ICARDA
Annual Report
1989

International Center for Agricultural Research in the Dry Areas

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

The CGIAR seeks to enhance and sustain food production and, at the same time, improve socioeconomic conditions of people, through strengthening national research systems in developing countries.

ICARDA focuses its research efforts on areas with a dry summer and where precipitation in winter ranges from 200 to 600 mm. The Center has a world responsibility for the improvement of barley, lentil, and faba bean, and a regional responsibility--in West Asia and North Africa-- for the improvement of wheat, chickpea, and pasture and forage crops and the associated farming systems.

Much of ICARDA's research is carried out on a 948-hectare farm at its headquarters at Tel Hadya, about 35 km southwest of Aleppo. ICARDA also manages other sites where it tests material under a variety of agroecological conditions in Syria and Lebanon. However, the full scope of ICARDA's activities can be appreciated only when account is taken of the cooperative research carried out with many countries in West Asia and North Africa.

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

ICARDA Annual Report 1989

International Center for Agricultural Research in the Dry Areas

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Cover :

Much of the agricultural production in West Asia and North Africa is derived from mixed farming systems; those which include field crops, livestock, and trees are often the most profitable.

Foreword

ICARDA's major challenge is to realise sustainable advances in agricultural production in an environment of extremely variable climatic conditions. The past two seasons provided ample illustration of this spatial and temporal variability: a record rainfall in the 1987/88 season produced bumper crops virtually in all countries of West Asia and North Africa, whereas the 1988/89 season was one of the driest on record in several locations including the Mashreq countries--an event aggravated by unfavourable distribution of rain and persistent below-zero temperatures at critical points in the growing season. Elsewhere, good rains were received and satisfactory harvests taken.

Such events confirm the soundness of ICARDA's chosen research options which hinge on developing germplasm and production practices and systems that enable crops to withstand not only the vagaries of the weather but a range of biotic stresses as well. They are also a warning against over-ambitious assumptions of success in cropping lands normally receiving marginal and erratic rainfall. In the pursuit of more intensive exploitation of resources, research and production must work with nature, not against it, and take into account the dictates of prevailing conditions and the limitations they impose on the decisions we wish to make. The 1988/89 season, the subject of this Annual Report, though regrettable in several instances from an economic point of view, is a salutary reminder of this need.

Nasrat Fadda

Nasrat R. Fadda
Director General

PART ONE

Major Developments in 1989

One of the highlights of the 1989 Board of Trustees meeting was the inauguration of ICARDA's new buildings. The ceremony was conducted under the patronage of Mr Hafez Al-Asad, President of the Syrian Arab Republic, and was performed on his behalf by Mr Mohamed Ghbash, Minister of Agriculture and Agrarian Reform. Several high-ranking officials from the host country as well as donor countries and donor agencies participated, some of whom appear in this picture.

Front row (right to left): Dr Sabah Bakjaji, Minister of State for Planning Affairs; Mr Mohamed Ghbash, Minister of Agriculture and Agrarian Reform; Ms Rosalina Salerno, Representative of the Government of Italy; Dr Nasrat Fadda, Director General of ICARDA; Dr Jose Ignacio Cubero, Chairman,ICARDA's Board of Trustees. Second row : Mr Mohamed Nour Mawaldi, Governor of Aleppo; Mr Isa Baba'a, Chef de Cabinet, IFAD; Dr Hasan Seoud, Deputy Minister of Agriculture. Standing behind Ms Salerno is Dr Mohamed S. Al-Mahdi, Assistant Director General, OPEC Fund.

Contents

Major Developments in 1989

ICARDA recognizes that production increases that impoverish natural resources jeopardise the long-term stability of increased yields. The Center's research, therefore, has always aimed at achieving sustainable increases in the productivity of its five mandated crops--barley, wheat, lentil, kabuli chickpea and faba bean, and a range of pasture and forage crops--in the harsh, stressful, and variable environment of rainfed agricultural systems. This approach continued to guide the 1989 activities. Changing research needs, however, dictated some major shifts in the Center's programs. These, as well as some of the highlights of the 1988/89 season, are reported here.

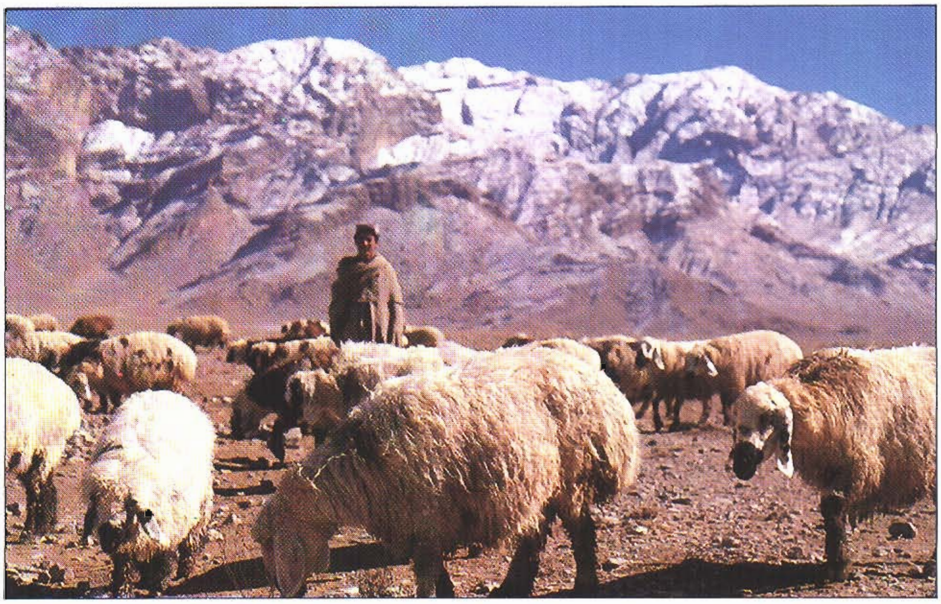
Strategic and Medium-Term Plans

A major achievement of the year was the development of Center's Strategy and Medium-Term Plan (1990-1994). Both documents embodied the recommendations of the second External Program and Management Reviews, and were approved by the Technical Advisory Committee (TAC) in June and the Consultative Group on International Agricultural Research (CGIAR) in October. This was gratifying to all those members of the ICARDA family who contributed to the development of the two documents.

Implementation of the major elements of the Medium-Term Plan proceeded with increasing momentum during 1989.

At the agroecological level, the Center made preparations for intensifying highland research and signed an agreement with Turkey for basing this work there. A Program Coordinator will move to Ankara in time to implement the program of work for the 1990/91 season. Work relating to the drier areas of WANA was also strengthened through the Mashreq Project, based in Amman, Jordan, and financed by the Arab Fund for

Before conducting the main phase of the reviews at ICARDA headquarters in May/June 1988, members of the External Program and Management Review Panels visited a few countries in WANA to assess the research needs of the region. Here, they are seen probing the subject in an informal atmosphere with national program scientists, farmers, and the ICARDA team in Balochistan, Pakistan.

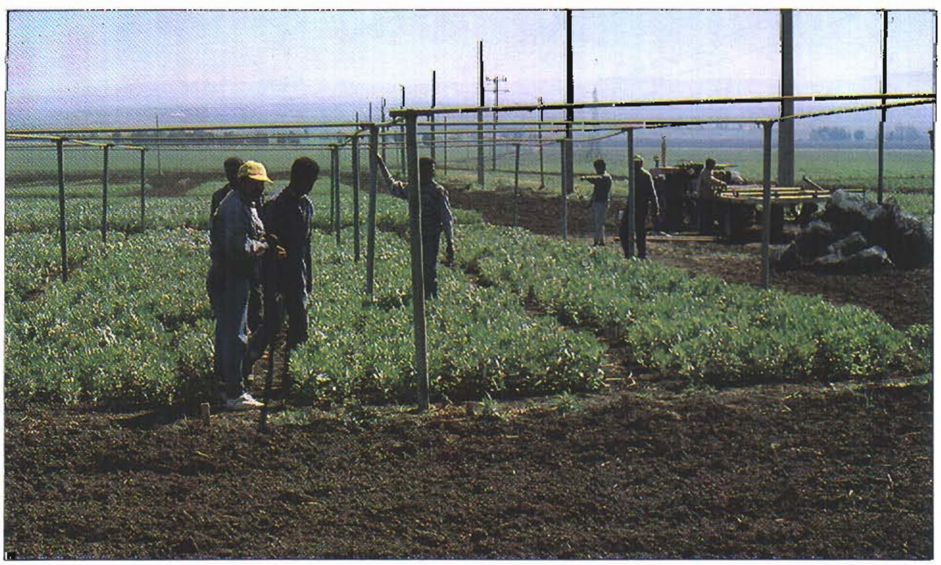


Severe cold in mountainous areas restricts the productivity of range vegetation, and the problem of feed shortage is further compounded by overgrazing.

Economic and Social Development (AFESD) and the United Nations Development Programme (UNDP).

At the commodity level, the core research activity on faba bean improvement was phased down by about 30%. The faba bean scientists were transferred to Morocco where they established an office at the Douyet research station, near Fez, in preparation for a full handing over of the work to Moroccan colleagues. At the same time, the Center's Lattakia office, which was primarily used for faba bean work, was closed down.

In collaboration with IFPRI, a study was undertaken to (i) analyze the existing evidence on the value of legumes in production systems of the region with respect to both their contribution to soil fertility under stressful conditions and the possibilities for expansion in their use as livestock feed, and (ii) assess the potential payoff of further research investment on the improvement of lentil to determine the appropriate allocation of resources to this crop. The report was nearing completion at the end of the year.



Constructing cages at the Douyet station, Morocco, to control pollination in faba bean. The faba bean researchers' team transferred from Aleppo headquarters to Morocco is making active efforts to establish a Regional Faba Bean Improvement Project on a sound footing before handing it over to Morocco.

At the research activity level, the Center was successful in obtaining financial support from the International Development Research Centre (IDRC) for the evaluation of, and training in, its Package of Agroecological Characterization in collaboration with Morocco and Turkey, as case studies. The UNDP provided a grant to strengthen biotechnology research and training for the improvement of ICARDA's mandated crops. The project will be implemented in collaboration with the Institut National de Recherche Agronomique, France, which will provide additional funds as well as expertise.

In the context of the CIMMYT/ICARDA agreement, signed in 1988 for sharing the various aspects of wheat research, a third scientist joined the CIMMYT's team at ICARDA. This team and ICARDA scientists are working in harmony and have carried out activities across Center boundaries. A project in Egypt is being executed jointly by CIMMYT/ICARDA from the same office in Cairo. It is likely that IRRI will use the same office and facilities, setting a model of cooperation among the International Agricultural Research Centers.

Research on annual pasture legumes and grazing management was strengthened. A small flock of goats was added to the existing sheep flock to replicate farmers' practice, and evaluate the potential of improved pasture and forage production techniques.

On the governance and management side, the Board, having worked on, and approved, the Center's personnel policies, carried out a thorough review of all aspects of its functions and operation. These efforts were formalized in a Board Handbook, which brings together the rules and regulations for the conduct of business by the Board and its Committees. The Board initiated an assessment of its own performance with a view to achieving an even higher efficiency in discharging its obligations.

Several other management-related activities were both streamlined and rationalized: operational planning, financial management, cost accounting, planning and budgeting, housing, vehicles, purchasing and supplies, physical plant department services.

The Center also succeeded in attracting highly qualified professionals to fill some of its senior management positions, including those of Deputy Director General (Operations), Director of Finance, and Assistant Director General (International Cooperation).

Research and Training Highlights

The highlights of ICARDA's activities must be reviewed against the background of the weather during the 1988/89 growing season. As in the past years, the WANA region experienced a great diversity of weather conditions. The season was good for countries located at

Crops faced severe cold and prolonged drought in the 1988/89 season in Syria. In cereals, symptoms of partial spike sterility were more frequent in wheat (left) than in barley at ICARDA's main station at Tel Hadya.

the western and eastern fringes of the region: Morocco harvested the second bumper crop in a row, although the season started rather dry but brought ample rainfall from March onward. Yields were also above average in much of Iran, Afghanistan, and Pakistan's Balochistan province due to adequate rain and snow, well distributed throughout the season.

With the exception of some coastal areas, other countries in WANA achieved only below average crop yields as a consequence of low rainfall: in Algeria the season was similar to Morocco, but rainfall ended too early. In Tunisia (which had a very poor season), Libya, Egypt, and Jordan, the rainfall distribution throughout the season was fairly satisfactory but the total amount was insufficient. In most of Syria, Turkey, and Iraq, ample rainfall at the beginning of the season was followed by severe drought from January onward.

Agroecological Characterization

Spatial Weather Generator

A spatial weather generator, developed at ICARDA, was put into use for the first time in 1989 in northern Syria. . Maps were developed using both generated daily and monthly rainfall data. These illustrated the influence of temporal and spatial variability of rainfall on the establishment and survival of early- and late-sown crops. Early sowing on 1 October was shown to be highly risky, with a high probability of severe drought during the seedling stage. Even in the wetter areas wheat farmers might have to wait 3 to 4 weeks, one year out of every two, for sufficient rain to germinate the crop; and barley farmers in the drier environments might have to wait 5 to 6 weeks.

A second set of examples, based on generated monthly data and utilizing regression equations derived from 75 on-farm barley fertilizer trials, related barley yields to October-April rainfall totals and levels of N and P_2O_5 applied in barley-barley and fallow-barley cropping sequences. Maps were generated to show the distribution, at the 80% probability level, of unfertilized and fertilized barley yields.

CERES-Wheat Model

The CERES-Wheat model was used to determine wheat responses to N fertilization under various conditions in the Xian region of the Peoples' Republic of China. Model output confirmed that responses to nitrogen were sensitive to initial soil nitrogen levels, and amounts and distribution of seasonal water supply. Season-dependent economically-optimum rates of N application were determined for the driest and wettest years. Split application of fertilizer at sowing and at the start of stem elongation was superior, and on average gave a 10% increase in yield over a single application at sowing.

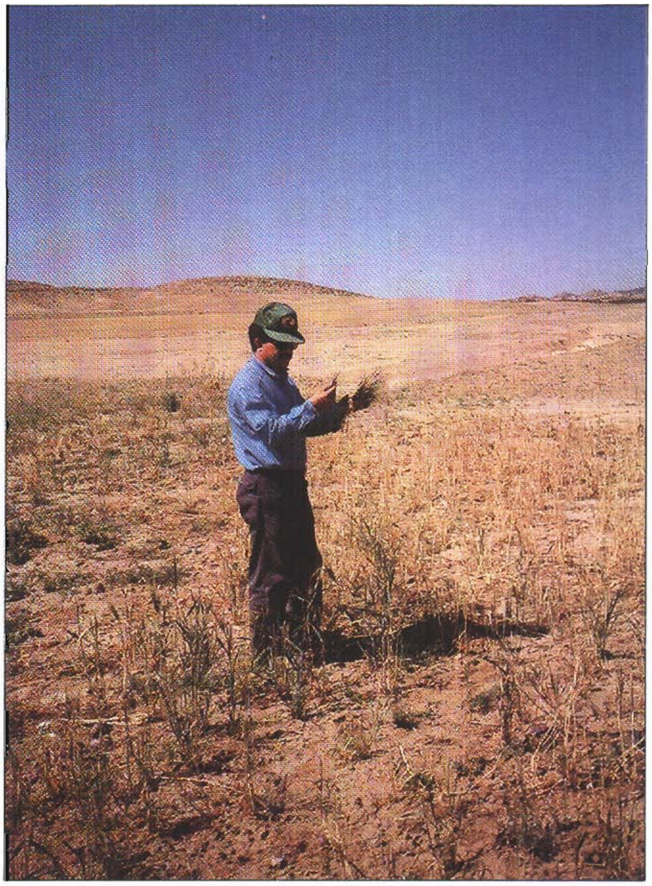
Characterizing Dryland Farming Systems of Northern Jordan

ICARDA and the Jordan University of Science and Technology began this project in 1988. Approximately 70% of the arable land in Jordan falls into the marginal zone category, and receives, on average, between 200 and 300 mm of annual precipitation. Over 41% of the country's population lives in this marginal zone.

Mafraq, which represents the marginal zones of Jordan, was chosen as the project area. Literature reviews were used to trace the history of agriculture to the early days when it was dominated by nomadic herdsmen. An overview of current farming systems was developed from a survey of 114 farmers in 35 villages. The dominant farming strategies or enterprise-mixes within the area are: cereal/livestock, cereal/livestock/olive, cereal/olive, and cereal production. Cereal production is dominated by barley, and livestock by sheep. Of these enterprises, livestock production was considered most rewarding, and both the cereal/livestock and cereal/livestock/olive farmers relied far less on off-farm employment. All farmers said they wanted to increase the feed productivity of their land to reduce their dependence on external sources.

Germplasm Conservation

As part of the global CGIAR effort, germplasm exploration, collection, evaluation, and conservation continue to be important components of ICARDA's core research programs. In 1989, the Center acquired over 4,400 new accessions through exchange and collecting missions in Algeria, Bulgaria, Cyprus, Egypt, Jordan, Syria, and Turkey. These included over 500 accessions of wild relatives of wheat. *Aegilops comosa* ssp. *comosa*, was collected from Cyprus for the first time, and natural



Collecting barley landraces from a highly saline site in Algeria.

hybrids between *Ae. cylindrica* and bread wheat were recorded from Turkey. This enhanced ICARDA's knowledge of the ecogeographic distribution of wheat wild relatives and of the gene flow between wild and cultivated species. As part of the taxonomic revision of *Aegilops*, 1,418 herbarium sheets were studied in 14 herbaria of European and Mediterranean countries.

Over 6,000 accessions were multiplied for medium- and long-term storage, and 13,000 were evaluated for morphological and agronomic characters. Passport and evaluation data were updated in preparation for producing a catalog on winter chickpea. Over 5,500 accessions were distributed to outside cooperators, and 11,000 seed samples were provided to colleagues within ICARDA.

The collection of rhizobia for pasture and feed legumes has been steadily expanding. Currently, it includes 465 strains of *Rhizobium meliloti* for annual *Medicago*, 35 antibiotic-resistant strains of *R. meliloti*, 36 strains of *R. leguminosarum* for food and feed legumes, and 45 strains of *R. trifolii* for clovers. The strains have been tested for their symbiotic characteristics for further use.

Germplasm Enhancement

ICARDA has been making adjustments in its emphasis on germplasm enhancement activities. Increasingly, downstream activities are being handed over to national programs, and the Center is steadily moving upstream. Advanced research in physiology and biotechnology, for example, has been established, and 1989 saw considerable progress in both areas.

In 1988/89, national programs within WANA and beyond released six new varieties of barley, eight of durum wheat, 10 of bread wheat, eight of kabuli chickpea, seven of lentil, one of faba bean, and one of dry peas.

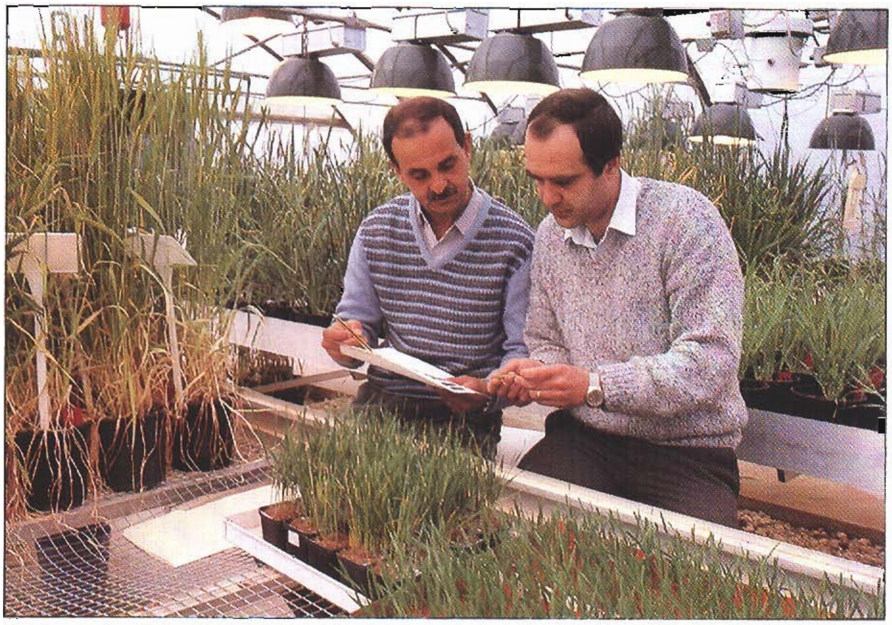
Cereal Crops

ICARDA's cereal breeding efforts have concentrated on developing genotypes with high and stable grain and straw yields. Landraces and derived pure lines are being successfully used in crossing programs to transfer drought tolerance into otherwise adapted germplasm, and the methodology is being tested in collaboration with NARSs (National Agricultural Research Systems) in Syria, Ethiopia, and Nepal. Hull-less and early barley lines have been developed and made available to NARSs. Over 1,098 sets of barley and wheat nurseries and 165 sets of specific-trait nurseries were provided to cooperators in 48 countries.

Durum and bread wheat breeding concentrated on the development of improved germplasm for the low-rainfall areas of WANA. A four-year multilocation testing program of 11,000 durum wheat accessions for 25 traits was completed in 1989. Five lines were selected as strong candidates for release in WANA.

Drought and cold-tolerant winter and facultative wheat germplasm was identified through screening for drought at Tel Hadya and Breda (Syria), and for cold at Sarghaya (Syria) and Haymana (Turkey). Work on wheat for highland and continental areas was

ICARDA's controlled environment facility became fully operational in 1989 at its main station at Tel Hadya. Here, a Ph.D. student (right) makes use of the new facility for disease scoring.



strengthened following the revised CIMMYT/ICARDA agreement in 1989.

Cereal germplasm pools for resistance to septoria, common bunt, and wheat stem sawfly were assembled and furnished to collaborators. Controlled environment facilities were used to screen barley and wheat germplasm for disease resistance. Physiological studies indicated that specific combinations of desirable morphological and physiological traits for specific environments can improve selection efficiency for yield in dry areas.

Doubled haploid (DH) plants of barley and wheat have been produced using anther culture and intergeneric or interspecific hybridization. Wheat cultivars with the 1B/1R translocation seemed to be particularly suitable for DH production through anther culture. A wheat-maize cross technique has been developed based on the application of 2,4-D to wheat spikes following wheat pollination with maize. This technique to produce haploid plants proved effective on all 20 tested genotypes and is considerably more effective than the *Hordeum bulbosum* technique.

Food Legume Crops

In addition to the new varieties released during 1988/89, NARSs selected several genotypes of kabuli chickpea, lentil, and faba bean for pre-release multiplication. Over 1,000 sets of trials and nurseries of these crops were provided to 105 cooperators in 47 countries for the 1989/90 season. In the case of faba bean, only a limited number of nurseries with specific characteristics, including determinate types and disease and pest resistance sources, were distributed. Distribution of faba bean yield trials and screening nurseries was discontinued in line with the Center's Strategy.

Opportunity was taken of the low-rainfall 1988/89 season to select drought-resistant kabuli chickpea and lentil lines. Early maturity, early vigor, and fast rate of ground cover development were identified as the major traits for the superior performance of the selected lines under drought.

Application of biotechnology to food legume improvement was initiated in collaboration with the Federal Republic of Germany. Preliminary results from the studies on host-plant resistance suggest the possibility of developing biological control measures for *Ascochyta* blight in chickpea and *Orobanche crenata* in faba bean. Several accessions of the wild *Cicer* spp. were found to possess resistance to major biotic and abiotic stresses. These resistant sources will be used to improve the cultigen through the application of biotechnology.

Biological nitrogen fixation studies showed that in all three food legumes (kabuli chickpea, lentil, and faba bean) the interaction between host plants and *Rhizobium* strains can be exploited not only for improved seed yield but also for an improved proportion of the total nitrogen fixed symbiotically. Seed treatment with Promet proved to be a cheaper and simpler method for controlling *Sitona* weevil damage to lentil and faba bean nodules.

Pasture and Forage Crops

Vicia sativa ssp. *amphicarpa*, one of the feed legumes which produce underground pods, was found to yield 138-185 kg/ha underground seed even under severe simulated grazing. Studies on common chickling (*Lathyrus sativus*) have led to the identification of lines containing substantially lower neurotoxin than in some of the known low-neurotoxin varieties. Further progress was made in identifying the factors responsible for low palatability of forage peas (*Pisum sativum*) to sheep.

Resource Management and Conservation

Fertilizer Use on Barley

Between 1984/85 and 1987/88, 75 on-farm trials were conducted in Zones* 2 and 3 of Syria to assess the biological and economic response to different combinations of nitrogen and phosphate fertilizer at a wide range of sites. The trials revealed that (i) the importance of N increased and that of P decreased with increasing rainfall (less clearly in passing from Zone 2 to Zone 3); (ii) N was marginally more important in barley-barley than in fallow-barley rotations; (iii) P was most important, and N least important, in gypsiorthid soils; and (iv) the initial soil content of available phosphate (Olsen) at 0-20 cm depth and mineral-N at 0-40 cm depth influenced fertilizer response.

*Zone 1: Rainfall between 350-600 mm and not less than 300 in 2 years out of 3.
Zone 2.: Rainfall between 250-350 mm and not less than 250 in 2 years out of 2.
Zone 3: Rainfall greater than 250 mm and not less than this in one year out of 2.
Zone 4: Rainfall 200-250 mm and not less than 200 mm in one year out of 2.
Zone 5: Rainfall less than 200 mm.

Based on the dataset, both descriptive and predictive models were developed which related grain and straw yields to environmental variables and fertilizer application. Grouping sites into different recommendation domains improved the predictive power of the models.

Legumes in Cereal-Based Crop Rotations

Research on pasture, food, and feed legumes grown in rotation with cereals at three different locations in Syria indicated again in 1988/89 that yields varied markedly between seasons, largely because of rainfall, but crop sequence also had a pronounced effect. In one trial at Tel Hadya, ICARDA's main research station near Aleppo, responses to nitrogen fertilization were also affected by season and to some extent by rotation. Food legumes showed a negative response to previous nitrogen application to wheat, largely because of the greater water use by the fertilized wheat crop, and hence greater stress on the subsequent crop. Cereal yields after medic pasture or after feed legumes were higher than after another cereal crop, but cereals growing after a fallow year gave the highest yields.

Yields of animal products were higher in a year of above-average rainfall such as 1987/88. At a stocking rate of 10 ewes/ha, 2,800 grazing days/ha were achieved, with a gain of 400 kg/ha of milk and 370 kg/ha of lamb weight. Vetch pastures grazed by lambs produced nearly as much gain in the same season. Even in a growing season of low rainfall, such as 1988/89, nearly 1,700 grazing days/ha were achieved from medic pastures and feed legumes, and lambs gained weight of over 100 kg/ha. In the Tah on-farm project, the seed bank of medic in several farmers' fields at the start of the third regeneration phase was well above the level needed to ensure a high plant population and herbage yields.

The rotations which included pastures and feed legumes in general had the highest gross margins, mainly because of the high prices of animal products. Of the other rotations, wheat/lentil was consistently superior and, in contrast, continuous wheat was invariably the poorest with negative gross margins in most years.

Barley Genotypes for Systems Using Supplemental Irrigation

In 1987/88 and 1988/89, two contrasting seasons with regard to rainfall, all barley varieties tested at Bouider in northern Syria responded well to additional water. Of these, Rihane-03 performed best. In the drier 1988/89 season, its grain yield increased from 0.22 t/ha to 2.70, 4.75, and 6.72 t/ha at supplemental irrigation to replace 33, 66, and 100% of the water balance deficit, respectively. The highest water-use efficiency, however, was obtained where 66% of the water balance deficit was replaced by supplemental irrigation, with a mean value for all genotypes of 17.8 kg grain/ha/mm of water (rainfall + irrigation) compared with 5.4 kg/ha/mm under rainfed conditions.

Improved Chickpea Production Practices

Between 1985/86 and 1988/89, 30 on-farm trials were conducted in Syria to assess the biological and economic impact of a range of factors known to enhance the production of chickpea. Winter sowing of this crop in early December, combined with weed control and phosphate application, was consistently profitable across all locations and seasons, and always surpassed the comparable later-sown crop both in yield and profitability. Early sowing gave an average grain yield of 1,590 kg/ha, and a 30% more net revenue than the later-sown crop.

