as well as other desirable traits.

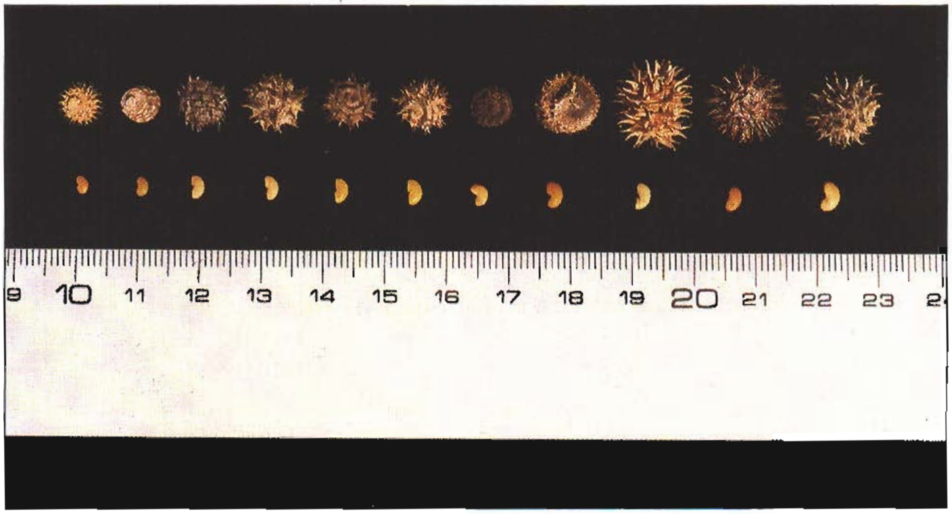
A most interesting subspecies, the subterranean vetch, *Vicia sativa* ssp. *amphicarpa*, was retrieved from the central Anatolian plateau in Turkey and has also appeared as a weed in barley-growing areas of Syria. Subterranean vetch produces flowers both above and below ground and, since it is autofertile, these develop pods and seeds. The seeds are quite hard, so very few will germinate in the following season when they would be competing with the barley crop. However, they do germinate in quantity in the succeeding year when, of course, they would reestablish a pasture (very much in the way medics regenerate in the second year to provide a pasture between cereal crops). Work at ICARDA on subterranean vetch is still at an early stage. Seed stocks are being increased, and the effect of grazing intensity on the production of subterranean seed is being tested.

This work indicates that the genus *Vicia* provides a spectrum of species, many of which have the potential of finding an appropriate niche in Mediterranean farming systems. At higher rainfall, there is the food legume *V. faba* then, with decreasing precipitation, the subspecies of *V. sativa* and *V. villosa*, and finally *V. narbonensis* for the drier margins.

Survival of medic seeds

ICARDA's efforts to study the effectiveness of the ley farming system were described in the Annual Report for 1986. Ley farming is known to have greatly increased production in those regions of Australia that have a Mediterranean climate. It involves a cereal cropped in rotation with a leguminous pasture, usually a medic (*Medicago* spp.). The system is self-perpetuating, because a significant proportion of the medic seeds lie dormant in the soil during the cereal crop, but germinate and reestablish the pasture in the following year.

If the ley farming system is to be adopted in those areas of West Asia and North Africa with rainfall in the range from 300 to 400 mm, adapted medics will have to be found that produce seed with appropriate rates of survival and dor-



A great diversity exists among medic species in the morphology of pods (top row) and in seed size (bottom row). Seed size and seed-coat hardness are also influenced by the degree of stress to which plants have been subjected.

Some medic seeds survive the passage through a sheep and germinate from a stool.

mancy. This appears already to have been achieved on fields in the village of Tah (70 km south of Aleppo) where the farmers have been cooperating with ICARDA, but it is expected that different species and varieties of medics will be needed under different environmental conditions.

One set of experiments involved sowing six different medics in plots at two different seeding densities (10 kg/ha and 200 kg/ha). At the end of the summer, the plots were tilled as they would be in the ley farming system and, thereafter, were left undisturbed. Germination was observed after the arrival of autumn rains, but core samples were also periodically taken from the plots so that the numbers of ungerminated seeds could be determined.

In general, on those plots that were densely seeded, the first-year germination rate (typically 6%) was substantially less than on those plots that were lightly seeded (typically 20%), and the plots originally seeded at high density retained more dormant seeds in the soil profile.

This effect seems to be correlated with seed size. In plots sown at high density, the environmental stress on the plants is much greater, and their seeds are both smaller and harder. They are far less likely to germinate in the first year, though dormant seeds taken from the soil can be germinated in the laboratory and clearly remain viable. It is concluded that, when plants and growing conditions yield small hard seeds, a great proportion remain dormant and are potentially available for second-year germination. However, this probably also means that tillage must be shallow, because smaller seeds will have less reserves and, if buried deep, their cotyledons may not be able to reach the surface.

The same effect of environmental stress is seen where a comparison is made between medics growing in favorable areas with those growing in drier areas. Indeed, where dormancy is more likely to be needed, more of the seeds remain dormant. This is an interesting case of adaptation and further proof, if it is needed that the physiology of plants must be studied *in situ*.

The ley pasture is, of course, intended for grazing. Sheep will consume considerable quantities of seed and, since medic seeds are rich in protein, they are an important source of nourishment. However, if the pasture is to regenerate, enough seeds must be returned to the soil, either in ripe pods, or by surviving the passage through the sheep and being excreted with its faeces. Indeed, where pastures are overgrazed, the whole system may function only if some seeds survive their passage through the sheep. And, indeed, if they do, the sheep can be the vectors to carry desirable medics to new areas, for example by grazing improved pastures in the morning and cereal stubble or marginal land in the afternoon.

In another set of experiments, groups of sheep were given known quantities of medic pods along with other feed, and surviving seeds were counted in samples of their faeces. Seeds of some medics consistently survived better than others: as in the previous set of experiments, survival was better for small seeds than for larger ones, and this was particularly true for some clovers (*Trifolium* spp.) that were tested along with the medics.

If the farmers of this region begin to adopt the ley farming system, national or commercial organizations will need to produce pasture seeds in massive quantities and, before that effort can be launched, choices must be made among the many candidate species and varieties of medic that are available. Experiments such as those described in this section help give confidence that ICARDA is developing an understanding of the many factors on which those choices should be based.

Highlights - Crop Improvement

Durum wheat: evaluation of germplasm

The large genebanks that have now been set up around the world hold many thousands of "accessions" of the same species. Each accession is numbered, and usually carries data about its provenance ("passport information") and descriptors that identify its principal characteristics.

However, the sheer quantity of accessions is itself an impediment to the rational utilization of this precious resource. ICARDA, for example, had by 1985 acquired about 18 000 accessions of durum wheat from the US Department of Agriculture, Beltsville, from the Istituto del Germoplasma, Bari, Italy, and from a number of other national collections, but had no way of knowing which of the accessions might be more useful for breeding durum wheats tailored to the agroclimatic conditions of West Asia and North Africa. The entire collection needed to be evaluated for the behavior of each genotype under typical environmental stresses.

Inevitably, priorities change over the years. An outbreak of disease might call for a search of the genebank for genotypes with appropriate resistance. Or the needs of national programs might dictate an evaluation for performance in saline soils. But, *ad hoc* evaluations to respond to transient priorities could easily lead to wasteful expenditure of effort over the longer term. ICARDA, therefore, welcomed the Italian government's offer to provide restficted-core funding for a systematic evaluation and documentation of the entire collection; this work is being carried out in close association with the Universita degli Studi della Tuscia at Viterbo.

The work began in 1984 and will be completed in four annual seasons. By then, each accession will have been evaluated for 28 different attributes, of which six are measures of its resistance to particular stresses and four are indicators of grain quality.

Typically, ICARDA received only about 35 g of seed of each accession. The biggest quantity of seed of each accession was sown at Tel Hadya in four 2.5-m rows, both for evaluation and multiplication, but single 30-cm rows were also sown in areas artificially infected with yellow rust and common bunt. Single 1-m rows were sown in the colder, drier environment at Breda and in saline soil at Hegla, 40 km south-east of Aleppo, which has a very dry climate (mean precipitation 150 mm) and where temperatures soar in the later part of the growing season; finally, in the wetter environment at Lattakia, a 30-cm row was sown where *Septoria* is present.

After multiplication, grain-quality tests are carried out in the laboratories at Tel Hadya, and specimens are sent to Viterbo for electrophoretic tests that determine the pasta-making potential of each genotype. Also, one year after ICARDA's own evaluations, when enough seed becomes available to send, the Institut National Agronomique de Tunisie (INAT) does an evaluation under dry North African conditions and for resistance to the local races of *Septoria*.

The seed multiplication has also allowed ICARDA to replenish the basic stock at Bari, and this ensures that a duplicate collection is maintained outside ICARDA; in l987, 300 g of seed from each of the first 8 000 accessions was sent. Similarly, while all the evaluation data are stored on computer tape, a duplicate copy will be kept at another location for safety.

By 1987, about 13 000 accessions had been evaluated and, already, several hundred lines identified that exhibited traits promising for future efforts in crop improvement. There are accessions, identified in consultation with cereal pathologists, that show resistance to the three diseases of major importance in this region - *Septoria*, yellow rust and common bunt - and also sources of drought resistance and desirable grain qualities, including high protein. The Universita degli Studi della Tuscia has identified several lines with good pasta-making properties and some of these combine this character with other desirable traits.

One of the many useful results is the identification of lines that combine resistance to both drought and salt: in a year when there was only 80 mm of rain at Hegla, four genotypes were able to produce grain. Tracing back the provenance, it was found that these came from high-altitude areas of Afghanistan and Ethiopia.

All of these more promising lines are resown to verify the results and produce more seed, which is then shared with an

Typical variation among spikes of the more than 20 000 accessions of durum wheat that are now available in ICARDA's genebank.

informal network of collaborators. For the 1987/88 season, in addition to the larger quantities sent to INAT, seed sets made up of 200 selected lines were sent to scientists in Canada, Ethiopia, India, Italy, Kenya, Pakistan and Turkey. The collaborators evaluate performance against a standard durum-wheat variety, Sham-1, as well as against their local checks.

In 1988, a similar activity will be started to evaluate wild relatives and primitive forms of durum wheat but, already, a good understanding of the extent of the spectrum of *Triticum durum* germplasm has been accomplished.

Physiology of wheat and barley

As described earlier, ICARDA's cereal breeders are seeking to improve yield and the year-to-year reliability of yield under conditions of little and irregular rainfall. Essentially, they are looking for more efficient use of moisture in the wheat and barley fields.

The problem is addressed directly by selecting genotypes and their progeny according to how well they perform as crops. In this, one is looking only at the results and not at the innumerable factors that determine how plants respond to particular sets of conditions (temperature, solar radiation, water, and nutrients). This effort may be described as work at the highest level of integration. ICARDA has achieved progress in its work at this level but, because there are so many variables, such progress requires a large number of experiments and trials over a span of years and, as indicated in the previous chapter, over a range of agroclimatic conditions.

At the lowest level of integration, one can study the cellular - and even molecular - processes that govern photosynthesis and growth. Work at this level is, however, probably best left to scientists undertaking basic research in advanced institutions. ICARDA is primarily concerned with applied research and, in the last two to three years, has begun a modest, but promising program at an intermediate level. This seeks to identify those morphological and physiological characteristics of plants that correlate with their performance as crops. Once these have been identified, breeders could be advised to look for them as they make their selections: if the correlations are true, this would speed the development of cultivars that will perform well under stress.

In fact, the several species are quite closely related, and a useful first-order approach to the problem is obtained by comparing the characteristics of bread wheat, durum wheat, barley, and the wild *Hordeum spontaneum*, which succeeds even at the drier margins. Natural selection and the actions of farmers over many centuries have clearly set each of these species in an appropriate environmental niche. Figure 4 simply confirms what farmers already know and, in normal circumstances, no sensible farmer chooses wheat over barley if he is living in an area where the average rainfall is less than about 300 mm. For environments where moisture is plentiful, performance can be maximized by looking for plants with the physiological characteristics that are expressed in bread wheat but, when selecting for performance in dry areas, it is important to know the qualities that endow *Hordeum spontaneum* with its capacity to produce seed even in very dry years.

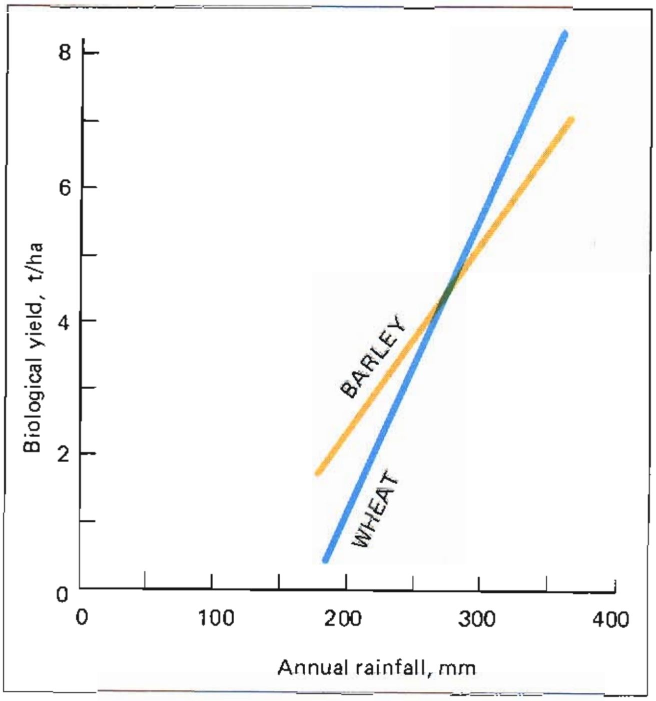


Figure 4. Barley produces in areas too dry for wheat (each regression line derived from six environments).

Improved cultivars do perform extremely well when they are provided with enough moisture and nutrients. Under stress, however, they often do less well than the locally adapted landraces. Pure lines have been developed from the landraces and, when we compare the improved cultivars with the lines developed from landraces, a set of characteristic differences is almost immediately apparent (Table 4). These characteristics can now be used in the search for material with survival potential. In addition, physiological tests have been developed that can be used to identify the more stress-tolerant genotypes. Such tests involve measurements of, for example, osmotic pressures within plant tissue, water retention in leaves, leaf temperature, and the leakage of electrolytes from plant tissue after exposure to stress.

Table 4. Qualities exhibited by barley landraces under stress (in comparison with improved two-row barley cultivars).

Lighter green color
More tillering
Less stature
Earlier heading
Shorter grain-filling
Shorter crop duration
More grain mass
Higher harvest index
More yield stability

Of course, having identified genotypes adapted to stress, there is a need to sort out those that have the best potential for yield. Yield (Y) can be expressed as the product of three factors:

$$Y = T \times TE \times H$$

where T is the amount of water transpired during the life of the plant, TE is the efficiency of transpiration (the amount of dry matter produced per unit of water transpired), and H is the harvest index (the yield as a fraction of total dry matter).

Where there is no stress, TE is not so important, because moisture is available and the plant can compensate just by transpiring in larger amounts (higher value for T). Indeed, for non-stressed environments, the remarkable increases in yields of crops such as rice and wheat have been achieved largely by selecting for a high harvest index, the plant putting more of its resources into the production of grain at the expense of stalks and leaves.

For stressed environments, however, T is limiting, and TE becomes very important. At one time, it was postulated that, for large groups of plants, TE might be constant. However, very careful work at the Australian National University (ANU) has shown that, among different wheat and barley genotypes, TE may vary by up to 30%.

Very difficult laboratory procedures are needed for a direct measurement of TE. To follow all the moisture dynamics, would require that each plant be grown in a container with separate input and output measuring devices above and below the soil surface. Instead we can look for indicators of TE, and we are fortunate that a novel method has recently come into use.

In the process of photosynthesis, plants normally discriminate between the two naturally-occurring carbon isotopes and take up ^{12}C in preference to ^{13}C. But plants with a high TE are less discriminating in this respect, and they show a higher proportion of ^{13}C when plant matter is subjected to analysis in a mass spectrometer. ICARDA enjoys the cooperation of ANU for ^{13}C analysis of wheat, and of the Institute for Plant Science Research, Cambridge, England, for ^{13}C analysis of barley.

Today, if we compare the yields of many genotypes under stress conditions, as we do in the farm at Breda, we can see that only about 10% of the variation is correlated with a potential to yield under non-stressed conditions. About 30% can be correlated with phenological characters, particularly an early flowering date and a short time-to-maturity. However, we find that the most significant correlation (40%) is with the $^{12}C/^{13}C$ ratio, and thus with transpiration efficiency. We look forward to screening more of our genetic stocks for this desirable property.

Such work is relatively new for ICARDA and, in 1988, a new component will be added. Crosses will be made between parents having a contrasting character (present or absent), but otherwise very similar. At the F_2 generation, as the population segregates, selections will be made on this character, and trials will be conducted to determine whether its presence or absence has a correlation with yield. ICARDA is becoming increasingly confident that physiology research will speed the development of cultivars that will yield well and reliably under the stresses of little and irregular rainfall.

Aphid tolerance: cooperation in the Nile Valley

ICARDA cooperates with Egypt and the Sudan in the development of resistant lines of both faba bean and cereals. A major laboratory for screening for aphid resistance was commissioned at the Agricultural Research Center at Giza, Egypt, as part of the IFAD-funded Nile Valley Project, and has demonstrated its usefulness in the search for resistance in faba bean: indeed, in 1986/87, a year of major aphid infestation in Middle and Upper Egypt, two lines that had previously shown resistance in the laboratory, now also demonstrated it in the field. In this account, however, we turn our attention to the cereal component, which occupies about half of the facilities in the Giza laboratory.

Aphids are serious pests of wheat and barley under the conditions of high temperature and humidity typical of the micro-environments within which cereals grow in the irrigated areas of Upper Egypt and the Sudan, but they are also important in large areas of, for example, Ethiopia and Morocco. Although aphids can be largely controlled by pesticides, national authorities are rightly anxious to avoid becoming dependent on a single means of control, and they are seeking also to promote methods of biological control (predators) and to develop resistant plants.

Work has been focused on two species: the greenbug, *Schizaphis graminum*, which is a particularly important pest of wheat in the Sudan, and the oat bird cherry aphid, *Rhopalosiphum padi*, which is the most serious aphid attacking cereals in Egypt. The laboratory at Giza is employed for rapid screening of many genotypes of wheat and barley. With the temperature, humidity and lighting controls available in the laboratory, up to about 10 000 genotypes can be tested in one year. Thereafter, promising lines are tested in the field, and such trials are carried out at the Sids research center in Middle Egypt, at the Shandaweel center in Upper Egypt, and at the Wad Medani, New Halfa and Hudeiba centers in the Sudan.

For this work, ICARDA provides appropriate germplasm from the ICARDA/CIMMYT stock. Both Egyptian and Sudanese scientists are involved in breeding and field-testing, and all parties rely on the Egyptian team at Giza for the initial screenings. The large test capacity of the Giza laboratory depends on the maintenance of a delicately balanced set of inputs and, for example, the aphid cultures must be refreshed every few months by collecting representative samples from a geographically dispersed set of environments, and they must be kept free of parasitoids.

Laboratory work has been under way for only two years, but already there are promising results. Rye is much more aphid-resistant than wheat and, a few years ago, using techniques of biotechnology, American scientists introduced rye genes into wheat and produced the Bushland/Amigo varieties, which are resistant to greenbug. Egyptian scientists



In the laboratory at Giza.
Left: aphid stock cultures are raised in pots covered with glass hoods to maintain humidity and keep out parasitoids. Centre: several different cereal lines and one susceptible check are grown in each tray in the screening laboratory. Right: greenbugs migrate from a leaf taken from the stock culture and infest test plants.

have crossed Bushland/Amigo lines with varieties that are adapted to the wheatlands of Egypt and Sudan, and the progeny is also showing resistance to greenbug, both in the laboratory and in the field.

For the oat bird cherry aphid, resistance is best manifested in the primitive species now being screened by the laboratory: *Hordeum spontaneum*, *Aegilops sclerosa* and *Triticum timopheevi*, as well as in a few durum wheat lines. The mechanisms that impart resistance are not yet fully understood, and it is not possible to predict how robust the resistance will be when confronted with the spectrum of aphid biotypes that are present along the whole length of the Nile Valley.

The work on aphid resistance illustrates how ICARDA seeks to become a true partner of national research institutions, and the work in Egypt and Sudan should prove, in time, to be of benefit to others as well. Ethiopia has expressed interest in joining the endeavor and, as ICARDA's breeders build aphid resistance into lines adapted to other environments, one can look forward to the development of a pool of germplasm from which other national programs can extract the aphid-resistant characteristics that may be of use to them.

Straw for feeding sheep

In areas with less than 300 mm rainfall, the farmers of West Asia and North Africa largely depend on sheep for their cash income, and they grow barley to provide feed. While grain is very important for enhancing the diet of ewes when they are gestating or lactating, straw is almost equally important to the farm economy, whether grazed as stubble in the summer or harvested and fed to sheep in winter.

In northern Europe, straw is seen as an almost unsaleable by-product of grain production, and many attempts have been made to improve its value by chemical treatment. That, however, would not be appropriate in West Asia and North Africa, where straw is already a valuable commodity traded among poor farmers.

Indeed, from its early days, ICARDA recognized that local straw is more nutritious than that produced in northern Europe, and, starting in 1982, it has cooperated with the Overseas Development Natural Resources Institute (ODNRI) in London, England and, more recently, with the University of London, in research aimed at a better understanding of the qualities that determine the nutritional value of the straw produced by different barley genotypes. The objective is to advise barley breeders on the qualities of straw they should be seeking as they work to develop improved cultivars.

Free to choose from straw on the field, a sheep will eat leaves in preference to stems. However, after farmers harvest straw, they chop it into pieces, thus ensuring that the sheep are constrained to eat both leaves and stems together.

In feeding experiments at ICARDA, early work indicated that the digestibility of straw is strongly correlated with the leaf/stem ratio. However, more recent work has shown that other factors may also be involved. Unfortunately, it requires time and resources to conduct *in vivo* experiments, and to measure how much straw is actually ingested and digested. Typically, to get one result, a group of four to six sheep must be fed the same straw for a month, and faeces must be collected, dried and weighed.

Quicker results can be obtained from *in vitro* studies that simulate what happens in the sheep's rumen but, unfortunately, these only indicate potential rates of digestion and give no measure of ingestion. However, ICARDA has also been applying the so-called nylon-bag technique to speed up the research: as with the *in vitro* test, it is only digestion that is directly measured but, because measurements are taken at intervals up to 72 hours, potential rates of ingestion can more easily be inferred.

When a cannula is constructed from the side of a sheep into its rumen, straw can be packaged in small nylon-gauze bags and inserted directly into the rumen fluids. Typically, eight bags are inserted in each of three sheep, and each set of bags contains four different straws (two of each). The bags are withdrawn after 12, 36, 48 or 72 hours, and the amount of straw remaining in each bag is measured. For the same commitment of time and sheep, the nylon-bag technique will give about 30 results for every one that could have been obtained from classical *in vivo* digestibility trials.

Clearly, the nylon-bag results must be calibrated against those from the classical trials and, indeed, a reasonable correlation (r = 0.73) is observed when the nylon bags have remained in the rumen for 72 hours (Table 5). But an advantage of the nylon-bag technique is that it also permits a direct comparison between the rates of digestion of different straws (Figure 5). Since the amount that a sheep will eat depends on how much is still left in its rumen, straws that digest quickly are likely to be accompanied by a faster voluntary intake.

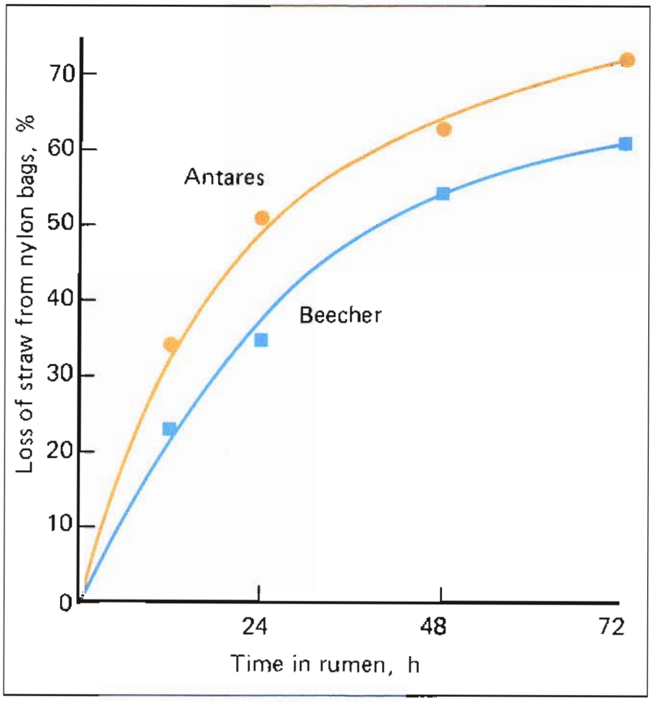


Figure 5. Rate of digestion of different barley genotypes.

Table 5. Comparison of nylon-bag technique with classical feeding experiments.

Barley genotype	Classical DDMI*	Loss of straw from nylon bags in the rumen for 72 hours (%)
Badia	16.4	59.3
Apam	16.6	64.8
Beecher	17.0	61.2
Arabi Abiad	18.2	70.8
Arabi Aswad	21.3	70.3
C63	21.4	66.3
Rihane	21.5	71.5
Arar	22.1	71.3
Antares	27.3	71.8

* DDMI (digestible dry-matter intake) is an indicator from classical feeding experiments of the animal's capacity to digest a particular feed.

More work needs to be done before useful predictors of straw quality can be offered to barley breeders. This was the conclusion of a workshop held at ILCA, Addis Ababa, in December 1987, when representatives of several international and national agricultural research centers focussed on the importance of plant breeding in determining the nutritive value of crop residues. Much of the barley breeding in the past was aimed at greater grain yield and, often, this was achieved without an increase in the total biomass (in other words, production of straw was sacrificed). What does seem clear is that shorter plants tend to have a better leaf/stem ratio than taller plants, and genotypes that mature late have more leaf than those that mature early; however, since early maturing is also associated with drought avoidance, this advantage might easily be lost in drier years. From the point of view of digestibility, some of the best barley straws are those from landraces and, as ICARDA's breeding efforts seek increasingly to incorporate characteristics obtained from these sources, there are good prospects that straw quality will be retained in the improved varieties of the future.

In the whole annual cycle, straw is about as important as grain for feeding farmers' flocks in West Asia.

"Determinate" faba bean

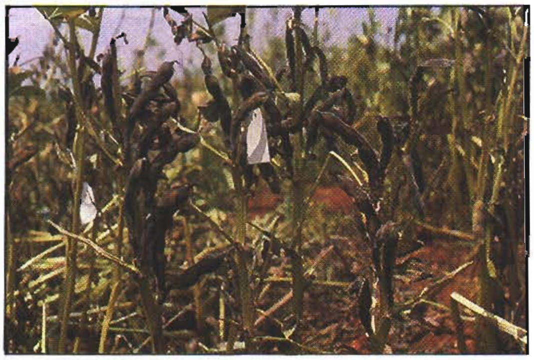
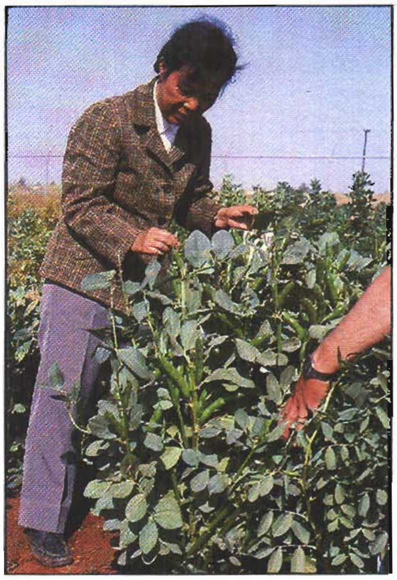
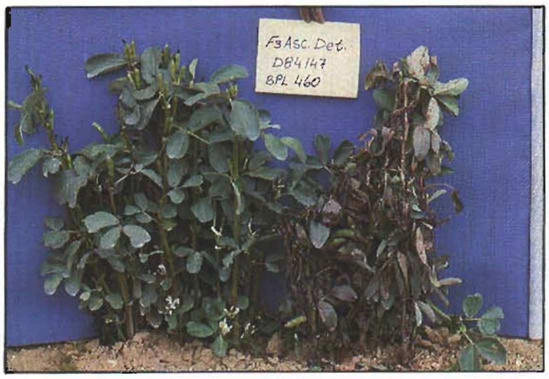
The faba-bean plant continues to grow taller as long as conditions remain favorable. Under irrigation in Egypt, for example, it is not unusual to see plants two meters high. Unfortunately, this means that a lot of the resources available to the plant are consumed in vegetative growth, and the harvest index (mass of seeds/total mass) is low.

About 18 years ago, the Swedish Seed Association in Svalov, using gamma radiation to induce mutations in faba bean, produced a plant that terminated its growth with a flower. This "determinate" mutant offered the prospect of developing a faba bean which, after a certain amount of vegetative growth, would put more of its resources into the production of seed. The original mutant was derived from stock adapted to northern European conditions, and the irradiation had also produced many deleterious effects. It is a small plant with few pod-bearing nodes, and many floral abnormalities that reduce the setting of pods. It has no resistance to important diseases.

Crosses with the original mutant have been carried out in northern Europe but, because of the problems of adaptability, that work is not of benefit for West Asia and North Africa. At ICARDA, during the last ten years, almost 1000 crosses have been made to improve the determinate mutant and to adapt it to Mediterranean conditions. Repeated backcrosses were needed to rid the plant of its deleterious genes and chromosomal abnormalities.

All faba-bean crossing needs to be carried out under protected conditions because the species has a marked



The original determinate mutant (upper left) produces few pods, small seeds and overall low yield, but selection has improved seed size to 2g (upper center) and fruiting to 4 or 5 pods on up to 5 or 6 podded nodes (upper right). Further selection and back-crossing has more than doubled the total biomass production of the original mutant and with a better harvest index (lower left). Recent crosses have introduced resistance to ascochyta blight (lower center) and to botrytis (lower right).

tendency to out-cross, and autofertile lines with closed flowers have only recently been developed. Crossing is done in cages to screen out insects, and subsequent generations are planted in plots surrounded by *Brassica* to discourage bees. Fortunately the determinate feature, which is carried by a single recessive gene, is immediately apparent in the progeny and non-determinate plants can be rogued from the plots.

The series of photographs that accompany this account show how the original mutant has been improved, first to raise the seed size, then to increase the pod set as well as the total biomass production. The yields of the determinate types are now matching those of the best indeterminate checks (Table 6) and, starting in 1985, the crossing has been directed towards the incorporation of disease resistance.

Table 6. Grain yields (kg/ha) of determinate faba beans in 1986/87.

	Tel Hadya	Lattakia
Original Swedish mutant		
SV 0622	700	800
ICARDA's improved determinates		
FLIP 84-107FB	3 300	3 300
FLIP 84-145FB	3 400	3 700
Best indeterminate check		
ILB 1814	4 000	3 300

The winter at Tel Hadya was markedly colder than at Lattakia, but yield was almost as good. The indeterminate check lodged at Lattakia.

Since 1984, determinate lines have been tested by cooperators in China, Egypt, Ethiopia, Morocco and Turkey (see chapter on *Nursery Network for Food Legumes*) and, for the 1987/88 season, determinates have been made available to 21 countries. In Jordan and Syria, development has reached the stage of on-farm trials. The determinate types resist lodging and, since the pods are carried relatively high on the plant, are superior for combine harvesting.

In parallel with its work on determinates, ICARDA has also followed other routes in its faba-bean breeding. One exploits a feature known as 'independent vascular supply' which reduces flower-shedding and enhances the harvest index. Also, the development of lines that combine closed flowers with autofertility opens the door to the breeding of genetically pure stocks. In the next few years, we expect to combine the determinate feature with independent vascular supply and autofertility and thus be able to construct a superior and stable cultivar that is well adapted to the needs of the region.

Mechanizing the lentil harvest

Lentil is an important crop of drier areas of West Asia and North Africa, where it is usually grown in rotation with barley or durum wheat. The grain provides a protein-rich food for man, the straw is widely used as feed for sheep and, as with other legumes, nitrogen fixation on the roots helps to restore soil fertility for the next cereal crop. But, in most countries of the region, lentil production has diminished significantly during the last twenty years, and this decline is attributed to the facts that lentil is traditionally harvested by hand, that it is an arduous task which calls for a lot of labor during a short harvesting season, and that, even when such labor can be organized, its rising cost tends to wipe out much of the farmers' potential profit.

Over a number of years, ICARDA has been seeking to develop methods of mechanical harvesting and, in so doing, has enjoyed the support of both IDRC and GTZ. The last year's Annual Report discussed the problem with particular reference to the machines under development. This year, an account is given of the plant breeding work that seeks to develop lentil cultivars that will be more suitable for mechanical harvesting.

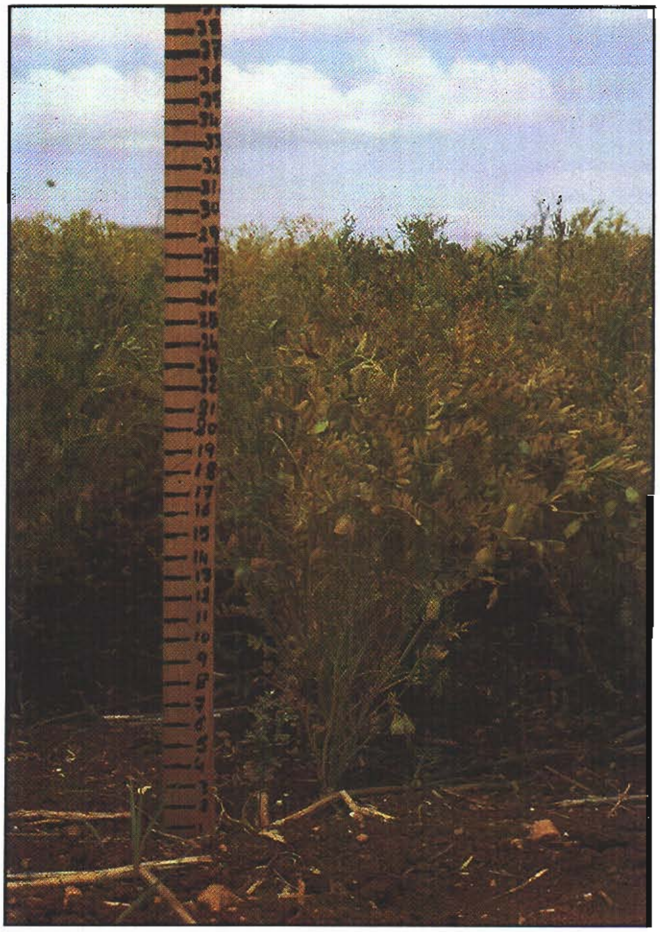
Mechanical harvesting is hindered by a number of factors, including some that are beyond the reach of the plant breeder: stony ground and inappropriate soil preparation and sowing methods. However, the growth habit of unimproved genotypes has also imposed limitations.

First, lentil has a strong tendency to lodge before the crop is ready for harvest, but since this characteristic is displayed to different degrees in different genotypes, it is - at least in part - determined by heredity. In the lentil breeding program, selection is first made on other important parameters that ensure yield of grain and straw and, at a relatively late generation, seed is taken only from plots that have not lodged.

Second, plant height is also variable - from 10 to 45 cm - and short plants pose problems for mechanical harvesting, particularly on uneven ground. However, plant height is also strongly correlated with lodging so - at an earlier generation - selection is made for intermediate height, knowing that subsequent screening will reject material that is more likely to lodge.

Third, early work had shown that, as compared with hand-pulling, mechanical harvesting resulted in lower grain yields. Two-thirds of harvest losses are due to pods breaking away from plants and one-third to the shattering of pods and the release of their seeds. No genetic variability has been found for pod-shedding, but seed retention (indehiscence) is a heritable characteristic. In fact, it is easy to select for this by delaying the harvest: plants with the property of indehiscence retain most of their seeds, while others have already shed theirs.

These selection practices have now been under way for some years, and the results are reflected in the cultivars newly released by national authorities (Appendix 9). In Syria, for example, Idlib-1, which was released in 1987, in addition to having a 16% yield advantage over the local check, is also significantly less likely to lodge. Another



A tall, non-lodging lentil plant suitable for mechanical harvesting (scale in cm).

selection, which is in pre-release multiplication in both Lebanon and Syria, has demonstrated both reduced lodging and reduced pod shattering in on-farm trials of mechanical harvesting.

Coupled with the development of tractor-pulled harvesting machines, these plant improvements are bringing the research closer to the fulfilment of its objectives. Economic analyses of on-farm trials in Syria show a distinct advantage for mechanical harvesting over hand harvesting and, in cooperation with the University of Jordan, a second training course on lentil mechanical harvesting was held during 1987.

Since lentil has not been well researched in the past and since it exhibits an immense range of genetic diversity, much remains to be learned about its physiology as a guide to future work. For example, a large stem diameter is strongly correlated with reduced lodging, and selection for stem diameter can be made at an early generation. This is a tempting alternative to the plot selection that has been employed in previous years. However, one must be careful. In cooperative work with the University of Durham, England, fluorescent microscopy of thick stems shows that these have proportionally more lignin than thin-stemmed genotypes. Since lentil straw is an important animal feed, and lignin is indigestible, care must be taken not to lose in one quality while winning in another.

Highlights - Research Networks

Fertilizers and soils

Fertilizer is a costly commodity: it can be wasted if it is applied where it is not needed, and the best economic return can be assured only if we have a proper understanding of how different crops make use of the nutrients already in the soil and the conditions under which fertilizers will enhance yields and profits. Economic judgements are taken at a macro level when governments allocate fertilizer supplies to particular regions or for particular crops, and they are also taken at a micro level when individual farmers decide to buy fertilizer and to use it on particular fields. Both governments and farmers need reliable information on which to base these judgements.

In the Mediterranean basin, large areas are covered by well-weathered calcareous soils. The long dry summer breaks down organic matter and, for example, in central and northern Syria, organic matter typically makes up only about 1.5% of the top soil. The breakdown of organic matter produces mineral nitrogen but this is soluble and, with the onset of winter rain, it may leach deeper into the soil.

Dry conditions also foster the accumulation of free calcium carbonate, and this reacts with phosphate to form compounds that are nearly insoluble. Various methods for measuring available phosphate have been developed but, in these soils, the most useful method, known as the Olsen method, involves extraction with sodium bicarbonate. Levels of Olsen-P in unfertilized calcareous soils are typically only 6 ppm or less.

Much still needs to be learned about the chemical processes that take place in soil at different seasons of the year and under different cropping systems. Historical records of soil analysis are available for only about 20 years. Even within this short time-span, however, some developments can be seen. Until recently, for example, Syria has allocated phosphate fertilizer for the wetter wheat-growing and irrigated areas, and not for the drier barley-growing areas, and soil analyses in the wheat-growing areas show a trend that, in most farmers' fields, has brought Olsen-P up to about 10 ppm or more. Obviously there is much local variation, but it may be the case that many wheat fields now need only maintenance amounts of fertilizer phosphate. On the other hand, there is growing evidence that a good economic return can be obtained by applying phosphate in previously unfertilized barley areas.

ICARDA's fertilizer work in the last 10 years has been largely carried out in northern Syria, and less is known about other parts of the region. To help correct this situation, ICARDA, MIAC and IDRC jointly sponsored a regional workshop on soil-test calibration in Aleppo in June 1986. The participants agreed to establish a network that would foster training in soil and fertilizer management and to exchange information on the application of different soil-test procedures.