Dinitrogen Fixation and Nitrogen Balance in Cool-Season Food Legumes

In field experiments at Tel Hadya and at ENSA-INRA station in Montpellier during the 1986/87 and 1987/88 seasons, pea and lentil derived, on average, 70% of their N from the atmosphere. Dinitrogen fixation in faba bean was more variable between trials but the large-seeded type was consistently more efficient than the small-seeded. The %Ndfa (proportion of plant N derived from dinitrogen fixation) obtained in France for faba bean was much higher than at Tel Hadya, though the reverse trend was observed for pea, lentil, and winter-sown chickpea. In all trials winter sowing improved %Ndfa.

Seed Production

Non-availability of quality seed is almost invariably reported to be one of the major production constraints. Recognizing the crucial role of this aspect for the success of its recommended technology packages, ICARDA maintains a modest Seed Production Project supported by the Governments of the Netherlands and the Federal Republic of Germany.

The Project aims at strengthening seed programs in WANA through training, assistance in infrastructure development, and providing small quantities of quality seed, on request from NARSs, for multiplication and distribution to farmers. The Project also serves the commodity programs of the Center by cleaning, treating, and quality testing their seed, and manages the Central Seed Store of ICARDA.

In 1989, three training courses were held: two in-country and one at headquarters. In addition, 27 individuals were trained, 12 in seed testing techniques and 15 in seed processing and storage. Three round-table discussions were held in Morocco and Egypt on food legume seed production, rules and standards for field inspection, and morphological description of varieties. The Project has developed morphological descriptions of 45 commercial varieties of wheat and 17 of barley for publication in 1990.

Post-control plots (plots planted with seed taken from seed lots that were approved in the previous season) were initiated in Egypt as part of the Seed Certification System.

Impact Assessment and Enhancement

Adoption of Winter Sowing of Chickpea

ICARDA started a cooperative demonstration program of winter-sown chickpea in Morocco in 1985/86. In 1987/88, two varieties (ILC 482 and ILC 195) were released and the demonstration program was expanded. In 1989, the Center, in cooperation with the Moroccan scientists, surveyed 112 farmers to evaluate the adoption dynamics of winter sowing. The economic performance of the practice was assessed, and trends in farming systems were evaluated. The area under food legumes was reported to be declining because of diseases and high labor costs, although, by contrast, some farmers had increased their area in response to high market prices.

Good plant stand, high grain and straw yields, lower risk of crop failure, and resistance to diseases were cited by farmers as advantages of improved varieties. Small seed size, susceptibility to diseases (particularly

To meet the increased demand for livestock feed, farmers in Syria and other WANA countries are increasingly extending barley cultivation to marginal lands.

Ascochyta blight), pests, and the problem of weeds were considered the major constraints to future adoption of winter sowing.

Based on the results of this survey, recommendations were developed on how the adoption process might be enhanced.

Assessment of Risk Associated with Increasing Feed Supplies in Syria

Rising demand for livestock products has resulted in a dramatic increase in the national sheep flock size (from 3.1 to 13.3 million) in Syria over the past 35 years. The derived demand for barley grain and straw has caused an equally large increase in the area sown to this crop, from 0.75 million ha in 1960 to 2.9 million ha in 1988/89, but yields have largely remained stagnant. As a consequence, Syria has turned from an exporter to an importer of barley.

The rapid increase in the area under barley has been achieved by expanding its cultivation into marginal environments, and growing it continuously. Currently, barley occupies two-thirds of the arable land in Zones 2 to 5. This has serious implications to sustainable production and resource conservation. Reducing the area under barley in the marginal areas of Zones 4 and 5 and increasing production in the remaining area through improved practices, such as seed dressing, drill sowing, use of fertilizer, and crop rotation, has the potential to meet feed requirements of the national flock in 75% of the years, and increase the stability of production over time. In addition, the introduction of forage legumes can further enhance the national feed supply in all but the driest years.

Changes in Lentil Production Technology in Syria

In 1978/79 and 1979/80, ICARDA conducted a lentil production survey in northern Syria. Ten years later, in 1988/89, a similar survey was carried out with the assistance of trainees. Although the geographical areas covered differed slightly in the two surveys, some interesting observations emerged.

In general, land preparation intensity has increased, with two-thirds of the farmers now cultivating twice. They have also increased seed rates from an average of 144 to 185 kg/ha, but the seeding method has remained largely unchanged (70% manual and 30% mechanical). Similarly, the varieties used remain the same (80% local small red, 20% local white large). Farmers sow the seed several weeks later than they did 10 years ago.

The average rate of phosphate application has increased from 64 to 145 kg P_2O_5, and whereas 10 years ago 50% of farmers applied fertilizer, now 87% apply it. This is clearly attributable to the availability of fertilizer to farmers at a relatively low price. All farmers interviewed still harvest by hand. The average per hectare production cost of lentil in 1979 was equivalent to the value of 1,218 kg of lentil grain, but this had fallen to 667 kg in 1989.

Outreach Activities

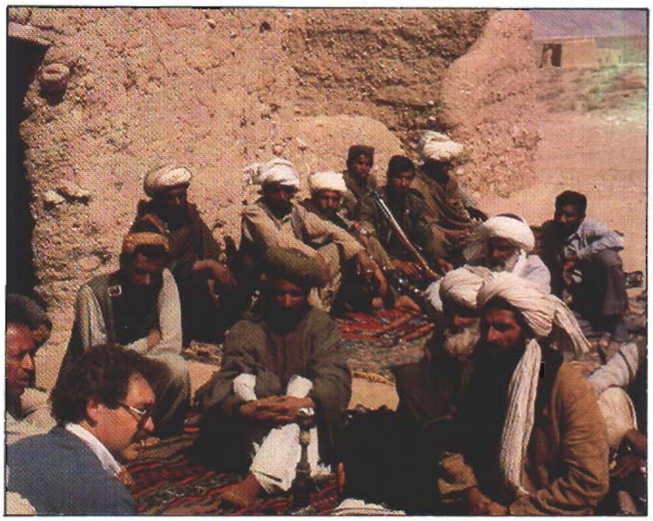
ICARDA has grouped its outreach activities into six regional programs for the highlands, the Arabian Peninsula, West Asia, the Nile Valley, North Africa, and Latin America. These programs have been established on the basis of commonalities of geography, ecology, and constraints to production, and with a view to achieving resource-effectiveness, eliminating duplication of effort, balancing activities according to the identified needs of each country, and exploiting the spillover of research results from one region to another with similar agroecologies and infrastructure.

The regional programs seek to link scientists both within countries and within the region; promote leadership at the national and regional levels; engender cooperation in solving problems common to a group of countries; acquire, pool, and optimize the use of scarce resources; and encourage self-reliance. Within the framework of these programs, specific problem-oriented networks operate both across and within countries.

The Highland Regional Program

The highlands of WANA are mainly in Turkey, Iraq, Afghanistan, and Pakistan in the east; and the Atlas mountain range in Algeria and Morocco in the west. Considerable progress was made in 1989 in cooperative activities with Turkey, Iran, and Pakistan, and efforts are under way to increase the participation of other countries.

In Pakistan, the USAID-supported MART/AZR Project completed its first four-year phase at the Arid Zone Research Institute (AZRI), Quetta, Balochistan, in November 1989, and was renewed by USAID for a further three-year period. In its second phase, the Project will concentrate on three interlinked areas: livestock management and rangeland rehabilitation; agronomic management, including improved techniques of water harvesting; and the economics of farming systems.



Farmer surveys are an integral component of the regional programs of ICARDA. Here, the MART/AZR team discusses the economics of farming systems with the Balochi farmers in Upland Balochistan, Pakistan.

The Arabian Peninsula Regional Program

The countries participating in this program are: the United Arab Emirates (UAE), Bahrain, Qatar, Kuwait, Saudi Arabia, the Sultanate of Oman, the Yemen Arab Republic (YAR), and the People's Democratic Republic of Yemen (PDRY). The Program is supported by the Arab Fund for Economic and Social Development (AFESD). In 1989, it focused on germplasm and information exchange, seed production, and training. Several wheat, barley, food legume, and forage nurseries were provided for a wide range of agroecological conditions. ICARDA's bread wheat variety, Doha 88, was identified for release in Qatar, and Cham 2, introduced to Saudi Arabia and UAE, performed well.

Senior government officials evaluate ICARDA's wheat germplasm at Al-Ain in the United Arab Emirates with the Center's Regional Program Coordinator for the Arabian Peninsula (fourth from left).

The West Asia Regional Program

ICARDA's on-going activities in Syria, Jordan, Iraq, Lebanon, Cyprus, and lowland areas of Turkey were consolidated into a West Asia Regional Program. In July 1989, a Program Coordinator was appointed who established an office in Amman, Jordan.

This Program is also responsible for the execution of the Center's Mashreq Project, supported by UNDP and AFESD, for increasing the productivity of barley, pastures, and sheep in critical rainfall zones of Syria, Jordan, and Iraq.

Traveling workshops promote communication and personal contacts among the scientists from participating countries. Here, scientists from Egypt, the Sudan, and Ethiopia evaluate a faba bean field at a site in Ethiopia in an NVRP traveling workshop.

The Nile Valley Regional Program

The Nile Valley Project (NVP) on faba bean, successfully operated by ICARDA in Egypt and Sudan from 1979 to 1988, and in Ethiopia from 1985 to 1988, was expanded in 1989 and renamed the Nile Valley Regional Program (NVRP). In addition to faba bean, the new Program covers research and training activities to improve the production of cool-season cereals (wheat and barley) and food legumes (chickpea and lentil) in the participating countries, as well as field pea in Ethiopia.

The activities of NVRP, like its predecessor, are built around a multi-disciplinary, multi-institutional, and problem-oriented approach that makes full use of the expertise, human resources, and infrastructure available in the participating countries. Funding for the Program is provided by the EEC for Egypt, the Government of the Netherlands for the Sudan, and SAREC of Sweden for Ethiopia.

The North Africa Regional Program

The North Africa Regional Program (NARP) covers Algeria, Libya, Morocco, and Tunisia. It was strengthened by outposting two faba bean scientists from Aleppo headquarters to the Douyet station, near Fez, Morocco. NARP is also responsible for executing ICARDA's Maghreb Project, supported by UNDP, for cereal and food legume disease monitoring and germplasm enhancement in Algeria, Morocco, and Tunisia; and a Government of Italy/IFAD-supported Technology Transfer Project to increase barley, food legumes, and livestock production in Algeria, Libya, Morocco, and Tunisia.

In 1989, the Program started collaboration with the Agricultural Research Center, Libya. A supplement to the 1980 agreement with Tunisia was signed; it allows ICARDA to base its Maghreb regional office in Tunisia. The 1986 agreement with Algeria was updated and ratified.

Training of national program personnel is accorded high priority by ICARDA both at its headquarters and in its regional program activities. Here, a trainee shakes hands with ICARDA's Regional Program Coordinator for North Africa after receiving his certificate from the Director, INRAT, Tunisia (second from left).

The Latin America Regional Program

This Program is at its early stage of development. The ICARDA scientist based at CIMMYT in Mexico has been focusing on barley improvement activities, but the possibility of including food legumes is being considered in consultation with ICRISAT.

Training

The Center trained 525 persons in 1989, about 60% of them at its headquarters and 40% in collaborative training courses held in WANA countries. Participants came from 18 countries in WANA, 3 developing countries outside the region, and 4 countries of the European Community. About 13% of the participants were women, reflecting an encouraging 18% increase over 1988.

Of the training courses offered, 15 were short- and long-term residential courses at headquarters and 10 were collaborative in-country or subregional courses. Eight senior colleagues from WANA participated in the Center's research programs as visiting scientists. Over 20 M.Sc. and 10 Ph.D. scholars conducted their degree-related research at Center headquarters.

A training follow-up study, covering nine WANA countries, was conducted. The results will be published in 1990.

Information Dissemination

Increased attention was paid to communication activities to assure the quality of information and its subsequent dissemination and utilization.

During 1989, ICARDA published 65 titles. Over 41 journal submissions were processed, of which 31 had been published by the end of 1989. The Annual Report for 1988, published in 1989, was restructured with a view to better reflect the Center's work and address a much wider readership.

The Center participated in the CGIAR's Public Awareness Association meeting in Bonn, and in the Frankfurt Book Fair. Efforts were intensified to widen contacts with media both within WANA and beyond, focusing on the vital issues of ICARDA's Strategy.

There was a steady expansion of library holdings and a continual increase in photocopying services in response to requests. The first ever library inventory was carried out. A library database was developed and put on-line as a first step toward providing improved service to scientists at ICARDA and within the region.

As part of the cooperative arrangement with other CGIAR libraries, ICARDA participated in a scheme of publication depositories with libraries in industrialized countries. Five out of 13 libraries contacted have responded positively. The Center continued its active participation in AGRIS/CARIS.

To facilitate communication with target audiences both within and outside WANA, numerous publications were translated into or from Arabic.

New Partnerships

The Center continued its efforts to establish new partnerships worldwide. An agreement was signed with the All-Union Academy of Agricultural Sciences of the USSR, and this was followed by a work plan under which several scientific missions were exchanged; a two-year work plan was signed with the Tropical Agricultural Research Center (TARC), Japan; an agreement of cooperation was reached with the International Center for Advanced Mediterranean Studies (CIHEAM), and another with the Chinese Academy of Agricultural Sciences; and a cooperative research and graduate training agreement was signed with the Alemaya University of Agriculture, Ethiopia. The government of Iran provided funds for the cooperative activities envisaged in the work plan for 1989/90.

Buildings

Construction of the Nazareno Strampelli Genetic Resources Building, named after the famed Italian wheat breeder, and financed by the Government of Italy, marked the completion of the Center's Phase 1 building program. The building was designed by Prof. Ing. Alessandro Bianchi of the Istituto di Costruzioni Rurali of the University of Bari and Ing. Giacomo Scarascia, and built by ICARDA's construction and maintenance staff. It covers 1,070 m^2, houses the Center's Genetic Resources Unit, and includes 790 m^2 for laboratories and 280 m^2 for germplasm storage rooms.

Site development and construction of ICARDA's permanent buildings started at Tel Hadya, 35 km southwest of Aleppo, in 1982 (above). The buildings were completed in 1989 (below).

Looking Ahead

ICARDA is an ambitious and forward looking Center. It believes that, in its highly professional and dedicated team of scientists and technicians, it has the capability to realize the highest standards in agricultural research. The main constraint that the Center faces is the tight funding which, in spite of strong support from the Technical Advisory Committee and the CGIAR, remains inadequate to fully support the multi-faceted activities of the Center.

The real challenge for the Center is to continue to deliver high quality, relevant, and effective research through an even more efficient utilization of the resources available to it, and through the mobilization of the valuable expertise available in the countries it seeks to serve.

PART TWO

Research and Training Review

Contents

Research and Training Review

During the course of developing its Strategic Plan in 1987/88, ICARDA carefully reevaluated the orientation and appropriateness of its programs. The Center made several adjustments in the approach and design of its research and management activities in the context of both the near and distant future. One of the major changes was the grouping of its total research effort into seven integrative activity-packages: agroecological characterization, germplasm conservation, germplasm enhancement, resource management and conservation, training, information dissemination, and impact assessment and enhancement. Each package is a multidisciplinary research effort with a well-defined program of work and a set of objectives, designed to contribute to the Center's overall goal of achieving sustainable increases in crop and livestock productivity.

The advantages of introducing the seven activity-packages were discussed in the Center's 1988 Annual Report, but are restated here for quick reference. Introduction of these packages has enhanced interaction between programs at ICARDA's main research station as well as between main station and outreach programs. It has also helped in achieving greater coherence of activities and a more efficient use of resources across the Center, and has allowed a clearer perception of the balance between and among activities in terms of human and financial resources allocation. The Center is now able to efficiently measure the appropriateness and effectiveness of its research programs.

ICARDA reported its research achievements by activity for the first time in its 1988 Annual Report. The same structure of reporting is followed in this 1989 Annual Report.

The Weather in 1988/89

The 1988/89 crop season was characterized by a similar weather pattern over much of Syria, Turkey, and Iraq: a good start with ample rainfall in the autumn of 1988 was followed by a prolonged drought, cold nights, and warm days with high evaporative demand from January 1989 onward. Rains in April in parts of Turkey came too late to relieve the severely stressed crops. Yields were below average in Turkey and Iraq and very low in Syria. In Cyprus and in the coastal areas of Syria and Turkey, however, enough rain was received during the second part of the season to permit a good crop to be harvested.

In Jordan and southern Syria, the rainfall was less than average, but sufficient and well distributed until mid-March. Dry and unusually warm weather followed, causing an early end of the season and below-average yields.

In most of Iran, Afghanistan, and the Balochistan province of Pakistan, the winter of 1988/89 brought adequate rain and snow, well distributed throughout the cropping season. In consequence, yields were above average in many areas. However, late frost in May damaged crops in parts of Balochistan. Melting snow and rains in southern Afghanistan and southeastern Iran in late March and early April caused some flooding, and damage to crops.

In North Africa, there was a distinct gradient of rainfall and, therefore, crop yields from west to east. In Morocco, the autumn of 1988 was rather dry, particularly December, and emergence was delayed. Rainfall was hardly sufficient up to March, but ample from March onward to result in a second bumper crop in a row.

In Algeria, the season developed in a similar way, but March and April rains were not as good as in Morocco, and dry conditions prevailed from the end of April onward. Altogether, rainfall and yields were below average.

In Tunisia, rainfall was quite well distributed throughout the season, but was not adequate. Complete crop failure was, however, prevented by some moderate rains during the grain-filling period in the principal cereal growing areas.

The season was moderate in Libya and Egypt, but there too, in the rainfed crop growing areas of Cyrenaica and the Egyptian northwest coast, rainfall and crop yields were below average.

In the Sudan, the rains came late and were erratic through the season. Planting was delayed by one or two months and yields were markedly reduced compared to the previous season, especially in the western provinces.

Ethiopia and Somalia have two rainy seasons per year, the 'small' and 'main' rains, although not at the same time. The small rains produced an average yield in Ethiopia, but were inadequate in Somalia. Ethiopia's main rains were sufficient in the center, south, and west, but very sparse elsewhere and crops virtually failed.

Somalia recorded average yields from its main rains and some flooding in the north. Despite floods and soil erosion, the season was good both for the centeral PDR Yemen and Yemen AR.

Agroecological Characterization

Agroecological characterization is the documentation of the environmental characteristics of a geographical area and their variability, including rainfall, temperature, soil, growing seasons, and cropping systems. These are then translated into expressions of crop productivity and mapped onto the geographical area for predicting how agroecological variability will interact with and modify the impact of new technology. Characterization also includes research into the productivity of existing farming systems and cultural practices, the economic organization and conditions of the farming populations, the social environment, and the long-term strategies of farmers.

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

The Center relies on NARSs for the testing and validation of such techniques, both through their access to the required data and first-hand knowledge of local socioeconomic conditions. Thus, in the extension and application of these techniques within the region, ICARDA is increasingly working in partnership with NARSs through training and collaborative research projects. In 1989, through a special-project funding from IDRC, the Center initiated a collaborative evaluation of its Package for Agroecological Characterization (PAC) with Turkey and Morocco.

A selection of examples of the progress made by the Center in 1989 in its agroecological characterization work is presented below.

Spatial Rainfall Generation: A Case Study in Northwest Syria

The Tool

Weather generators are computer programs for the simulation of weather data. These data can be used for estimating the frequencies of weather events of significance for crop production, such as dry spells, wet spells, or frost. In combination with various kinds of crop models, they can provide information on the expected frequency distribution of yield and on the effects of management alternatives. Weather generators typically consist of two main components: a parameter estimation component, which reduces the original weather data to a set of coefficients for each weather station; and a generator component, which reproduces from the coefficients, synthetic weather sequences which have identical characteristics to the real data. In spatial weather generators, a third part, the interpolation of coefficients between the stations, is added between parameter estimation and weather sequence generation. This enables the generation of realistic weather sequences for any location, independent of its distance from meteorological stations, and the presentation of the results in the form of maps.

Since 1986, a spatial weather generator (SWG) has been under development at ICARDA. It is capable of generating rainfall, maximum and minimum temperatures, and solar radiation on a daily or monthly time-step, depending on the requirements of the task and the availability of data. Examples of the use of the SWG presented here focus on the generation and mapping of rainfall- related events.

The approach used with SWG to simulate rainfall is similar to that of many other rainfall models: the probability of receiving rain is separated from the amount of rainfall received*. When working on a monthly time-step, the unconditional probability of a calendar month with at least one rainy day determines whether a dry or a wet month is more likely to be generated. On a daily time-step, however, the conditions during the two previous days influence the probability of

* For a more detailed description of rainfall simulation by the SWG and more examples from this case study, see the FRMP Annual Reports for 1988 and 1989.

whether the next generated day will be dry or wet; i.e., the SWG employs a second order Markov chain with two states, dry and wet, to model the sequence of wet and dry days.

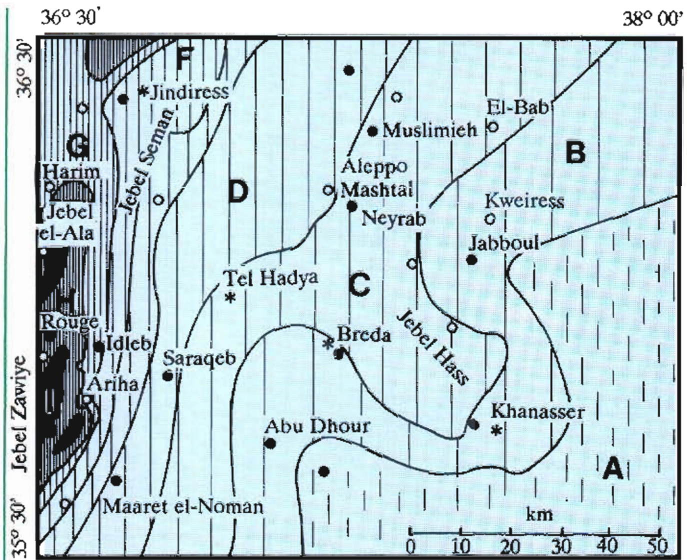
For modeling the amount of rainfall received during a wet day or a wet month, a Gamma-distribution is used. The flexibility of the Gamma-distribution makes it possible to use one model for both daily rainfall, where it takes on the shape of an inverse J, and for monthly values, where it resembles a skewed Normal-distribution.

Whenever necessary, a number of corrections are applied to the station data and coefficients during parameter estimation. Such a necessity arises from unequal lengths of, and gaps in, station records, inhomogeneities caused by the relocation of a station or changes in its surroundings or instrumentation, and varying reliability in reporting small daily rainfall amounts.

The spatial interpolation of the generator coefficients is mainly performed by hand, guided by topography and a knowledge of typical weather situations during the course of the year. Where possible, regionally valid regressions of some coefficients on others are used to facilitate the construction of some of the coefficient maps.

The Case Study in Syria

The study region is located in northwestern Syria, between 35°30' and 36°30' North and 36°30' and 38°00'East, with its center about 20 km south of Aleppo. It stretches from the mountains of Jebel Zawiye, Jebel el-Ala, and Jebel Seman in the west to near the Euphrates River in the east, and from near the Syrian-Turkish border in the north to a range of more elevated land extending eastward near Maaret el-Noman in the south. Roughly in the middle of the area, there lies a range of hills, the Jebel Hass, extending from near Aleppo to Khanasser in the southeast. Except for this range of hills and the mountains in the west, the area is largely composed of vast agricultural plains with rangeland occupying the driest part in the southeast. Within the last few years, much of this traditional rangeland has been planted to barley. In the wetter western and northwestern part of the area, wheat-based farming systems dominate, whereas the drier part is occupied by barley-livestock systems.



A 200-250 mm B 250-300 mm C 300-350 mm D 350-400 mm
E 400-450 mm F 450-500 mm G 500-550 mm H 550-600 mm
I 600-650 mm

O Stations with monthly data
● Stations with daily data
* ICARDA stations in or after 1979 (data not used)

Fig. 1. Mean annual rainfall in the study area in northwest Syria and network of meteorological stations.

Annual rainfall totals drop quickly from up to 600 mm in the west to 400 mm on an eastward gradient from the mountains on the western side of the area (Fig. 1). Across the flat land rainfall continues to decrease gradually to approximately 200 mm in the southeast and 300 mm in the northeast. This trend is interrupted by the hills of Jebel Hass which receive higher rainfall than the surrounding plains.

Rainfall data from 49 stations, obtained through the courtesy of the Meteorological Department of the Syrian Arab Republic, were used in the study. For 19 of the stations, daily data were available, and for the other 30, only monthly totals and the numbers of rainy days per month were available. Twenty-seven of the stations used are located inside the study area, the others are situated within a perimeter of about 30 km of the area, facilitating the interpolation of coefficients to its borders. As far as possible, records from a standard period of 26 years, 1960-1985, were used; data for earlier or later years were not available for many of the stations at the time the dataset was assembled. Data from ICARDA stations could not be used, since they were only established in or after 1979. The overall density of stations in the study

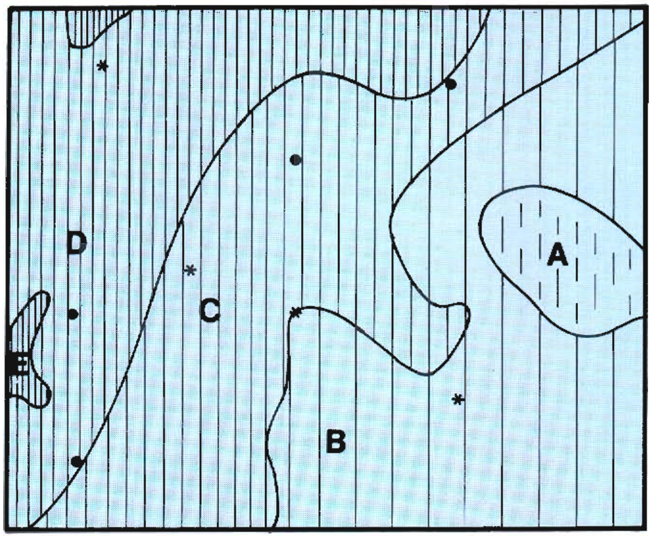


Fig. 2. Probability of a >20 day-long period with <5 mm rainfall during 40 days starting with 1 November (for scale and place names, see Fig. 1).

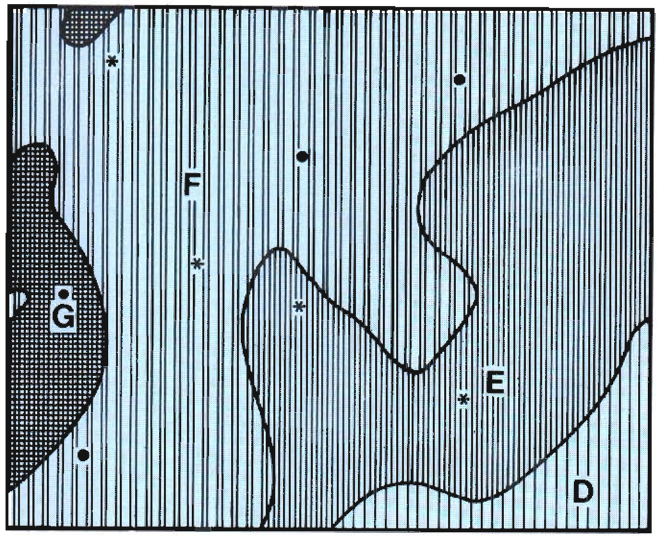


Fig. 3. Probability of a >20-day long period with <5 mm rainfall during 40 days starting with 1 December (for scale and place names, see Fig. 1).

area is quite adequate, although there are a few places where the interpolation of rainfall coefficients depends heavily on the disputable interpretation of data from a single station.