Participants at the Second Soil Test Calibration Workshop, Ankara, September 1987.

Early in 1987, ICARDA undertook to help develop the *Soil Test Calibration Network*, and a second workshop was held in Ankara in September 1987. Participants from 12 countries described work carried out in the previous season and presented results of research that had been based on a common experimental purpose. With reservations, some conclusions began to emerge.

For nitrogen, it was already known that measures of organic matter (or of total nitrogen) are not good indicators of availability. At the workshop, the participants concluded that a more reliable indication can be obtained by measuring the nitrogen present as nitrate at sowing time. This was seen as a useful means for deciding whether to apply nitrogen fertilizer to cereals.

For phosphorus, the workshop participants accepted some preliminary recommendations which, in this case, could be applied to either cereals or legumes. In sum, the recommendations suggest that, if Olsen-P is more than 10 ppm, there may be no advantage in adding fertilizer phosphate; that, if it is between 6 and 10 ppm, a farmer might apply 30-40 kg P_2O_5/ha; and that, if it is less than 5 ppm, the farmer might well benefit by applying 50 to 60 kg P_2O_5/ha.

In practice, such recommendations may be more useful when interpreted in the form of policy recommendations for the allocation of fertilizers by governments. At the micro level, they may be difficult to apply in developing countries: an Olsen-P determination requires a fairly well-equipped laboratory, and one needs an established infrastructure to bring samples from many small farms and then to relay back the laboratory's results and recommendations.

It is little more than a year since the network was started, and much work is planned in terms of both training and comparative research. However, cooperation is now under way, and the participants look forward to being able to structure recommendations to their governments and farmers for principal crops and for different sets of soil and climate conditions.

Rhizobium inoculation

In April 1986, ICARDA hosted an international symposium on biological nitrogen fixation, and the participants recommended that studies be made to find out where, in West Asia and North Africa, *Rhizobium* inoculations are needed to ensure the productivity of important legume crops. Much depends on whether appropriate strains of *Rhizobium* are present in the soil. Often, where a crop has been grown over a long sequence of years, the needed strains are already there, and nitrogen-fixing nodules develop freely on the roots of each plant. But when a legume is introduced into areas where it has not been grown before, or not for many years, there is evidence that production can be increased, sometimes by as much as a factor of five, if an appropriate *Rhizobium* strain can be found and the legume seeds are successfully inoculated.

While projects have been initiated in particular countries, most of the national agricultural research institutions of this region have had little or no experience with *Rhizobium* work. Hence, there was no easy way to survey the need. ICARDA's two microbiologists, one concerned with food legumes and the other with pasture legumes, sought to build on the contacts established at the symposium, and to visit those institutions that had expressed an interest.

Here, the network that has been developed for pasture legumes is described, though equally interesting results have been obtained with food legumes, especially in the context of introducing winter-sown chickpea to new areas. For pasture legumes, as ICARDA contacts the national institutions, it offers an experimental 'protocol' as well as seeds of five medic species and a set of strains of *Rhizobium*. Each medic would be sown, preferably at more than one site, both with and without inoculant. Cooperators were encouraged to enlarge the experiment by including some of their own medic ecotypes plus, wherever possible, any locally identified *Rhizobium* strains.

Plots of Medicago polymorpha. The seeds sown on the right were inoculated with a matching strain of Rhizobium.

Table 7. Cooperators in the *Rhizobium*-inoculation network.

Institution	Locations
STARTING IN 1986	
AU - Commonwealth Scientific and Industrial Organization	Canberra
ES - Estacion Experimental del Zaidin	Granada
FR - Institut National de la Recherche Agronomique	Montpellier
IT - Universita degli Studi di Perugia	Perugia
JO - University of Jordan and SAGRIC International, in cooperation with Ministry of Agriculture	Guier Mushaqar Rabba Ramtha
MA - Universite Mohammed Ben Abdallah V	Meknes Fes
SY - Ministry of Agriculture and Agrarian Reform	Kamishly
- Tishreen University	Lattakia
TN - Office de l'Elevage et des Paturages	Kairouan
TR - Cukorova Universitesi	Adana
STARTING IN 1987	
DZ - Institut Technique des Grandes Cultures	El Khroub Sidi Bel Abbes Zleidji

The first set of experiments was carried out in the 1986/87 season and, at the end of the year, many more are now under way. Table 7 lists the institutions that are cooperating. They provide their own land and labour, and ICARDA offers no financial incentives. Cooperators identify the type, distribution and number of root nodules on plants in each plot, as well as the overall herbage yields. They share the results with ICARDA. The French, Turkish and Moroccan institutions have already involved graduate students in this work.

In 1986/87, every cooperator found dramatic increases in herbage production, at least in some of his plots. One strain of *Rhizobium*, ICARDA M29, appeared to be markedly beneficial in nearly all the environments in which it was tested. The microbiologist has now visited all the cooperators and, in most instances, he has been invited to give seminars to explain the nature of the work to a larger group of agricultural scientists and students. Indeed, the interest is such that the normal processes of network development have been overcome by events, and national participants are expressing needs that may stretch ICARDA's capacity to respond. For example, Morocco and Tunisia are establishing *Rhizobium* laboratories and have asked ICARDA to provide the advanced training for their staff.

No unusually sophisticated equipment or procedures are needed for a national institution to get started in research on *Rhizobium* inoculation. In such cases, and when the topic is one of potential economic significance, network cooperation quickly develops its own dynamic. Our investment of resources has been minimal: by offering some professional advice and an initial set of experimental material, we are now involved in a program of cooperation that brings together institutions from many parts of the region, and has already been joined by partners in Australia and Europe.

Food-legume nurseries

The term "nursery" is applied to a set of seeds, along with other essential materials, for example, inoculant or herbicide, that is made available for conducting a trial or experiment. For the 1987/88 season, the eleventh since the network was established, national institutions collaborating with ICARDA's food-legume program requested nearly 1400 nurseries of 43 different types; they were despatched to more than 150 cooperators in 60 different countries.

Several mechanisms exist for consultation with the cooperating scientists and, as a result of the views that they express and their response to the previous year's work, ICARDA draws up a 'menu' of available nurseries for the next season. Each cooperator selects the experiments that he would like to conduct and that might prove helpful in resolving his local problems. Because of limited supplies, ICARDA may not be able to respond to every request, but 90% were met in 1987.

Each nursery is sent out with two copies of a field book, in which the results of the experiments are recorded, and one copy of which is returned to ICARDA. Detailed analyses of each season's experiments are carried out at Aleppo, and the results are shared with all cooperators.

ICARDA also sends out nurseries for cereals and, to a small extent, for pasture and forage legumes. However, some national institutions now have wheat-crossing programs of their own, and ICARDA is not the sole source of cereal nurseries in West Asia and North Africa. For food legumes, however, this remains largely the case, and national institutions still look to ICARDA for the genetic material from which they will develop and release their new cultivars of chickpea, faba bean and lentil.

The Charter of ICARDA, written in 1975, makes an interesting distinction when it calls for us to serve as an "international" center for faba bean and lentil, and as a "regional" center for chickpea. However, as a result of ICARDA's special relationship with ICRISAT, the two centers join in providing a global service on kabuli chickpea and, in fact, the nursery network encompasses institutions throughout the world that wish to receive nurseries for any of the three legumes.

- One of the more important components of the program is the distribution of material at an early stage of development (F_3/F_4). Receiving this heterozygous material enables cooperators to make single-plant or bulk selections and, through succeeding generations, to produce their own lines that are adapted to local conditions. National programs that have developed their research capabilities ask increasingly for this kind of material.

- The second component involves nurseries distributed for the purpose of sowing a large number of advanced lines (F_5 to F_7), each in single-row non-replicated tests. These are called "screening nurseries", and they enable the cooperators to select lines that already perform well under their local conditions. It is largely as a result of the data obtained from these tests, that ICARDA and national cooperators identify the lines that are to be promoted and subjected to full-scale replicated yield trials in another season.

- The third component also involves these advanced lines, but now mostly past the F_7 generation when the material has become homozygous. Major users of these lines are those national programs which, because of shortage of manpower and physical resources, would like to have nearly finished varieties for testing and possible adoption. Cooperators test each nursery, mainly for yield, against local checks. It is from these yield trials that national institutions identify the cultivars that they want to carry into on-farm trials, and a successful trial may be followed by a request that ICARDA provide seed in greater quantity for large-scale demonstration and eventual multiplication and release (for nationally released cultivars, see Appendix 9).

- "Stress nurseries" test the products that result when high-yielding and adapted lines are crossed with those that exhibit resistance, either to abiotic stresses (cold) or to particular biotic stresses (diseases, pests). The main purpose is to see whether the resistance now manifests itself in a range of environments or whether it is location-specific. Other *Highlights* report some of the breeding results with the three legumes, but the fact that national programs and ICARDA have been able to combine disease resistance with wide adaptability is largely due to the results that have been shared within the nursery network.

- "Agronomy" trials are experiments to test how a particular technology will confront a particular agronomic problem. In such cases, the nurseries are often accompanied by other materials needed to implement the technology. Trials have been conducted for different sowing methods and weed-control practices, for *Rhizobium* inoculation and for techniques to mitigate *Orobanche* infestation. One example of the knowledge acquired through agronomy trials is that we are now able to quantify the plant population density that is needed to achieve a full canopy and maximum yield under various conditions in the region.

ICARDA seeks to transfer breeding technologies to national programs. Here, a training course in lentil-crossing is under way at the Debre Zeit Agricultural Research Station in Ethiopia.

Thus the 'menu' that is prepared each year has a wide range of options. Indeed this reflects an equally diverse span of capacities in the national institutions. Some are about to begin their own crossing work and are seeking to identify the most useful germplasm to link to their adapted stock; others are happy to receive early segregating populations from which they can make selections according to their own criteria; others again, especially those in countries with only a small area devoted to one of these crops, prefer to identify a finished product.

Of course, a network is greatly strengthened if its members communicate with each other as well as with the central node. Such links are fostered at the meetings that ICARDA convenes, whether for research coordination or for training. Traveling workshops have proved to be particularly effective to this end.

In this report, we have offered a somewhat brief account of what is, in fact, a very complex operation. It requires the handling of great quantities of data and, fortunately, much of this is now computerized. To overcome the logistical problems requires considerable experience and occasional feats of innovation: shipping air parcels to 150 different addresses in 60 different countries, meeting all quarantine requirements, and ensuring that delivery is made at the right time for sowing (some cooperators are in the Southern hemisphere). Failures are remarkably few and, without the efforts of the cooperators in this network, ICARDA'S own work in Syria would have had far less relevance to the rest of the region and to the world.

Seed health testing

In other *Highlights*, reports were presented on ICARDA's food-legume nursery program and on a project to evaluate a large collection of durum-wheat genotypes. As explained in those sections, the first involves, every year, the despatch of many shipments of seeds out of Tel Hadya, and the second involved the receipt of a very large number of seeds at Tel Hadya. These activities, however, are not the only ones under way in any one year, and ICARDA maintains a special laboratory dedicated to ensure that, with all such transactions, there is no inadvertent spreading of pests or pathogens.

The staff of the Seed Health Laboratory carry out routine inspections of the germplasm collections and seed stores, as well as the fields where ICARDA multiplies seed for international nursery distribution, for germplasm rejuvenation, or for the production of breeder's seed. In 1987, flag smut (*Urocystis tritici*) was found at low incidence on durum and bread wheat in one field, and, to prevent its spread, infected plants were rogued, contaminated seeds were destroyed, and this field will not again be used for wheat for the next five years.

Seeds destined for other countries are sent in packages, each with the phytosanitary certificate necessary to ensure that it will be handled expeditiously in the national quarantine agencies through which it must pass. Such certificates are issued by the appropriate Syrian authority on the basis of a rigorous set of tests carried out in ICARDA's Seed Health Laboratory.

First, all seeds to be despatched are inspected by eye for contamination by soil, weed seeds or other extraneous material. Then random samples are subjected to one or more of a series of laboratory tests designed to detect contamination or infection by significant bacterial or fungal pathogens. In cases where a virus disease is suspected, appropriate checks have also been carried out, and this will become routine in 1988. In a few cases, when seeds are needed for research in pathology or for long-term storage, they are sent without a fungicide treatment; however, the great majority of shipments are routinely treated with fungicide, and all legume seeds are also fumigated. Random samples are germinated to make sure that the treatment of these seeds is not causing loss of viability.

Incoming seeds must also be rigorously examined to prevent the introduction of a new disease into our host country. After disinfecting the packages to prevent the escape of any live insects, all seeds are inspected by eye for soil, weed seeds, bunt balls, or seeds with visible symptoms of infection. Laboratory tests are conducted on random samples, and the results for 1986/87 are recorded in Table 8. In this season, we detected no pathogen of quarantine significance in Syria.

In 1986/87, since 72% of the incoming shipments had not been treated with fungicide at source, a broad-spectrum fungicide was applied to those seeds that were to be planted here. Even then, incoming seeds were planted only in an isolation area where frequent inspections are made for pests and diseases and any plants showing the symptoms of infection are rogued. During the 1986/87 season, no exotic diseases were detected in the isolation area, but there was a high incidence (43%) of loose smut on bread wheat that had come from another country in the region. This is not a quarantine disease in Syria but, because a different race may be more virulent than those locally endemic, we removed all infected heads and discarded seeds harvested from adjacent plots.

The Seed Health Laboratory conducts its own modest research program to develop more effective methods for achieving its goals. In the last year's Annual Report it was reported that the Laboratory had developed a method for detecting *Xanthomonas translucens* on wheat and barley; in 1987, it was seeking ways to eradicate these bacteria when they are found.

Ensuring healthy seed requires continuous monitoring, both in the field and in the laboratory.

Table 8. Pathogens detected on seed received at ICARDA, 1986/87.

	Number of samples		
Seeds	Tested	Infected	Pathogens
Durum wheat	1175	45	*Tilletia caries* and/or *T. foetida*
Bread wheat	2226	256	*Tilletia caries* and/or *T. foetida*
Barley	139	37	*Helminthosporium* sp.
		19	*Fusarium* sp.
		11	*Helminthosporium* sp. and *Fusarium* sp.
Triticale	142	0	-
Lentil	51	12	*Ascochyta lentis*
		1	*Ascochyta lentis*, *Fusarium* sp., and *Botrytis cinerea*
Faba bean	28	1	*Ascochyta fabae*
		2	*Fusarium* sp.
Peas	32	9	*Pseudomonas* sp.
Total	3793	393	

ICARDA is not alone, of course, in its efforts to hinder the spread of crop pathogens, and the ultimate responsibility lies with national quarantine organizations. It is essential that seed-production organizations also pay attention to this very important aspect, and the Seed Health Laboratory routinely provides a contribution in all the seed-production courses sponsored by ICARDA. Training to individuals is offered and, in 1987, the Laboratory received trainees from Ethiopia, Egypt and Tunisia.

Agriculture at high elevations

About 40% of the arable land in West Asia and North Africa is located at elevations over 1000 meters and 21% is over 1500 meters. Severe climatic stress limits the scope of crop production and, typically, fields put to cereals produce no more than 500 kg/ha. Yet, millions of families are living on the plateaux and in the mountains, and most of them are engaged in subsistence agriculture. The areas are difficult of access and, even if agricultural surpluses were available from more-favored lowland regions, the costs of transportation are such as to forbid their delivery.

The problems of agriculture at high elevations were very much in the mind of the founders of ICARDA, and early action was taken to establish a research station near Tabriz in Iran. Unfortunately, this had to be abandoned in 1978, but scientists have continued to visit Iran and, in the following years, the Center has reserved a modest part of its resources for research related to the high-elevation areas.

The focus of this work has been largely on cereals and, to a limited extent, on food legumes. A breeding strategy for cereals was developed and applied in cooperation with national stations in Morocco (Annoceur), Pakistan (Quetta), Syria (Sarghaya) and, more recently, Turkey (Ankara). This breeding strategy and its impact were described in *ICARDA Research Highlights* 1985. A major new thrust came with the initiation of the MART/AZR project in Baluchistan at the end of 1985, and its progress is described later in this report.

The year 1987 provided new opportunities for a major review of research at high elevations: the agreements signed in 1985 and 1986 with Morocco and Algeria had opened the door to further cooperation in research related to the Atlas region, and these were followed by the development of a new work plan with Iran. The review was carried out at an international symposium sponsored by ICARDA and the Ministry of Agriculture, Forestry and Rural Affairs of the Government of Turkey. It was held in Ankara in early July, and it focused both on cereals and on food legumes.

Participants at the symposium took particular note of the achievements of the Turkish national program on the central Anatolian plateau. Production practices have been developed which, with improved germplasm, have raised yields from less than 1000 kg/ha to more than 2000 kg/ha for a cereal/fallow rotation. The fallow year serves to restore fertility, but its primary purpose is to conserve moisture that will become available to a winter cereal crop in the succeeding season. Also, in more-favored areas, much of the fallow has been replaced by food and forage legumes, and there has been a four- to six-fold increase in production of these crops.

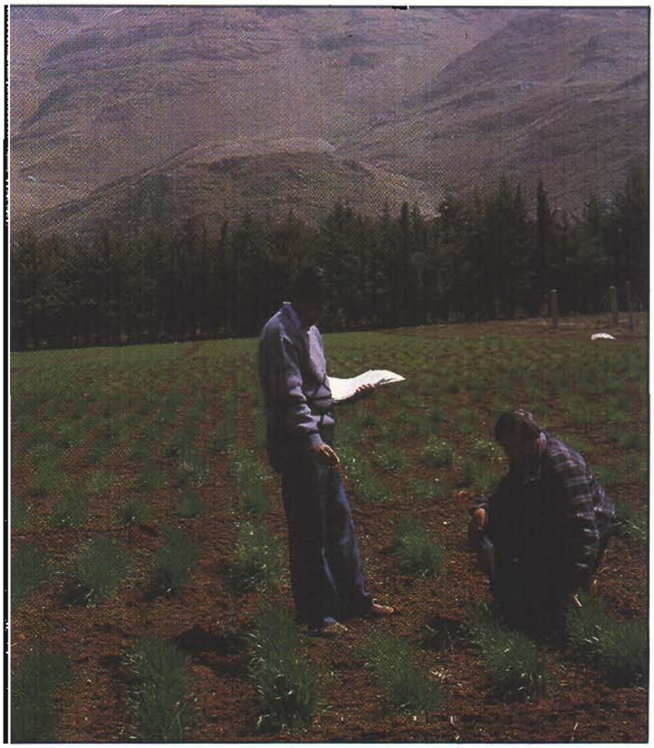
Unfortunately, these practices cannot be extended to the plateaux of eastern Turkey and western Iran as, here, the summers are hotter, and the combination of solar radiation and high-velocity winds dries virtually all the moisture out of a fallow. New agronomic practices need to be developed for these and other high-elevation areas, and it is almost certain that such practices will involve an annual application of fertilizers. Of course, continuous cropping has its dangers, and methods must be sought to protect the soil from wind erosion in the hot, dry months following the harvest. Where land is sloping, other sets of practices are needed to combat water erosion at the onset of the rainy season (see also item on *Tillage and Stubble Management*).

The symposium proposed the establishment of a network for cooperation in research on high-elevation agriculture. The participants made a tentative classification of zones within which sub-networks might be developed. These are:

- central Anatolian plateau
- western Iran, eastern Turkey and mountainous Iraq
- Pakistan, Afghanistan and central Iran
- temperate and subtropical Himalayas
- Atlas mountains
- mountainous areas of China

Effective research will depend on a proper understanding of the agroclimatic conditions existing in these zones and of how these conditions vary within each zone. Sufficient agroclimatic data is not now available, and the collection and analysis of such data is seen as a necessary first step. No standard simple procedure can be prescribed, because so much depends on topography and, while agroclimatic conditions may be relatively easy to identify across a uniform plateau, many of the high-elevation areas are made up of mountains dissected by steep-sided valleys.

Genotypes displaying resistance to yellow rust at Quetta in Pakistan (elevation 1670 m).



Scoring germplasm for cold tolerance at Sarghaya in Syria (elevation 1450 m).

The basic cereal-breeding strategies remain valid, and it is expected that ICARDA will continue to work with national programs and to develop winter x winter and winter x spring crosses. As in the past, such crosses are made with locally-adapted material from landraces as one parent, while the other is chosen because it displays desired properties such as disease resistance. Also, for food and forage legumes, ICARDA will work with the partners in the several networks to deliver germplasm from which adapted lines may be selected. Indeed, the key to success in all the high-elevation areas is adaptive research, both for germplasm and for production technologies. Such research can be conducted only at the national level, and ICARDA appreciates the enthusiasm with which national programs have indicated their readiness to focus research on areas that, sadly, have been much neglected in the past.

Agricultural labor studies

In an earlier chapter, it was noted that ICARDA is placing a stronger emphasis on the socio-economic sciences. One network-building effort is already underway: it takes the form of a special project that has been financed by the Ford Foundation since 1986 and, in this case, the budget includes the salary of a scientific coordinator who is on the staff of ICARDA.

In West Asia and North Africa, mechanization of agriculture began about fifty years ago and has continued, with policy and market incentives, in subsequent decades. Tractors and harvesters are now used on almost all cultivated land. This development and the industrialization policies of the 1950s and 1960s, which created employment in urban areas, have caused many agricultural laborers to leave the farms and migrate to cities. Of the remaining labor force, large numbers migrate seasonally to work abroad or in urban areas. Agricultural work is increasingly carried out by women and the elderly, who are unable to find other employment.

These changes are particularly noticeable in areas where agriculture is rainfed. Here farming is characterized by highly seasonal labor demands as well as by relatively low labor productivity. These factors, coupled with the small size of landholdings, lead farmers to look for better incomes in non-agricultural pursuits.

As a result, labor-replacing technologies are usually of interest to owners of small as well as large farms. Such technologies are often made available economically to small and medium-size farms by custom operators, who may be private entrepreneurs, cooperatives, or government agencies.

There is much yet to be learned about the impact of labor-replacing technologies on landless rural families: to what extent does work on farms still figure in their employment calendar? Certainly rural unskilled labor is less readily available, and farmers are changing their choice of crops to accommodate this situation. For example, the area devoted to lentil is declining, and farmers explain this in terms of the cost and problems associated with manual harvesting.

The *Agricultural Labor and Technological Change* project was undertaken to assess the relevance of these issues to ICARDA and agricultural research generally. Through cooperation between ICARDA and scientists of West Asia and North Africa, the present project is:

- preparing a review of available data on the impact of technological change on employment and labor, and the importance of labor issues in the choice of technology.

- supporting field research on these topics by scientists in national institutions.

- establishing a network of regional scientists working on adoption and impact issues in agriculture.

The study of available data will result in regional review papers on *Labor markets in non-agricultural sectors; Mechanization; off-farm employment, and agriculture*; and *Changing availability and allocation of household labor*, as well as country reviews for Cyprus, Iraq, Jordan, Morocco, Syria, Tunisia, Turkey, and the Yemen Arab Republic. Most manuscripts have been received, and a book containing these papers will be published in 1988.

Eight proposals for research projects by national scientists have been accepted and funded (with funds from the Ford Foundation and IDRC). ICARDA provides technical support and facilitates sharing of research experience among the participants. All eight projects are to be completed and reported by 30 June 1988. They are:

Algeria (Centre de Recherches en Economie Appliquee pour le Developpement, Ben Aknoun). Emploi global et technologies agricoles.

Jordan (University of Jordan, Amman). Impact of technology on employment in rainfed farming in Irbid.

Morocco (Universite Mohamed Ben Abdellah, Fes). Implications des mutations technologiques sur l'emploi et le systeme agricole dans la region de Karia Ba Mohamed.

(Institut Agronomique et Veterinaire Hassan II, Rabat). La mechanisation et l'emploi agricole en zones aride et semi-aride: cas de la Haute-Chaouia.

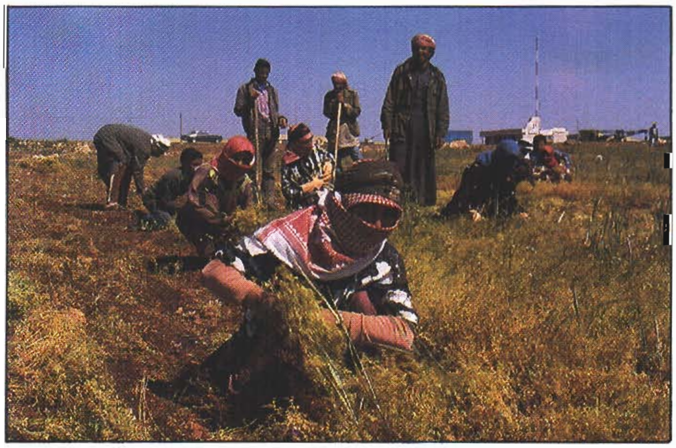
Tunisia (University of Missouri, Columbia, USA). Bases for acceptance and rejection of technical change: case study of a Tunisian rural community.

(Institut National de Recherche Agronomique de Tunisie, Tunis). Mechanisation agricole et transformations socio-economiques dans l'agriculture d'une region semi-aride de la Tunisie.

Turkey (University of Ankara). Household and hired labor and optimal crop choice in Konya.

(Middle East Technical University, Ankara). Aspects of labor affecting choice of technologies by farmers.

A workshop is planned at the completion of these projects. It will bring together the national scientists and ICARDA staff for a joint assessment of the results. This should lead to recommendations for a research policy on employment and labor availability and identify important areas for further research within the network.



Rural labor is now much less readily available for arduous tasks such as the hand harvesting of lentil (left) and barley (right).

Major Cooperative Programs

As indicated in the *Foreword* and in the list of agreements shown in Appendix 10, ICARDA cooperates closely with governments and research institutions in West Asia and North Africa. The larger joint endeavors are singled out for separate description later in this chapter. However, from year to year, as ICARDA builds its experience, it has more to offer to the national institutions who then seek a closer partnership.

In some cases, the partnership has been continuing for a decade. One example is that of Cyprus, a country with a relatively small research establishment but a significant effort in cereal breeding. In a workplan agreed in 1987, the Agricultural Research Institute takes over the main responsibility for developing lines of spring barley and durum wheat for dry areas with mild winters and with an emphasis on obtaining quick maturity. On the other hand, Cyprus sows a rather small area to chickpea and, rather than devote its own limited scientific resources to chickpea breeding, it is interested in taking finished cultivars from ICARDA.

At the other end of the scale, Algeria is an example of a country whose partnership with ICARDA is relatively recent. An interesting tripartite effort has been started which involves the principal Algerian research institute, ITGC, working in cooperation with ICARDA and the French INRA. During 1987, the research began cautiously, pending the outcome of applications for funds. Its main focus is at the ITGC station at Sidi Bel Abbes, and it involves the several ICARDA research programs in training courses and the design of on-farm experiments and demonstrations.

Work with Tunisia has already been presented in the *Highlights* section of this report. In Morocco, the cooperation was strengthened by the appointment of a pasture/forage/livestock scientist to augment the ICARDA team that already involves a cereal scientist and a food legume scientist. ICARDA cooperated with INRA in organizing the first national seminar on food legumes, which was held at Settat in April and which led to a set of recommendations for future research.

ICARDA's major project with Egypt, Sudan and Ethiopia is described later in this chapter. However, the Nile valley project is by no means our only contact with these countries. An agreement signed in May provides for ICARDA cooperation in a five-year USAID project for crop improvement in the lower Nile Delta and Middle Egypt. Another activity involves studies of water harvesting and supplementary irrigation in areas back from the coast in northwest Egypt.

The methodologies of the Nile valley project are being applied in the OPEC-funded project on wheat production technology based at the Agricultural Research Corporation, Wad Medani, Sudan.

Large-scale lentil germplasm trials conducted by ITGC at Sidi Bel Abbes, Algeria.

Cooperation with Turkey was strengthened in many ways in 1987. Two of the important meetings held in Ankara have been highlighted in the items on *Fertilizers and soils* and *Agriculture at high elevations*. Another of the meetings was to coordinate ICARDA's program of cooperation with Turkish research institutions. Land was made available at the Central Anatolian Agricultural Research Institute for the evaluation of ICARDA's winter-habit barley and wheat germplasms.

Lebanon provides an important ICARDA site at Terbol, and work is conducted in cooperation with the Agricultural Research Institute. Relations with Jordan are close even though no major projects were in progress in 1987. A mission went to Iraq to explore research needs in pasture and forage legumes. After visits to Iran earlier in the year, a workplan was agreed for cooperation with the key Iranian research institutions on a range of topics in the period 1987-1990. Closer links were set up with the Agricultural Research Authority in the Yemen Arab Republic, more training was started, and preparations were made for a formal agreement to be signed in 1988. Saudi Arabia, where agricultural conditions are markedly different, makes considerable use of ICARDA's cereal germplasm.

Outside the region, special note is required of our cooperation with countries along the northern littoral of the Mediterranean. A new agreement with the Chinese Academy of Agricultural Sciences foresees an expansion of existing cooperation, particularly on faba bean. An agreement signed with the Tropical Agricultural Research Council of Japan is expected to lead to more cooperation, especially in the application of 'biotechnology'. A mission of senior ICARDA scientists visited the Soviet Union and discussions continue on a possible agreement with that country.

Particularly for more basic research, many arrangements have been made for collaboration with advanced institutes in industrialised countries. These are detailed in Appendix 2.

Host country

Inevitably, given the location of ICARDA's main station, cooperation with Syria is particularly intimate. It involves the various directorates and organizations reporting to the Minister of Agriculture and Agrarian Reform, as well as the universities, most notably our neighbor, the University of Aleppo. This year, more cooperation was developed with certain parastatal enterprises, such as the Syrian-Libyan Company for Agricultural and Industrial Investment (SYLICO), which applies scientific management to vast areas of newly developed land in the east of the country.

A working session between Syrian and ICARDA scientists at the Sixth Annual Coordination Meeting.

All research programs of ICARDA are involved in the cooperation, and Syria has always been a close partner in the breeding work for our major crops. This is reflected in the number of varieties released (Appendixes 8 and 9). Increasingly, however, the partnership extends to research carried out with the participation of farmers, some of whom, along with many high officials, were present at the Sixth Annual Coordination Meeting, held in Aleppo in October.

That meeting reviewed the results of the 1986/87 season and established the plans for cooperative research in 1987/88. The on-farm research covers many topics including diverse aspects of crop improvement, but recently with special emphasis on winter chickpea, lentil lines developed for mechanical harvesting, medic pastures and various forages, supplementary irrigation of wheat, and the value of fertilizer for barley in dry areas.

A total of 73 Syrian nationals were involved in ICARDA's training programs, and others participated in research workshops and conferences. The cooperation extends from germplasm collection to seed production, and the goodwill that is expressed at the highest levels reflects a recognition that the cooperation is indeed of mutual benefit.

Nile Valley Project

The eighth annual coordination meeting was held in September in Cairo, and was honored by the presence of Ministers of Agriculture from both Egypt and Sudan. These, and the Director of Ethiopia's Holetta Research Station, led their national delegations in a detailed technical review of the progress of the project during the previous season and drew up a schedule of activities for the next. ICARDA's delegation was led by its Director General; representatives of several international and donor agencies were also in attendance, including those from IFAD and the Government of Italy which are funding the current phase of the project.

The fact that the top echelons of the national research authorities were all present for a four-day meeting attests to the importance that the countries give to this remarkable and enduring project.

Started in 1979, the Project is concerned with the improvement of faba bean production in the Nile Valley and, since 1985, also on the highlands of Ethiopia. Every relevant facet has been studied: genetic improvement, agronomic practice, pathology, entomology, and postharvest conservation. But, more than that, it has become a model for research cooperation that has involved, not only the researchers themselves, but also the Ministries that have the power to allocate resources, the extension agencies to interact with farmers and, most important of all, the farmers that grow faba bean.

ICARDA provides the connection to the donors, logistical support, scientific advice, specialized training, and germplasm. But, in terms of professional staff, ICARDA has had only one scientist-administrator in Cairo and, more recently, the support of a breeder-pathologist outposted in Ethiopia under a different but related project.

In previous Annual Reports of ICARDA, figures were cited for the bigger yields and profits that had been achieved by farmers who participated in demonstrations or pilot production schemes. In most cases, these increases are far more than marginal. The process involves the development of 'packages', each tuned to the needs of faba bean production in a particular agricultural environment. Typically, a package involves a recommended cultivar, a method of seed-bed preparation, an irrigation regime, fertilizer and herbicide.

The pace of application is accelerating. Under a different project, IFAD supports Egypt's Minya Governorate in a large extension and production program that has been launched to exploit the recommended technologies. An even larger IFAD-supported project, involving rehabilitation of major irrigation works, has been started in Sudan's Nile Province aimed at offsetting deficits in the country's faba bean production and reducing costly imports. In areas south of Khartoum (Gezira, Rahad and New Halfa schemes), 150 farmers have sown faba bean in 1987, thus introducing the crop into a region where it could not be grown only a few years ago. Conservative estimates suggest a potential doubling of the 16 000 ha that Sudan devotes to faba bean.

Giza 402, a cultivar with partial resistance to *Orobanche*, has been produced in sufficient quantities to seed 32 000 ha out of the 140 000 ha on which faba bean is grown in Egypt.

Egyptian and ICARDA scientists select lines resistant to Botrytis in greenhouses provided to the Agricultural Research Center at Giza in the context of the Nile valley project.

But the impact of the project can now be seen well beyond its original scope. It has demonstrated how to improve faba bean production, but it has also demonstrated a model of research cooperation and research management that ensures that the scientific resource is brought to bear on high-priority problems in national agricultural development. There is a new confidence among the scientists and in the way in which they take up on-farm multidisciplinary research.

The model has been adopted nation-wide for research on wheat in the Sudan and on all crops in the Gezira scheme (850 000 ha). In Egypt, it is employed for the USAID Small Farmers' project, where it will be applied to all field crops as well as cotton and sugar-cane; similarly Minya Governorate uses it for an IFAD-supported project covering all field crops. Ethiopia plans to apply the model to research on all pulses.

Unlike many other externally funded projects, the Nile Valley project has wrought enduring change in the conduct and administration of research, and has strengthened the realization of what can be achieved when scientists reach beyond their laboratories and work in partnership with governments, extension agencies, and farmers.

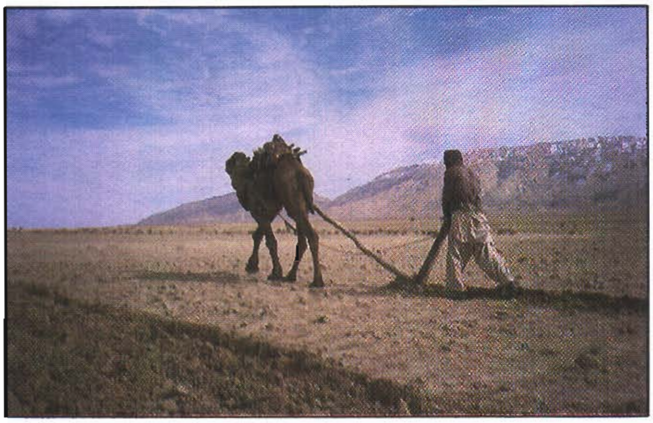
Baluchistan (Pakistan)

Under the institutional and contractual arrangements summarized in last year's report, the MART/AZR project provides for five expatriate scientists: each, including the Project Director, is associated with a division in the structure of the Arid Zone Research Institute (AZRI) at Quetta. The work, is characterized by a farming-systems perspective which ensures a high degree of cooperation among disciplines.

Last year's report briefly presented the research carried out in the project's first season, one that was marked by adverse weather - not, however, uncharacteristic of these high-elevation areas where farmers recognize that they are likely to lose their crops in three or four years out of every ten.

The 1986/87 season was more favorable, even though early rains germinated crops that were then subject to severe cold. The forage vetch *Vicia villosa* ssp. *dasycarpa* repeated its good performance of the previous year and showed a net economic advantage over lentil in some trials. Rhizobia inoculations proved highly beneficial in several, but not all tests. At most sites, barley was more productive than wheat.

During 1987, the project conducted surveys in five dryland regions, and the results clearly revealed the fragile nature of the farming systems of upland Baluchistan. Households average 17 persons, of whom four are active workers, but these households are increasingly dependent on off-farm employment. Decisions whether to crop, and how much land to crop, depend on the amount of rain that has fallen before sowing time, and how much money the household has at its disposal. Wheat is the dominant crop, but farmers estimate their yields at 100 to 300 kg/ha in bad years, and not over 1000 kg/ha even in good years. All farmers reported that the physical environment had seriously deteriorated within living memory.



ICARDA needs to help improve agricultural systems even for the least-favored sites, such as those in the mountains of Baluchistan.

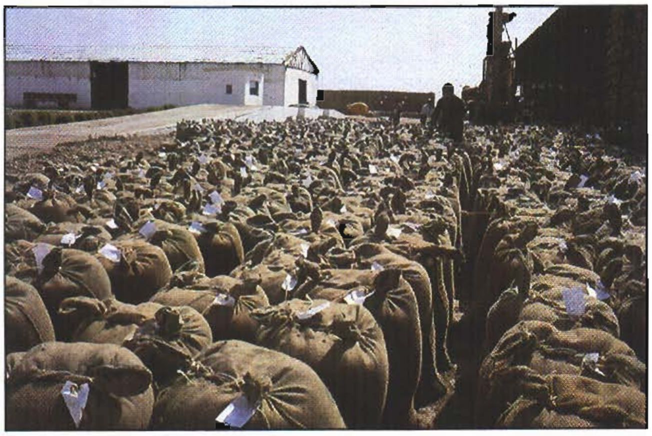
Parallel studies of the livestock situation indicate there are about 12 million small ruminants in Baluchistan, and these are about equally divided between sheep and goats. There is active grazing on more than 20 million hectares of rangeland, but there are acute feed deficits in winter, and many farmers drive their flocks to distant lowland regions where there are complex traditional arrangements under which winter grazing is obtained in return for animals or labor.

The total research program is remarkably diverse, and by arrangement with the Pakistan Agricultural Research Council (PARC) and with agricultural agencies of the Government of Baluchistan, work has been carried out at a dozen different sites.

The rangeland/livestock component involves animal nutrition and husbandry as well as the management of the range itself and the possible introduction of new species, either to enrich the range or to provide forage reserves. Germplasm evaluation takes advantage of the resources of ICARDA's nursery networks. The diversity of languages and the seasonal migrations of shepherds pose formidable obstacles for those seeking to improve instruments and methods for agricultural extension; in the remote sites, the project is introducing farmer-managed trials for the first time.

The agronomy component includes water harvesting and, to mention one specific set of experiments, some farmers were able to increase their net revenues by 50% when they compacted the soil in the upper portion of gently sloping fields, benefitted from the run-off, and cropped only the lower half.

The major objective of the project is the reinforcement of AZRI itself and, now that the facilities have been upgraded (see Annual Report for 1986), the expatriates are much involved in the professional development of the Institute's staff. A notable example is the introduction of computers: nine microcomputers are now in continuous use, and training has been given in statistical procedures. Video techniques have been introduced for agricultural extension, and a considerable effort has been put into English-language training particularly as this proficiency is a prerequisite for more advanced training in Pakistan and abroad.



ICARDA's seed-production project offers training and other services to private as well as public organizations, including, for example, the Societe de Gestion de Terres Agricoles (SOGETA) which multiplies and supplies seed to the national authorities responsible for distribution to farmers in Morocco. In this photograph, wheat produced on SOGETA's farm near Casablanca is made ready for shipment.

Seed production

Financed by the Netherlands and the Federal Republic of Germany, this special project was started in 1985 and seeks to assist in the development of national seed-production capacities. The methods for doing so were presented in last year's report, and work continued throughout 1987.