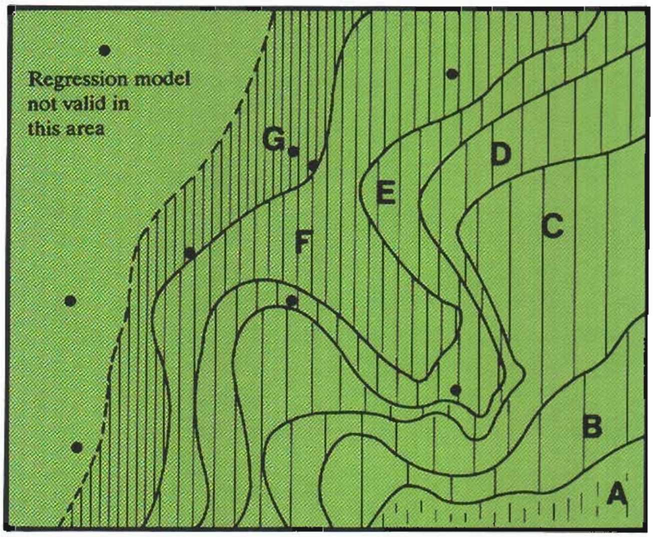
Results and Examples of Generated Maps

To generate maps, 500 years of daily and 1000 years of monthly rainfall data were generated for the central points of 2 by 2 minutes (i.e., 3.7 km by 3.0 km) wide rectangles of land which form a regular grid of 30 by 45 cells across the study area.

The examples based on generated daily sequences, presented in Figs. 2 and 3, are concerned with the risk of drought in the early vegetative phase of crops. Early planting is desirable as it extends the effective growth period of the crop, thereby conferring a yield advantage which is further increased by a higher water-use efficiency, as early-planted crops develop a closed canopy more rapidly, reducing evaporation from the soil surface. Early planting, however, also increases the risk of damage by drought in the early growth stages. Experience has shown that a dry spell of 20 days or more during the seedling stage causes cessation of growth of wheat and barley, and seedling mortality if it falls within the 40 days following germination. Assuming that germination had occurred by 1 November, Fig. 2 gives the probability of a drought of this severity during the seedling stage. While this risk is around 20% in the more humid areas in the west of the study area, it increases to about 50% in the drier eastern part.

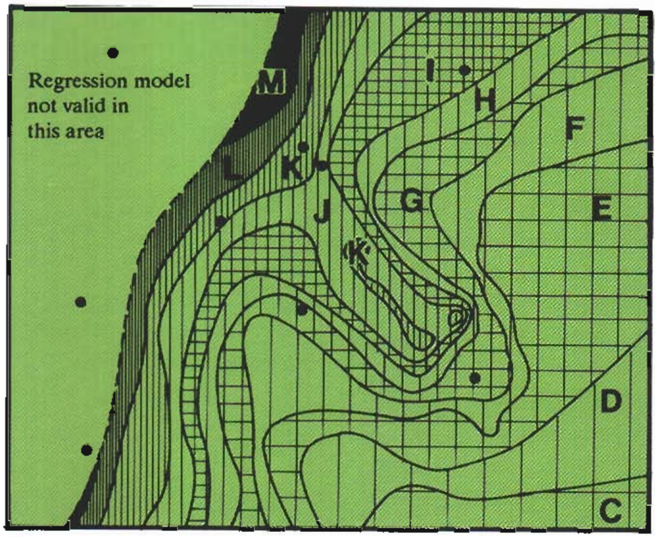
The wheat growing area coincides approximately with the area where the risk is less than 35% (units E, D and the western half of C in Fig. 2), whereas the area of predominant barley-livestock farming systems is characterized by a risk of more than 35%. Taking into account that not all of the so-defined droughts necessarily lead to seedling mortality, the chance of successful crop establishment in the wetter parts of the wheat growing area is better than four out of five, indicating that early planting in late October or early November may be a useful strategy to follow in those parts.

In the barley area, however, the risk seems unacceptably high, even when taking into account that barley is less likely to suffer irreparable damage from such an event. Fig. 3 shows the probability of a similarly defined drought condition for the period starting on 1 December. In the wheat growing areas it is negligible and has to be expected less often than once in every 10 or 20 years. In the barley areas, the risk of seedling drought is reduced to between 10% and 30%; i.e., it has to be expected every one year out of 5 to 10, and only in the



A 200-400 kg/ha | B 400-600 kg/ha | C 600-800 kg/ha
D 800-1,000 kg/ha | E 1,000-1,200 kg/ha | F 1,200-1,400 kg/ha
G 1,400-1,600 kg/ha

Fig. 4. Mean barley yield in an unfertilized barley-barley rotation (for scale and place names, see Fig. 1).



C 150-200 kg/ha | D 200-250 kg/ha | E 250-300 kg/ha
F 300-350 kg/ha | G 350-400 kg/ha | H 400-450 kg/ha
I 450-500 kg/ha | J 500-550 kg/ha | K 550-600 kg/ha
L 600-650 kg/ha | M 650-700 kg/ha

Fig. 5. Yield increase of barley in a barley-barley rotation from 60 kg N/ha and 30 kg P_2O_5/ha expected in four years out of five (for scale and place names, see Fig. 1).

steppe in the southeastern corner of the study area does a noticeable risk still persist, a reminder that any rainfed crop production in this zone is a risky undertaking (see also "Impact Assessment and Enhancement" section of this Report).

The second set of examples (Figs. 4 and 5) is based on the generated monthly rainfall totals, and demonstrates the use of the spatial weather generator for the regionalization of predictions based on the analysis of on-farm trials. Regression models derived from four years of on-farm fertilizer response trials (see also "Resource Management and Conservation" section of this Report) in northwestern Syria were used in combination with the SWG to produce maps of mean unfertilized barley yields in a barley-barley rotation and of the response to 60 kg N/ha and 30 kg $P_2 0_5$/ha which can be expected in four years out of five. The regressions are not valid for areas receiving rainfall beyond the range represented by the trial locations. This boundary has been marked on the maps by a dashed line.

Fig. 4 shows how mean yields of unfertilized barley drop by 80%, from about 1,600 kg/ha in the most favored areas to only about 300 kg/ha in the dry southeastern corner of the study area. The fertilizer response expected in 80% of the years (Fig. 5) shows a similar trend and drops from around 650 kg/ha to below 200 kg/ha. Across the whole range, its proportion to mean yield remains almost constant (40 to 50%). This high level of response is indicative of the depletion of soil nitrogen under continuous barley. The predictions on which Figs. 4 and 5 are based assume the same average soil types and conditions as existed at the sites of the trials, thereby overpredicting yields in areas of shallow and degraded soils, such as those encountered in hilly and degraded areas southeast and west of Aleppo. For a more "realistic" picture, showing the effect of different soils, separate models for different soil types, which have also been developed, would have to be used in conjunction with computerized soil maps.

Characterizing Dryland Farming Systems of Northern Jordan

The Project Area

The Jordan University of Science and Technology (JUST) and ICARDA began a multidisciplinary cooperative research program in 1988 with the objective of characterizing the agricultural production systems of the so-called "marginal zone" of rainfed agriculture. Approximately 70% of the arable land in Jordan falls into this category and receives between 200 and 300 mm of average annual precipitation. Over 40% of the country's population lives in this marginal zone.

The JUST/ICARDA team began its characterization work by selecting a small geographical area that is representative of the entire marginal zone in Jordan. Called the Mafraq area, it is bounded on the north by the Syrian border, on the south by the Zarqa valley, on the east by the Hejaz railway, and on the west by the Ramtha-Jarash highway. These boundaries encompass an area of approximately 1000 square kilometers. About 40% of the land is arable. The rest consists of rocky hillsides, very shallow soils, scrubby woodland, wasteland, and village sites. According to the last census in 1979 the area had a population of 35,550 persons. Since then, the total rural population has expanded to about 50,000 people living in 84 villages. A reasonable estimate is that two-thirds of the people are engaged in agricultural

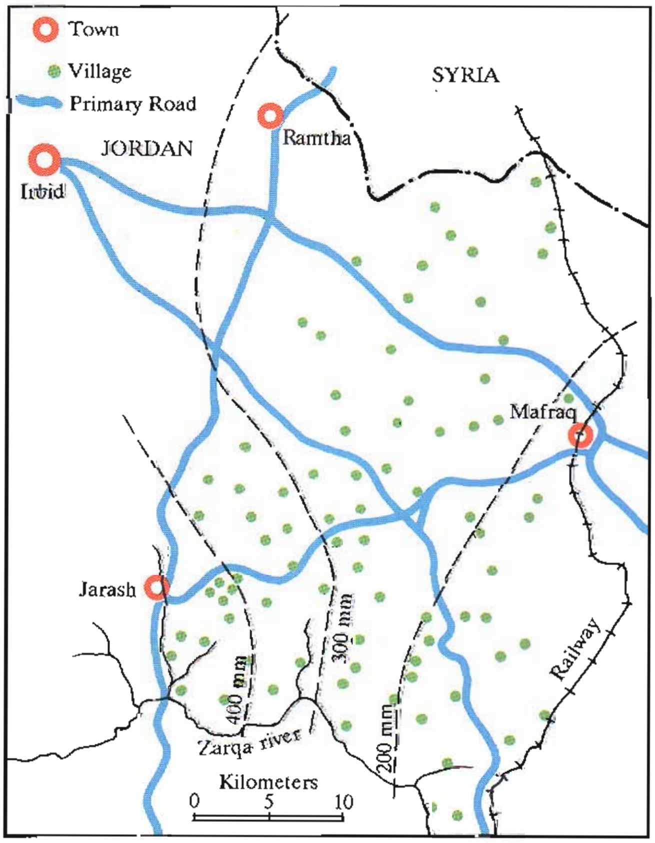


Fig. 6. Settlements and provisional rainfall isohyets of the Mafraq area, Jordan.

activities, although most farm families also receive a greater or lesser amount of off-farm income. The sheep and goat population owned by local farmers stood at around 150,000 head in 1988 (Fig. 6).

Along the periphery there are three sizeable market towns: Ramtha in the northwest, Jarash in the southwest, and Mafraq in the east. Jordan's second largest town, Irbid, is some 15 km to the west, and the suburbs of Greater Amman end a few kilometers away from the southeastern corner. During the 1980s, considerable road construction took place in the Mafraq area, and now every village is connected to the principal highways between Ramtha and Mafraq, Jarash and Mafraq, and Mafraq and Amman.

Also illustrated in Fig. 6 are provisional rainfall isohyets. These lines divide the study area into three rainfall zones. Zone 1 is the wettest and receives from 300 mm to as high as 500 mm rainfall near Jarash. The second area, or Zone 2, lies between the 200 mm and 300 mm rainfall isohyets. It covers slightly over half the Mafraq area and includes some 60% of the farm population. Finally, the southeastern corner, or Zone 3, receives less than 200 mm of rain.

The History of Settlement

Agricultural settlement is relatively recent in the project area. In the nineteenth century there were no farming systems, and land was used by seasonally grazing nomadic flocks. Following the end of World War I, a strong centralized administration, later to become the Hashemite Kingdom of Jordan, was established and nomadic tribes began to settle in the area and cultivate the land. The present farming systems in the Mafraq area date from that period. A few scattered old villages were reoccupied and new ones sprang up in the atmosphere of peace and security. At first, the new agricultural areas were concentrated in the southwest around Jarash where conditions were most favorable, but later villages appeared throughout the area. Today's population distribution reflects these developments. Population density is two to three times as great in the wetter hill country than in the drier north and east.

The founding of new villages continues today. Six new villages have been established and recognized by the government since 1979. Five of these are in the southwestern half of the study area and the remaining one is in the extreme north. New villages largely result from the younger generation leaving older villages to begin independent households, but there is still a trickle of immigration.

An Overview of Survey Findings

The characterization work is planned to continue over a period of three or more years. The first year (1987/88) was spent in collecting secondary data and culminated in an exploratory farmer survey with a sample of 55 farms in 20 villages. In 1988/89, the farm survey research continued. A slightly modified questionnaire was administered to 59 farmers and covered an additional 15 villages. The second sample was chosen to complement the first so that the two together represent the entire area. A full analysis of this large dataset is under way, and some of the preliminary results are reported below.

Agriculture in the area is dominated by cereal (principally barley) and livestock (largely sheep) production (Table 1). However, farmers are increasingly planting their land to olives, even though reported olive yields are very low. Farmers estimated the fruit yield per harvested tree as follows:

In a poor year	5.3 kg per tree
In an average year	12.5 kg per tree
In a good year	25.0 kg per tree

Table 1. Mafraq area farm size and land use, 1988/89.

Rainfall zone	Av. farm size (ha)	Barley (ha)	Wheat (ha)	Olives (ha)	Ewes (head)	Goats (head)
Zone 1 (>300 mm)	14.1	3.0	2.6	3.0	47	19
Zone 2 (200-300 mm)	23.6	9.5	5.1	1.1	81	7
Zone 3 (<200 mm)	26.2	13.3	4.0	1.4	59	13
Mean	22.4	9.4	4.3	1.6	69	11

Maximum yields of irrigated olives in the project area were reported to be over 100 kg/tree. Of the interviewed farmers, 89% confirmed that olive production is on the increase, and 63% agreed that the best farmland should be under olives.

Four basic farming strategies (or enterprise-mixes) dominate within the area, and all but 4 of the 114 farmers interviewed fell within this grouping. The strategies (Fig. 7) are: cereal/livestock (CL), cereal/livestock/olive (CLO), cereal/olive (CO), and cereal production (C).

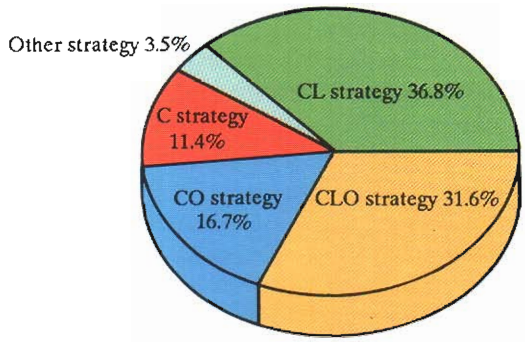


Fig. 7. Distribution of production strategies in the Mafraq area, Jordan.

Fig. 8 shows the relative division of on-farm income among the various enterprises for the entire survey sample. Several observations need to be made. First, farmers were asked to estimate the relative proportion contributed by each enterprise averaged over the past five years in order to lessen the effect of dramatic price changes in any single year. Second, they were asked to figure the contribution of wheat and barley to their total income and not simply income realized from their sale. Thus, barley should be viewed as an on-farm source of feed for livestock within the farming system. Third, the average figures do not reflect the considerable variation across the study area. Livestock and crops are not evenly distributed. Tree crops and wheat are more commonly grown in the wetter southwestern area whereas the north, central, and eastern areas are dominated by barley and livestock production.

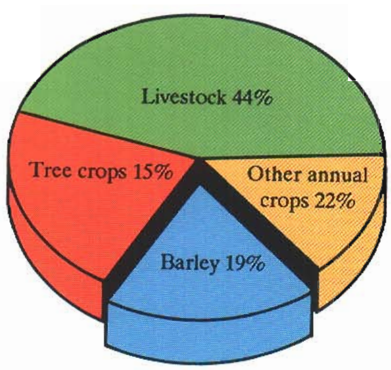


Fig. 8. Sources of on-farm income in the Mafraq area, Jordan.

Reliable income data are difficult to collect and interpret. Fortunately, it was possible to obtain reasonable estimates from about half of the farmers surveyed. Farm size, production strategy, and on-farm to off-farm income ratios for these farmers are generally much the same as for the entire sample. The limited data indicate that total income for livestock producers (CL and CLO) averages 64% higher than the income earned by non-livestock producers (C and CO) in the Mafraq area. In summary, sheep producers with more than 80 head statistically (i) tend to have the largest holdings, (ii) have the highest total income, (iii) are located in Zone 2, and (iv) derive the least amount of their income from off-farm sources. Livestock was confirmed as the best source of farm income by 85% of the farmers, and 50% confirmed that livestock numbers were on the increase.

The relative importance of on-farm versus off-farm income to total household income varies greatly. The range is from 100% derived on-farm to as little as 10%. The ratio can have important implications for farmer decision-making, especially decisions about enterprise-mix, capital investments, and cash expenditures on inputs. Some 44% of income for the entire sample comes from off-farm sources. This high level is indicative of Jordan's recent economic expansion in non-agricultural sectors, the Mafraq area's location near several large towns and government centers, and the relatively meager agricultural resources of the area.

Given the dominance of barley production in the area (Table 1) and its importance as a source of livestock feed, farmers were asked about their experience with barley performance during the last 10 years. Their responses are shown in Table 2. As would be expected in such dry environments, yields were reported to be low and highly variable.

Table 2. Barley performance for the last 10 seasons in the Mafraq area in Jordan.

Performance	Number of years occurring: Mean	SD
No seeding	0.8	1.5
Grazed, no harvest	4.3	1.8
Low yield (average 208 kg/ha)	1.8	1.8
Average yield (626 kg/ha)	1.8	0.8
High yield (average 1454 kg/ha)	1.3	0.7
Total years	10.0	

Interestingly, a comparison of the farmers reporting the highest and lowest barley yields showed no clear pattern of differences with regard to rainfall zone, soil type, soil depth, or holding size. In fact, the only variable which seems to correlate with yield level is the degree of dependence on on-farm income. Farmers reporting the highest average yields received about 25% of income from off-farm sources, while those with lowest yield received 61%.

Conclusions

Any program designed to improve the productivity and income from farming in the Mafraq area must not require farmers to make substantial changes in their production strategies, nor should it involve costlier inputs than those already being used. Success should be sought through modest objectives and incremental benefits built upon the existing productive base and farming systems. The key on-farm element to focus on is the livestock-crop interface. When asked to identify their principal problem, almost all farmers with livestock said "an adequate feed supply." They said they desired to increase the productivity of their land with the specific intention of reducing their dependence on external sources of livestock feed.

Although some other issues, such as the low productivity of olives, are relevant to the problems of the area, examination of farm and farmer characteristics overwhelmingly points to the need for increasing local production of livestock feed.

Using the interrelations among the variables examined, a preliminary target farmer population would display the following minimum characteristics: (i) mean farm size of 20 ha, (ii) mean combined sheep and goat flock of 90 head, and (iii) mean annual area planted to barley of 8.5 ha. Such a group would be geographically concentrated in Zone 2 (200-250 mm) and would depend on on-farm sources for the bulk of its household income.

Although agronomic research for the marginal zone is still at a preliminary stage, the first year's results indicate that increased feed production may be possible by introducing new varieties of barley and feed legumes, better management techniques, and an alternative rotation that includes feed legumes as a substitute for fallowing and continuous barley. This conclusion is reinforced by ICARDA's experience in similar marginal zones of northern Syria.

CERES-Wheat Model and Strategic Planning for Nitrogen Fertilization in China: A Framework

The CERES-Wheat model was applied to assess wheat yield responses to N fertilization under various conditions in the Xian region of the Peoples' Republic of China. The objective was to appraise the feasibility of using such tools as this model to improve fertilizer recommendations and to develop long-term policies for the maintenance of soil productivity. Soil parameters, the necessary crop coefficients required by CERES, and nine seasons of daily climatic data were used to predict wheat grain yield responses to levels of nitrogen fertilizer ranging between 0 and 210 kg N/ha on four soils of contrasting nitrogen status.

Model output confirmed that responses to nitrogen are sensitive to both initial soil nitrogen levels and amounts and distribution of seasonal water supply (Figs. 9 and 10). Further analysis, using the current Chinese fertilizer cost:grain price ratio of 3.82, indicated seasonally dependent, economically optimum rates of N application ranging between 0 and 150 kg N/ha in the driest and wettest years. Timing of fertilizer application was also evaluated, and the model output confirmed that split application of 30 kg N/ha at sowing and 60 kg N/ha at the start of stem elongation was superior, and on average gave a 10% increase in yield over a single application of 90 kg N/ha prior to sowing (Table 3).

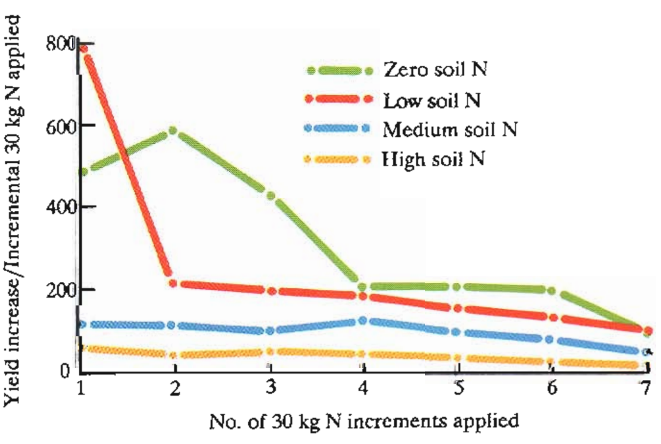


Fig. 9. Simulated yield increase due to successive increments of 30 kg N/ha in four soils with hypothetical zero, low, medium, and high base nitrogen levels. Each point is the mean of nine years' simulation.

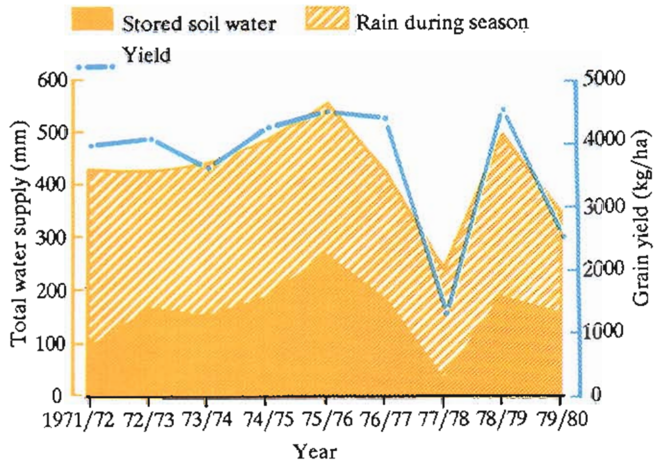


Fig. 10. Pre-sowing soil water (mm), growing-season rainfall (mm), total water supply (mm), and simulated grain yields of winter wheat (kg/ha). Simulations based on nine years of weather data from the Xian region of the Peoples' Democratic Republic of China.

Table 3. Wheat grain yield predicted for Xian province, China, for different patterns and dates of N-fertilization[1].

Stage of application of N fertilizer	Wheat grain yield (kg/ha): Low potential year (1977/78)	Wheat grain yield (kg/ha): High potential year (1974/75)	Mean of 9 years
90 kg/ha as basic fertilizer (15 days before sowing)	1277	3196	2992
30+60 kg N/ha Julian day 35 (soil thaw)	1166	3889	3197
30+60 kg N/ha Julian day 70 (stem elongation)	1175	4149	3286
30+60 kgN/ha Julian day 105 (pre-heading)	1175	3991	3053
30+60 kg N/ha Julian day 125 (start of grain fill)	1175	3255	2616

[1] Wheat sown on 1 October. Plant population 250 plants/m^2. Soil nutrient status, low. Julian day 1 = January 1.

Crop/soil nitrogen balances were also assessed, and it was concluded that in order to avoid long-term depletion of soil nitrogen reserves, 120 kg N/ha should be added annually to wheat crops in Xian Province (Fig. 11).

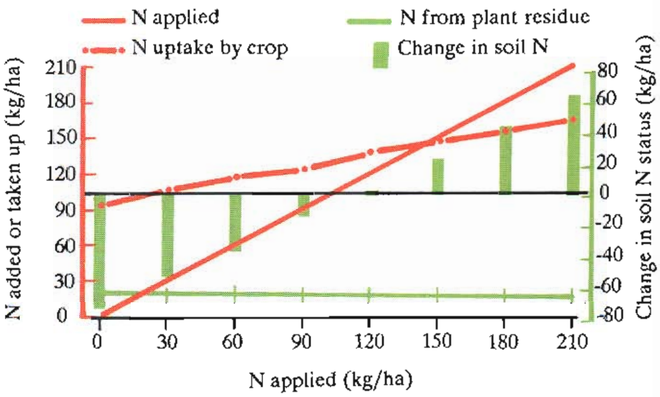


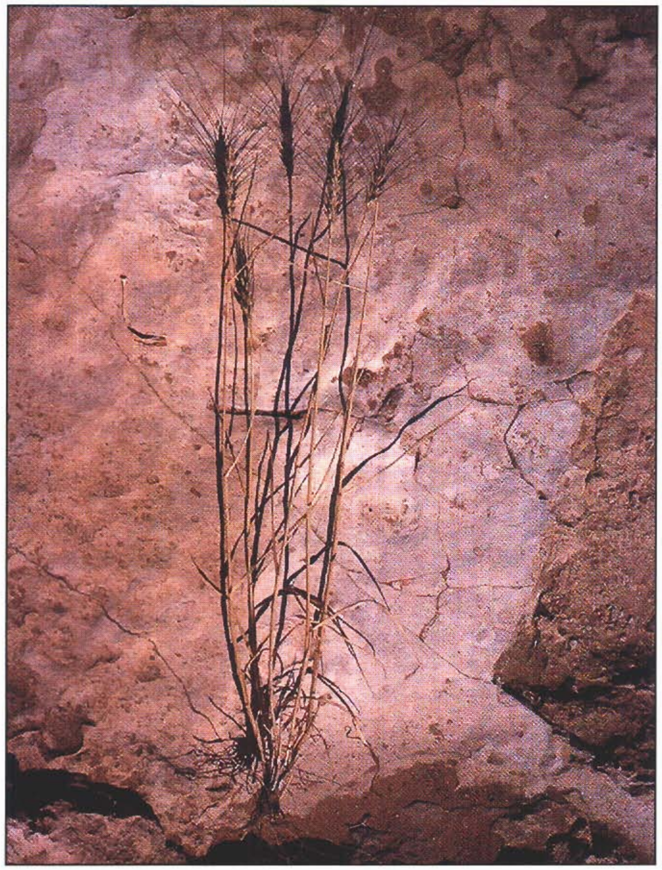
Fig. 11. Simulated components of nitrogen balance of winter wheat systems on a soil with an initial middle level of soil nitrogen. Each point is the mean of nine cropping seasons from 1971 to 1980.

While the results in this report are derived from model output, and only a limited number of seasons were tested, the estimated responses obtained are in line with field experience. Based on this initial analysis, a more thorough evaluation has been proposed using longer climatic datasets, several contrasting locations, and validation with field trial data.

Germplasm Conservation

As part of the global CGIAR effort, germplasm exploration, collection, evaluation, and conservation are important components of ICARDA's core research programs. These activities are carried out in close collaboration with NARSs and IBPGR. In 1989, consultations were held with IBPGR in response to the EPR recommendations, with a view to avoid duplication of effort, as well as to develop joint projects of research, germplasm collection and exploration, training, and networking.

In 1989, the Center acquired over 4,400 new germplasm accessions through collecting missions and exchange. Of these, over 1,500 samples of cereals and food and forage legumes were collected in Algeria, Bulgaria, Cyprus, Egypt, Jordan, Syria, and Turkey. These included over 500 accessions of wild relatives of wheat.



Stress-tolerant germplasm is the main objective of ICARDA's collecting missions. This bread wheat plant, growing at a highly saline site in Djelfa, Algeria, was collected in 1989.

Over 6,000 accessions were multiplied for medium- and long-term storage, and 13,000 were evaluated for morphological and agronomic characters. Construction of a new cold store facility was completed in 1989 and most of the active collections were transferred to it.

As part of the taxonomic revision of *Aegilops*, 1,418 herbarium sheets were studied in 14 herbaria of European and Mediterranean countries.

Passport and evaluation data were updated in preparation for producing a catalog on winter chickpea. Over 5,500 accessions were distributed to cooperators in 26 countries, and 11,000 seed samples were provided to ICARDA colleagues.

Collection of rhizobia for pasture and feed legumes has been steadily expanding. Currently, it includes 465 strains of *Rhizobium meliloti* for annual *Medicago,* 35 antibiotic-resistant strains of R. *meliloti*, 36 strains of R. *leguminosarum* for food and feed legumes, and 45 strains of *R. trifolii* for clovers. The strains have been tested for their symbiotic characteristics for further use.

Collection of Wheat Wild Relatives

In collaboration with national program scientists, wheat wild relatives were collected from Egypt, Cyprus, Turkey, Bulgaria, and Syria.

In Egypt, 20 samples of *Aegilops*, representing four species and one subspecies, were collected. The genus was found only along the coast. The reported presence of *Ae. crassa* in the Flora of Egypt was not supported either by samples collected or by collections in the visited herbaria.