Another training course was given. It was carried out in cooperation with the Aleppo office of Syria's General Organization for Seed Multiplication (GOSM) and on its own premises. The 16 participants in this 12-day course were all from GOSM.

Consultancy visits to Ethiopia and the Yemen Arab Republic led to the definition of future cooperative activities. Modest research efforts were started to assess the quality of the seed available to farmers in Egypt and to describe important varieties according to their morphological characteristics.

National authorities promote improved cultivars by releasing them as 'varieties'. For cereals and legumes, as indicated in Appendixes 8 and 9, many of the varieties released in recent years were developed in cooperation with ICARDA. But the release of a variety does not mean that it becomes immediately available for a nation's farmers. They will be denied the benefits until adequate quantities of seed are produced and made available through public or private marketing organizations.

Ideally, the seed that reaches the farmers is "certified", which means that it conforms with the description of the variety and meets other standards of health and quality. Certified seed is produced by the seed multiplication entreprises, but their starting-point is "breeder's seed". So the production of certified seed depends on the quantity and quality of the supply of breeder's seed.

Both ICARDA and the national programs are sources of breeder's seed. The national authorities also monitor the production of certified seed. A significant development of 1987 was the realization that, due to the strength of the Dutch and German currencies, funds could be employed for direct actions beyond those originally planned. Given the project's objectives, it was felt that those could best take the form of developing facilities for on-the-job training, and the donors authorized us to set up a new seed-processing line and a seed-testing laboratory at Tel Hadya. These will be used for training staff from the national programs and, at the same time, will augment ICARDA's capacity to produce breeder's seed to supply to national seed-multiplication agencies.

Using facilities already available, more than 31 tonnes of breeder's seed, representing 27 cereal varieties, was produced in the 1986/87 season and 60% of it was then distributed to Syria and other countries of the region. With the new facilities in prospect, chickpea and lentil, as well as cereals, were sown for multiplication in the 1987/88 season.

Training and Information

Training

In 1987, the total number of scientists and technicians participating in the Center's training activities fell somewhat from that for 1986 (Fig. 6). The drop resulted from the postponement of four short courses that had been tentatively scheduled to be held in particular countries of the region. These postponed courses will be held in 1988 or 1989. Procedures have been set up to ensure that a lead-time of 12 to 18 months is allowed for the systematic preparation of each in-country or sub-regional training course.

On the other hand, as compared with 1986, there was an 8% increase in the number of participant days. This reflected a greater concentration on highly specialized training for individual scientists. Such activities usually last longer than formal courses and, as mentioned in the *Foreword* of this report, make more demands on the time of ICARDA's scientific staff who do the teaching. But the shift reflects the growing maturity of many of the agricultural research institutions in West Asia and North Africa, and the need to target training for specific rather than general purposes. Nevertheless, the more basic training programs still continue, and mostly take the form of residential courses at Aleppo.

As in the past, most participants came from countries of West Asia and North Africa (Table 9), although it is interesting to note that we also welcomed the first-ever participants from Colombia and Ecuador. This year, 37 of the participants were women; at 12% of the total, the proportion compares with 8% in the previous year. The training courses are listed, with other ICARDA events, in the overall calendar, Appendix 3.

The *Foreword* also makes reference to the agreements that have been signed with universities to enable graduate students to carry out their thesis research in ICARDA. A significant increase in this type of training was already under way in 1987, and more is expected.

About 40% of all direct costs for the support of participants was met either by restricted-core funds or by grants from particular foundations and donor agencies. The Arab Fund for Economic and Social Development is the major source of support for Arab participants, and the Ford Foundation continues to provide much of the support for training of postgraduate researchers, with a special emphasis on women scientists. However, we also acknowledge contributions from AOAD, CIDA (through BARD-Pakistan), FAO, GTZ, IDRC, IFAD, OPEC, UNDP, and USAID.

During 1987, ICARDA's work was reinforced by a visiting scientist attached to the Training Coordination Unit. He helped in the preparation of several new and updated manuals and also in the development of ten autotutorial modules employing audiovisual techniques. Seven of these are sufficiently well advanced that they are scheduled for production in 1988.

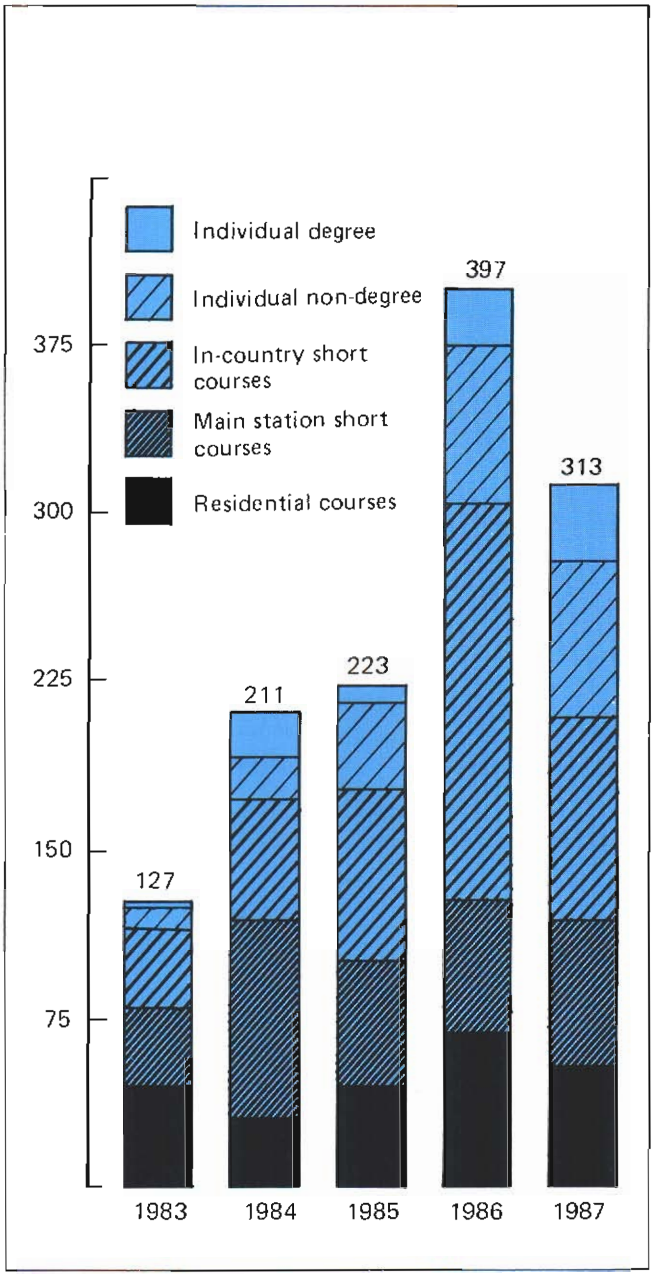


Figure 6. Training participants 1983-87.

Table 9. Country participation in ICARDA training (1978-87).

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	TOTAL
West Asia and North Africa											
Afghanistan	-	4	3	-	4	1	-	-	1	-	13
Algeria	1	4	3	3	2	-	3	1	45	63	125
Bahrain	-	-	-	-	1	-	-	-	-	-	1
Cyprus	-	4	1	-	1	-	1	1	1	-	9
Djibouti	-	-	-	-	-	3	-	-	-	-	3
Egypt	4	1	-	7	5	31	20	5	33	13	119
Ethiopia	-	3	-	1	-	2	1	6	27	38	78
Iran	2	-	-	-	2	1	5	9	10	2	31
Iraq	-	5	-	-	1	-	2	2	7	1	18
Jordan	2	4	4	1	4	5	7	2	14	16	59
Kuwait	-	-	-	-	-	-	-	-	-	1	1
Lebanon	3	1	-	-	3	1	3	4	4	1	20
Libya	1	1	-	-	-	3	9	-	3	-	17
Morocco	-	4	5	1	30	-	27	62	36	12	177
Oman	-	2	-	-	-	-	-	-	-	1	3
Pakistan	-	-	3	2	5	4	20	28	7	4	73
Qatar	-	-	-	-	-	-	1	-	-	-	1
Saudi Arabia	-	-	2	-	-	-	1	2	1	-	6
Sudan	-	2	7	12	4	13	8	13	29	25	113
Syria	10	16	8	19	41	41	70	53	55	72	385
Tunisia	-	3	5	2	11	13	6	9	37	20	106
Turkey	2	2	7	-	-	-	-	4	57	11	83
U.A. Emirates	-	-	-	-	-	-	-	-	-	1	1
Yemen AR	-	2	-	-	-	2	3	4	11	4	26
Yemen PDR	-	1	2	2	2	3	4	5	3	5	27
Total	25	59	50	50	116	123	191	210	381	290	1495
Other developing countries											
Argentina	-	-	-	-	-	-	-	1	-	-	1
Bangladesh	-	3	2	1	-	-	2	1	1	-	10
Chile	-	1	-	1	-	1	-	-	-	-	3
China	-	-	-	1	-	-	3	2	4	3	13
Colombia	-	-	-	-	-	-	-	-	-	1	1
Ecuador	-	-	-	-	-	-	-	-	-	1	1
India	1	2	1	1	-	-	1	1	1	3	11
Kenya	-	-	-	-	-	-	2	-	-	-	2
Nepal	-	-	-	-	-	-	-	1	-	1	2
Rwanda	-	-	-	-	1	-	-	-	-	-	1
Somalia	-	-	2	-	-	1	1	1	1	-	6
Tanzania	-	-	-	-	-	1	-	1	-	-	2
Total	1	6	5	4	1	3	9	8	7	9	53
More developed countries											
France	-	-	-	-	1	-	-	-	-	-	1
Germany FR	-	-	-	-	5	1	1	1	5	8	21
Greece	-	-	-	-	1	-	-	-	-	1	2
Netherlands	-	-	-	1	-	-	-	2	2	2	7
Spain	-	-	-	-	1	1	1	-	2	2	7
United Kingdom	-	1	-	-	-	-	-	2	-	1	4
United States	-	-	-	-	-	-	1	-	-	-	1
Total	-	1	-	1	8	2	3	5	9	14	43
Grand total	26	66	55	55	125	128	203	223	397	313	1591

Scientific and technical information

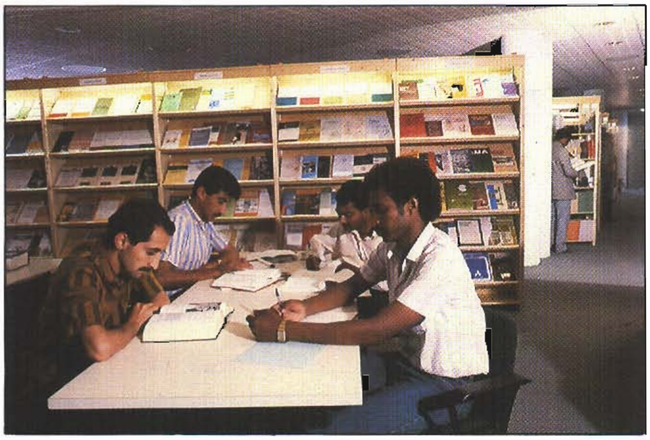
This program acquired a new name and structure in 1986, when a new manning-table was also designed to permit scientists to be recruited for a few key positions. However, recruitment remained a problem in 1987, particularly because of the scarcity of candidates having both the required training and the Arabic language. Arabic is seen as important because many of the services of the program are intended to supplement those available to the national agricultural research community in West Asia and North Africa.

However, in 1987 the staff came together under one roof from the several locations dispersed in the city of Aleppo and at Tel Hadya. The library was the first to move into the new buildings. To maintain speed, the word-processing and typesetting functions needed short lines to the computer centre, and they remained longer in their old location, but they followed as soon as the computer itself was transferred. The move of the printshop was particularly gratifying: machines could be unpacked that had long been held in storage because of lack of space in Aleppo. Now all the steps of printing, folding and binding are done in a single working area at Tel Hadya.

In May, a meeting was held at the International Potato Centre (CIP) in Lima, Peru. It was the first such gathering of all persons with responsibility for information and documentation activities in the various international agricultural research centres. A series of recommendations were made, and agreement was reached on actions that would be more effective if taken jointly rather than separately.

The Lima meeting put particular stress on the need to cooperate with national programs to help remedy some of the very serious difficulties that many developing countries face when they need access to recent scientific information, especially that published in journals. ICARDA is responding, partly through its specialized information services on faba bean, lentil and cereals, but also by strengthening cooperation with national centers participating in AGRIS. During 1987, there was a marked increase in the flow of photocopies to and from other AGRIS centers, particularly those in West Asia and North Africa. The resources of AGRIS were further exploited by the production of a new bibliographic service *Faba Bean in AGRIS* which is computer-produced by FAO, printed and distributed by ICARDA.

ICARDA is participating in two major efforts that call for joint action by the CGIAR centers. One, known as the Preservation Project, is managed by the CGIAR secretariat in Washington, and it plans to record all the publications of the Centers on compact disks with, of course, the indexing necessary for precise retrieval. The other is managed by ICRISAT in India and aims at constructing a composite list of the journals held by the libraries in all the Centers. This should permit improved service to developing countries, but eventually also to more cooperation among the Centers and a rationalization of their journal subscriptions.



Participants in ICARDA training courses often get their first opportunity to use a library that has a convertible-currency budget for the purchase of scientific journals and books.

At present, ICARDA still has no means of accessing international electronic telecommunications and therefore, unlike other Centers, is not able to participate in the CGIAR electronic-mail network, and cannot make on-line searches in international information systems. Fortunately, through the generosity of FAO and some donors, the Center is able to telex inquiries to persons who are willing to do searches on its behalf, and they send the outputs by mail. Although the volume remains small, these services are used by ICARDA scientists, and the library has seen a substantial increase in their demands for photocopies of selected articles.

The year was particularly busy for the editing and publications unit, and their output is listed in Appendix 6. There was a noticeable increase in the number of Arabic publications, and the newsletters on faba bean and lentil now accept original contributions in Arabic as well as English. The first scientific publication in French was also produced in 1987. Three training manuals were published in a revised and improved format.

The production of proceedings of meetings took up much of the resources that are available for editing English text. Attempts were made to improve the process, particularly by having the editor present at the meeting and thus able to resolve problems with authors in face-to-face discussion. Nevertheless, the load could be managed only with the help of five consultant editors, each recruited for two or three months.

Relations with the media were maintained, and a few magazines carried feature articles on ICARDA's work, several being in Arabic. A new ICARDA brochure was prepared in both languages and widely distributed. A display of posters was prepared for a high-level conference between the CGIAR and the Arab States which took place in Damascus in March. The posters, in English and Arabic, were retained and provide an overview of ICARDA's work for visitors and for other occasions.

Appendix 1

Special Projects

During 1987, the following activities were in progress utilizing funds that various organizations had provided separately from ICARDA's core budget.

DGIS (Directorate General for International Cooperation), the Netherlands and GTZ (German Agency for Technical Cooperation), Federal Republic of Germany

Seed Production. For a period of three years from 1985, 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 (297 000 USD in 1987).

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 (88 000 USD in 1987).

Ford Foundation

Agricultural Labor and Technological Change. This grant, now extended to December 1988, 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 (168 000 USD in 1987).

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 (67 000 USD in 1987).

Graduate Fellowships. This two-year grant is to extend ICARDA's own program of graduate fellowships.

Supplementary Irrigation. The grant covers the cost of national consultants and their technical support (19 000 USD in 1987).

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 (104 000 USD in 1987).

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* (17 000 USD in 1987).

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 (62 000 USD in 1987).

Faba Bean Pollination. ICARDA works in cooperation with an entomologist at the University of Manitoba (9 000 USD in 1987).

Lentil Harvest Mechanization. This project, for three years, 1985-88, involves work in Algeria, Iraq, Jordan, Morocco, Syria and Turkey and included a training course at Tel Hadya (46 000 USD in 1987).

Mechanization and Rural Employment (Morocco). This new project, agreed in November 1987, is to enable ICARDA to support studies at the Institut Agronomique et Veterinaire Hassan II.

Rhizobia Carrier System. ICARDA and the University of Manitoba cooperate to develop production techniques for rhizobia and methods of inoculation of chickpea, particularly for areas where this crop is being newly introduced (7 000 USD in 1987).

Yellow Dwarf Virus. ICARDA cooperates with Laval University in Canada and the Instituto Nacional de Investigaciones Agropecurias (INIA) in Chile to determine the extent of infection of this virus on barley in Morocco and Tunisia, and to screen cultivars for resistance (19 000 USD in 1987).

Supplementary Irrigation Seminar. Funds were provided to support preparations for the seminar held in Rabat in December 1987 and the attendance of national scientists (15 000 USD in 1987).

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 (693 000 USD in 1987).

Near East Foundation

Fertilizer in Dryland Barley/Livestock Systems. This grant supports the joint program of ICARDA with the Soils Directorate of the Syrian Ministry of Agriculture and Agrarian Reform (78 000 USD in 1987).

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 (119 000 USD in 1987).

USAID (United States Agency for International Development)

MART/AZR Project, Baluchistan. ICARDA is contracted by USAID for a component of its Management of Agricultural Research and Technology (MART) project. This component is to strengthen Pakistan's Arid Zone Research Institute (AZRI) and involves an interdisciplinary team conducting research in harsh high-elevation environments (869 000 USD in 1987).