In Cyprus, a total of 63 accessions were collected, representing six species and one subspecies of *Aegilops*. The northern part of the island was visited for the first time. Samples of *Hordeum spontaneum* and *H. bulbosum* were also collected, specially from locations with saline soils. *Ae. comosa* ssp. *comosa*, which occurs in Greece and Turkey, was collected from Cyprus for the first time. The rare *Ae. bicornis* was also found several times and it was restricted to sandy soils near the coastline. Other interesting observations included the frequent presence of *Ae. peregrina* ssp. *cylindrostachys* and the abundance of hybrids between *Ae. ovata* and *A. peregrina.*

In Syria, the common *Aegilops* species were collected from Homs and northwest of Aleppo.

Natural hybrids (three spikes in the middle) between bread wheat (right) and *Aegilops cylindrica* (left) found near Yunak, Turkey.

Two areas were visited in Turkey: (i) the area around the Sea of Marmara, not covered by any of the previous collection missions, and (ii) the Anatolian highlands. Besides 132 accessions of *Aegilops* and 18 of wild, diploid *Triticum*, one immature plant of the rare *Ae. comosa* ssp. *heldreichii* was also collected from the former area. From the highlands, 102 accessions, representing 10 species and one subspecies of *Aegilops* were collected. Natural hybrids between *Ae. cylindrica* and bread wheat were also found several times. This collection mission, thus, enhanced ICARDA's knowledge of ecogeographic distribution of wheat wild relatives and of the gene flow between wild and cultivated species.

In Bulgaria, 64 accessions of *Aegilops* and four of *Triticum monococcum* subsp. *boeoticum* were collected. *Ae. cylindrica*, a species, rare or not found in West Asia and North Africa, was ubiquitous.

Collection of Rare Species of Vicieae

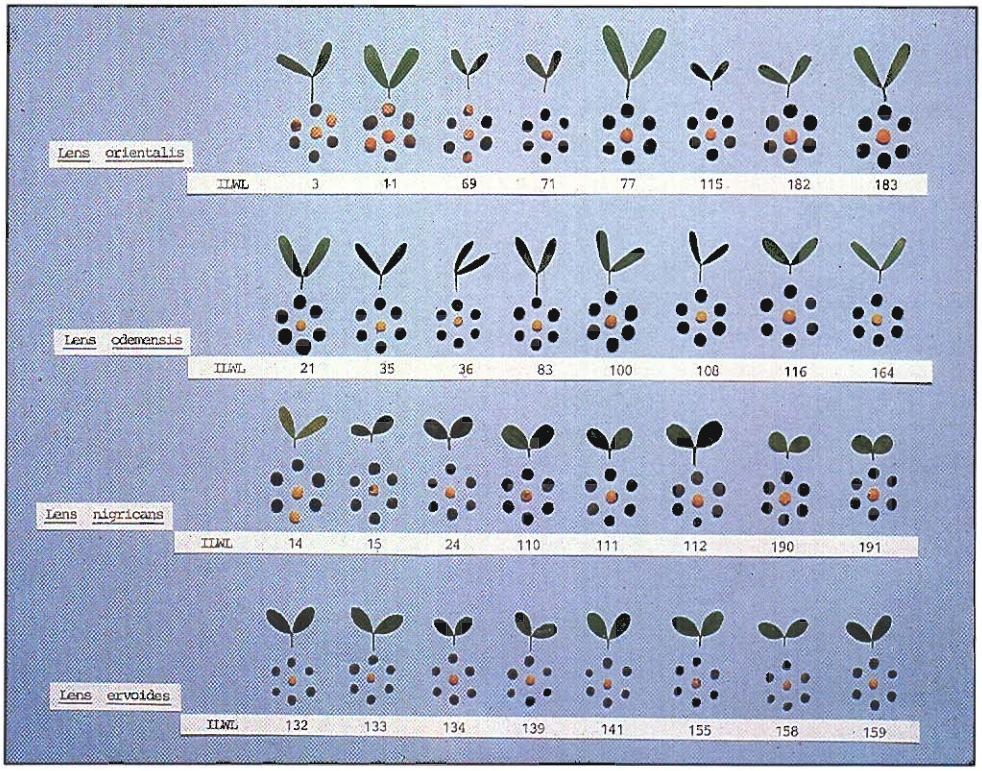
In collaboration with experts from the Southampton University, U.K., 127 samples were collected from 17 sites in Syria. These included five samples of *Vicia hyaeniscyamus* and three of the new *Vicia* species (*Vicia kalakhensis*), which was first discovered in 1986. *Vicia noeana* was collected again near Afrin. It is used in its distribution area as a forage in mixture with *Trifolium* species

Ecogeographic Survey and Collection of Native Pasture and Forage Legumes in Jordan

Sixty-one sites were visited and 685 samples collected. Soil samples were also collected from each site for isolation of *rhizobia* and for chemical analyses and physical characterization. Annual *Medicago* and *Trifolium* as well as *Astragalus* and *Trigonella* were the most commonly found pasture and forage species in the surveyed areas. In addition, two samples of wild lentils (*Lens orientalis* and *L. odemensis*) were also collected.

Studies on *odemensis*-Type Wild Lentils

The Near East and European types of *Lens nigricans*, in



Variation in leaflet shape, seed coat pattern, and cotyledon color in wild *Lens* species.

spite of sharing a common character of semi-hastate dentate stipule, are not crossable with each other. Stipule orientation has been suggested as the main discriminating morphological character between the two groups. It has also been reported in the literature that, other than *L. orientalis*, only the Near East type of *L. nigricans* with horizontal stipules is crossable with cultivated lentils by conventional techniques. A subspecies status has recently been suggested for this group within *Lens culinaris* (*L. culinaris* ssp. *odemensis*).

From the surveys of wild lentils in Syria and Turkey, 17 new *odemensis*-type samples were recently collected in addition to the five accessions received earlier from the USDA collection. Three of the new genotypes (ILWL 116, LR 129, and LR 158) collected from Syria have vertical or semi-vertical stipules similar to the European-type *L. nigricans,* making the distinction between the two groups difficult. In 1988/89, all 22 *odemensis* genotypes currently available in ICARDA's wild lentil collection were planted along with *L. culinaris, L. orientalis, L. ervoides*, and *L. nigricans* to identify suitable discriminating characters for these taxa. Most of the characters studied (stipule shape and orientation, cotyledon color, flower color, length of calyx teeth) were polymorphic in the *odemensis*-type accessions and overlapped with other accessions belonging to different species. However, two characters were specific to *L. odemensis*: (i) a dark inverse w-shaped mark on the seed coat near the hilum, and (ii) the narrow elongated shape of leaflets of the first bifoliate leaves. The length/width ratio of these leaflets (Fig. 12) in the *odemensis* types (>3.0) was distinctly different from that for *L. nigricans*

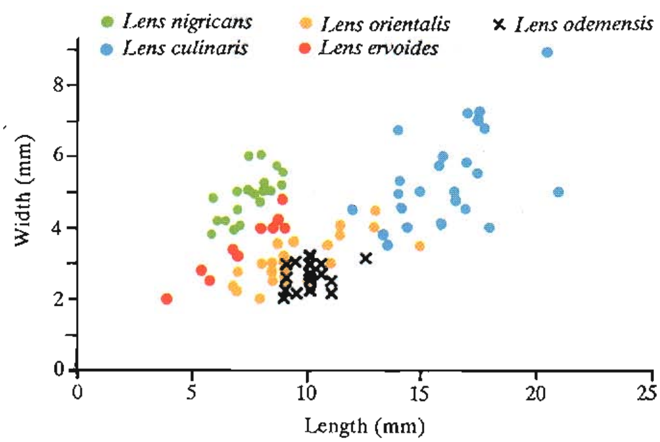


Fig. 12. Scatter diagram of leaflet size on the first bifoliate leaf in different lentil species.

(1.3 - 1.8) and *L. ervoides* (1.9 - 2.3) but overlapped with *L. orientalis* (2.5 - 4.3) and *L. culinaris* (2.1 -4.5). The dark mark on the seed coat and the leaflet shape, thus, appeared to be the definitive distinguishing characters between *L. odemensis* and *L. nigricans*.

Genetic Studies on Wild Chickpea Progenitor

Segregating generations (F_2, F_3) of four interspecific crosses between a simple leaf mutant of cultivated chickpea (ILC 1250) and its wild progenitor, *Cicer reticulatum* (ILWC 21),were evaluated in 1988/89.

White flower color and simple-leaf characters were found to be inherited independent of each other as recessive monogenic traits. Although all F_1 plants were fully fertile, complete or partial sterility was observed in three of the four F_2 families. The sterility was associated with the compound leaf character inherited from the wild parent. The differences in compatibility among wild genotypes highlight the importance of using selected, fully interfertile plants for interspecific crosses, especially if the breeding objective is to transfer polygenic characters (e.g., cold tolerance in *C. reticulatum*) to cultivated species.

Seed size, seed type, and seed coat roughness showed quantitative segregation, and the F_3 plants were intermediate between the two parents. The segregation for days to flowering was transgressive, and plants flowering both earlier and later than parents appeared in the F_3 generation. The results confirm the value of *C. reticulatum* in breeding for earliness in chickpea.

Seed Health

During 1988/89, 96 seed consignments from 38 countries were received, representing a 25% increase over 1987/88. Seed not treated by the sender was treated against insects and fungi at ICARDA's Seed Health Laboratory. As an additional safeguard against the introduction of pests and pathogens, all newly acquired seed was planted in an isolation area. No exotic diseases were detected.

The Center dispatched 525 consignments to 72 countries in 1988/89. These included cereal and food legume international nurseries, as well as germplasm and breeder seed to meet individual requests.

Germplasm Enhancement

As the number of persons trained by ICARDA in crop improvement has been increasing in the region, the Center has been making adjustments in the emphasis of its germplasm enhancement activities. The conventional research techniques are being increasingly handed over to national programs, and the Center is gradually but steadily shifting its emphasis to advanced research. In this regard, the progress in physiological and biotechnological research is reflected in the account that follows. The outreach activities of the Center serve as an important vehicle for decentralizing its germplasm enhancement activities among national programs.

Pasture and Forage Crops

Neurotoxin in Chickling

Chickling (*Lathyrus sativus*) has been shown to have a high potential for dry areas. However, its seeds contain a neurotoxin responsible for a paralytic disease, called "lathyrism," in the Indian subcontinent where the grains are used for human consumption. This fact may explain why the genus has received so little research attention as a forage crop.

The major neurotoxin responsible for lathyrism is beta-N-oxalyl-amino-L-alanine (BOAA). With the assistance of the Canadian Grain Commission, seeds from 122 selections of three *Lathyrus* species were screened for BOAA content. The lowest BOAA contents in *L. sativus* (17.6 ug/g seed) and *L. cicera* (20.0 ug/g seed) were found to be nearly 100 times and 10 times below the content of an Indian and a Canadian variety, respectively. The seed yields of these accessions are being evaluated. This interesting finding should help in the selection and development of new chickling lines with a low BOAA content.

Subterranean Vetch

Several feed legume species have the characteristic called amphicarpy, i.e., the ability to produce pods both above and below ground. This important characteristic is being studied at ICARDA, using the subterranean vetch *Vicia sativa* ssp. *amphicarpa* in simulated grazing trials. The proportion of above-ground to underground seeds was found to vary depending on the severity of defoliation.

For example, severe defoliation by clipping prevented production of aerial pods but plants still produced 138-185 kg/ha of underground seed which is well above the estimated seed rate for this species (Table 4). Under the severe drought conditions of 1988/89, many plants only produced underground pods, indicating their adaptation to these conditions.

Table 4. Effect of clipping height on underground seed production in four genotypes of subterranean vetch (kg/ha).

	Clipping height (cm)			
Genotypes (origin)	5	7.5	15	No. clipping
2614 (Turkey)	185	214	291	641
2660 (Turkey)	155	243	306	675
2647 (Syria)	161	194	237	690
2650 (Syria)	138	151	245	501
Mean	160	200	270	627

LSD (P=0.05) for clipping treatments = 101 kg/ha.
LSD (P=0.05) for genotypes = 35 kg/ha.

The hardseededness of the species is another advantage. In previous trials, 60-80% of seeds remained dormant for up to six months. Thus, subterranean vetch has the potential to be developed into a self-regenerating, feed-producing legume crop grown in rotation with wheat or barley.

Unpalatability of Forage Peas to Sheep

Significant progress was made in 1989 in finding out why the Syrian landrace of forage peas (*Pisum sativum*, accession number 205) is unpalatable to sheep. The ingestion rate of straw from this landrace by sheep was lower than from the ICARDA germplasm collection lines. Degradability of the same straw was also lower when incubated in nylon bags in the rumen of fistulated sheep. The degradability of leaf from the Syrian landrace was higher than that from palatable Syrian common vetch (*Vicia sativa*, accession number 2541), but the opposite was the case for the stem (Fig. 13). Since the extent and rate of degradation of plant materials in the rumen are important factors for determining the amount of feed ingested by ruminants, variations in the proportions of leaf to stem in the genotypes of peas being examined should result in differences in the feed intake.

Vicia sativa ssp. *amphicarpa*, with its underground pods exposed.

There were also marked differences in the preference of sheep for different plant fractions of the Syrian pea, with little discrimination between leaf and stem, a distinct preference for the white flowers, and a clear dislike for the young green pods. It is anticipated that chemical analysis of the primary and secondary compounds in different plant fractions taken from a range of germplasm will make it possible to explain the unpalatability of peas to sheep.

Fostering Pasture and Feed Legume Improvement in Morocco

In 1988/89, the Center initiated an effective strategy for pasture and feed legume improvement in Morocco. The strategy emphasizes the current research being conducted by Moroccan scientists with ICARDA playing a supporting role. It involves the following components: (i) developing locally adapted genotypes of pasture

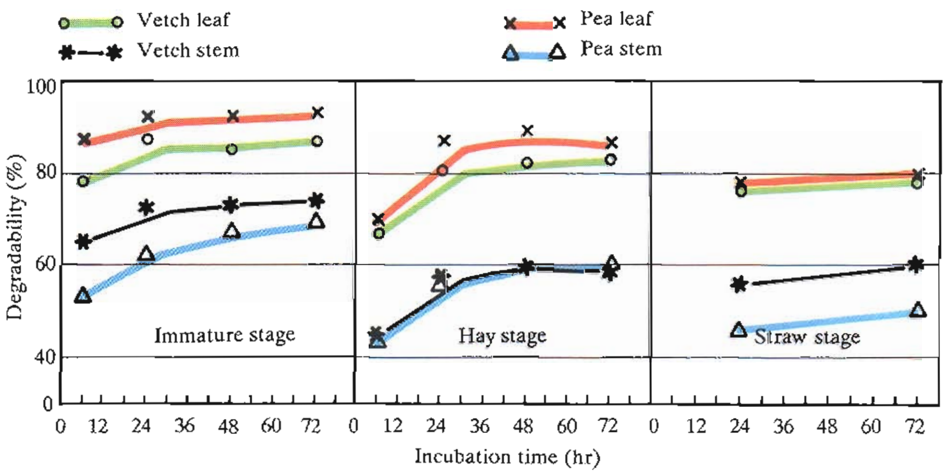


Fig. 13. Degradability in the sheep rumen of leaf and stem fractions of the Syrian landraces of pea and common vetch harvested at three stages of crop maturity.

legumes, especially from the local flora, (ii) enhancing the production of weedy fallows, (iii) evaluating feed legumes, (iv) developing local seed industries to reduce costs and reliance on imports, and (v) establishing the benefits of new systems for animal productivity using self-regenerating pastures and annual feed legumes.

An ecogeographic survey of wild legumes in Morocco illustrates the first step of the strategy. In the 1988 summer, 161 sites were sampled and 1,194 accessions belonging to 18 genera and at least 50 species were collected. Of particular interest were the clovers (*Trifolium* sp.) and annual medics (*Medicago* sp.). Multiplication of the seed and further identification of species took place in 1989.

During the survey, a field near Beni Mellal was found to have a high density of *M. aculeata* which still had a good seed bank in July 1989 at the original collection site (Table 5). This species has not been used commercially, but appears to be of considerable value for Morocco. The pods are hard and tend to become partially buried in the soil. This may provide a degree of protection from grazing animals which could be useful in a ley farming system.

Studies also started at eight sites to evaluate balansa clover (*T. balansae*), an annually-sown pasture legume, and on application of phosphate fertilizer, with a view to enrich the legume component in the extensive weedy fallows in North Africa. Balansa clover was hand broadcast at 10 kg/ha on half the area of a cereal stubble; half this area and half the control area of weedy fallow received phosphate fertilizer at 45 kg P_2O_5/ha. Seed and fertilizer were incorporated into the soil using traditional methods. Although the clover establishment was not always successful, drought and weeds posed greater problems. However, at two of the eight sites balansa clover proved to be well adapted.

Table 5. Yields of medic seed, plant density, and pasture composition at Beni Mellal in Morocco.

Species	Seed (kg/ha) May 1988	Plants (/m²) Dec 1988	Pasture composition (%) Apr 89	Seed (kg/ha) July 1989
M. aculeata	93	93	22	117
M. truncatula	31	58	28	48
M. orbicularis	14	0	0	2
M. polymorpha	21	100	6	16
M. minima	0	0	0	2
Weeds	-	-	38	-
Bare ground	-	-	6	-

At Had Soulem, the total dry-matter production of the weedy fallow sown with balansa clover and receiving phosphate was nearly 6,000 kg/ha in spring compared with under 4,000 kg/ha from the unimproved fallow (Fig. 14). However, the yield response of the weedy fallow to phosphate application was greater than that of the clover.

To evaluate the annual feed legumes, improved ICARDA lines and local Moroccan selections of common vetch (*Vicia sativa*) were sown near Fez and Tangiers where annual rainfall was 451 and 750 mm, respectively. Many of the feed legumes produced high yields of dry herbage by the end of May (Fig. 15). This was the case with accession 1812 which also had resistance to *Orobanche*, and was therefore chosen for further evaluation.

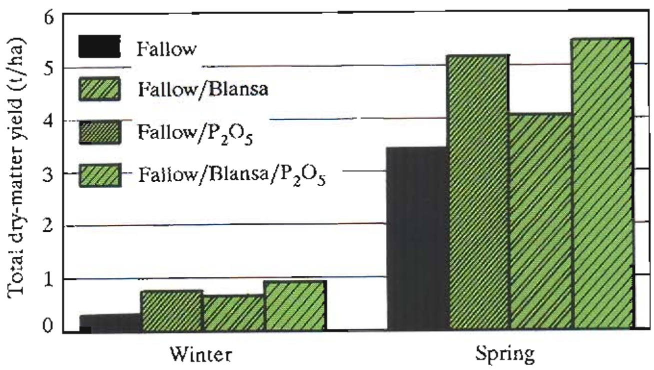


Fig. 14. Total dry-matter yields of weedy fallow improved with blansa clover and phosphate fertilizer at Had Soulem in Morocco in winter and spring, 1988/89.

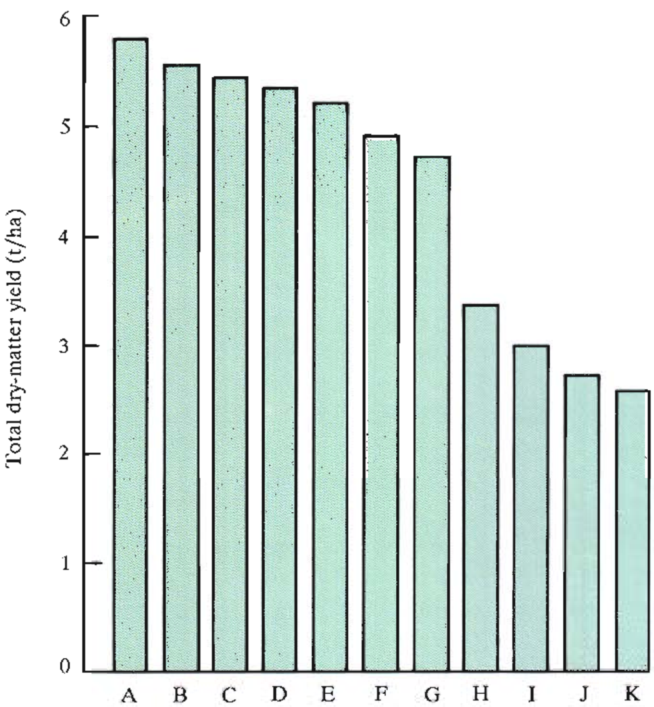


Fig. 15. Total dry-matter yields of vetches in May 1989 at Fez (rainfall 451 mm), Morocco. Letters A to K refer to different accessions; A refers to accession 1812.

Sheep grazing a weedy fallow in Morocco.

Cereal Crops

Barley Germplasm for Target Environments

Within and outside the WANA region, barley is grown in diverse environments ranging from moderately wet (350 mm or more annual rainfall) to very dry (less than 250 mm) and from warm or mild to very cold winters. To enhance the adaptation of new germplasm to major agroecological zones, ICARDA characterizes it for targeted distribution through the international nurseries system.

In 1989, two major changes were introduced in the barley observation nurseries: (i) more germplasm from specific NARSs was included, and (ii) the "observation nursery for low-rainfall areas" was divided into two sets, one for low-rainfall areas with mild winters, and the other for low-rainfall areas with cold winters. The composition of nurseries was based on results of three years of testing in nine environments (Fig. 16). Germplasm in the moderate rainfall nursery had the characteristics of high yield potential and early heading; and that in the low-rainfall mild-winter nursery, the earliest heading. The material for the low-rainfall, cold-winter areas was late-maturing but cold tolerant. The nursery targeted for the high-altitude areas contained more cold-tolerant winter and facultative type material, and will be further improved by including more winter-hardy material. This nursery is proposed to be developed into an International Winter and Facultative Barley Observation Nursery, in collaboration with Oregon State University.

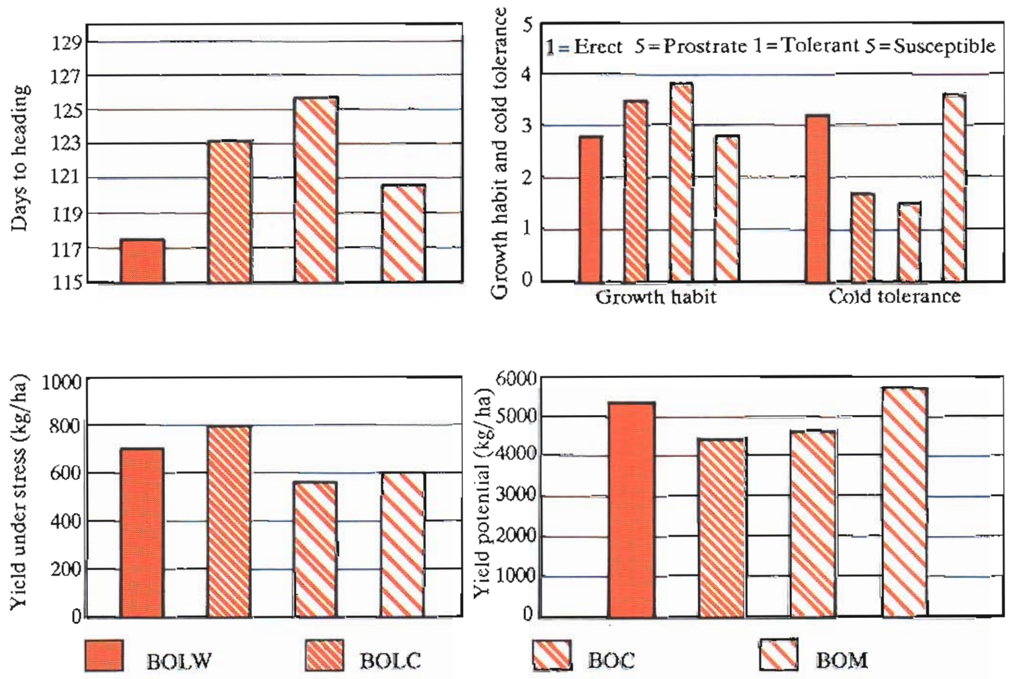


Fig. 16. Characteristics of germplasm included in the 1989/90 barley observation nurseries.
BOLW = nursery for low rainfall, mild winter areas; BOLC = nursery for low-rainfall, cold winter areas; BOC = nursery for high elevation and very cold areas; BOM = nursery for moderate-rainfall areas.

Barley for the Dry Areas

ICARDA's strategy recognizes the importance of barley "in view of the crop's vital contribution to livestock production in the drier areas."

In large barley areas within and outside WANA, landraces are still grown because of their production stability under unfavorable and variable soil and weather conditions. The Center has derived promising pure-line selections from Syrian landraces and tested them in diverse environments of Syria. One of these lines, Tadmor, derived from the black-seeded landrace Arabi Aswad, traditionally grown in Syria in areas receiving less than 250 mm annual rainfall, has consistently performed well for four seasons, 1985/86-1988/89 (Fig. 17). Another example of a pure line is Arta, which is derived from Arabi Abiad, a white-seeded landrace commonly grown in the relatively wet (yet semi-arid) areas of Syria (rainfall between 250 mm and 350 mm). In spite of the success with derived pure lines, landraces still retain their advantage in certain specific environments and should therefore be preserved for fuller expoitation of their genetic variability.

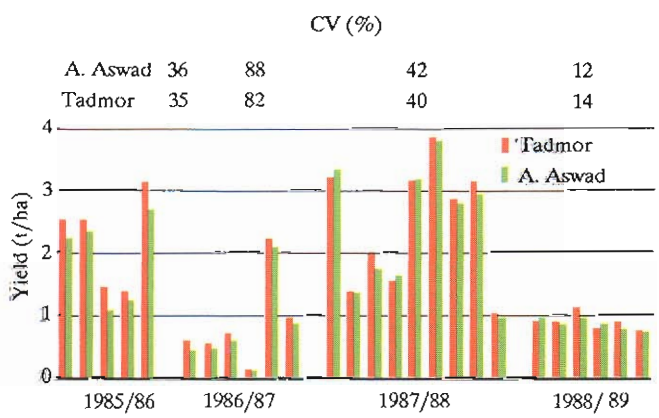


Fig. 17. Comparison of yield of Tadmor with that of Arabi Aswad at 26 on-farm dry sites (<250 mm rainfall) in Syria. Tadmor is a pure-line selection from the black-seeded landrace Arabi Aswad. Stability is represented by the coefficient of variation (CV) for the genotype performance across environments. A better stability is associated with a lower CV.

The landrace-derived lines, Tadmor and Arta, performed well in the dry and cold environment at Breda, Syria, 1989.

Landraces and derived lines have also been used successfully in crossing programs. In 1989, a very dry year in Syria, the average grain yield obtained in ICARDA trials (2,710 entries) was 640 kg/ha at Bouider (184 mm annual rainfall), and 3,000 kg/ha at Tel Hadya (234 mm); some of the highest yielding entries were progenies of crosses involving Arabi Abiad, Arabi Aswad, or Tadmor.

ICARDA's advanced germplasm is tested in the region through international nurseries system to identify promising genotypes for direct use by NARSs, or for use in crossing programs at NARSs and ICARDA. Table 6 shows some of the 1988/89 season's best performing lines.

Table 6. Grain yield (kg/ha) of selected barley lines in the regional barley yield trials for low rainfall areas: 1986/87, 1987/88, and 1988/89.

	Season*		
Line	1986/87	1987/88	1988/89
WI2197/Cam	4095	3885	-
Deir Alla106/Strain 205	4012	4048	-
Pld10342//Cr.115/Por/3/ Bahtim9/4/Ds/Apro/5/WI2291	-	3778	2794
Bal.16/Api//Deir Alla 106	-	4398	3142
Long-term check (Beecher)	4045	3912	2938
Average of all lines	3953	3627	2801

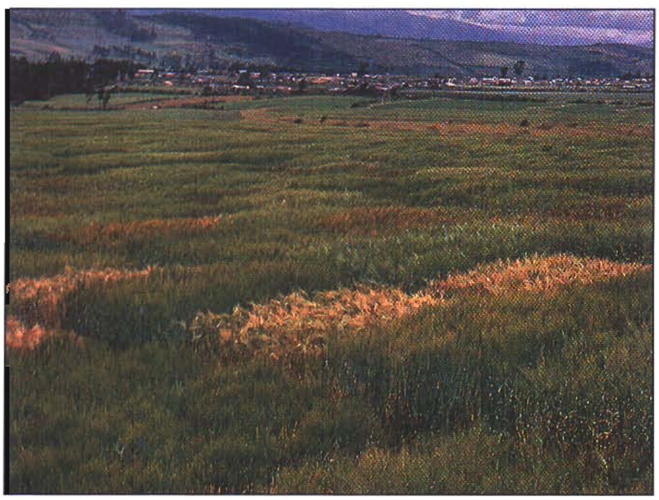
* 22 locations in 1986/87, 29 in 1987/88, and 26 in 1988/89.

Although grain is obviously the end-product, barley straw is also valuable, particularly in those areas that suffer from drought. In such areas, the crop is often entirely grazed, as noted during 1989 in many parts of West Asia.

Barley for Wetter Areas

Though predominant in the dry areas, barley is also grown in relatively favorable rainfall areas, or under supplemental or full irrigation. In developing germplasm for such environments, ICARDA places emphasis on high yield potential (both grain and dry matter) and resistance to diseases. Fig. 18 illustrates the Center's progress in improving powdery mildew resistance in barley populations screened in 1989 under heavy disease pressure of a natural epiphytotic in Lattakia, Syria.

Insect pests can also cause damage to barley. Recently, two parental lines, identified for their resistance to wheat stem sawfly, have been intensively used in crosses to transfer resistance to otherwise adapted germplasm. Several promising breeding lines were identified by NARS scientists in 1989, particularly the early line, Cr115/Por//Strain205, which yielded consistently well in WANA, and possessed satisfactory resistance to lodging and diseases. Other germplasm with relatively good performance in the moderate rainfall areas included the lines Comp. cross229//As46/Pro and WI2291/3/CI03309/Attiki//Hja33.



Early-maturing barley genotypes are desired by farmers both in dry Mediterranean environments and more favorable areas of the world.

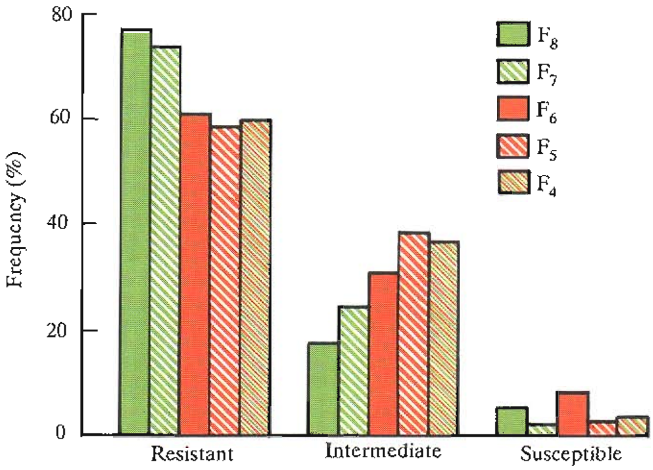


Fig. 18. Frequency distribution of barley populations for reaction to powdery mildew at Lattakia, Syria, 1988/89.

In moisture-favorable environments, barley is often cut for forage and then allowed to regrow to produce grain. Several NARSs in WANA have identified barley genotypes suitable for this practice.

ICARDA's work at its main station at Tel Hadya is complemented by the joint ICARDA/CIMMYT project located in Mexico. During 1989, barley germplasm developed through the joint project performed particularly well in countries of the Andean region, and in China, Pakistan, Korea, and Saudi Arabia. Early-maturing types, such as the Marco"s" lines, have been developed and made available to NARSs. Because of their short growing cycle, these genotypes are preferred by farmers of southeast Asia who plant short-duration barley in an annual three-course rotation : rice-rice-barley. Early types are also desired in areas of Mexico and South America where later-maturing cultivars are often damaged by early frost. Hull-less barley types, such as the Viringa"s" lines, have also been developed recently using the single-seed descent method, some of which combine disease resistance and high 1000-kernel weight (59-60 g vs 28-29 g for hulled 6-row and 2-row barley checks).

Spring Durum Wheat for WANA

The joint CIMMYT/ICARDA spring durum wheat project continued to emphasize the selection of germplasm resistant to diseases and insect pests as well as drought, cold, and heat.

Several promising lines of durum wheat were selected in 1989 for future use from the fourth year of multilocation testing of 11,000 accessions. Some of these lines possess improved gluten strength, associated with specific low molecular weight glutenin subunits.

Improved durum wheat germplasm was crossed with evaluated wild species, including *T. dicoccoides, T. monococcum,* and *T. aegilopoides,* to broaden the genetic base and transfer desirable characteristics. Segregating material was screened at Terbol (Lebanon) and Tel Hadya and Lattakia (Syria) to select material with an increased level of combined resistance to *Septoria* leaf blotch, as well as leaf, stem, and stripe rusts.

Studies on abiotic stresses have revealed that fertile tillering, heading time, and early plant vigor are major factors influencing yield under drought, cold, and heat.

Advanced durum wheat lines performed well in WANA, and many were selected for use by NARSs. The best performing lines were Bicre, Belikhe 2, and Brachoua in West Asia; and Omrabi 5, Belikhe 2, and Syrica 2 in North Africa. Cultivars Sebou and Omrabi were released in Morocco, and the line Lahn, a strong candidate for release in Syria, performed well in large-scale testing in that country.

Spring Bread Wheat for WANA

The joint CIMMYT/ICARDA spring bread wheat project made further progress in 1989 toward developing improved germplasm for the low rainfall areas of WANA. Multilocation testing in collaboration with NARSs provided valuable information on production constraints and germplasm suitability for specific areas.

During the past six years, approximately 1,300 crosses have been made yearly to develop germplasm for various agroclimatic conditions of the region; about one-third of these were aimed at abiotic stress resistance and another one-third at biotic stresses. Over 20% of the crosses involved landraces that were selected from accessions collected in the Middle East and evaluated for two consecutive years for their performance under drought, cold, and disease pressure.

The Center actively participated in on-farm trials conducted by NARSs in Syria, Algeria, Sudan, Lebanon, Morocco, Tunisia, Yemen AR, PDR Yemen, and Jordan.

Gv/Ald's' (=Zidane 89), a bread wheat variety, well adapted to dry areas of the Algerian high plateaux and similar rainfed Mediterranean environments.

New bread wheat varieties were released as a result of this collaboration (Appendix 2). Small quantities of seed of newly-bred cultivars registered in the region were supplied to many countries on request.

In Syria, the line Nesser again surpassed other cultivars in comparative testing in lower rainfall areas, and will be submitted for release. In Algeria, in on-farm trials conducted in low rainfall areas (200-350 mm), the line Gv/Ald's' consistently performed well, with an average yield advantage of 13% over the widely grown variety Mahon Demias (Table 7). Based on these results, Algeria decided to release it as Zidane 89. This variety combines drought and cold tolerance with good bread making quality.

Table 7. Performance of Gv/Ald's' (= Zidane 89), a promising bread wheat line, under dry (200-350 mm) conditions in Algeria. Farmers' field verification trials, 1986/87 to 1988/89.

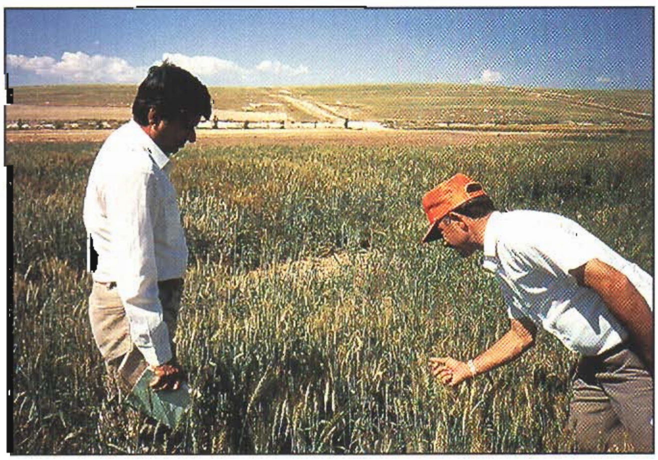
	Yield (kg/ha)				%
Variety	1987	1988	1989	Average	Chk
Gv/Ald 'S' L882-1AP-OAP-2AP-OAP	2141	2334	780	1752	113
Mahon Demias (local check)	1711	2226	730	1555	100
No. of locations	4	6	3	13	-

Chk = Local check.

Cereals for Highlands and Cold Areas

New material was evaluated for cold tolerance and agronomic performance, and 900 crosses (369 for bread wheat, 207 for durum wheat, and 324 for barley) were made with winter-hardy entries. Segregating populations of all three crops were screened for drought and diseases at Tel Hadya. The unusually dry 1988/89 season proved useful for selecting drought-tolerant lines at Tel Hadya (234 mm annual rainfall) and Breda (194 mm). All components of the high altitude germplasm (i.e., parental stocks, hybrid populations, observation nurseries, and yield trials) were grown at Tel Hadya, but only advanced material was tested at Breda. Segregating populations and observation nurseries were grown at Sarghaya (Syria) and Haymana (Turkey) where a more efficient screening for cold tolerance is achieved. A high BYDV infestation at Sarghaya made it possible to select resistant material. Barley and durum wheat were more affected than bread wheat. Selection made at these two sites point to the need for increased cold tolerance in barley germplasm for high altitude areas. As part of the new CIMMYT/ICARDA agreement in 1989, CIMMYT seconded a breeder to ICARDA to work on winter and facultative bread wheat. This will free ICARDA's resources for more attention to winter and facultative barley.

Studies on photoperiod and vernalization in 30 spring and winter bread wheat cultivars revealed that growth habit and cold tolerance are independent of each other, suggesting the possibility of combining earliness and cold tolerance in wheat for highlands.



Scientists from Turkey and ICARDA jointly evaluate the winter cereal germplasm at Haymana, Turkey.

Physiology

The knowledge of physiological processes is essential for understanding certain genotype x environment or management interactions and can be a key factor in directing or enhancing crop improvement efforts. At ICARDA, physiologists and breeders together have formulated a rational approach based on physiological concepts and breeder experiences to develop superior germplasm for rainfed environments of WANA.

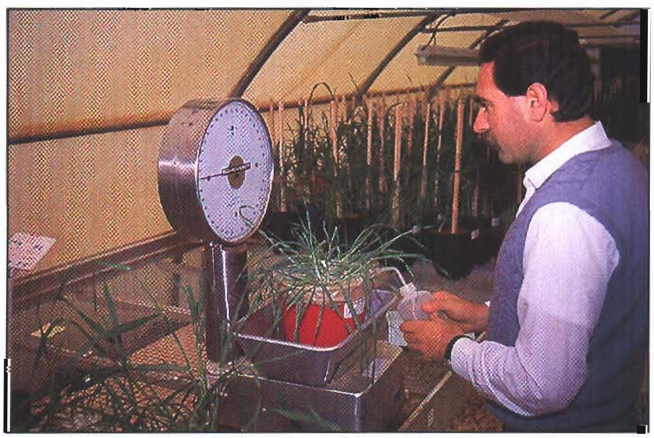
Starting with barley as a priority crop for dry areas, ICARDA developed and characterized a nursery of diverse genotypes for a large number of morphological and physiological traits. The value of these traits, both individually and in combinations, is being assessed with the ultimate objective of developing suitable ideotypes for target stress environments. Desired traits should correlate with breeding objectives, relate causally to yield, possess higher heritability than yield, and be amenable to simple and reliable screening. Table 8 shows the attributes found to be correlated with a yield-derived stress resistance index in 2-row barley genotypes. The stress resistance index reflects genotype performance under stress, free from the confounding effects of yield potential and earliness.

Currently, the breeder-physiologist team is conducting divergent selection experiments for winter ground cover, plant color in winter and spring, growth habit, growth vigor at the 5-leaf stage, and flowering time. The experiments are designed to evaluate performance and obtain heritability estimates of individual traits and trait combinations for increased selection efficiency in Mediterranean stress environments. About 1,600 F_4 bulks from each of three well-designed crosses are grown in solid-seeded plots at Tel Hadya or Breda, Syria. Fig. 19 shows the distribution of winter plant color for the parents and the F_4 progenies of one of the crosses grown in 1989 at Tel Hadya. Similar selection experiments are conducted for ^{13}C discrimination, a potential indicator of stress resistance and perhaps yield potential as well.

Table 8. Phenotypic attributes associated with a yield-derived stress resistance index in 2-row barley genotypes.

Type of trait	Desired attribute*
Phenological	Short grain-filling period Short crop duration
Morphological	High winter ground cover Initial prostrate growth habit Initial horizontal leaf position Short stature High tillering High number of fertile spikes
Physiological	High above-ground biomass at anthesis High kernel weight High total above-ground biomass at harvest High harvest index High ^{13}C-discrimination Light plant color at anthesis

* With the exception of ^{13}C-discrimination, all traits can be scored visually.



Accurate measurements of transpiration and dry-matter assimilation showed that barley biomass production is inversely related to transpiration efficiency per unit of water vapor pressure deficit.

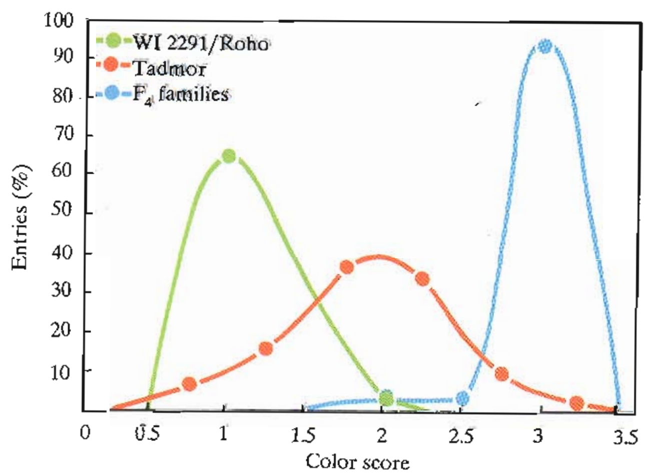


Fig. 19. Frequency distribution of winter plant color of the parents, WI2291/Roho (light green), Tadmor (dark green), and of the 1600 F_4 families derived from the cross, Tel Hadya, 1989. Color scale: 1 = light green; 3 = dark green.

Pathology

Pathologists work in close association with breeders to develop disease-resistant germplasm with the goal of achieving sustainable production in cereal-based farming systems. Testing of advanced wheat and barley material for reaction to major cereal diseases continued at ICARDA's main research sites at Tel Hadya and Lattakia, Syria, and at collaborating institutions within and outside WANA. Several lines with combined resistance to two or more diseases were identified and made available to breeders. Lines showing resistance at various sites are assembled and retested for two to four years and those which prove particularly resistant to specific diseases and possess desirable agronomic traits are pooled, increased, and distributed to users. For 1989/90, a total of 39 sets of the following new germplasm pools for resistance were furnished to collaborators: durum wheat and bread wheat lines resistant to *Septoria tritici,* and durum wheat lines resistant to common bunt.

Barley leaf stripe, caused by *Pyrenophora graminea* is an important disease in many parts of the world, including WANA. Diseased plants appear stunted and bear little or no seed. Varietal resistance is an efficient method of controlling the disease.

Multilocation testing for powdery mildew (*Erysiphe graminis*) resistance confirmed the usefulness of the new controlled environment facilities at ICARDA. Disease scoring in greenhouses at Tel Hadya correlated relatively well with those at nine sites outside Syria. A number of barley lines showed combined resistance both at seedling and adult stages. The work on powdery mildew will be further expanded to cover landraces and wild species with the objective of broadening the genetic base for resistance to this pathogen.

Barley leaf stripe, caused by *Pyrenophora graminea,* is an important disease in parts of Turkey, Ethiopia, Nepal, and other wet and cool areas of the world. Infected plants are stunted and produce little or no seed. Strains of the pathogen from Syria (e.g. 8710C) were found particularly aggressive as they infected the cultivars CI 6306 and CI 0920, previously reported as highly resistant. In contrast, two isolates from Nepal (8901A and 8902B) were ineffective on CI 6944 known for its high susceptibility. Differences in virulence among isolates of different origins, also found with *Rhynchosporium secalis,* point to the risk of screening germplasm in a single location.

Of 2,200 cereal breeding lines evaluated at Tel Hadya for their reaction to BYDV, 34 barley, 17 durum wheat, and 38 bread wheat lines were found tolerant. Useful sources of BYDV resistance were also identified from *Agropyron* and *Aegilops* species.

Entomology

Barley and wheat germplasm was tested under natural and artificial infestation and a number of lines were identified for their tolerance to major insect pests. Collaborative research with NARSs continued, particularly with Egypt and the Sudan on aphids, with Morocco on Hessian fly, and with Syria on wheat ground beetle.

Studies at Tel Hadya showed that wheat stem sawflies occurred more often in durum wheat than in bread wheat or barley. Sawflies of the genus *Cephus* appeared more frequently and earlier in the season than *Trachelus.* Parasite populations in wheat, consisting primarily of the ichneumonid *Collyria orientator* and the braconid *Terebrella* spp., were low and increased only late in the season. Populations of parasites were consistently low in barley.

Two years' research data indicate that both genotype and row spacing affect sawfly infestation in durum and bread wheat. Sawfly resistance was best expressed in widely-spaced plants which had previously been identified as resistant. Lines selected from wheat stem sawfly screening trials for three consecutive years form the core of resistant germplasm pools being developed at ICARDA for use in sawfly-infested regions, or in crossing programs.

Results suggest that the H5 gene contained in cultivar SD 8036 may be effective against Hessian fly in West Asia. A survey in North Africa revealed Morocco, Tunisia, and Algeria to have Hessian fly infestations in barley and wheat. Barley was more infested, but less damaged than wheat. The insect was more frequent in Morocco than in the other two countries.

Applied Biotechnology

The biotechnology work in cereal germplasm enhancement aims at developing and adapting techniques and methodologies that would accelerate and improve the efficiency of breeding. Activities are focused on the production of doubled haploid (DH) lines of barley and wheat using two different methods: anther culture and intergeneric or interspecific hybridization, as complementary tools to conventional breeding methods.

Anther culture in barley, using various cultivars as well as landraces and wild species (*H. spontaneum*), indicated the possibility of producing DH lines from these different sources but pointed to the need for further improving the frequency of green plant regeneration. In bread wheat, cultivars carrying the 1B/1R translocation seem to confer better embryo induction and enhanced plant regeneration (Table 9). Replacing sucrose by maltose in the culture medium enhanced green plant regeneration in genotypes with low aptitude to anther culture in classical sucrose medium, but depressed it in other genotypes.

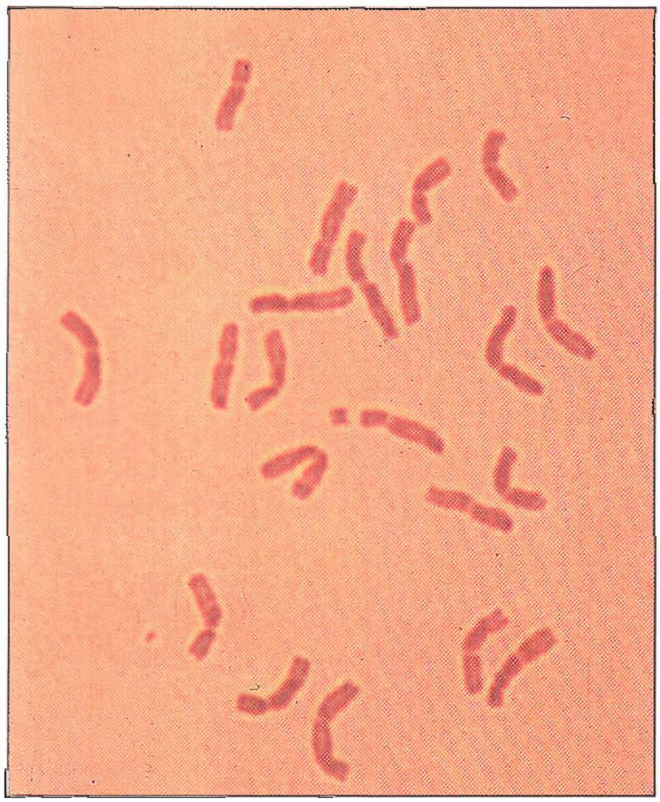
Low regeneration frequency of DH wheat lines through intergeneric hybridization using tetraploid *Hordeum bulbosum* was attributed to frequent cross-incompatibility of *H. bulbosum* with wheat (ICARDA Annual Report 1988, p. 34). Recent literature reports cite successful hybridization of wheat with maize followed by elimination of maize chromosomes.

Table 9. Performance in anther culture of eight bread wheat hybrids[1].

Hybrid	No. of inoculated anther	No. of embryoids per 100 anthers	No. of plants per 100 anthers: Green*	Total
Seri 82/Veery/Sunbird	286	28.0	22.4 a	22.4
Hobhod/Sudan	576	24.5	11.9 b	12.1
Sunbiro/Genaro 81	370	12.4	5.4 c	5.4
Kavkaz/Giguena//Chilero	1009	6.4	1.4 d	1.4
Egvd 14/Roshan	1203	6.1	0.9 de	1.0
Sunbird//Clement/Alondra	446	7.2	0.7 de	0.7
Cham 4/76529A5-3	933	3.7	0.3 e	0.3
Parula/Sonalika	648	5.6	0.3 e	0.3

[1] Composition of anther culture medium: modified MS-nutrient + sucrose 85.5 g/l + glutamine 750 mg/l + myo-inositol 100 mg/l + $AgNo_3$ 10 mg/l + 2,4-D 2 mg/l, solidified and + filter sterilized.

* Values followed by a common letter are not significantly different at P= 0.05.



Somatic chromosomes (2n=21) of a haploid plant produced from the wheat cultivar, Mexipak 65, through the maize cross.

However, the reported technique requires a tedious and sophisticated rescue of immature embryos at a very early developmental stage for haploid plant regeneration. ICARDA has developed a more efficient technique for the wheat-maize cross, based on applying a 100 ppm solution of 2,4-D to wheat spikes following pollination with maize. The technique proved effective with all tested wheat genotypes, including those cross-incompatible with *H. bulbosum* (Table 10). Results with 20 wheat genotypes from the WANA region indicated haploid plant frequencies of 0.2% of pollinated florets for *H. bulbosum* and 9.5% for maize.

Table 10. Effect of 2,4-D treatment on embryo formation frequencies (%) in bread wheat cultivars crossed with *Hordeum bulbosum* or maize.

		Cultivar			
Pollen source	2,4-D treatment	Norin 61	Chinese Spring	Mexipak 65	Highbury
None	-	0.0	0.0	0.0	0.0
None	+	0.0	0.0	0.0	0.0
H. bulbosum	-	23.6	16.9	0.0	0.0
H. bulbosum	+	28.5	25.0	0.0	0.0
Maize	-	0.0	0.0	0.0	0.0
Maize	+	17.5	21.1	18.9	8.3

Haploid production in barley was initiated in 1989 using the interspecific cross with diploid *H. bulbosum*. Table 11 shows the results of an experiment involving 15 barley F_1 hybrids in which 317 haploid plants were regenerated from a total of 7,975 pollinated florets, and their embryos were incubated on a B_5 medium. Efforts will be made to increase the recorded 12.8% regeneration frequency.

Table 11. Production of haploid plants from 15 barley F_1 hybrids through interspecific crosses with *H. bulbosum*.

	Seed set	Embryos	Regenerated plants
Total number	3150	2479	317
Percent	39.5	31.1	4.0
Genotype range	13.7-75.6	6.3-64.9	1.1-15.8

A dihaploid barley plant (left) produced through the *H. bulbosum* technique, and a dihaploid wheat plant (right) produced through the maize cross technique.

International Nurseries

During 1988/89, 1,098 sets of barley and wheat nurseries and 165 sets of specific-trait nurseries were furnished to cooperators in 48 countries upon their request. Approximately 74% of the nursery sets were distributed within the WANA region. These included 3 crossing blocks, 7 segregating populations, 9 observation nurseries, 9 yield trials, and 5 specific-trait nurseries.

To quantify the changing demand for international nurseries, the trend of requests for ICARDA and CIMMYT/ICARDA international nurseries from national programs in WANA over the past 10 years was studied. Written requests for regular international nurseries for 1978/79-1979/80 were averaged and compared with those for 1987/88-1988/89. Adjusted total nursery requests increased by 97% (the non-adjusted increase was 363%), with the highest rate of increase being for yield trials (Fig. 20). During the 1978/79-1979/80 period, the greatest demand was for observation nurseries (31% of total demand), followed by yield trials (30%), crossing blocks (22%), and segregating populations (17%). In the 1987/88-1988/89 period, the proportion of yield trials increased to 36%, while other regular nurseries decreased by 2%.

Since the launching of the first trait-specific Heat Tolerance Observation Nursery in 1987, several other trait-specific nurseries for drought and heat tolerance and for disease resistance have been prepared. The demand for this type of nurseries has been increasing rapidly.

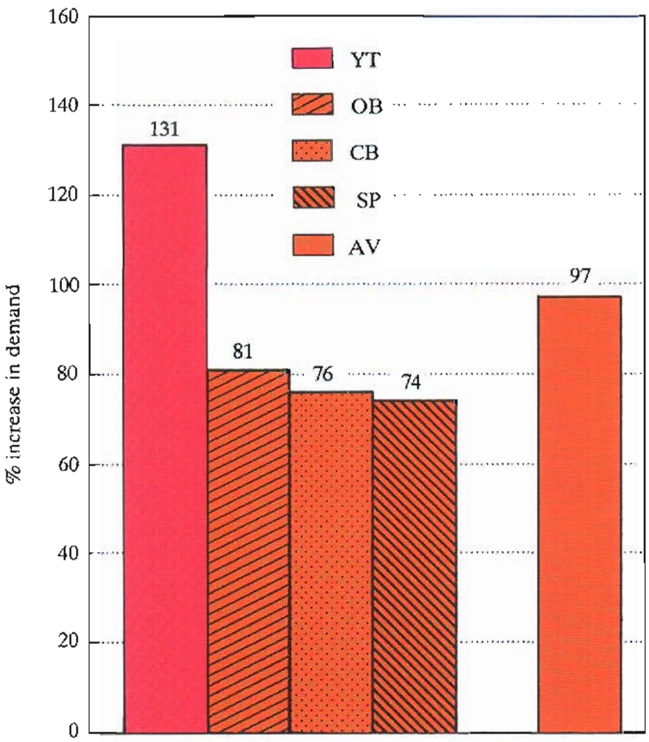


Fig. 20. Adjusted average increase in demand from WANA for the four types of regular international nurseries, 1978/79-1979/80 to 1987/88-1988/89. YT = Yield Trials; OB = Observation Nurseries; CN = Crossing Blocks; SP = Segregating Populations; AV = Average.

Food Legume Crops

Kabuli Chickpea

The importance of winter sowing became particularly evident in the relatively dry 1988/89 season when spring-sown chickpea grown in several areas failed to produce any seed yield. The area under winter sowing was reported to be increasing in several countries of WANA. Adoption and impact studies of winter sowing in Syria and Morocco provided interesting results (see "Impact Assessment and Enhancement" section of this Report).

Winter sowing of new breeding lines over six years (1983/84 to 1988/89) at Tel Hadya and Jindiress, Syria, and at Terbol, Lebanon, consistently produced an average yield increase of 62% (625 kg seed/ha) over the spring-sown crop.