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 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

Agriculture Canada *and* Laval University, Sainte Foy, Quebec
- Screening advanced ICARDA wheat and barley lines for resistance to barley yellow dwarf virus (BYDV)

Canadian Grain Commission, Winnipeg
- Development of techniques for evaluating the quality of barley, durum wheat and food legumes

University of Saskatchewan, Saskatoon
- Collection, evaluation and conservation of barley, durum wheat and their wild relatives
- Information services on lentil, including publication of the *LENS Newsletter*

France

Institut national de la recherche agronomique *and* Ecole nationale superieure d'agronomie, Montpellier
- Study of biological nitrogen fixation and nitrogen assimilation in food legumes as a function of genotype
- Study of chickpea rhizobia
- Inoculation of medics in southern France

University of Paris South
- Haploid breeding and anther culture for cereal improvement

Federal Republic of Germany

University of Bonn
- Decline in cereal yield in continuous cropping systems

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 smallholders in Sudan
- Economics of annual self-regenerating forage legumes to intensify livestock production in Syria
- Physiological factors as determinants of yield in durum wheat
- Improvement of nutrient-uptake efficiency in chickpea
- 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 Nuremburg
- Genetic characterization of faba-bean rhizobia

Italy

Institute of Nematology, Bari
- Studies of parasitic nematodes in food legumes

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

University of Perugia *and* Ministry of Agriculture, Catania
- Improving yield and yield stability of barley in stress environments

University of Tuscia, Viterbo; Germplasm Institute, Bari; *and* ENEA, Rome
- Evaluation and documentation of durum-wheat germplasm

Japan

Tropical Agriculture Research Center, Tskuba, Ibaraki
- Eco-physiological studies for improvement of high-yielding wheat varieties

Portugal

Estacao Nacional de Melhoramento de Plantas, Elvas
- Screening cereals for resistance to yellow rust, scald, *Septoria* and powdery mildew

Spain

University of Cordoba
- Effect of environmental stresses on nitrogen fixation

University of Cordoba *and* INIA
- Barley stress physiology

University of Granada
- Isolation of VA-Mycorrhiza from forage legumes

United Kingdom

Institute of Plant Science Research, Cambridge
- Characterization of barley genotypes
- Study of resistance of faba bean to *Botrytis fabae*

Overseas Development Natural Resources Institute, London
- Evaluating the nutritive value of straws for small ruminants

Royal Veterinary College, London
- Factors that cause peas to be unpalatable to sheep

University College, London
- Development of metabolic index for drought stress in barley and durum wheat

University of 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, wheat 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*
- Investigation of seed dormancy in plant populations on grazed marginal land

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

Wye College, University of London
- Studies on quality of barley straw

United States

Montana State University, Bozeman
- Research and training on barley diseases and associated breeding methodologies

Oregon State University, Corvallis; Montana State University, Bozeman; *and* Kansas State University, Manhattan
- Interdisciplinary research and training to enhance germplasm of selected cereals for less favorable environments

Appendix 3

ICARDA Calendar 1987

January

18-29 Aleppo SY. Training course on soils and plant analysis

26-30 Khartoum SD. Board of Trustees: 14th meeting of the Program Committee

February

1-14 Aleppo SY. Training course on statistical data analysis for cereal and food legume crops

15-26 Aleppo SY. GOSM/ICARDA training course on seed production technology

15-April 5 Aleppo SY. Residential training course on farm resource management

22-March 5 Aleppo SY. Training course on field techniques in biological nitrogen fixation

March

1-June 18 Aleppo SY. Residential training course on pasture, forage and livestock improvement

1-12 Aleppo SY. Training course on barley improvement

1-June 18 Aleppo SY. Residential training course on cereal crops improvement

1-5 Larnaca CY. Workshop on plant parasitic nematodes

1-June 18 Aleppo SY. Residential training course on food legume improvement

4-5 Sevilla ES. Board of Trustees: Executive Committee

15-24 TN. Cereal-disease survey in north and central Tunisia in cooperation with INAT and INRAT

21-25 Sidi Bel Abbas DZ. Training course on research skills Part II. Field experimentation

22-24 Damascus SY. CGIAR/AFESD seminar on agricultural research priorities and Arab food security

29-April 2 SY. ICARDA/Soils Directorate travelling workshop on fertilizer use on barley in Syria

April

1-15 Aleppo SY. Training course on cereal disease methodology

6-13 Tunis TN. IDRC's review of farming systems project

7-9 Settat MA. National food legume conference

10-12 MA. Travelling workshop on food legumes

12-16 Aleppo SY. ICARDA/Syrian Atomic Energy Agency training course on neutron probe usage

20-23 Settat MA. ICARDA/Morocco seminar on barley/livestock systems research

20-25 Sidi Bel Abbas DZ. Training course on food legume hybridization techniques

21-23 Amman JO. Workshop on on-farm trials with medics

23 Aleppo SY. Presentation day for diplomats and government officials

25 Aleppo SY. Presentation day for farmers of Hama and Homs provinces

26-29 Aleppo SY. 20th meeting of Board of Trustees

May

3-11 Aleppo SY. Training course on lentil harvest mechanization

10-17 TR. Travelling workshop on barley diseases in the region (with Montana State University)

10-21 Aleppo SY. Training course on germplasm evaluation: cereal landraces and wild relatives

16-28 DZ, TN. Travelling workshop on cereals

17-23 TR. Travelling workshop on food legumes

23-27 Aleppo SY. IAMFE/ICARDA conference on mechanization of field experiments

June

19-24 Cairo EG. ICARDA/UNDP international workshop on genetic resources of cool season pasture, forage and food legumes for semi-arid temperate environments

27-July 1 Sidi Bel Abbas DZ. Training course in research skills: Part III. Harvesting and data analysis of experimental results

July

5-9 Salamieh SY. Training course on medic planting and harvesting techniques

6-10 Ankara TR. International symposium on high-elevation research on winter cereals and food legumes

10 Ankara TR. Coordination meeting with Turkish national program

20-22 Wad Medani SD. Second national wheat coordination meeting

27-29 Viterbo IT. Consultation on durum germplasm evaluation

27-30 Quetta PK. MART/AZR Workshop on range-livestock issues

August

27-28 Aleppo SY. Board of Trustees: Executive Committee

September

1-6 Ankara TR. ICARDA/MIAC workshop on soil test calibration

8-9 Aleppo SY. Strategic Planning Workshop (for ICARDA senior staff, led by Mr Selcuk Ozgediz, CGIAR Secretariat)

13-18 Cairo EG. VIIIth Annual coordination meeting, Nile Valley Project

14-15 Rabat MA. INRA/ICARDA coordination meeting

17-19 Tunis TN. INRAT/ICARDA coordination meeting

21-23 Algiers DZ. ITGC/ICARDA/France coordination meeting

October

1-2 Aleppo SY. Board of Trustees: Committee on strategic plan

4-6 Aleppo SY. VIth annual coordination meeting, Syrian national program

9-14 Holetta ET. Training course on barley improvement

20-23 Washington US. Board of Trustees: Search Committee

26-29 Cordoba ES. Seminar on growth of cereals under environmental stresses

27-November 1. Quetta PK. MART/AZR workshop on laboratory and survey techniques for livestock parasitological infestations

November

9-12 Aleppo SY. Board of Trustees

11 Quetta PK. MART/AZR workshop on planning for effective agricultural communications

30-Dec 3 Aleppo SY. Workshop on small ruminants in Mediterranean areas

December

5-9 Rabat MA. ICARDA/FAO Seminar on supplemental irrigation in West Asia and North Africa

15-17 Nicosia CY. Second General Conference of AARINENA (sponsored by FAO, ICARDA and ISNAR)

Appendix 4

Statement of Activity

FOR THE YEAR ENDED DECEMBER 31, 1987
(in thousand US dollars)

	1987	1986
REVENUE		
Grants	21 515	20 686
Exchange gains	4 697	4 101
Investment income	954	961
Other income	88	141
	27 254	25 889
EXPENSES		
Research		
Farm research management	1 883	1 898
Cereal improvement	2 467	2 352
Food legume improvement	2 559	2 091
Pasture, forage & livestock	1 645	1 533
	8 554	7 874
Research support	2 810	2 777
Cooperative programs	648	599
Training	603	446
Information	1 084	880
General administration	2 713	2 316
General operations	2 404	2 186
	18 816	17 078
Special projects	2 408	1 927
Capital expenditure	5 660	2 538
Special projects capital	269	110
	27 153	21 653
EXCESS OF REVENUE OVER EXPENSES	101	4 236
ALLOCATED TO		
Operating fund	906	533
Locally generated fund	(805)	3 703
	101	4 236

Statement of Grant Revenue

FOR THE YEAR ENDED DECEMBER 31, 1987

(In thousand US dollars)

	Current year grants	Funds received	Receivable December 31, 1987	(Advance) December 31, 1987
CORE UNRESTRICTED				
Australia	246	(246)	–	–
Austria	175	–	175	–
Canada	783	(783)	–	–
China	30	(30)	–	–
Denmark	244	(244)	–	–
Ford Foundation	210	(300)	–	(240)
International Bank for Reconstruction and Development (World Bank)	4 800	(4 800)	–	–
Italy	515	–	515	–
Netherlands	554	(825)	–	–
Norway	433	(433)	–	–
Spain	155	(155)	–	–
Sweden	541	(541)	–	–
United Kingdom	910	(910)	–	–
United States Agency for International Development	4 500	(4 500)	–	–
	14 096	(13 767)	690	(240)
CORE RESTRICTED				
Arab Fund	370	–	370	–
France	189	–	189	–
Germany	1 827	(2 179)	–	(358)
International Development Research Center	273	(258)	82	(15)
Italy	1 867	–	200	(93)
The OPEC Fund for International Development	115	(145)	–	–
United Nations Development Programme	338	(425)	175	–
United States Agency for International Development	263	(320)	–	(128)
Closed projects		(1 035)	263	
	5 242	(4 362)	1 279	(594)
SPECIAL PROJECTS				
Ford Foundation	254	(130)	–	(397)
German Agency for Technical Cooperation	182	–	217	–
International Development Research Centre	175	(208)	31	(96)
Near East Foundation	78	(80)	–	(2)
Netherlands	203	(249)	73	(7)
Nile Valley Project	693	(250)	357	–
The OPEC Fund for International Development	119	(49)	76	–
United States Agency for International Development	869	(728)	376	–
IBRD (World Bank)	104	(50)	47	–
Less: Provision for doubtful accounts	–	–	(80)	–
	2 677	(1 744)	1 097	(502)
Less: Refund to Stabilization Mechanism Fund	(500)	–	–	–
GRAND TOTAL	21 515	(19 873)	3 066	(1 336)

Appendix 5

Senior Staff as of 31 December 1987

SYRIA

Aleppo: Headquarters

Director General's Office
Ir. G. Jan Koopman, Acting Director General/Deputy Director General (International Cooperation)
Dr. Aart van Schoonhoven, Deputy Director General (Research)
Mr. Samir El-Fayoumi, Director of Administration
Ms. Afaf Rashed, Administrative Assistant to the Board of Trustees

Government Liaison and Public Relations
Dr. Adnan Shuman, Assistant Director General (Government Liaison)

International Cooperation
Dr. Samir El-Sebae Ahmed, National Research Coordinator
Dr. A. van Gastel, Seed Production Specialist

Finance
Mr. Suresh Sitaraman, Acting Financial Controller and Treasurer/Finance Officer-Financial Operations
Mr. Mohamed Barmada, Finance Officer, Outreach
Mr. Hany Galal, Finance Officer-Costing and Cost Control
Mr. Suleiman Is-haak, Finance Officer-Cash Management
Mr. Vijay Sridharan, Finance Officer-Financial Reporting
Mr. Mohamed Samman, Pre-Audit and Control

Computer Services
Mr. Khaled S. El-Bizri, Director
Mr. Bijan Chakraborty, Project Leader
Mr. Michael Sarkissian, Senior Systems Engineer
Mr. C.K. Rao, Senior Programmer
Mr. Awad Awad, Associate Project Leader

Personnel
Ms. Leila Rashed, Personnel Officer

Farm Resource Management
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
Dr. Hamid Fakki, Post-Doc. Fellow
Mr. Wolfgang Goebel, Post-Doc. Fellow, Agro-climatologist
Dr. Sobhi Najjar, Post-Doc. Fellow
Dr. Mohamed E. Sheikhoun, Post-Doc. Fellow
Dr. Ammar Wahbi, On-Farm Agronomist-Barley/Livestock System
Mr. Ahmad M. El-Ali, Weed Control
Mr. Ahmad Mazid, Agricultural Economist
Mr. Abdul Bari Salkini, Agricultural Economist
Dr. Mohamed el Ashram, Visiting Scientist
Mr. Sobhi Dozom, Research Associate
Mr. Mahmoud Oglah, Research Associate
Ms. Andree Rassam, Research Associate

Cereal Crops Improvement
Dr. Jitendra P. Srivastava, Program Leader
Dr. Edmundo Acevedo, Physiologist/Agronomist
Dr. Salvatore Ceccarelli, Barley Breeder
Dr. Masanori Inagaki, Senior Researcher (seconded from Japan)
Dr. Habib Ketata, Senior Training Scientist
Mr. Joop van Leur, Barley Pathologist
Dr. Omar Mamlouk, Plant Pathologist
Dr. Ross Miller, Cereal Entomologist
Dr. Miloudi Nachit, Durum Wheat Breeder (seconded from CIMMYT)
Dr. Guillermo Ortiz-Ferrara, Bread Wheat Breeder (seconded from CIMMYT)
Dr. Muhammad Tahir, Plant Breeder
Dr. A.B. Damania, Durum Germplasm Scientist
Mrs. Stefania Grando, Research Scientist
Mr. Issam Naji, Agronomist
Dr. S.K. Yau, International Nurseries Scientist
Dr. Ahmad Zahour, Visiting Scientist
Ms. Loretta Dominici, Research Associate
Mr. Angelo Grottanelli, Research Associate
Mr. Luciano Pecetti, Research Associate
Ms. Antonella Grillo, Research Fellow
Mr. Rudi Petti, Research Fellow

Food Legume Crops Improvement
Dr. Mohan C. Saxena*, Program Leader/Agronomist-Physiologist
Dr. Douglas Beck, Food Legume Microbiologist
Dr. William Erskine, Lentil Breeder
Dr. Susanne 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, Acting Program Leader (seconded from ICRISAT)
Dr. Akhlaq Hussein, Post-Doc. Fellow, Lentil Breeding
Dr. R.S. Malhotra, International Trials Scientist

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* on sabbatical leave with International Atomic Energy Agency, Vienna.

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
Dr. Karl H. Linke, Post-Doc. Fellow, Orobanche (seconded from Germany)
Dr. Oreib Tahhan, Post-Doc. Fellow, Agronomy/Entomology
Dr. Geletu Begiga, Post-Doc. Fellow, Chickpea Breeding
Mr. Ihsan Ul-Haq, Asst. Training Scientist
Mr. Thomas Bambach, Visiting Research Associate (seconded from Germany)
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 Mohamed Abd El Moneim, Senior Training Scientist
Dr. Luis Materon, Microbiologist
Dr. Ahmed El-Tayeb Osman, Pasture Ecologist
Dr. Alan Smith, Grazing Management Specialist
Dr. Euan Thomson, Livestock Scientist
Mr. Faik Bahhady, Assistant Livestock Scientist
Mr. Hanna Sawmy Edo, Research Associate
Mr. Nerses Nersoyan, Research Associate
Ms. Silvia Lorenzetti, Research Associate
Mr. Mario Pagnotta, Research Associate
Mr. Safouh Rihawi, Research Associate
Mr. Luigi Russi, Research Associate
Mr. Yassin Swedan, Assistant Training Scientist
Mr. Munir Turk, Research Associate
Mrs. Monika Zaklouta, Research Associate

Genetic Resources
Dr. Bhai Somaroo, Program Leader
Dr. Laszlo Holly, Genetic Resources Scientist
Dr. Khaled Makkouk, Plant Virologist
Dr. Yawooz Adham, Assistant GRP Scientist/Documentation Specialist
Dr. Marlene Diekmann, Seed Pathologist
Mr. Bilal Humeid, Research Associate
Mr. Anne Elings, Associate Expert

Scientific and Technical Information
Mr. John Woolston, Program Leader
Dr. Walid Sarraj, Senior Information Specialist, Arabic
Dr. Surendra Varma, Head, Editing and Publications
Ms. Souad Hamzaoui, Center Librarian
Mrs. Joyce Kerley, Science Editor
Mr. Nihad Maliha, Information Specialist, FABIS

Training
Dr. Lawrence R. Przekop, Head
Dr. B.R. Tripathi, Visiting Training Scientist

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Mr. Bassam Hinnawi, Travel and Visa Officer

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Dr. Juergen Diekmann, Farm Manager (Tel Hadya)
Mr. Ahmed Sheikhbandar, Assistant Farm Manager

Physical Plant
Dr. P. Jegatheeswaran, Chief Engineer
Mr. Peter Eichhorn, Vehicle Workshop Supervisor
Mr. Farouk Jabri, Officer-Food and General Services
Mr. Ohannes Kalou, Building and Maintenance Engineer

Labor Office
Marwan Mallah, Administrative Officer

Development and Construction
Mr. Issac Homsy, Civil Engineer
Mr. Khaldoun Wafali, Civil Engineer
Mr. Bahig Kawas, Senior Horticultural Supervisor

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

International School of Aleppo
Mr. Denis Sanderson, Headmaster

Damascus
Mr. Abdul Karim El-Ali, Administrative Officer

Lattakia
Dr. Salim Hanounik, Faba Bean Pathologist

ETHIOPIA
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Dr. Surendra Beniwal, Food Legume Breeder/Pathologist

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

LEBANON
Beirut
Mr. Anwar Agha, Executive Manager/Senior Accountant

Terbol
Mr. Munir Sughayyar, 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
Dr. Philip Beale, Pasture, Forage, and Livestock Scientist

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Quetta

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Dr. Richard Aro, Range/Livestock Management Specialist (sub-contracted from Colorado State University)
Dr. Joseph Nagy, Farming Systems Specialist/Agricultural Economist
Dr. David J. Rees, Agronomist
Dr. Cemal Talug, Extension/Communications Specialist

TUNISIA
Tunis

Dr. Ahmed Kamel, ICARDA Representative/Cereal Pathologist
Dr. Thomas Stilwell, Agronomist

CONSULTANTS

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Mr. Mohamed Aziz Shoukry, Legal Advisor, Damascus
Dr. Hisham Talas, Medical Consultant, Aleppo
Dr. Philip Williams, Analytical Services

Appendix 6

Publications 1987

Articles in scientific journals

Abdallay, A., K.M. Makkouk, and C. Cardona. Control of *Heliothis* spp. on chickpea by insect pathogenic nuclear polyhedrosis virus. Arab Journal of Plant Protection 5(2): 80-78. (Arabic summary).

Brown, S.C., J.D.H. Keatinge, P.J. Gregory, and P.J.M. Cooper. Effects of fertilizer, variety and location on barley production under rainfed conditions in northern Syria. 1. Root and shoot growth. Field Crops Research 16(1): 53-66 (AGRIS 87-092613).

Ceccarelli, S. Yield potential and drought tolerance of segregating populations of barley in contrasting environments. Euphytica 36(1): 265-273 (AGRIS 87-031541).

Ceccarelli, S. and S. Grando. Diversity for morphological and agronomic characters in *Hordeum vulgare* ssp. *spontaneum* C. Koch. Genetica Agraria 14(2): 131-142.

Ceccarelli, S., S. Grando, and J.A.G. van Leur. Genetic diversity of barley landraces from Syria and Jordan. Euphytica 36(2): 389-405 (AGRIS 87-093720).

Cocks, P.S. and T.A.H. Ehrman. The geographic origin of frost tolerance in Syrian pasture legumes. Journal of Applied Ecology 24: 673-683. (An Arabic version is available as report ICARDA-103 Ar, AGRIS 87-082055).

Cooper, P.J.M. and P.J. Gregory. Soil water management in the rain-fed farming systems of the Mediterranean region. Soil Use and Management 3(2): 57-62.

Cooper, P.J.M., P.J. Gregory, D. Tully, and H.C. Harris. Improving water use efficiency of annual crops in the rainfed farming systems of West Asia and North Africa (Farming Systems Series-Number 5). Experimental Agriculture 23(2): 113-158. (Spanish summary).

Cooper, P.J.M., P.J. Gregory, J.D.H. Keatinge, and S.C. Brown. Effects of fertilizer, variety and location on barley production under rainfed conditions in northern Syria. 2. Soil water dynamics and crop water use. Field Crops Research 16(1): 67-84 (AGRIS 87-092614).

Diekmann, M. Monitoring the presence of Karnal bunt (*Tilletia indica*) in germplasm exchange at ICARDA. Phytopathologia Mediterranea 26(1): 59-60.

Hoshino, Tsuguhiro. Circumstances and constraint of wheat and barley production in North Africa and West Asia. Nogyogijutsu 42(4): 29-34. (In Japanese).

Hoshino, Tsuguhiro and Muhamd Tahir. Relationship between ear primordia development and growth attributes of wheat cultivars in dry areas of North Africa and West Asia. Japan Agricultural Research Quarterly 21(3): 226-232.

Hughes, G., J.D.H. Keatinge, P.J.M. Cooper, and N.F. Dee. Solar radiation interception and utilization by chickpea (*Cicer arietinum* L.) crops in northern Syria. Journal of Agricultural Science (Cambridge) 108(2): 419-424.

Makkouk, K.M., L. Bos, O.I. Azzam, L. Katul, and A. Rizkallah. Broad bean stain virus: identification, detectability with ELISA in faba bean leaves and seeds, occurrence in West Asia and North Africa and possible wild hosts. Netherlands Journal of Plant Pathology 93(3): 97-106 (AGRIS 87-096023).

Makkouk, K.M., O.I. Azzam, and L. Katul. Sensitivity of dot-ELISA on nitrocellulose membranes in comparison with ELISA on polystyrene plates for the detection of four plant viruses. Lebanese Science Bulletin 3: 29-35.

Rihawi, S., B.S. Capper, A.E. Osman, and E.F. Thomson. Effects of crop maturity, weather conditions and cutting height on yield, harvesting losses and nutritive value of cereal-legume mixtures grown for hay production. Experimental Agriculture 23:451-459.

Shepherd, K.D., P.J.M. Cooper, A.Y. Allan, D.S.H. Drennan, and J.D.H. Keatinge. Growth, water use and yield of barley in Mediterranean-type environments. Journal of Agricultural Science (Cambridge) 108(2): 365-378.

Yau, S.K. and M.S. Mekni. Breeding dual-purpose barley. Field Crops Research 15(3/4): 267-276 (AGRIS 87-072295).