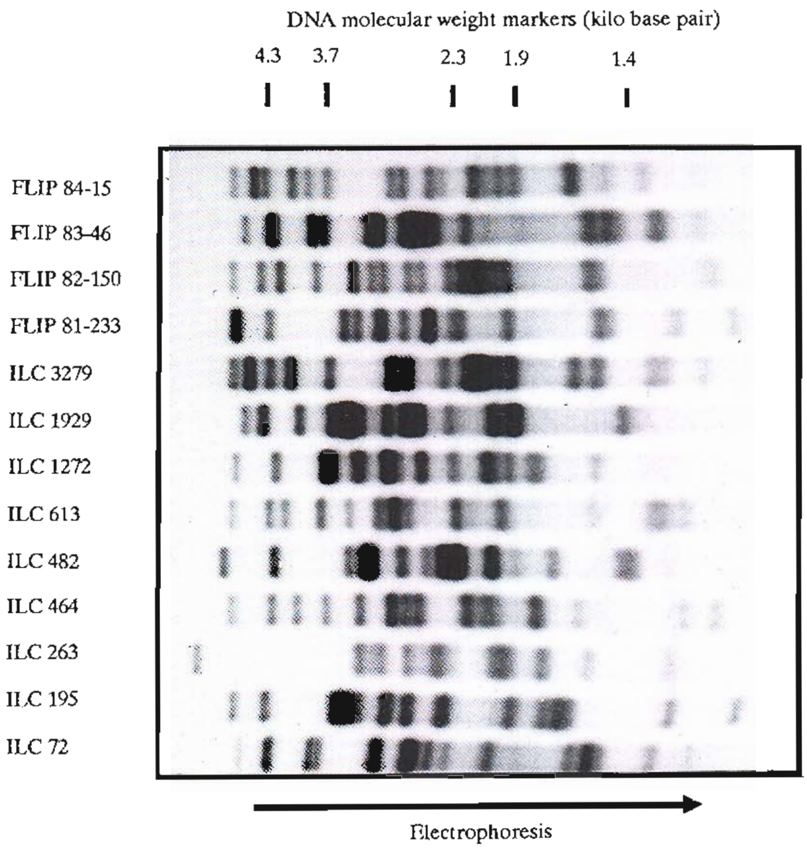
Increased use by NARSs of genetically enhanced material supplied by ICARDA led to the release of six new varieties. With these, the total number of winter chickpea variety releases reached 27 as of 1989 (Appendix 2). In addition, in 1989 the Center furnished 15,595 entries to NARSs in 42 countries for use in their breeding programs; 12 countries selected 42 entries for prerelease multiplication or on-farm testing.

Resistant sources were identified from cultivated and wild species for *Ascochyta* blight, *Fusarium* wilt, leafminer, seed beetle, and cyst nematode as well as cold stress (Table 12). Efforts are under way to transfer genes for resistance from wild to cultivated species using conventional interspecific hybridization as well as embryo rescue techniques. F_2 seeds were produced for the first time from crosses of *C. arietinum* x *C. echinospermum* and *C. reticulatum* x *C. echinospermum,* which marked success in transferring genes from *C. echinospermum* to the cultivated species.

Table 12. Evaluation of annual wild *Cicer* species for resistance to biotic and abiotic stresses.

Stresses	Resistant *Cicer* species
Ascochyta rabiei	*C. bijugum, C. cuneatum, C. judaicum, C. pinnatifidum.*
Liriomyza ciceri	*C. bijugum, C. chorassanicum, C. echinospermum, C. judaicum, C. pinnatifidum.*
Heterodera ciceri	*C. bijugum, C. pinnatifidum, C. reticulatum.*
Callasobruchus chinensis	*C. bijugum, C. cuneatum, C. echinospermum, C. judaicum, C. pinnatifidum, C. reticulatum.*
Cold	*C. bijugum, C. echinospermum, C. judaicum, C. pinnatifidum, C. reticulatum.*
Fusarium wilt	*C. bijugum, C. echinospermum, C. judaicum, C. pinnatifidum, C. reticulatum.*

Opportunity was taken of the 1988/89 season to select drought-resistant lines. The early-maturity selections from the chickpea drought-tolerance project, initiated four years ago, performed well. The line-source sprinkler system proved effective in the study of the response of diverse genotypes to varied moisture supply and the selection of drought-resistant material. Several early-maturity lines showed good adaptation in multilocation testing in southerly latitude areas where earlier ICARDA germplasm had not succeeded.



Genotypic differentiation of 13 chickpea accessions after hybridization with the synthetic oligonucleotide probe $(GATA)_4$. DNA of individual plants was digested with Tag I.

In cooperation with the University of Frankfurt, FRG, research was started on the application of restriction fragment length polymorphism (RFLP) to identify economically important genes in chickpea genotypes and the isolates of *Ascochyta rabiei*. Analysis of 15 chickpea genotypes, using a synthetic oligonucteotide probe, revealed that chickpea has a high degree of polymorphism making it specifically suitable for RFLP analysis.

One spray application of Endosulfan reduced the percent leaves mined by leafminer and increased the seed yield of spring chickpea at three locations in farmers' fields in northern Syria. Studies at Tel Hadya showed that neem seed extract might be an effective alternative to conventional insecticides used for leafminer control. Variations in susceptibility of chickpea genotypes to aphid infestation appeared to be related to the pH of leaf washings--a higher pH indicated a higher susceptibility (Fig. 22).

Studies on dinitrogen fixation in chickpea focused on the identification of an alternative inoculant carrier to peat, and on the host plant genotype and *Rhizobium*

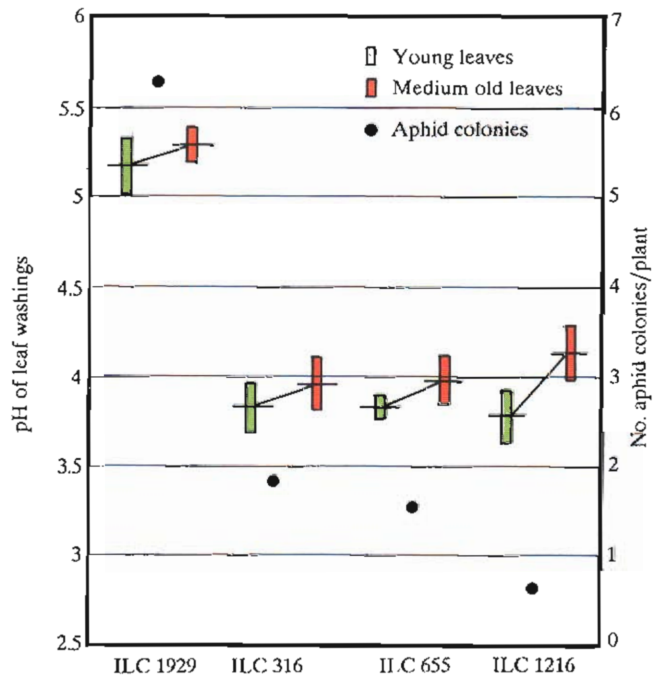


Fig. 22. The pH of leaf washings and number of aphid colonies on four chickpea lines with different degrees of susceptibility to *Aphis craccivora*, Tel Hadya, 1988/89.

strain interactions. A soil sample containing >10% organic matter from the Ghab Valley of Syria, when amended with charcoal, proved equally effective to peat in maintaining high (>10^9/g) populations of chickpea nodulating rhizobia over 126-day periods. Studies on inoculation of a range of chickpea cultivars with different strains of *Rhizobium* showed conspicuous interactions for seed and nitrogen yield responses as well as for the fraction of total nitrogen derived from fixation (Fig. 23), suggesting that through appropriate genotype and *Rhizobium* combinations, biological nitrogen fixation could be considerably improved.

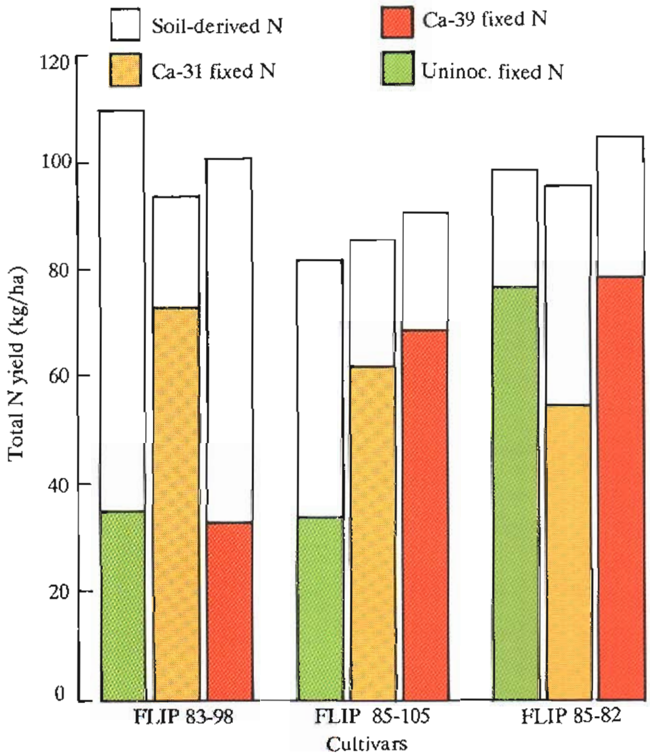


Fig. 23. Effect of inoculation by two strains on nitrogen source in three chickpea cultivars, Tel Hadya, 1987/88.

Lentil

Low average lentil yields in WANA and elsewhere are attributed to poor crop management and inferior yield potential of landraces. In South Asia and East Africa, diseases are also a major production constraint. Accordingly, an integrated approach to lentil improvement is being pursued at ICARDA covering the development of both improved production technology and genetic stocks.

Lentil genotype ILL 4605 (left) survived the rust attack, whereas the local check (right) was completely destroyed by rust in Morocco, 1989.

During 1989, Algeria, Australia, Canada, Chile, and Morocco released lentil cultivars developed from ICARDA-enhanced germplasm (Appendix 2). Cultivars Centinela and ILL 4605 were released in Chile and Morocco, respectively, on the basis of their resistance to rust. Rust screening is conducted in cooperation with the national program of Morocco where the weather conditions permitted a rust epiphytotic to develop in 1988/89.

The lentil breeding program is directed towards the three agroecological zones of WANA (low and medium elevation Mediterranean region, lower latitudes, and high elevation). In 1988/89, over 300 crosses were made to develop targeted segregating populations for these three zones. Four nurseries were assembled for distribution from the material developed.

The subnormal rainfall at Breda and Tel Hadya, Syria, in 1988/89, facilitated selection of breeding lines for drought tolerance, using the line-source sprinkler system. Lines with differences in response to moisture supply are shown in Fig. 24. Special traits associated with better crop performance under drought were identified.

To support genetic improvement work, studies were carried out on variability in lentil growth habit, genotype

Use of a line source sprinkler system at Breda, Syria, proved an effective method for selecting drought-tolerant lentil genotypes.

x environment interaction for the potential feeding value of lentil straw, methods of plant selection, and heterosis. A uniform system was developed for describing lentil developmental stages, to facilitate communication among lentil scientists.

Future genetic improvement in lentil might require transfer of genes from wild species to the cultigen. Studies showed that *Agrobacterium tumefaciens* can be used as a gene vector.

Studies continued on the biology and control of *Sitona crinitus*, a major pest of lentil in the region. Carbofuran effectively controlled the nodule damage from the larvae of this insect. Seed dressing with Promet also proved very promising, and a safer and cheaper method of control than the use of Carbofuran (Fig. 25). Effect of nodule damage control on biological nitrogen fixation is being investigated using ^{15}N methodology.

The ICARDA lentil growing region includes a wide diversity of soils, climates, crop management, and history of lentil production. Indigenous populations of *Rhizobium leguminosarum* should, therefore, be very diverse. Hence, rhizobia were sampled from nodules of lentils growing in seven WANA countries. Symbiotic effectiveness studies under aseptic hydroponic culture

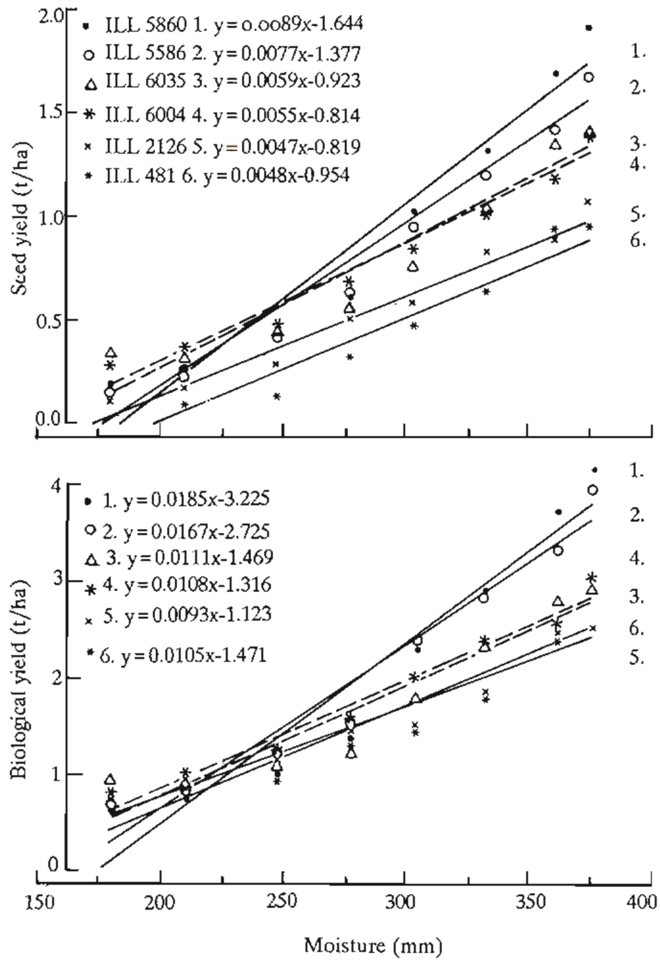


Fig. 24. Relationship between moisture supply and seed and total biological yields of lentil genotypes, Breda, Syria, 1988/89.

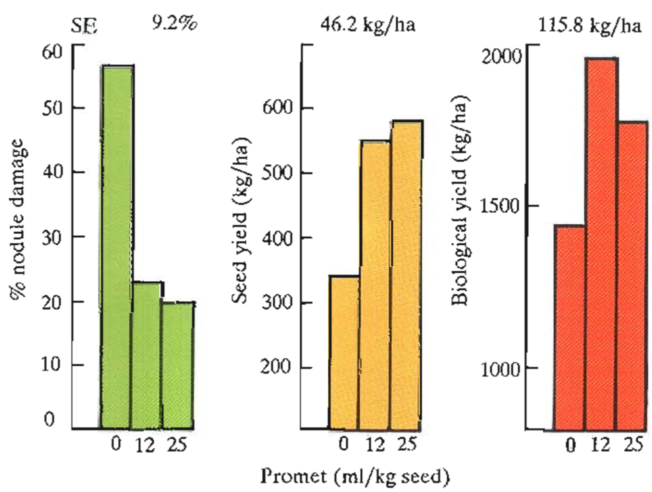


Fig. 25. Effect of Promet application on *Sitona* damage control and lentil seed and biological yields, Tel Hadya, 1988/89.

showed that 50% of the isolates (mostly from Turkey and Jordan) were highly effective, whereas the rest (mostly from Syria, Egypt, and northwest Africa) were moderate to low in symbiotic efficiency. Isolates that could tolerate high temperature (>40°C) and high salinity levels (0.5% NaCl) also were identified. Efficient strains are being studied further for their performance under field conditions. Studies of host plant genotype and rhizobial strain combinations in the field showed significant interactions for yield response.

The cost of hand labor for harvesting is the major lentil production problem in the Mediterranean region. Systems of mechanization developed earlier were tested again in 1988/89, but because of cold and dry winter, the restricted crop growth precluded machine harvest and demonstrated the ecological limits of lentil harvest mechanization.

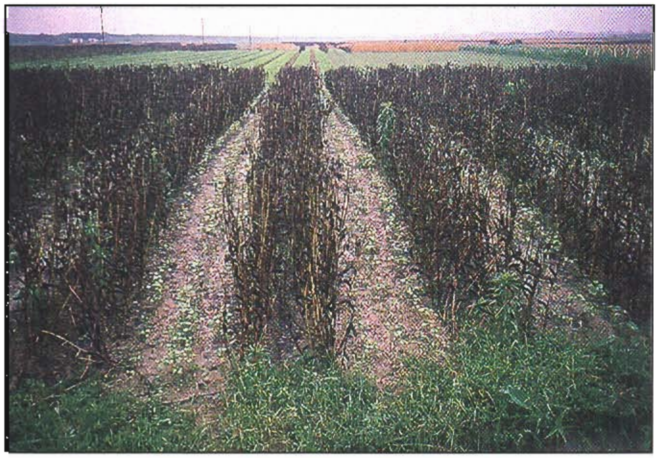
Faba Bean

In pursuance of the Center's decision to phase out faba bean improvement research from its core programs, the ICARDA faba bean breeder and pathologist moved to Douyet Research Station (near Fez in Morocco) in 1989. Simultaneously, faba bean research activities at Tel Hadya and Lattakia (Syria) were reduced. Faba bean work was expanded in other North African countries besides Morocco, in the Nile Valley of Egypt and Sudan, and in the highlands of Ethiopia.

The NARSs continued to use ICARDA-enhanced germplasm. Portugal released the line 80S 43977 as Favel. In southern China, a determinate line (FLIP 84-146 FB) was used in on-farm trials for relay cropping with cotton. Syria conducted on-farm testing of the determinate line 80S 44027 for the second year.

Of the lines available at ICARDA as sources of resistance to one or more of the common faba bean diseases (chocolate spot, ascochyta blight, rust, stem nematodes), 136 were evaluated for IBPGR/ICARDA faba bean descriptors. The data will be published as a catalog for use by NARSs in their breeding programs for disease resistance.

Work on common viruses showed that two pure lines (BPL 756 and 758) were resistant to BLRV and tolerant to BYMV. Four BPLs had a high level of resistance to BYMV. Seed transmission rate of broad bean stain virus was 1.5%, and of BYMV less than 1%. Results of a preliminary study suggested that *Phomopsis* sp. could be a potential biological control agent against *Orobanche crenata* in faba bean.



A determinate faba bean line (FLIP 84-146 FB), developed by ICARDA, is being used for relay cropping with cotton in on-farm trials in southern China.

As part of the Nile Valley Regional Program, 1,100 faba bean lines from Egypt, Sudan, Ethiopia, and ICARDA were screened in the Giza laboratory for resistance to *Aphis craccivora*. Forty lines showed some degree of resistance. In two field experiments with 15

Aphid resistance screening laboratory in Giza, Egypt. Of 1,100 faba bean lines screened in 1989, 40 were found to have varying degrees of resistance.

previously selected genotypes each, up to six genotypes were identified with low aphid infestation and yield reduction. With the most promising lines identified to date, a "Regional Aphid Screening Nursery" will be established and tested in the three participating countries. Five of 114 BPLs screened at Tel Hadya in the plastichouse for resistance to *Aphis fabae* were found to be resistant. One of them was also resistant, and two tolerant, against *A. crassivora*.

Field experiments on response of some promising and diverse faba bean genotypes to different strains of *Rhizobium* again showed significant interactions for seed and nitrogen yield. These results highlighted the potential for exploiting cultivar-strain interactions for improved biological nitrogen fixation, even in an area where the naturalized population of *Rhizobium* is adequate.

Dry Peas

Work continued on evaluating the adaptability of the available pea cultivars to the farming systems of WANA, and on providing the adapted materials to NARSs. From the material supplied, the Sudan released Karima-1 for its northern province.

Of 308 lines evaluated during the season, 14 performed well and were selected for multilocation testing. From preliminary yield trials at Tel Hadya and Terbol, 23 accessions were selected for the Pea Adaptation Trial in WANA for the 1989/90 season.

International Nurseries

International nurseries serve as a vehicle for the dissemination of genetic material and improved production practices to NARSs both within and beyond WANA. The genetic material comprises early segregating populations in the F_3 and F_4 generations, and elite lines with wide and specific adaptation, special morphological or quality traits, and resistance to common biotic and abiotic stresses.

In line with EPR recommendations, distribution of faba bean yield trials and screening nurseries was discontinued in 1989, and only a limited number of nurseries with special characteristics, such as determinate plant type and stress resistance, were distributed for the 1989/90 season.

The chickpea nurseries were diversified with the addition of the following: F_4 Nursery for Southern Latitudes (CIF$_4$N-SL), Screening Nursery for Southern Latitudes in Asia (CISN-SL1), Screening Nursery for Southern Latitudes in Africa (CISN-SL2), Screening Nursery with Extra Large Seed Size for Latin America (CISN-LA), Yield Trials for Southern Latitudes in Africa (CIYT-SL2), and Yield Trials for Latin America (CIYT-LA). For lentil, F_4 nurseries were diversified to include the following: Segregating Populations for Large Seed Size (LIF$_4$N-L), Small Seed Size (LIF$_4$N-S), and Cold Tolerance (LIF$_4$N-CT). A new nursery with sources of resistance to *Fusarium* wilt was also added. Over 1,000 sets of 45 nurseries were dispatched to 47 countries for the 1989/90 season (Table 13).

Table 13. Food legume international nurseries supplied for the 1989/90 season.

	Chickpea		Lentil		Faba bean		Pea	
Trial/Nursery	Types	Sets distributed	Types	Sets distributed	Types	Sets distributed	Types	Sets distributed
Yield Trials	5	136	3	123	-	-	1	38
Screening Nurseries	5	111	4	139	1	51	-	-
Seg. Pop. Nurseries	2	43	4	48	-	-	-	-
Stress Tolerance Nurseries	4	104	3	50	3	58	-	-
Agronomic Trials	3	53	3	50	4	18	-	-
Total	19	447	17	410	8	127	1	38

Resource Management and Conservation

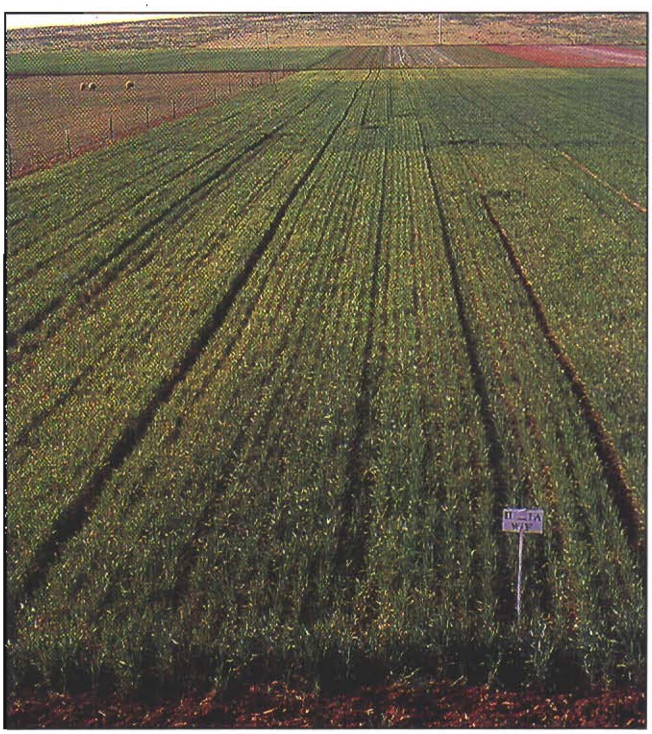
Productivity of Cereal-Based Rotations

Wheat and barley are the two major cereal crops in WANA grown on approximately 35 and 15 million hectares, respectively. Wheat is generally grown in rotations with food legumes where annual rainfall exceeds 350 mm, whereas barley generally follows a fallow year, or increasingly another barley crop, in areas where annual rainfall is 200-350 mm.

ICARDA pays special attention to improved management practices in its research on cereal-based rotations. In the case of barley-based rotations, the Center's focus also includes the use of fallow land to grow annual pastures, such as medics and feed legumes, to reduce the WANA region's increasing dependence on imported livestock feed. In West Asia, farmers generally keep fallow land clean by cultivation, but in North Africa fallows are generally weedy and grazed by ruminant livestock.

At Tel Hadya, there are two on-going wheat-based rotation trials. The first trial, planted on deep soil, incorporates seven rotations: wheat/fallow (W/F), wheat/summer crop (W/S), wheat/chickpeas (W/C), wheat/lentils (W/L), wheat/vetch (W/V), wheat/annual *Medicago* (W/M), and wheat/wheat (W/W). A livestock component in this trial includes stocking rates of 8-10 ewes/ha on medic and, for a short period in spring, 25-30 lambs/ha on vetch. In the second trial, on shallow soil, there are the rotations W/F, W/S, W/V, W/L, and W/M; the annual *Medicago* (medic) pastures in this trial are grazed by ewes and their lambs at a low (4 ewes/ha), medium (7 ewes/ha), and high (10 ewes/ha) stocking rate. Another rotation trial is being conducted near Kamishli in northeast Syria by national scientists assisted by ICARDA. It has the rotations W/F, W/V, W/M, and W/W; the annual medic is stocked at 5, 9, and 12 ewes/ha. Higher stocking rates are possible at Kamishli because the average rainfall, hence productivity, is greater than at Tel Hadya.

On-farm evaluation trials of annual medics, managed by Syrian scientists, farmers, and ICARDA, are being conducted in Idlib Province. These trials are part of another on-going project at Tah near Aleppo; they



Effect of previous crop/fallow on response of wheat to nitrogen application: left, wheat after fallow showing response to nitrogen; right, wheat after medic showing no response to nitrogen, possibly because there was not enough moisture left in the soil for nitrogen to be effective.

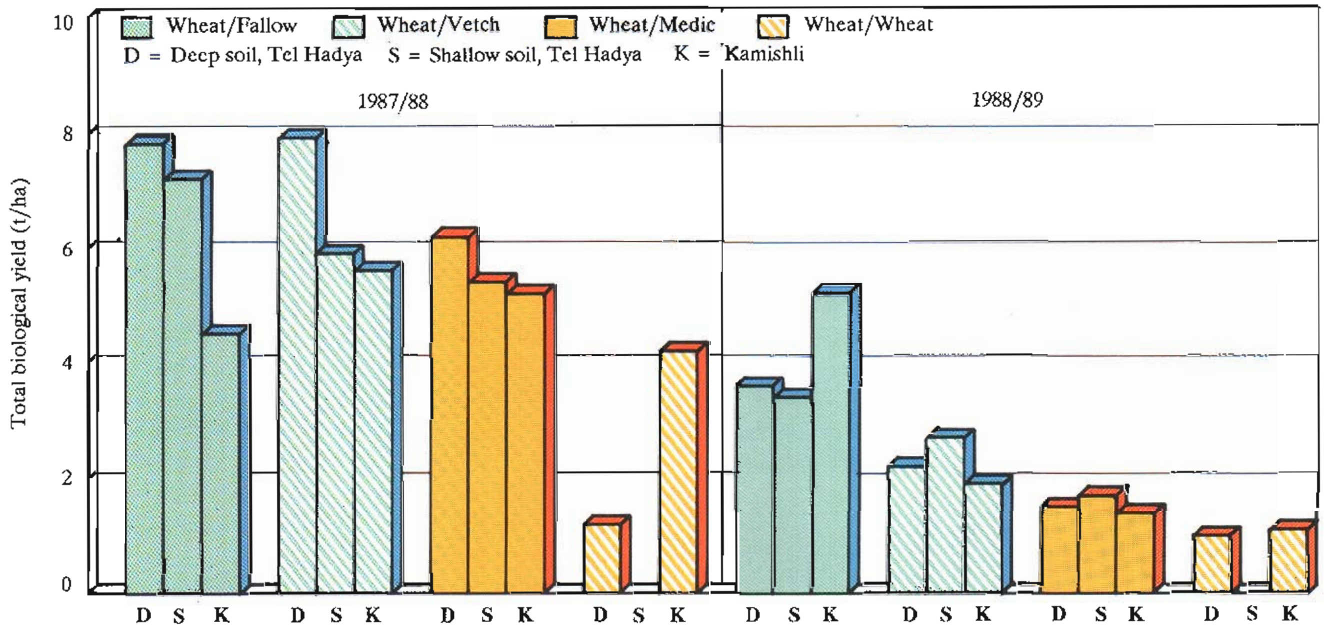


Fig. 26. Wheat yields following different crops at Tel Hadya and Kamishli, Syria, in 1987/88, a wet year, and 1988/89, a dry year. Only rotations common to each soil are shown.

include the rotations W/F, W/S, W/C, W/L, W̄/M, and W/W, and are generally conducted at sites where the average annual rainfall exceeds 300 mm.

In the drier areas of Syria (< 300 mm annual rainfall), on-farm barley-based rotation trials are under way near El-Bab, northeast of Aleppo, also in collaboration with national scientists. The rotations include barley/fallow (B/F), barley/vetch (B/V), barley/medic (B/M), and barley/barley (B/B).

The growing seasons from 1985/86 to 1988/89 were characterized by wide extremes of rainfall and temperature. Rainfall in 1985/86 and 1986/87 was close to the long-term average (349 mm) at Tel Hadya, but 1987/88 was exceptionally wet (504 mm) and 1988/89 exceptionally dry (238 mm) with a very cold period occurring in January and February 1989.

In all rotations at Tel Hadya in both wet and dry years, wheat after fallow consistently produced the best yields, and wheat after wheat the poorest (Fig. 26). A similar finding was reported from the Tah project in 1988/89. In the El-Bab project, barley after fallow also yielded more than continuous barley (Fig. 27). The reasons for the poor yields in continuous cereal rotations are being investigated.

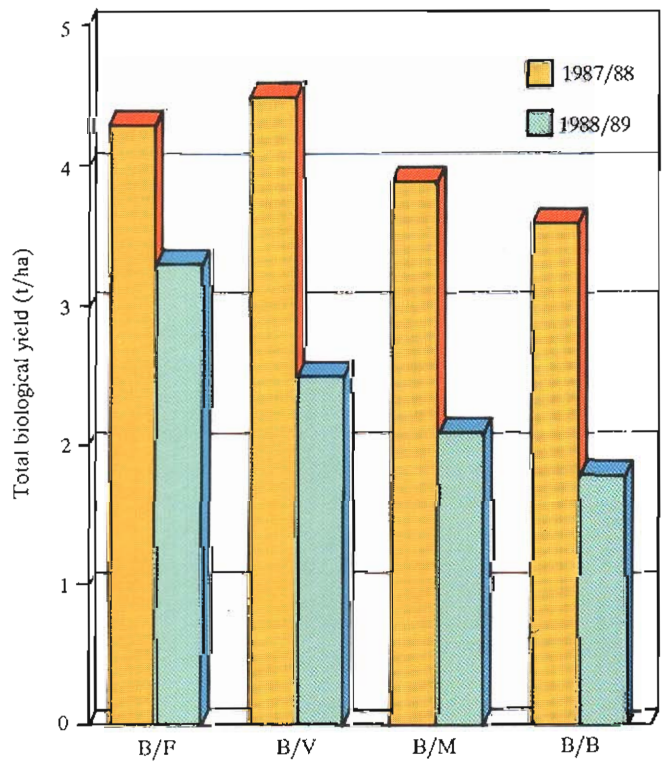


Fig. 27. Barley yields following different crops at El-Bab, northwest Syria, 1987/88 and 1988/89.

Cereals after lentil and vetch at Tel Hadya, Kamishli, and El-Bab yielded more biomass than cereals after medic. This may be due to the fact that lentil and vetch do not completely use soil-stored water, whereas medic removes as much water as wheat. In 1987/88, a wet season, the ranking of legumes was unclear and yields of wheat after medic in the Tah project were higher than after vetch and lentil. However, water was not the sole cause of wheat's low yield after medic, as it is known that wheat plants growing after medic lack vigor, even before tillering, when water is usually abundant.

At Tel Hadya, wheat after legumes responded to nitrogen in three of the four years. These data suggest that the legumes used in the trials contributed little, if any, nitrogen to the next wheat crop. However, in the winter of 1988/89, wheat after medic showed no nitrogen deficiency symptoms, whereas in all other rotations deficiencies were evident at zero and low nitrogen application rates.

The main factor limiting crop production in dryland farming systems is availability of water; rotation research indicates how different crop sequences and agronomic practices affect the efficiency of water use. The variations in the water-use efficiency of wheat growing after different crops or after fallow were small when water use by the fallow was included in the efficiency calculation (Table 14). Nitrogen application increased water-use efficiency for all rotations.

Table 14. Water-use efficiency (kg/ha/mm) for grain production of durum wheat as influenced by rotation, nitrogen fertilizer application, and season at Tel Hadya.

Season	Nitrogen (kg/ha)	W/F	W/C	W/M
1987/88	0	3.9	4.8	5.7
	90	5.8	8.4	8.3
1988/89	0	2.7	1.8	2.0
	90	3.9	2.5	1.4

W/F = Wheat/Fallow; W/C = Wheat/Chickpea; W/M = Wheat/Medic.

Fallows can store substantial amounts of water depending on the season and soil depth. For example, at Tel Hadya water stored after a fallow year for use by a subsequent wheat crop varied from 25 to 170 mm, or 8 to 35% of the previous season's rainfall over four years of the trials. However, even though wheat yields after fallow were higher than after any other crop, such rotations only use half the land area each year and do not necessarily provide the greatest overall economic benefits.

This fact becomes obvious from the calculation of gross margins (gross revenue minus variable costs) from different rotations. The gross margins from the deep soil rotation at Tel Hadya in 1987/88 and 1988/89 are shown in Table 15. These data need to be interpreted with caution because some of the costs associated with the grazing of medic and vetch pastures are not included. Regenerating medic pastures do have the major advantage of eliminating crop establishment costs after the first year. However, costs in the establishment year are likely to be high unless a viable seed industry is developed for the area. The gross margin from the W/V rotation seems to be very attractive due to the high economic returns from the sale of lambs.

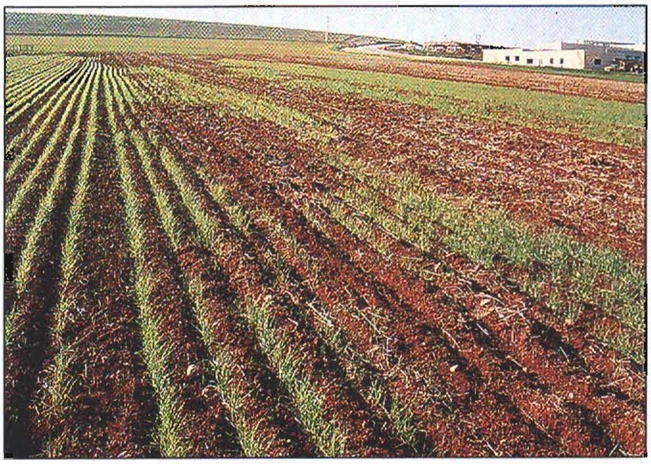
Table 15. Gross margins (x1000 SYP/ha)* from different crop rotations in 1987/88 and 1988/89 at Tel Hadya. (Data are for wheat crops receiving no nitrogen).

Gross margin	Crop rotation				
	W/F	W/V	W/L	W/M	W/W
1987/88	2.9	14.1	5.7	11.6	-1.8
1988/89	1.0	6.2	3.1	2.6	-2.0

* SYP 11.2 = 1 USD

The next best rotations were W/L and W/M, although W/F at a high level of nitrogen application to wheat gave a gross margin as high as W/L. The W/W crops were decimated by the larvae of wheat ground beetle, *Zabrus tenebroides*, in 1987/88. Clearly, continuous cereal growing is an unsustainable farming practice although many farmers, especially in the driest areas of Syria, grow continuous barley with minimum inputs just to produce some feed.

The high prices of meat and milk products in West Asia make wheat/medic and wheat/vetch rotations particularly attractive. Lamb weight gains of 100 to 360 kg/ha can be achieved from vetch pastures. At high stocking rates, over 370 kg/ha of lamb weight gains and 400 kg/ha of milk can be achieved from medic pastures



Damage to wheat crop by larvae of the wheat ground beetle, *Zabrus tenebroides*, Tel Hadya, 1989.

(Table 16). These products more than compensate for any reduction of wheat yields after medic. The number of grazing days on medic pastures exceeded 2,800/ha in 1987/88 at Tah, equivalent to a stocking rate of about 15 ewes/ha during the six-month period in which these pastures support grazing in areas receiving 350-400 mm annual rainfall.

Table 16. Outputs of sheep products from annual *Medicago* (medic) pastures and feed legumes in different years and trials (kg/ha).

	Lamb gain		Milk		Wool	
	87/88	88/89	87/88	88/89	87/88	88/89
Annual medic pastures:						
Tel Hadya (ewes+lambs)	258	113	200	104	-	-
Tel Hadya (ewes+lambs):						
- 4 ewes/ha	192	127	192	43	9	8
- 7 ewes/ha	263	188	349	108	15	15
- 10 ewes/ha	373	274	402	85	22	21
Kamishli (ewes+lambs):						
- 5 ewes/ha	-	58	-	75	-	10
- 9 ewes/ha	-	111	-	135	-	16
- 12 ewes/ha	-	151	-	235	-	23
Feed legumes:						
Tel Hadya (lambs)	361	246	-	-	-	-
El Bab (lambs)	324	104	-	-	-	-

Note: Annual rainfall at Tel Hadya, El Bab, and Kamishli was 504, 465, and 699 mm in 1987/88, and 234, 201, and 245 mm in 1988/89, respectively.

However, the rate of adoption of these new feed producing systems will depend on the availability of seed and on how fast the farmers become familiar with the improved medic pasture grazing management practices.

Improved Management of Chickpeas

Chickpea is grown on 2 million hectares in WANA, or about 24% of the total world area. However, the average yield of 750 kg/ha in farmers' fields is far below the 4,000 kg/ha achieved in researcher-managed plots with improved varieties and crop management practices. To investigate the management factors affecting yield, a four-year study was conducted in northwest Syria. The factors examined included the effects of sowing date and method, weed control, inoculation, and phosphate application. Replicated factorial trials were conducted on farmers' fields, with each trial receiving 16 treatment combinations.

In 28 of the 30 researcher-managed on-farm trials, winter sowing produced significantly higher yields (Table 17). However, effects of inoculation were small and inconsistent. Weed control was one of the most important factors, and hand weeding the best option because the crop was sensitive to herbicides. However, hand weeding may not be practical for farmers because of the scarcity and high price of labor. Crop yield responses to phosphate application were significant only in the first three years of the trials, but were erratic with 7 of 30 trials that showed positive responses. Early-sown

Table 17. Yields of chickpea grain (kg/ha) under different management practices in northwest Syria (1985/86 - 1988/89).

Management practice		85/86	86/87	87/88	88/89
Sowing time	Winter	1409**	1797**	1519**	972**
	Spring	1108	1335	997	822
Weed control	None/hand	1198**	1634**	1294**	938**
	Herbicide	1400	1498	1221	855
Phosphate	0	1237**	1471**	1208**	904
(kg P_2O_5/ha)	50	1360	1660	1307	889
Inoculation	None	1265	1594	na	na
	With	1332	1538	na	na
Sowing method	Broadcast	na	1490**	1200**	853**
	Planter	na	1641	1315	940
LSD (P=0.05)		67	54	49	36

** P = <0.01.
na = not available.

chickpea responded more to phosphate application than the late-sown, probably because of its greater nutrient requirement and larger yield potential.

The amount of risk associated with the different agronomic practices was analyzed by plotting average net revenues against the standard deviation of the net revenue. In three of the four years, the standard deviation of net revenue increased as the average net benefit increased, indicating that yield variability increased with the increase in the number of improvements in management practices. The low-input combinations (cluster 1, Fig. 28) were distinct from the high-input combinations (cluster 2) which included mainly winter sowing treatments.

This research indicates how winter sowing, combined with a new cultivar ILC 482 which is tolerant to cold and *Ascochyta* blight, can offer a substantial boost to net revenue. Revenues are increased even more when both weed control and phosphate fertilizer are applied. In addition, replacement of the traditional hand-broadcasting method of sowing with a precision drill can further enhance productivity and economic returns.

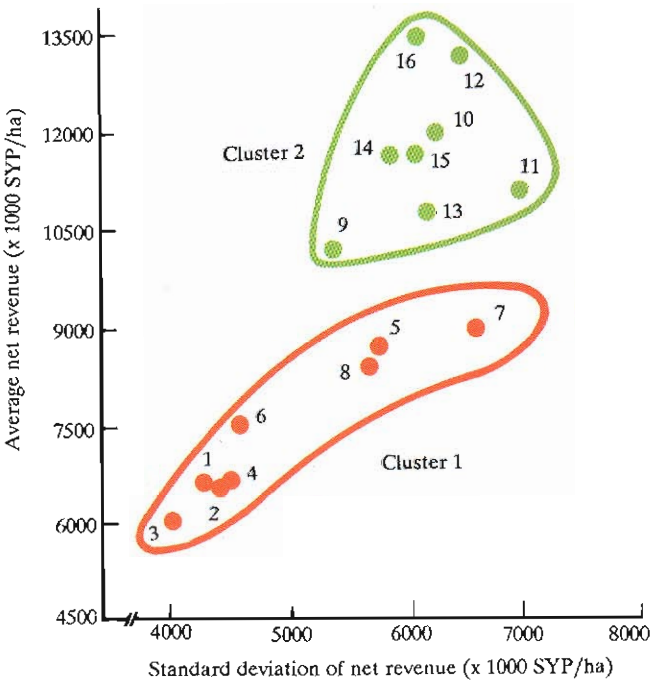


Fig. 28. Average net revenue and the standard deviation of net revenue of different combinations of agronomic treatments (kg/ha). Cluster 1 indicates the spring sowing treatment combinations and cluster 2, the winter sowing treatment combinations.

On-Farm Fertilizer Research on Barley

To assess the biological and economic response of barley to nitrogen and phosphate fertilizers, 75 on-farm trials were conducted between 1984/85 and 1987/88 in Zones* 2 and 3 of Syria. The trial sites represented a range of rainfall conditions, soil types, soil fertility status, and cropping sequences (barley-barley and fallow-barley). Each site was characterized for environmental variables that could affect fertilizer response. Each trial comprised two replicates of the 16 factorial combinations of four rates each of nitrogen (0, 20, 40, and 60 kg N/ha) and phosphate (0, 30, 60, and 90 kg P_2O_5/ha) fertilizers.

Agronomic analysis of yields revealed that seasonal rainfall, soil type, soil fertility status, and crop sequence all had important effects on crop growth. In particular, yields increased with rainfall (range: 136-568 mm; mean: 248 mm) to a maximum at 400-450 mm. Rainfall-use efficiency (kg yield/ha/mm) also increased, up to a maximum at about 350 mm (Fig. 29). This analysis highlights one major problem of dry areas and dry years: not only is there less rainfall but that rainfall is less effectively used. However, results from these trials show that fertilizer application greatly increases rainfall-use efficiency.

Of 75 trials, 74 produced a significant grain or straw yield response to fertilizer, either to N or P or both. In general:

(a) the importance of N increased and that of P decreased with increasing rainfall; but response to N and P applied together increased with rainfall (Fig. 30);

(b) N was more important in the lower-yielding barley-barley rotation than in fallow-barley rotation, though not by a wide margin;

(c) P was most important, and N least important, in gypsiorthid soils (as compared with calciorthid and xerochrept soils);

(d) initial soil status of available phosphate (Olsen) and mineral-N influenced barley response to fertilizer.

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* Zone 2: Rainfall between 250 and 350 mm and not less than 250 mm in two years out of three.

Zone 3: Rainfall more than 250 mm and not less than this in one year out of two. (see also Table 27.)

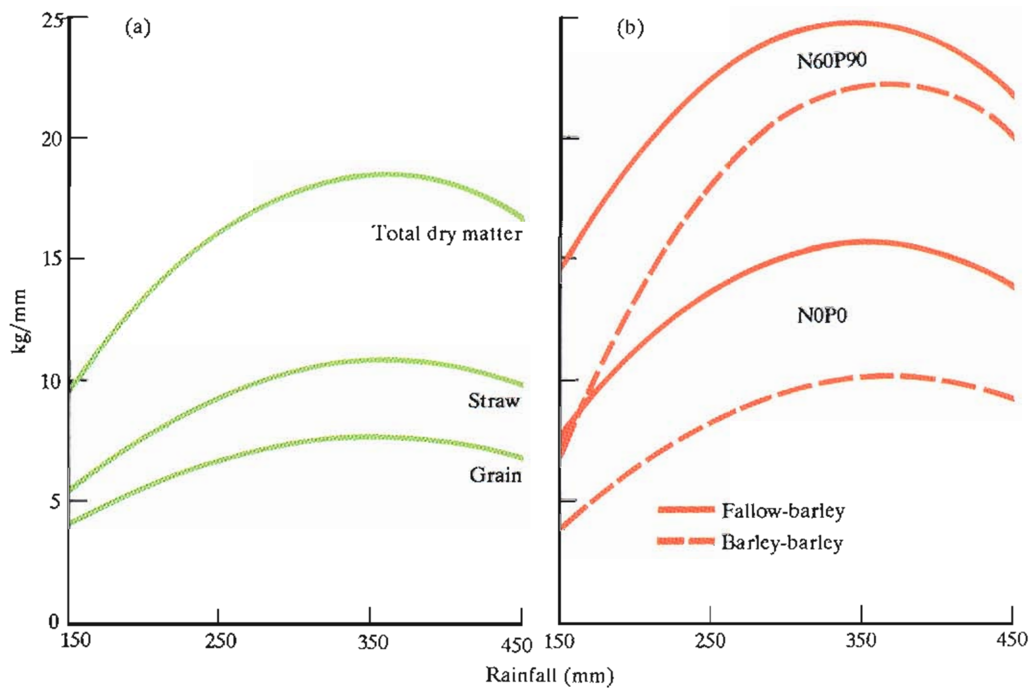


Fig. 29. Relationship of rainfall-use efficiency (kg/ha/mm) to total seasonal rainfall in Zones 2 and 3 of Syria, 1984/85-1987/88: (a) means for grain, straw, and total dry matter over all 16 fertilizer treatments; (b) values for total dry matter for zero fertilizer and N60P90 fertilizer treatments in fallow-barley and barley-barley rotations.

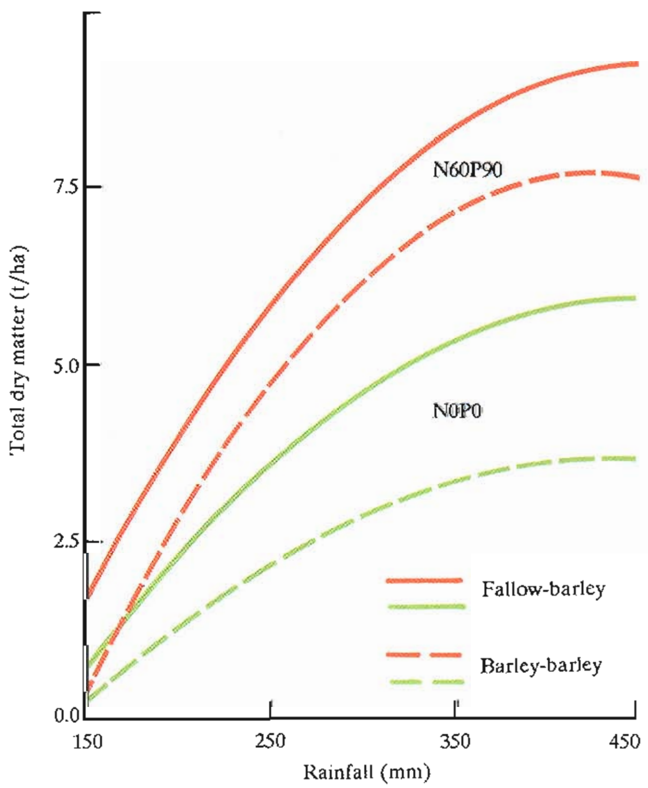


Fig. 30. Relationship of total dry-matter yield to rainfall under zero and high fertilizer regimes in fallow-barley and barley-barley rotations in Zones 2 and 3 of Syria, 1984/85-1987/88.

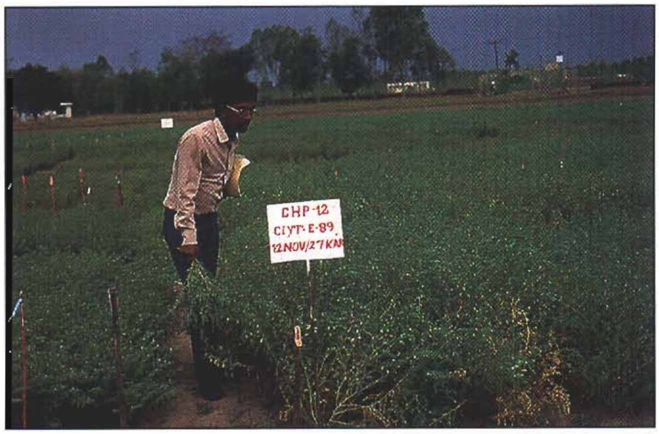
These analyses show that barley generally responds well to fertilizer, but that the size and statistical significance of the response depends on environmental conditions, rainfall, soil, and preceding crop. For better understanding and for practical application, it is useful to express these relationships quantitatively as equations or models. Accordingly, simple quadratic regression models that express yield in terms of fertilizer rates and rainfall have been developed for alternative sets of environmental conditions. They have two different aims:

(i) Descriptive: to distinguish the separate and interacting effects of fertilizer and various environmental factors on crop performance.

(ii) Predictive: to indicate how barley will respond to future applications of fertilizer.

The dual aim leads to two different approaches to the definition or utilization of these models, since not all information available for retrospective description is available for prediction. This is obviously true for rainfall, but may also apply in many cases to soil parameters.

F$_1$ progeny from a cross between the wild *Cicer echinospermum* and cultivated *C. arietinum* species of chickpea.



Performance of kabuli chickpea lines in the CIYT-E-89 in Nepal.

Studies continued on the pathogenic variability in *Ascochyta rabiei* under controlled environmental conditions, using six single-spored isolates on the currently available host differential set of nine genotypes. Isolate-3 was the weakest, and isolate-6 most aggressive (Fig. 21). The results indicated that there was no reversal of ranking in the genotypes with different strains. Therefore, screening breeding material against the most aggressive isolate-6 should be sufficient to identify resistant genotypes.

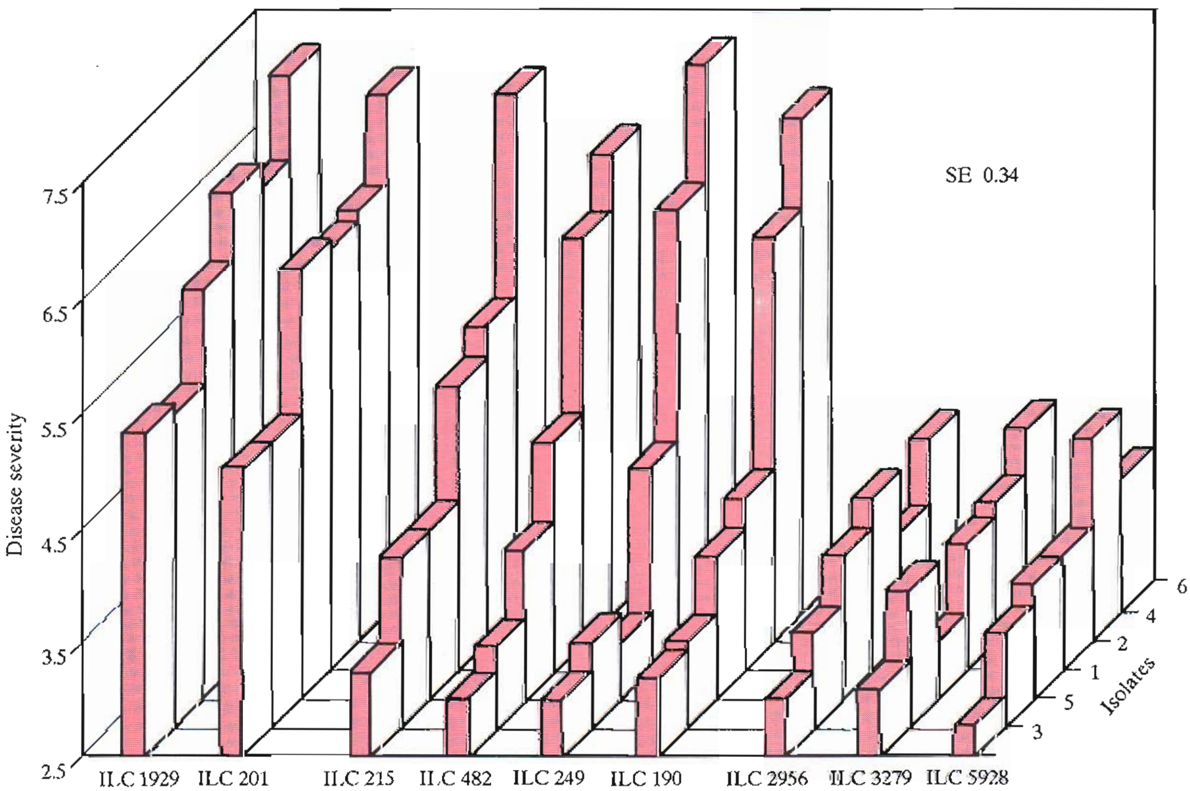


Fig. 21. Host-pathogen interaction between nine chickpea genotypes and six single-spored isolates of *Ascochyta rabiei* in controlled environmental conditions at Tel Hadya, 1988/89. Disease severity was recorded on a single-plant basis nine days after inoculation on a 1-9 rating scale. Values in the figure are means of four replicates.

The most useful form of the descriptive model is:

$$Y = aN + bP + cNP + dN2 + eP2 + fR + gR2 + hRN + iRP + const...Eqn\ 1$$

where N and P represent rates (kg/ha) of fertilizer N and P_2O_5 applied, R is total seasonal rainfall, and a, b, c, d, e, f, g, h, and i are derived coefficients. Such equations have been found to account for between 55 and 75% of the observed variability of barley yields, depending on the subset of trials concerned. Subsets may be chosen to demonstrate the effects of particular environmental factors, e.g., soil type, crop rotation, and initial soil content of available N and P. The curves comparing rainfall response in Fig. 30 are based on equations derived separately from data from 28 barley-barley trials and 47 fallow-barley trials.

There are other ways of representing the relationships described by such equations. Two examples: isoquants for grain yield increase over the zero-fertilizer control treatment for both rotations at three rainfall values (the 75-trial mean and one standard deviation above and below) are shown in Fig. 31; and the effect of rainfall on the grain yield response per unit of applied fertilizer, in Fig. 32.

For predictive purposes, the unpredictability of rainfall requires either that those terms in the descriptive equation that involve rainfall be omitted or that substitutions be made of appropriate rainfall values. These might simply be the means for the area concerned. Where long-term rainfall records are available, however, it is better to use them to generate rainfall probabilities and, from these, yield and fertilizer response probabilities. An example of this is given in Fig. 33 for two stations in northern Syria. Provided there is a sufficient density of stations with long-term rainfall records, maps of rainfall probability could be translated into maps of fertilizer response probability. (The use of ICARDA's spatial weather generator to achieve such maps is discussed in the "Agroecological Characterization" section of this Report.)

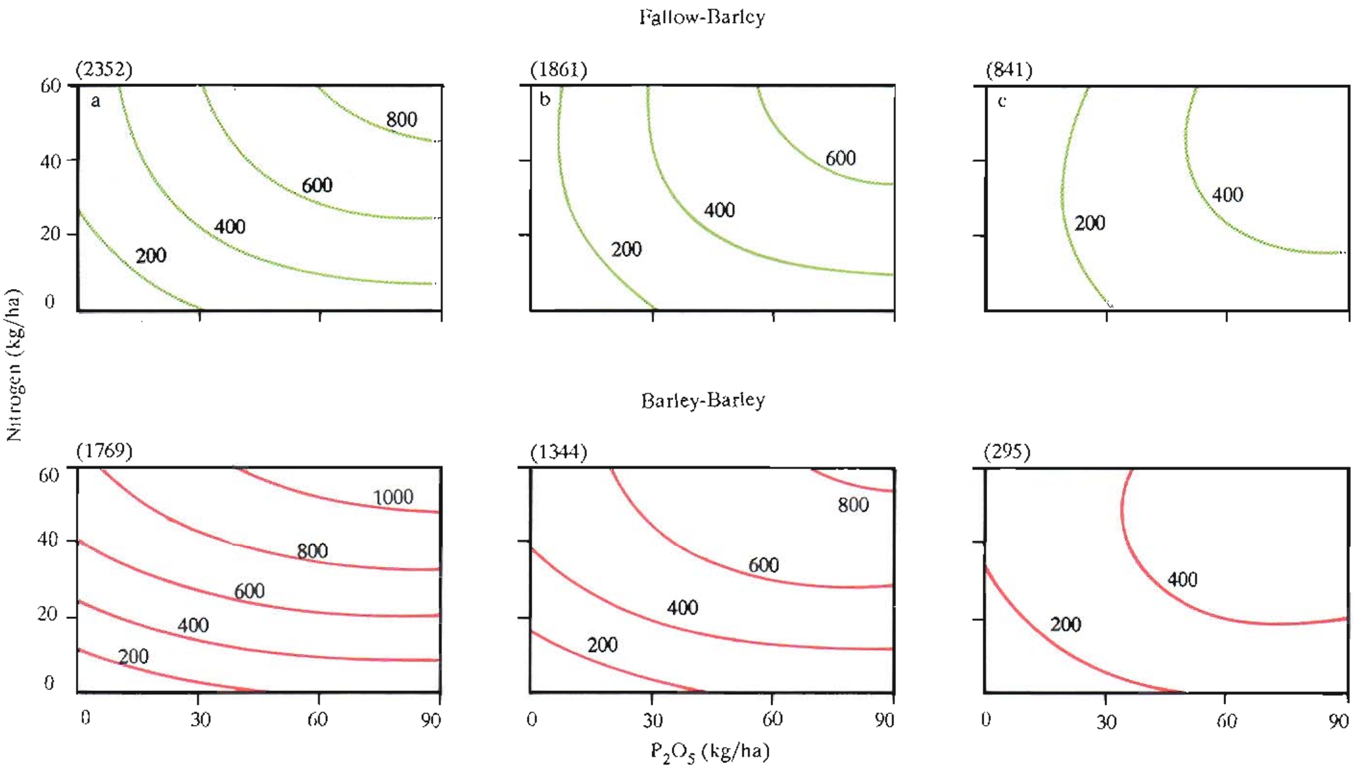


Fig. 31. Isoquants for grain yield increase over zero-fertilizer control in two rotations at three different seasonal rainfall values: a, 284 mm; b, 384 mm; c, 184 mm (i.e., 75-site mean + 1 standard deviation). Numbers in parentheses indicate zero-fertilizer control yields in that rotation for that rainfall value.