Magazine articles about ICARDA

El Banna, Hani. Crisis in production in *foul* spurs widespread agricultural aid effort. Middle East Times. 8.

Khoury, N. The International Center for Agricultural Research in the Dry Areas (ICARDA) is an advanced center to combat hunger in the region. Agriculture Middle East, 3(II): 34-36 (in Arabic)

Sarraj, W. ICARDA and the problem of fallow land in arid regions. Agriculture Middle East, 3(11):6-7 (In Arabic)

ST (Tarbush, Susannah) "Landmark seminar gives regional edge to research." Middle East Economic Digest 31(20): 37.

Thomson, E.F. Forage crops and pastures for intensifying sheep production in Northern Syria. Entwicklung + landlicher raum. 21(1): 8-10.

---Valuable research for improving the quality and quantity of food production in the developing countries. Alam Attijarat, 22(9) 14-17 (in Arabic).

Contributions to conferences

January

Sakha EG. International Symposium on Rice Farming Systems: New Directions

Ortiz-Ferrara, G., B.C. Curtis, D.A. Saunders and P.R. Hobbs. Wheat: a complementary crop for traditional rice-growing countries of Asia.

Nordblom, T.L. Crop-livestock systems in Egypt with respect to rice research.

February

Islamabad PK. First National Training Course on Technology Transfer for Agricultural Extension Staff

Talug, C. What makes an extension worker successful.

New Delhi IN. International Symposium on Climate and Food Security

Cooper, P.J.M., H.C. Harris and W. Goebel. Climatic variability and food production in West Asia and North Africa.

Jones, M.J. and H.C. Harris. Climatic variability and agronomic management in Mediterranean barley-livestock farming systems.

Srivastava, J.P. Development of crop germplasm with improved resistance to environmental and biotic stresses.

March

Bangkok TH. FAO/DANIDA Regional Workshop on Seed Pathology.

Diekmann, M. Seed Pathology Program in ICARDA.

Larnaca CY. Workshop on Plant Parasitic Nematodes in Cereal and Legume Crops in Temperate Semi-Arid Regions

Saxena, M.C., A.M. Abd El Moneim, O.F. Mamluk and S.B. Hanounik. A review of nematology research in ICARDA.

Srivastava, J.P. and R.A. Sikora. Nematodes in cool season and semi-arid cereal production.

Faisalabad PK. Economic Research Policy Workshop

Nagy, J.G. The production function and productivity index approaches to estimating returns of agricultural research.

April

Cairo EG. First Conference of Fertilizers: availability and needs

Matar, A.E. Long-term research on barley fertilization under low rainfed conditions of Syria.

Settat MA. National Food Legume Research Conference

Saxena, M.C. Mechanization in food legumes.

Solh, M. Food legume improvement programs in other North African countries.

Islamabad PK. Workshop on Livestock in Farming Systems

Nagy, J.G. Range-livestock production constraint diagnosis and potential research opportunities in Baluchistan: a farming system perspective.

May

Aleppo SY. IAMFE/ICARDA Conference on Mechanization of Field Experiments in Semi-Arid Areas.

Ahmed, Samir El-Sebae. Common designs and field plot techniques used at ICARDA.

Diekmann, J. Seedbed preparation on heavy clays in semi-arid areas.

Diekmann, J. Faba bean plot planter.

Diekmann, M. Treatment of experimental seed.

Erskine, W., K.B. Singh, L.D. Robertson, M.C. Saxena, J. Diekmann and P. Jegatheeswaran. Mechanization and field experimentation in faba bean, kabuli chickpea and lentil at ICARDA.

Jegatheeswaran, P. Compact straw and chaff collector.

Jegatheeswaran, P. Mid-mounted three-cone planter.

Przekop, L.R. Proposal for regional training project for improvement of management and mechanization of agricultural research station operations.

Saxena, M.C., J. Diekmann, W. Erskine and K.B. Singh. Mechanization of harvest in lentil and chickpea in semi-arid areas.

Seshadri, R. Spare parts procurement by ICARDA.

June

Cairo EG. International Workshop on Genetic Resources of Cool Season Pasture, Forage and Food Legumes for Semi-Arid Temperate Environments

Cocks, P.S. and A.M. Abd El Moneim. A systems approach to evaluation of pasture and forage legumes in West Asia.

Holly, L. The principles of genetic maintenance of germplasm accessions during rejuvenation for self- and open-pollinated pasture, forage and food legumes.

Robertson, L.D., K.B. Singh and W. Erskine. Evaluation of faba bean, kabuli chickpea and lentil germplasm collections at ICARDA.

July

Ankara TR. International Symposium on Problems and Prospects of Winter Cereals and Food Legumes in High-Elevation Areas of West Asia and North Africa

Pala, M. Systems approach for crop production in high-elevation areas.

Rees, D.J., J.G. Nagy, S.H. Raza, K. Mahmood, B.A. Chowdry and J.D.H. Keatinge. The dryland arable farming system of upland Baluchistan: a case study.

Saxena, M.C., K.B. Singh, W. Erskine, and R.S. Malhotra. Status and scope of cool season food legumes in high-elevation areas of West Asia, Southeast Asia and North Africa.

Srivastava, J.P. Status and scope of barley and wheat production in high-elevation areas of Asia and North Africa.

Srivastava, J.P. and M.C. Saxena. Development of a network for food legumes and winter cereals research for high-elevation areas.

Tahir, M. Characteristics of cereal germplasm suitable for the high altitude areas of West Asia and North Africa.

Cambridge GB. OECD Workshop on the Genetics and Physiology of Photosynthesis and Crop Yield.

Acevedo, E. and H. Gomez. Field observations on gas exchange of barley genotypes affected by drought.

Islamabad PK. UNESCO International Seminar on the Management of Arid Lands.

Rees, D.J., S.H. Raza, Z. Ali, F. Rehman, M. Islam, A. Samiullah, S.M. Shah and M.I. Channa. Improvements in water use efficiency in Barani arable agriculture in Baluchistan.

Udine IT. Barley Yellow Dwarf Workshop

Makkouk, K.M., O.I. Azzam, J. Skaf, M. El-Yamani, C. Cherif and A. Zouba. Situation review of barley yellow dwarf virus in West Asia and North Africa.

August

Edmonton CA. VII International Virology Congress

Makkouk, K.M., I. Barker, O.I. Azzam, J. Skaf and S. Forde. Serological variability among BYDV isolates from some countries of the Middle East and North Africa.

London CA. Canadian Society of Agronomy

Jaradat, A. and J.P. Srivastava. Genotypic and environmental clustering for the RDYT in the ICARDA region.

Quebec CA. XIth North American Rhizobium Conference.

Materon, L.A., P.S. Cocks and J. Brockwell. *Medicago rigidula* has highly specific requirements for effective rhizobia.

September

Ankara TR. Second West Asia and North Africa Soil Test Calibration Workshop

Abdelmonem, M.A.S., K. Harmsen, W.L. Lindsay and P.G. Vleck. Fate of nitrogen-tagged urea applied to wheat in the arid Mediterranean region.

Jones, M.J. Interpreting data from on-farm fertilizer trials for use where soil-test values are not available.

Matar, A.E., E. Jabbour and K. El Hajj. Prediction of barley response to fertilizers by means of soil nitrogen and phosphorus tests.

Matar, A.E., M.C. Saxena and S.A. Silim. Soil testing as a guide to phosphate fertilization of five legumes in Syria.

Pala, M. and A.E. Matar. Soil test calibration with N and P for wheat under dryland conditions in Syria.

Soltanpour, P.N., A.E. Matar and K. Harmsen. Program of work for the regional network of soil test calibration study sites in limited rainfall areas.

Como IT. Italian Society of Plant Breeding

Grando, S., A. Grillo, S. Ceccarelli and E. Acevedo. Variability for seminal root morphology in cultivated and wild barley.

Granada ES. VIIth Congress of the Mediterranean Phytopathological Union

Diekmann, M. Production of healthy cereal and legume germplasm at the International Center for Agricultural Research in the Dry Areas (ICARDA).

Haware, M.P. Occurrence of perfect state of *Ascochyta rabiei*.

Makkouk, K.M., L. Bos and O.I. Azzam. Variability among broad bean mottle virus isolates collected from infected faba bean from a number of Mediterranean countries.

Mamluk, O.F. and J.A.G. van Leur. Screening for resistance to the major wheat diseases in the ICARDA region.

Penticton CA. Entomological Society of Canada/Entomological Society of British Columbia/Washington State Entomological Society.

Miller, R.H. ICARDA, agriculture and entomology.

October

Bursa TR. Turkish Cereal Symposium.

Yilmaz, B. and M. Tahir. Genetic diversity in wheat from Ahlat-Turkey.

Cordoba ES. International Symposium on Improving Winter Cereals under Temperature and Salinity Stress

Acevedo, E. Morphophysiologic traits of adaptation of cereals to Mediterranean environments.

Ceccarelli, S. Selection for specific environments or wide adaptability?

Cooper, P.J.M. Crop water use and water use efficiency in West Asia and North Africa.

Cranford, P.Q., N.J. Clipson, R.B. Austin and E. Acevedo. Defining an ideotype for barley in low rainfall Mediterranean environments.

Harris, H.C. and W. Goebel. Quantifying weather and soil effects on crop production.

Ortiz-Ferrara, G., D. Mulitze and S.K. Yau. Bread wheat breeding for tolerance to thermal stresses occurring in West Asia and North Africa.

Mekni, M. and M. El-Mourid. Effect of drought and temperature stresses on grain filling in semi-arid Mediterranean environments.

Nachit, M.M. and H. Ketata. Selection for heat tolerance in durum wheat.

Srivastava, J.P. Physical and biological constraints for the growth of wheat and barley crops in North Africa and South West Asia.

Srivastava, J.P. Synthesis: a critical assessment of the possibilities of improving winter cereals for temperature and salinity stresses.

Tahir, M. Breeding of cold-tolerant, early maturing wheat and barley varieties.

Fayetteville US. Farming Systems Symposium: "How Systems Work"

Pala, M., D. Tully, A. Rassam, A. Mazid and P.J.M. Cooper. Fertilizer and herbicide effects on farmers' wheat production in northwest Syria.

Montpellier FR. FAO-European Cooperative Network on Pasture and Fodder Crop Production

Materon, L.A., P.S. Cocks, M. Zaklouta, D. Daoud and J. Brockwell. *Medicago rigidula* has specific symbiotic requirements.

November

Atlanta US. Annual Meeting of American Society of Agronomy

Damania, A.B., A.A. Jaradat and J.P. Srivastava. Multitrait selection procedure for drought tolerance and yield response.

Srivastava, J.P. and A.A. Jaradat. Genetic diversity in durum wheat landraces from Jordan.

Damascus SY. 27th Science Week

Acevedo, E. and I. Naji. Selected agronomical and physiological components affecting barley production in low rainfall Mediterranean environments.

Bahhady, F.A. and E.F. Thomson: Performance of Awassi lambs to fattening on different diets.

Miller, R.H. Screening for resistance to cereal insect pests of West Asia and North Africa.

Rihawi, S. The importance of hay mixture in sheep feeding.

Tahhan, O. Studies on the toothed-leg faba bean seed beetle *Bruchus dentipes* Baudi (Coleoptera: Bruchidae) in Syria.

December

Addis Ababa ET. Workshop on Plant Breeding and the Nutritive Value of Crop Residues

Capper, B.S., E.F. Thomson and F. Herbert. Genetic variation in the feeding value of barley and wheat straw.

Nordblom, T.L. The importance of crop residues as feed resources in West Asia and North Africa.

Aleppo SY. Workshop on Small Ruminants in Mediterranean Areas

Cocks, P.S. and E.F. Thomson. Increasing feed supplies for small ruminants in the Mediterranean basin.

Somel, K. The importance of barley in food demand and production in West Asia and North Africa.

Nicosia CY. Second General Conference of AARINENA

Woolston, John E. Information for agricultural research in the Near East and North Africa: problems and prospects for improvement.

External publications sponsored by ICARDA

Bunting, A.H. (editor). Agricultural environments: characterization, classification and mapping. Proceedings of the ... workshop ... [Rome IT 1986-04-14 to 18], 335 pp. (Wallingford GB: CAB International, ISBN 0-95198-582-3) 56 GBP.

Saxena, M.C. and K.B. Singh (editors). The chickpea, 409 pp. (Wallingford GB: CAB International, ISBN 0-85198-571-8) 35 GBP.

Soltanpour, P.N. (editor). First West Asia and North Africa soil test calibration workshop proceedings [Aleppo SY 1986-06-23 to 25] 176 pp. (Settat MA: INRA-MIAC Aridoculture Center).

Srivasvata, J.P., E. Porceddu, E. Acevedo, and S. Varma (editors). Drought tolerance in winter cereals: proceedings of an international workshop [Capri IT 1985-10-27 to 31]. 387 pp. (Chichester GB: John Wiley, ISBN 0-471-91650-1) 25.50 GBP.

Nordblom, Thomas L., Awad El Karim Hamid Ahmed, and Gordon R. Potts (editors). Research Methodology for Livestock On-Farm Trials: proceedings of a workshop [Aleppo SY 1985-03-25 to 28] Arabic edition, 235 pp. (Ottawa CA: International Development Research Centre, Publication IDRC-242a ISBN: 0-88936-517-2).

Faba Bean Abstracts Vol. 7 nos 1-4 (Wallingford GB: CAB International).

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

ICARDA publications

Scientific reports/new series

ICARDA-102 En Nordblom, Thomas L. and E.F. Thomson. A whole-farm model based on experimental flocks and crop rotations in northwest Syria. 78 pp.

ICARDA-103 Ar Cocks P.S. and T. Ehrman. The effect of plant density and geographic origin on frost tolerance of pasture legumes in Syria. 39 pp.

ICARDA-104 En Verification and adoption of wheat production technology in the Sudan. Proceedings of the first national wheat coordination meeting, Wad Medani, Sudan, 3-5 Aug 1986. 64 pp.

ICARDA-105 En Tunisia/ICARDA cooperative program on food legume improvement. Progress report 1985/86. 159 pp.

ICARDA-106 En Thomson, Euan F. Feeding systems and sheep husbandry in the barley belt of Syria. 20 pp. (also Ar, 19 pp.)

ICARDA-107 En Nordblom, Thomas L. Farming practices in southern Idleb province: 1985 survey results. 88 pp.

ICARDA-108 En Farming systems program: annual report 1986. 184 pp. (also Ar, 181 pp.)

ICARDA-109 En Food legumes improvement program: annual report 1986. 271 pp. (also Ar, 337 pp).

ICARDA-110 En High elevation research in Pakistan: the MART/AZRI project annual report 1986. 26 pp. (also Ar, 38 pp.)

ICARDA-111 En Pasture, forage and livestock program: annual report 1986. 221 pp. (also Ar, 213 pp.)

ICARDA-112 En Cereal Improvement program: annual report 1986. 229 pp. (also Ar, 291 pp.)

ICARDA-113 En Genetic resources program: annual report 1986. 54 pp. (also Ar, 62 pp.)

ICARDA-114 En Seed production in and for Mediterranean countries: proceedings of the ICARDA/EC workshop, Cairo, Egypt, 16-18 December 1986. 245 pp.

ICARDA-115 En Mechanization of field experiments in semi-arid areas: proceedings of IAMFE/ICARDA conference, Aleppo, Syria, 23-27 May 1987. 237 pp.

ICARDA-116 Ar, En Collaborative research and training program: annual report 1985/86. 202 pp.

ICARDA-117 En Maerz, Ulrich. Methods to simulate distributions of crop yields based on farmer interviews. 39 pp.

ICARDA-118 Ar Diekmann, Marlene. Seed health testing and treatment of germplasm at ICARDA. 27 pp.

ICARDA-121 En Matar, Abdullah, Karl Harmsen and Sonia Garabed. Determination of particle size distribution in soils. 20 pp.

ICARDA-122 Fr Amelioration des legumineuses alimentaires. Synthese des travaux du stage de formation, Rabat, 11-16 fevrier 1985. 104 pp.

Technical manuals

9 (Rev. 1) En Miller, Ross. Introduction to the major insect pests of wheat and barley in the Middle East and North Africa. 209 pp.

12 (Rev.) En Introduction to food legume physiology. 105 pp.

15 En Smith, Alan. Range management for food production. 96 pp.

Periodicals

Al Yaum Vol 7 no. 1, En, 16 pp., Ar, 16 pp.; no. 2, En, 12 pp., Ar, 12 pp.; no. 3, En, 12 pp., Ar, 12 pp.

Faba bean in AGRIS. Vol 1 1975-85, 206 pp.; vol 2 1986, 49 pp.; vol 3 1987 no. 1, 26 pp., no. 2, 29 pp., no. 3, 25 pp.

FABIS Newsletter No. 15, 62 pp.; no. 16, 58 pp.; no. 17, 52 pp.

LENS Newsletter Vol 13 no. 1, 38 pp.; no. 2, 45 pp.

RACHIS Newsletter Vol 5, no. 2, En, 67 pp. Ar, 70 pp.

Other publications

Annual report for the regional barley yield trials and observation nurseries, 1985-86, 212 pp.

Annual report for the regional bread wheat yield trials and observation nurseries 1985-86, 136 pp.

Annual report for the regional durum wheat yield trials and observation nurseries 1985-86, 168 pp.

Cereal improvement program in Morocco: review and recommendations, April 1986. 20 pp. (En, Fr)

Cereal improvement program in Tunisia: review and recommendations, April 1986. 18 pp. (En, Fr)

Checklist: Journal articles from ICARDA 1978-1987. 16 pp. (En, Ar)

ICARDA Annual Report 1986, 68 pp. (En), 72 pp. (Ar)

ICARDA Annual Report for 1986: Executive Summary, 16 pp. (En), 16 pp. (Ar)

ICARDA: Investing in the future (Information brochure) 28 pp. (En), 28 pp. (Ar).

ICARDA/IFAD Nile Valley Project on faba bean; report of the seventh annual coordination meeting, 23-27 Sept 1986, Addis Ababa, Ethiopia. 109 pp.

ICARDA/IFAD Nile Valley Project on faba bean; report of the eight annual coordination meeting, 14-17 Sept 1987, Cairo, Egypt. 120 pp.

ICARDA International School Aleppo. 9 pp.

International Nursery Report No. 9 Food Legume Nurseries 1984-85, 440 pp.

Morocco/ICARDA. Report of the first cereal coordination meeting, 27 Oct 1986, Rabat, Morocco. 22 pp. (En)

Tunisia/ICARDA cooperative projects. Report of the fourth annual coordination meeting, 9-11 Sept 1986, Tunis, Tunisia. 41 pp. (En)

Hanounik, S.B. Screening techniques for disease resistance in faba beans (Information bulletin) 59 pp. (En)

Koopman, G. Jan. ICARDA preparing for its second decade. A presentation to the CGIAR, 26-30 Oct 1987, Washington DC, USA. 28 pp.

MART/AZR project publications

Research Report No. 11. Community profiles: a set of cultural sketches of five regions in Baluchistan by C. del Castillo, 65 pp.

Appendix 7

Genetic Resources

Germplasm collections at ICARDA in 1987.

Crop	Total	In medium-term storage	To be multi-plied	In long-term storage
	Number of accessions			
Cereals				
Barley	15942	12624	239	-
Durum wheat	20085	7000	5651	-
Bread wheat	10419	2780	2283	-
Wild relatives	3019	2385	256	-
Food legumes				
Lentil	6498	6190	308	4958
Chickpea	6437	5927	510	-
Faba bean	2892	2737	2596	-
Wild *Lens* spp.	195	190	195	-
Wild *Cicer* spp.	39	39	30	-
Forages				
Annual medics	4302	1020	2282	-
Pisum spp.	3301	1920	1381	3221
Vicia spp.	3548	1175	2373	-
Trifolium spp.	1268	-	1268	-
Trigonella spp.	154	-	154	-
Astragalus spp.	312	-	312	-
Lathyrus spp.	934	256	678	-
Other species	6046	398	6046	1130
Total	85391	44641	26562	9309

Samples from germplasm collection distributed in 1986/87*

Country	Barley	Durum wheat	Wild cereal spp.	Chickpea	Lentil	Faba bean	*Medicago* spp.	*Vicia* spp.	Other legume spp.
Algeria				2					
Argentina				100	85				
Australia	4				39			113	40
Canada	698								
Colombia								29	
Cyprus	40								
Egypt			4						
Ethiopia		200							
France	20						23	75	71
Germany F.R.					20			26	
India	30	201	8			30		176	
Iran				1223	968				
Iraq							15		
Italy		4672	30						
Jordan			116				15		
Japan				36	53				
Kenya		200							
Morocco		96							
Netherlands	2								
Pakistan		200			500			65	
Portugal		41							
Spain					70				
Sweden							61		38
Syria								40	20
Tunisia				1					
Turkey		220	12						
USSR				341	227		50	10	21
USA	59	8	57						100
Total	853	5838	227	1703	1962	30	164	534	290

*Each sample is taken from one accession in the genebank. The numbers do not include seeds sent out as nurseries in the course of crop-improvement work.

Appendix 8

Cereal varieties released by national programs

Country	Year of release	Variety
Barley		
China	1986	Gobernadora
Cyprus	1980	Kantara
Ethiopia	1981	BSH 15
	1984	BSH 42
	1985	Ardu
Iran	1986	Aras
Jordan	1984	Rum (6-row)
Mexico	1986	Mona/Mzq/DL71
Morocco	1984	Asni
		Tamellat
		Tissa
Pakistan	1985	Jau-83
	1987	Jau-87
	1987	Frontier 87
Portugal	1982	Sereia
	1983	CE 8302
Qatar	1982	Gulf
	1983	Harma
S. Arabia	1985	Gusto
Spain	1987	Rihan
Syria	1987	Furat 1113
Tunisia	1985	Taj
		Faiz
	1987	Rihane"S"
Yemen AR	1986	Arafat
		Beecher
Durum wheat		
Algeria	1982	ZB S FG'S'/LUKS GO
	1984	Timgad
	1986	Sahl
		Waha
Cyprus	1982	Mesoaria
	1984	Karpasia
Egypt	1979	Sohag
Greece	1982	Selas
	1983	Sapfo
	1984	Skiti
	1985	Samos
		Syros
Lebanon	1987	Belikh 2
Libya	1985	Marjawi
		Ghuodwa
		Zorda
		Baraka
		Qara
		Fazan
Morocco	1984	Marzak
Portugal	1983	Celta
Saudi Arabia	1987	Sham 1
Syria	1984	Sham 1
	1987	Sham 3
		Bohouth 5
Tunisia	1987	Razzak
Bread wheat		
Algeria	1982	Setif 82
		HD 1220
Egypt	1982	Giza 160
Ethiopia	1984	Dashen
		Batu
		Gara
Greece	1983	Louros
		Pinios
		Arachthos
Iran	1984	Azadi
	1986	Golestan
Libya	1985	Zellaf
		Sheba
		Germa
Morocco	1984	Jouda
		Merchouche
Portugal	1986	LIZ 1
		LIZ 2
Sudan	1985	Debeira
	1987	Wadi El Neel
Syria	1984	Sham 2
	1986	Sham 4
	1987	Bohouth 4
Tunisia	1986	Snb'S'
	1987	Byrsa
Yemen AR	1983	Marib 1
	1987	Mukhtar
		Aziz
		Dhumran
Yemen PDR	1983	Ahgaf

Appendix 9

Food-legume cultivars released

Country	Cultivars released	Year of release	Specific features
Kabuli Chickpea[1]			
Cyprus	Yialousa (ILC 3279)	1984	Tall
	Kyrenia (ILC 464)	1987	Large seeds
Italy	Califfo (ILC 72)	1987	(Verbally informed, details
	Sultano (ILC 3279)	1987	expected)
Morocco	ILC 195	1987	Tall
	ILC 482	1987	High yield, wide adaptation
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
Sudan	Shendi	1987	High yield
Syria	Ghab 1 (ILC 482)	1982/86	High yield, wide adaptation
	Ghab 2 (ILC 3279)	1986	Tall, cold-tolerant
Tunisia	Chetoui (ILC 3279)	1986	Tall
	Kassab (FLIP 83-46C)	1986	Large seeds, high yield
	Amdoun 1 (Be-sel-81-48)	1986	Large seeds, type
Turkey	ILC 195	1986	Tall, medium seed, cold tolerant
	ILC 482	1986	High yield, wide adaptation
Lentil			
Ecuador	INIAP-406 (FLIP 84-94L)	1987	Rust-resistant, high yield
Ethiopia	ILL 358	1984	Rust-resistant, high yield
Syria	Idleb 1 (78S 26002)	1987	High yield, reduced lodging
Tunisia	Neir (ILL 4400)	1986	Large seeds, high yield
	Nefza (ILL 4606)	1986	Large seeds, high yield
Turkey	Firat '87 (75Kf 36062)	1987	Small seeds, high yield
Faba bean			
Iran	Barkat (ILC 1269)	1986	Large seeds, long pods, high green-pod and dry-seed yield

[1] All chickpeas are resistant to ascochyta blight and released for winter sowing, with the exception of 1 which is resistant to fusarium wilt and released for spring sowing, and Shendi which is intended for use under irrigation. In Turkey, ILC 482 is released for spring sowing.

Appendix 10

Agreements

Important agreements relating to the establishment of ICARDA, its cooperation with national governments, with universities, and with other international organizations.

(Note: when the different parties to an agreement signed on different dates, the date of the agreement is given as that of the last signature).

Agreements for the establishment of ICARDA

These agreements were negotiated and signed by the International Development Research Centre (IDRC) of Canada acting as Executing Agency on behalf of the Consultative Group on International Agricultural Research.

1975-11-17 CHARTER of the International Center for Agricultural Research in the Dry Areas (En, Fr). Signed for IBRD, FAO, UNDP and IDRC.

1976-06-08 Amendment to the Charter (En, Fr)

1976-06-28 Agreement with the Government of the SYRIAN ARAB REPUBLIC (Ar, En, Fr) to establish a Principal Station on Syrian territory.

1976-07-20 Agreement with the Imperial Government of IRAN (En, Fa) to establish a Principal Station on Iranian territory.

1977-07-06 Agreement with the Government of the Republic of the LEBANON (Ar, En) to permit operations on Lebanese territory.

1977-07-14 Agreement with the Government of the SYRIAN ARAB REPUBLIC (Ar, En) for the provision of lands.

Agreements for cooperation with Governments in West Asia and North Africa (not including agreements for specific work plans)

Normally, these agreements set the modalities for cooperation in individual countries, identify the kind of facilities that each party will make available to the other, and give ICARDA's staff privileges equivalent to those accorded to the staff of the United Nations.

1977-10-27 with the Government of JORDAN (En)

1978-03-25 with the Agricultural Research Institute of LEBANON (En) for the provision of lands

1978-03-29 with the Government of EGYPT (En)

1978-10-21 with the Government of the Democratic Republic of the SUDAN (Ar, En)

1979-02-05 with the Government of CYPRUS (En)

1980-03-11 with the Government of TUNISIA (Ar)

1980-03-19 with the PAKISTAN Agricultural Research Council (En)

1980-05-31 with the Government of EGYPT (Ar, En)

1981-09-16 avec le Ministere de l'Agriculture et de la Revolution Agraire de la REPUBLIQUE ALGERIENNE DEMOCRATIQUE ET POPULAIRE (Fr)

1985-01-18 with the Kingdom of MOROCCO (Ar)

1985-09-29 with the Ministry of Agriculture, Forestry and Rural Affairs of TURKEY (En)

1986-06-26 with the Ministry of Agriculture and Agrarian Reform of the Government of the Kingdom of MOROCCO for the posting of ICARDA scientists in Morocco (Ar)

1986-09-06 with the Government of IRAQ (Ar, En)

1986-10-08 avec la REPUBLIQUE ALGERIENNE DEMOCRATIQUE ET POPULAIRE (Fr)

1987-05-26 with the Ministry of Agriculture and Land Reclamation of the Arab Republic of EGYPT (En)

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

1981-10-30 avec l'Office de la Recherche Scientifique et Technique Outre-Mer ORSTOM - FRANCE (Fr)

1982-06-16 with the Consiglio Nazionale delle Richerche CNR - ITALY (En, It)

1986-05-13 with Institut National de la Recherche Agronomique INRA, Centre de Cooperation International pour le Developpement CIRAD, and Institut Francais de Recherche Scientifique pour le Developpement en Cooperation ORSTOM - FRANCE (En, Fr)

1986-12-15 with the Indian Council for Agricultural Research ICAR - INDIA (En, Hi)

1987-08-20 with the Chinese Academy of Agricultural Sciences CAAS - CHINA (Ch, En)

1987-09-29 with the Tropical Agricultural Research Center TARC - JAPAN (En)

Agreements with universities

1978-10-21 with the University of Khartoum SD (Ar, En)

1985-09-15 with the University of Gizira SD (En)

1985-11-21 with Tishreen University SY (Ar)

1985-11-28 with the University of Tuscia IT (En)

1987-01-28 with the University of Khartoum SD (En)

1987-04-14 with North Carolina State University US (En)

1987-09-19 with the University of Alexandria EG (En)

Agreements with non-national organizations (not including agreements for specific work plans)

1980-04-05 with the International Fertilizer Development Center IFDC (En)

1982-04-05 with the Arab Organization for Agricultural Development AOAD (Ar)

1982-12-12 with the Arab Center for Studies of the Arid Zones and Dry Lands ACSAD (Ar)

1987-05-05 with Winrock International Institute for Agricultural Development (En)

Appendix 11

ICARDA International School, Aleppo

The ICARDA International School is the only English-language school in Aleppo and the only school that is intended primarily to serve an international community. It was founded in 1977 to meet the needs of the children of ICARDA's senior staff, and such children are always accepted. Others are accepted when places are available.

The school has grown steadily each year. In 1986/87, it had 95 students in kindergarten through grade 8, and had clearly outgrown its facilities in a set of converted suburban apartments. In addition, there was a desire to extend the program to the 12th grade, an expansion that would have been impossible in the old building.

An opportunity to move to much larger and more permanent quarters occurred in the summer of 1987 when ICARDA's scientific, administrative and office staff vacated the old Aleppo Office 1 and moved to the new facilities at Tel Hadya. Renovation to convert offices into classrooms began at once and, thanks to much overtime and dedicated work under the direction of ICARDA's Mechanical Engineering Department, the school was able to begin the 1987/88 school year in the new building.

The new facilities include classrooms, laboratories, an assembly hall, and an enclosed playground for kindergarten students. In addition, there are tennis courts and playing fields, which are shared with visitors at the new ICARDA Guest House.

The new building made it possible to expand the school. The 9th grade was added this year, and the ICARDA Trustees have approved a plan to add one grade each year until the school has the full 12-year program. This will mean that the students in this year's ninth grade may well be the first graduating class from an ICARDA High School. It also means that older students will not have to leave their families to attend boarding schools abroad.

Enrollment reached 125 students at the beginning of the new school year in September 1987, and it is interesting to note that 38 of these are from Syrian families and without a parent working at ICARDA. Together, the students come from more than 20 countries and, although 62% have Arabic as their first language, they represent a cultural diversity that provides much opportunity for informal learning about the world. Such diversity also provides challenges for the teaching staff.

The main hall of the new ICARDA international school.

An international school needs a high teacher-student ratio to meet the individual needs of children who come to the school with a wide range of skills. To meet these needs and to make more subjects available to students in the upper grades, two teachers were added in 1987. Including the headmaster, there are now 12 full-time and five part-time teachers. Two teachers are specialists in teaching English as a second language, a job they pursue full-time at the school to help students learn the basics of English as quickly as possible.

In addition to the school in Aleppo, ICARDA operates a small school in Baluchistan, Pakistan, which is intended primarily for children of ICARDA staff members that are working with the MART/AZR project.

Appendix 12

Visitors to ICARDA, Aleppo

During 1987, ICARDA's Visitors Services received 2 125 individuals. As in previous years, the peak month was April which, of course, is the time when most of the crops are maturing and visitors can best see the results of the field experiments. It is in April that ICARDA organises Presentation Days and provides programs for visits by distinguished guests, including diplomats, donors and officials of the Government of Syria - as well as for farmers from different parts of the country.

One of the most distinguished visitors of 1987 was H.E. Mr Yogendra Makwana, Minister of State for Agriculture in the Government of India. His Excellency came to ICARDA as part of a tour of the country organized by the Government of Syria, and he traveled by helicopter. As a result of that visit, we have marked helicopter landing-points at Tel Hadya and look forward to receiving others that have their own transportation to our very doorstep!

As explained in the main part of this report, ICARDA took over two villas as guesthouses, and we have continued to provide accommodation for most of our visitors, as well as apartments for our trainees. However, the situation is now changing. One new modern hotel opened in Aleppo in 1987, and two more are expected soon. With this development, ICARDA can look towards a phasing-down of the guesthouse service that had been needed during all the years that it has been in Aleppo.

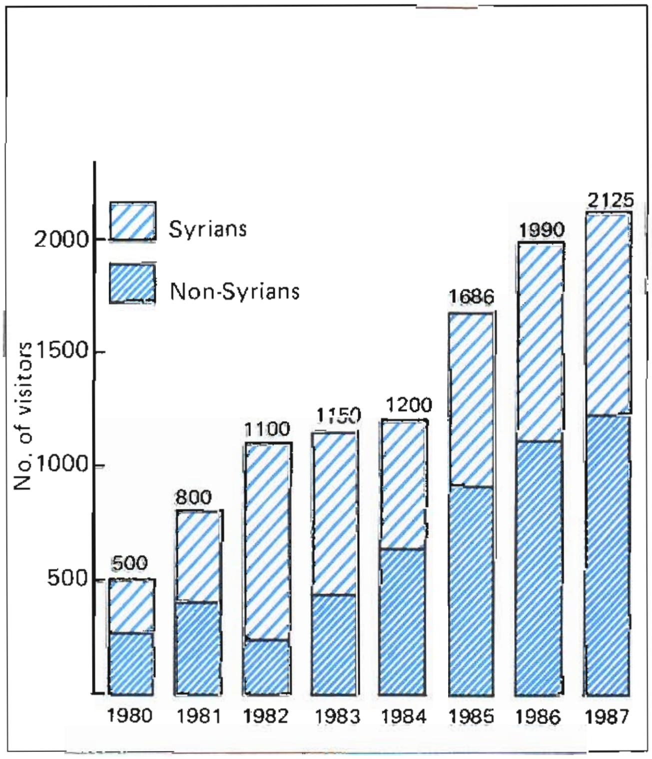

Figure 7. From year to year, more visitors come to ICARDA.

Appendix 13

Precipitation in 1986/87, mm

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	Season
TEL HADYA										
Total	31.5	33.4	47.2	88.9	63.2	63.5	12.6	2.6	15.0	357.9
Long-term average	21.3	44.8	53.8	66.1	51.6	42.0	31.9	15.6	4.0	331.5
*BOUIDER										
Total	10.8	23.8	27.2	48.3	24.4	27.8	11.7	2.2	0.0	176.2
*GHRERIFE										
Total	18.4	7.0	29.2	51.8	26.8	37.2	13.4	0.6	0.0	184.4
BREDA										
Total	23.0	25.4	33.2	66.8	31.6	47.2	17.4	0.0	0.0	244.6
Long-term average	13.9	31.5	57.4	49.4	38.5	35.1	34.3	15.8	1.4	278.8
JINDIRESS										
Total	30.0	70.6	115.0	161.9	83.0	118.6	18.8	2.8	0.0	600.7
Long-term average	25.3	51.3	98.5	92.3	76.3	60.6	44.9	19.1	2.7	472.5
*TERBOL										
Total	53.0	138.4	115.7	125.8	58.8	165.8	8.0	0.0	0.0	665.5

* Long-term average not available.

ICARDA collects weather data for all its major sites in Syria and Lebanon, except Lattakia. For locations, elevations, etc., see Annual Report 1986, p 13. The table above shows precipitation by month, as well as the long-term average. (note: because data have not been accumulated for many years, the "long-term" average is subject to some fluctuation as each year's new data are averaged in). No rain fell at any site during the months not included in the table.

For complete meteorological reports, including temperatures, request publication ICARDA-125 En (Mireille Abdelnour, *Meteorological reports for ICARDA experiment stations in Syria: 1986/87 season*, 150 pp. 1988).

Appendix 14

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 degree Celsius
cm centimeter
h hour
ha hectare
g gram
kg kilogram
km kilometer
m meter
mm millimeter
t tonne (1000 kg)

Currencies

SYP Syrian pound
(kSYP = thousand SYP)
TND Tunisian dinar
USD United States dollar
(kUSD = thousand USD)

Languages

Ar Arabic
Ch Chinese
En English
Fa Farsi
Fr French
Hi Hindi
It Italian

Countries

AU Australia
CA Canada
CY Cyprus
DZ Algeria
EG Egypt
ES Spain
ET Ethiopia
FR France
GB United Kingdom
IN India
IT Italy
JO Jordan
MA Morocco
PK Pakistan
SD Sudan
SY Syria
TH Thailand
TN Tunisia
TR Turkey
US United States

The following are the acronyms employed in this report

AARINENA	Association of Agricultural Research Institutions in the Near East and North Africa
ACSAD	Arab Center for Studies of the Arid Zones and Dry Lands
AFESD	Arab Fund for Economic and Social Development
AGRIS	International Information System for Agricultural Science and Technology
ANU	Australian National University, Canberra
AOAD	Arab Organization for Agricultural Development
AZRI	Arid Zone Research Institute (Quetta, Pakistan)
BARD	Barani Agricultural Research and Development Project (Pakistan)
BRD	German Federal Republic
BYDV	Barley Yellow Dwarf Virus
CAAS	Chinese Academy of Agricultural Sciences
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo (Mexico)
CIP	Centro Internacional de la Papa, (Peru)
CIRAD	Centre de Cooperation en Recherche pour le Developpement (France)
CGIAR	Consultative Group on International Agricultural Research
CNR	Consiglio Nazionale delle Richerche (Italy)
DGIS	Directorate General for International Cooperation (Netherlands)

EC	European Communities
FABIS	Faba Bean Information Service (managed by ICARDA)
FAO	Food and Agriculture Organization of the United Nations
GOSM	General Organization for Seed Multiplication, Syria
GTZ	German Agency for Technical Cooperation
IAMFE	International Association in Mechanization of Field Experiments
IBPGR	International Board for Plant Genetic Resources
IBRD	International Bank for Reconstruction and Development (World Bank)
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 Center (Canada)
IFAD	International Fund for Agricultural Development (Italy)
IFDC	International Fertilizer Development Center (USA)
IICA	Interamerican Institute for Cooperation on Agriculture
ILCA	International Livestock Center for Africa (Ethiopia)
INAT	Institut National Agronomique de Tunisie
INRA	Institut National de la Recherche Agronomique (France, also Morocco)
INRAT	Institut National de la Recherche Agronomique de Tunisie
ISBN	International Standard Book Number
ISNAR	International Service for National Agricultural Research (Netherlands)
ISSN	International Standard Serial Number
LENS	Lentil News Service (managed by ICARDA and the University of Saskatchewan)
MART	Management of Agricultural Research and Technology (project of USAID)
MART/AZR	The Arid-Zone Research component of MART
MIAC	Mid-America International Agricultural Consortium
ODNRI	Overseas Development Natural Resources Institute (United Kingdom)
OPEC	Organization of Petroleum-Exporting Countries
ORSTOM	Institut Francais de Recherche Scientifique pour le Developpement en Cooperation
PARC	Pakistan Agricultural Research Council
PS	Personal System
SOGETA	Societe de Gestion des Terres Agricoles (Morocco)
TARC	Tropical Agriculture Research Center (Japan)
UNDP	United Nations Development Programme
USAID	United States Agency for International Development

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