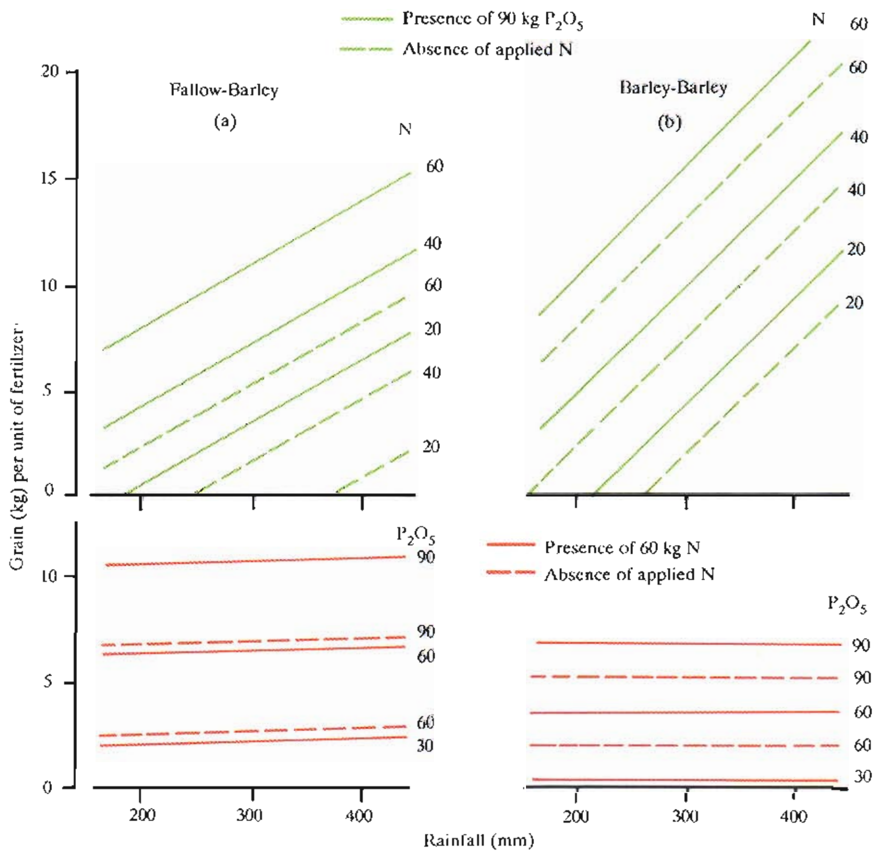


Fig. 32. Effect of rainfall and rotation on grain yield production per unit of fertilizer nutrient: (a) response to N at three rates of application in the presence of 90 kg P_2O_5 and in the absence of applied P; (b) response to P at three rates of application in the presence of 60 kg N/ha and in the absence of applied N.

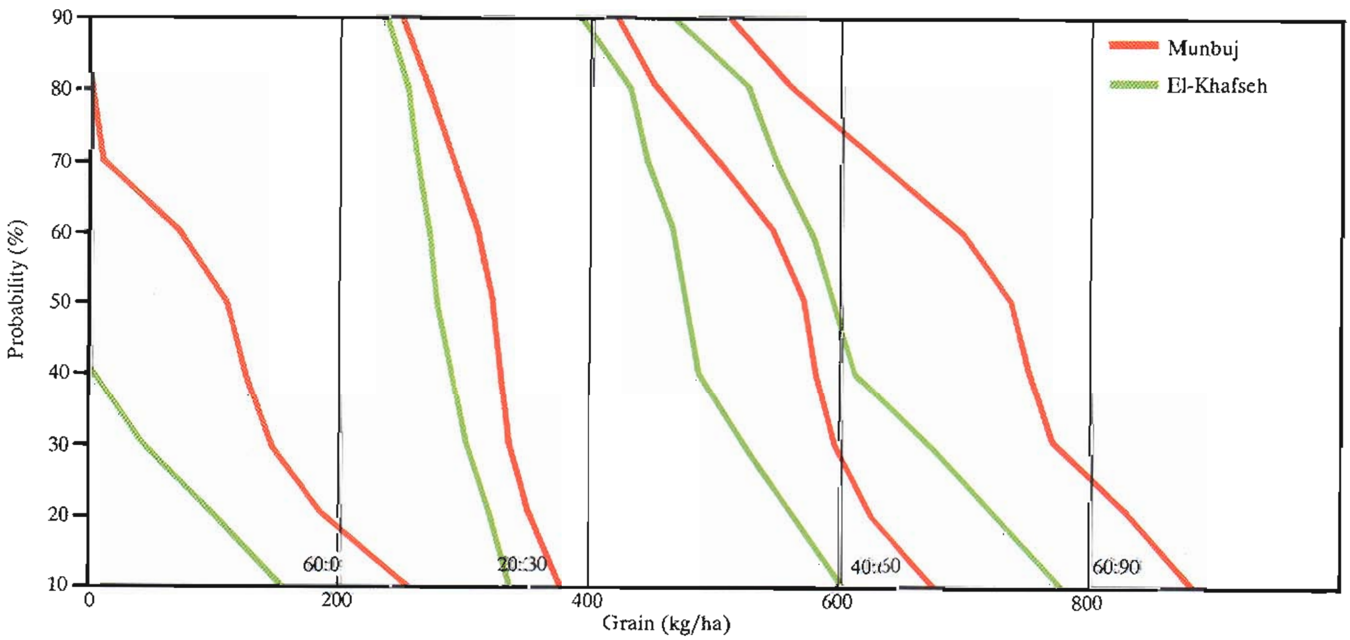


Fig. 33. Probabilities of grain yield increases over control from four fertilizer treatments applied to barley in fallow-barley rotation at Munbuj and El-Khafseh.

Dinitrogen Fixation and Nitrogen Balance in Cool-Season Food Legumes

Understanding the magnitude of N_2 fixation and export of plant N, particularly in harvested grain and straw, is necessary to assess the potential of grain legumes to contribute to long-term agricultural production stability. Proportions of total plant N derived from N_2 fixation in faba bean, chickpea, lentil, and pea were estimated using ^{15}N dilution methodology in field experiments at Tel Hadya during 1986/87 and 1987/88, and at the ENSA-INRA station in Montpellier, France, in 1986/87.

Crops and production practices included: (i) winter- and spring-sown chickpea cultivar ILC 482; (ii) large- and small-seeded cultivars of faba bean (Syrian Local Large and Lebanese Local Small); (iii) near-isogenic leafed and semi-leafless varieties of field pea (Frisson and Baff, respectively), and (iv) lentil cultivar ILL 8 with and without Carbofuran application for sitona larvae control. Chickpea grown in Syria was inoculated with a *Rhizobium* strain selected at ICARDA for high N_2 fixation. Nitrogen fixation in legume crops was determined using the 'A-value' methodology. The proportion of plant N derived from dinitrogen fixation (%Ndfa) vs. that obtained from soil (%Ndfs), as calculated from ^{15}N data, gives an indication of symbiosis efficiency under given environmental conditions.

On average, pea and lentil derived 70% of plant N from the atmosphere (Table 18), a reasonable N_2 fixation efficiency under field conditions. In lentil, Carbofuran did not improve N_2 fixation or total N production (Table 19) because sitona infestation remained low in all trials. Dinitrogen fixation in faba bean was more variable between trials, but the large-seeded type was consistently more efficient than the small-seeded type (Table 18). The %Ndfa obtained in France for faba bean (92% for the large-seeded type) was much higher than in Syria, though the reverse trend was observed for pea, lentil, and winter-sown chickpea. Variability between treatments in N_2 fixation efficiency was greatest in chickpea. Winter sowing improved %Ndfa in all trials. The improvement associated with winter sowing was most important under Syrian conditions where %Ndfa increased by a factor of 3 in 1986/87 and by 10 in 1987/88. Winter sowing also increased total crop N amplifying the effect of this improved practice on the quantity of N fixed (Table 19). In 1987/88, a typical year for northern Syria, yields of N derived from N_2 fixation were 3 and 89 kg/ha, respectively, for spring- and winter-sown crops.

Table 18. Percent N derived from N_2 fixation for different crops in three field experiments.

Crop	Treatment	% N derived from N_2 fixation		
		France 86/87	Syria 86/87	Syria 87/88
Chickpea	Winter-sown	55	81	80
	Spring-sown	44	27	8
Pea	Leafed	63	70	72
	Semi-leafless	69	74	70
Lentil	+ Carbofuran	63	68	75
	- Carbofuran	69	71	71
Faba bean	Large-seeded	92	76	72
	Small-seeded	88	65	63

The effect of legume crop on the N content of soil will be the balance between N input (from fixation) and N output during crop growth. This was estimated by calculating a simplified N balance for each crop using the following formula:

Soil N gain/loss = N from fixation + N from planted seed - N exported in harvested seed or seed + straw

Calculations of nitrogen balance, defined as net gain or loss of soil N as a result of legume crop grown, are reported in Table 19, both for a grain crop (with harvest removal of seed only) and for a dual-purpose crop (where both seed and straw are exported from the field). The latter case is prevalent in countries of West Asia and North Africa, where crop residues are utilized for animal feed and/or fuel.

Associated with increased %Ndfa in winter-sown chickpea in Syria (Table 18) was an improved N balance of 13 to 33 kg N/ha over the spring-sown crop (Table 19). In Montpellier, where %Ndfa values were low for chickpea, the largest soil N losses were calculated for both winter- and spring-sown crops. In the trials in Syria, winter sowing increased N_2 fixed by 20-30 fold over spring sowing, while total seed N increased by a factor of only 3-6, resulting in a net soil N gain in the winter-sown and a net loss in the spring-sown crop.

In WANA, these legumes are often harvested by hand, particularly where straw is utilized as animal feed

Table 19. Simplified N balance (kg/ha) calculated for a "grain crop" (export of seeds only) or for a "dual-purpose crop" (export of seeds and straw).

Crop	Treatment	Location and year	N from N_2 fixation	N from planted seeds	N exported with seeds	"Grain crop" Soil N gain/(loss)	N exported with straw	"Dual purpose crop" Soil N gain/(loss)
Chickpea	Winter-sown	France 86/87	74	10	115	(31)	13*	(44)
		Syria 86/87	115	4	110	9	32	(23)
		Syria 87/88	89	4	81	12	30	(18)
	Spring-sown	France 86/87	49	10	103	(44)	10	(54)
		Syria 86/87	6	4	18	(8)	3	(11)
		Syria 87/88	3	4	28	(21)	7	(28)
Pea	Leafed	France 86/87	126	8	146	(12)	53	(65)
		Syria 86/87	34	2	41	(5)	7	(12)
		Syria 87/88	62	2	70	(6)	16	(22)
	Semi-leafless	France 86/87	111	8	121	(2)	40	(42)
		Syria 86/87	33	2	32	3	12	(9)
		Syria 87/88	60	2	70	(8)	16	(24)
Faba bean	Large-seeded	France 86/87	181	17	154	44	42	2
		Syria 86/87	88	12	72	28	45	(17)
		Syria 87/88	133	12	140	5	44	(39)
	Small-seeded	France 86/87	165	6	152	19	35	(16)
		Syria 86/87	78	5	78	5	42	(37)
		Syria 87/88	103	5	131	(23)	33	(56)
Lentil	+ Carbofuran	France 86/87	133	7	125	15	85	(70)
		Syria 86/87	90	5	60	35	72	(37)
		Syria 87/88	108	5	96	17	47	(30)
	- Carbofuran	France 86/87	147	7	152	2	61	(59)
		Syria 86/87	101	5	67	39	76	(37)
		Syria 87/88	88	5	93	0	31	(31)

* This value of N exported with straw is different from maximum N produced because of leaf drop during desiccation.

or fuel. Straw removal was simulated by subtracting straw N from the N balance to obtain an estimate of soil N gain or loss in a 'dual-purpose' legume crop situation. The results (Table 19) demonstrate the impact that total legume crop removal may make on soil N availability for a following crop.

In the dual-purpose cropping situation, nearly all treatments effected a negative soil N balance, with utilization of up to 70 kg N/ha from soil. This soil N loss effect is of great importance in the case of crops with high quality straws such as lentil (in which soil N loss was calculated to be 30-70 kg N/ha), and will likewise apply to a forage legume crop, such as vetch, grown for hay. Any practice involving removal of the majority of above-ground plant material will result in a net loss of soil N, unless %Ndfa is extremely high.

The general trend with quantities of N_2 fixed was to approximately balance N in the harvested grain, particularly under Syrian conditions (Figs. 34 and 35). This implies that the actual legume N contribution in 'dual-purpose' cropping systems is minimal, with savings coming only from conservation of the soil N pool. The considerable variation in N balance of treatments where only grain is exported (from 44 kg N/ha gain to 44 kg N/ha loss), however, indicates the potential effects of a legume crop, grown for seed, on a succeeding crop.

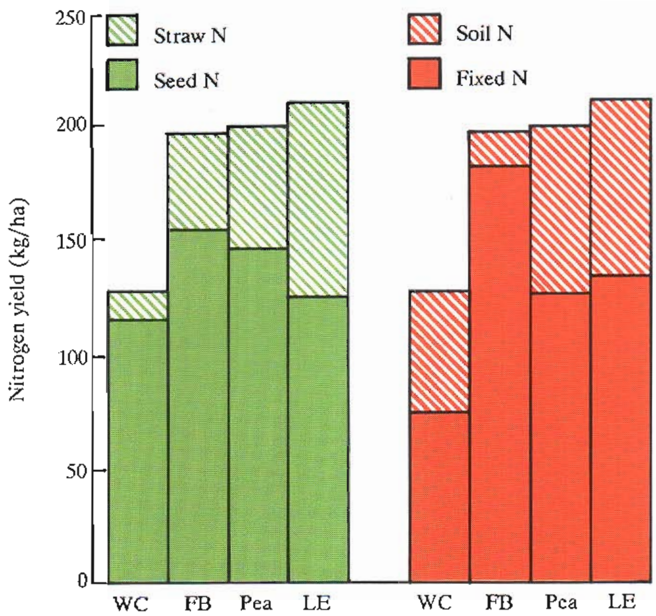


Fig. 34. Crop nitrogen distribution and source for winter chickpea (WC), large-seeded faba bean (FB), leafed-type pea, and lentil (LE) with Carbofuran in the Montpellier trial, 1986/87.

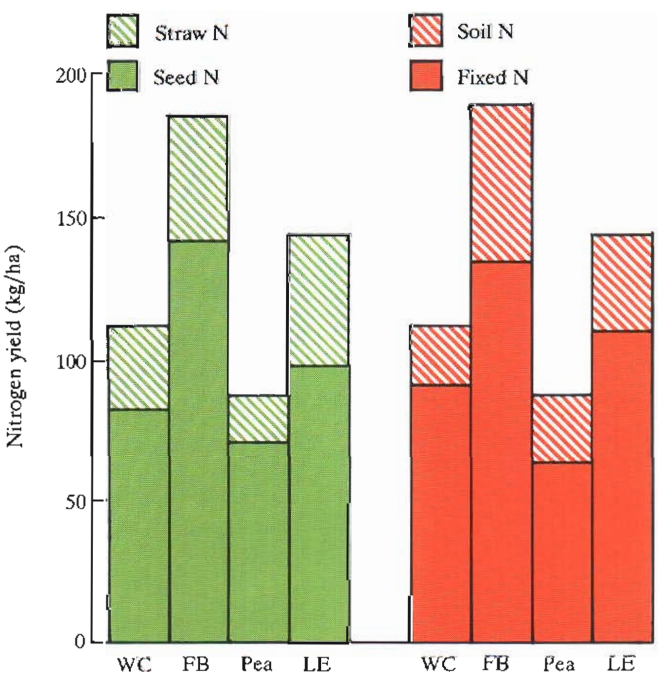


Fig. 35. Crop nitrogen distribution and source for winter chickpea (WC), large-seeded faba bean (FB), leafed-type pea, and lentil (LE) with Carbofuran in the Tel Hadya trial, 1987/88.

Seed Banks of Mediterranean Grasslands

Plant numbers are known to be one of the factors determining the productivity of grasslands. It was, therefore, instructive to see how phosphate application to a Mediterranean grassland at Tel Hadya over a five-year period affected seed mass and seed numbers (Table 20). Seed mass changed very little during the period when no phosphate fertilizer was applied and the increase in seed numbers was modest. However, at the highest level of fertilizer application, seed mass per unit area increased four times between 1985 and 1989, whereas seed numbers increased six times.

Table 20. Changes over a 5-year period of the seed mass and seed number of legumes in a grassland that received three levels of phosphate fertilizer at Tel Hadya.

Phosphate level	Seed mass (mg/m^2)		Seed number ($plants/m^2$)	
($kg\ P_2O_5/ha$)	1985	1989	1985	1989
0	2.9	2.7	2108	4327
25	3.7	12.1	3112	18637
60	4.6	17.4	3987	24129
LSD (P=0.05)	1.3	3.21	879	4811[1]

[1] LSD (P=0.01).

These results indicate that it is important to reduce the grazing pressure on such grasslands in spring when flowering takes place, particularly when degradation is advanced and seed numbers are very low. However, in practice, the opposite is usually the case, as farmers move their small ruminants to the regenerating communal grasslands. This makes it even more important to create alternative feed supplies for the spring period. Research on annual pastures at ICARDA aims to develop the required alternative feed producing systems.

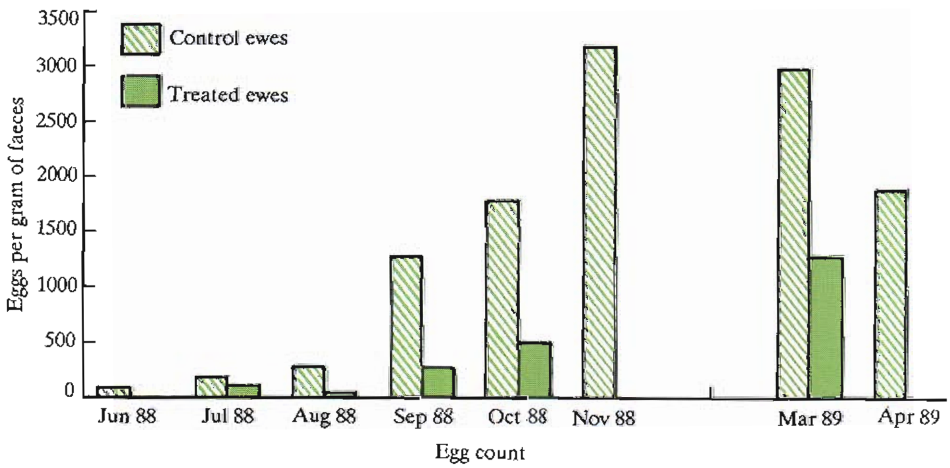
Helminth Parasites and Sheep Productivity

Effects of lungworms and gastrointestinal helminth parasites on the productivity of Awassi sheep are being studied in an on-farm research project in northwest Syria.

Nearly 200 ewes from 10 flocks were treated with Fenbendazole and a similar number left untreated. Other management factors in the two groups were the same. Treatment reduced mortality from 10.3 in the untreated ewes to 4.5%. Similarly, ewe fertility increased from 80 to 85% as a result of treatment, although this increase was not statistically significant. However, an improvement in fertility, together with reduced mortality, can considerably increase economic benefits to farmers.

Although Fenbenzadole effectively reduced parasite burdens, reinfection of treated ewes occurred because all sheep were mixed together and usually confined during feeding and at night (Fig. 36). However, infection levels never reached those of untreated ewes which indicates that two strategically-timed applications of anthelmintics in September and March effectively controlled the gastrointestinal helminths and *Protostrongylid* lungworms.

This on-farm research indicates that even though sheep appear to be healthy in areas receiving 250-350 mm annual rainfall, subclinical infections of helminth parasites can depress the animals' performance and, therefore, prophylactic measures are necessary. These findings have important consequences for the research on annual medic pastures in which sheep are continuously stocked on the same pasture for periods of up to six months.



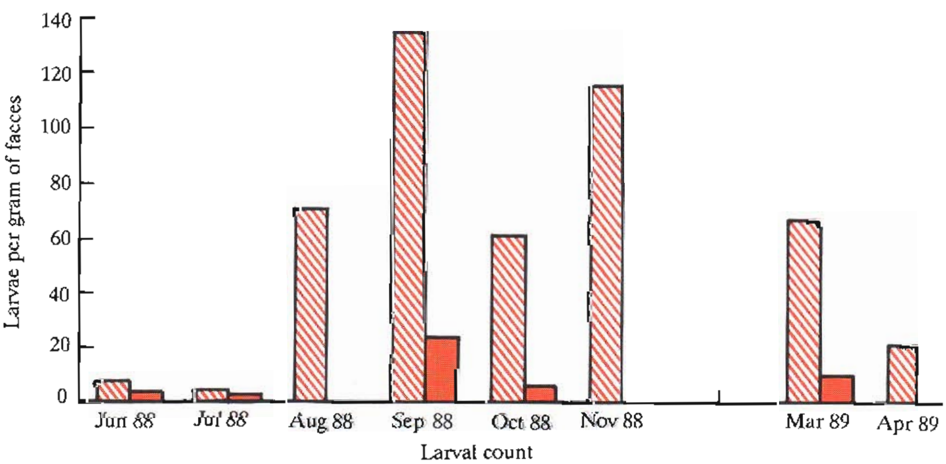


Fig. 36. Helminth parasites in sheep at Tel Hadya, 1988/89: (a) seasonal changes in parasite load; (b) lungworm larval counts in faeces.

Training

The Center trained 525 persons in 1989 (Fig. 37), about 60% of them at its headquarters and 40% in collaborative training courses held in WANA countries. Participants came from 18 countries in WANA, 3 developing countries outside WANA, and 4 countries of the European Community (Table 21). About 13% of the participants were women, reflecting an encouraging 18% increase over 1988.

Of the training courses offered, 15 were short- and long-term residential courses at headquarters and 10 were collaborative in-country or subregional courses. Eight senior colleagues from WANA participated in the Center's research programs as visiting scientists. Over 20 M.Sc. and 10 Ph.D. scholars conducted their degree-related research at Center headquarters.

Apart from the core budget support, the Arab Fund for Economic and Social Development (AFESD) was the major funding source for Arab participants from WANA, and Ford Foundation for graduate research training with particular emphasis on training of women in agricultural research. Other funding sources included AOAD, FAO, GTZ, IDRC, UNDP, USAID, and a growing number of multilateral/bilateral projects in research institutions.

A training follow-up study, covering nine WANA countries, was conducted. The results will be published in 1990.

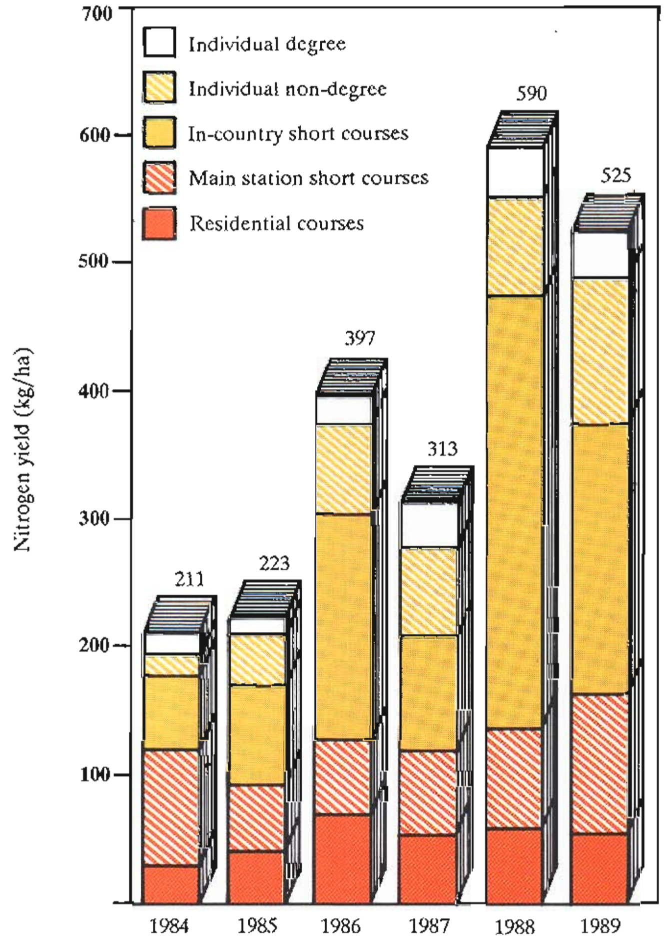


Fig. 37. ICARDA training participants, 1984-1989.

Table 21. Country participants by regions in ICARDA training (1978-1989).

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Total
<u>Latin America & Caribbean</u>													
Argentina	-	-	-	-	-	-	-	1	-	-	-	-	1
Bolivia	-	-	-	-	-	-	-	-	-	-	4	-	4
Chile	-	1	-	1	-	1	-	-	-	-	-	-	3
Colombia	-	-	-	-	-	-	-	-	-	1	6	-	7
Ecuador	-	-	-	-	-	-	-	-	-	1	5	-	6
Mexico	-	-	-	-	-	-	-	-	-	-	2	-	2
Peru	-	-	-	-	-	-	-	-	-	-	3	2	5
Venezuela	-	-	-	-	-	-	-	-	-	-	2	-	2
Total	-	1	-	1	-	1	-	1	-	2	22	2	30

Table 21 (*continued*).

South Africa													
Djibouti	-	-	-	-	-	3	-	-	-	-	-	-	3
Ethiopia	-	3	-	1	-	2	1	6	27	38	67	28	173
Kenya	-	-	-	-	-	-	2	-	-	-	-	-	2
Nigeria	-	-	-	-	-	-	-	-	-	-	1	-	1
Rwanda	-	-	-	-	1	-	-	-	-	-	-	-	1
Somalia	-	-	2	-	-	1	1	1	1	-	1	2	9
Tanzania	-	-	-	-	-	1	-	1	-	-	-	-	2
Zimbabwe	-	-	-	-	-	-	-	-	-	-	1	-	1
Total	-	3	2	1	1	7	4	8	28	38	70	30	192
North Africa & Near East													
Algeria	1	4	3	3	2	-	3	1	45	63	16	34	175
Bahrain	-	-	-	-	1	-	-	-	-	-	-	-	1
Cyprus	-	4	1	-	1	-	1	1	1	-	-	3	12
Egypt	4	1	-	7	5	31	20	5	33	13	85	58	262
Iran	2	-	-	-	2	1	5	9	10	2	5	58	94
Iraq	-	5	-	-	1	-	2	2	7	1	-	-	18
Jordan	2	4	4	1	4	5	7	2	14	16	20	9	88
Kuwait	-	-	-	-	-	-	-	-	-	1	1	1	3
Lebanon	3	1	-	-	3	1	3	4	4	1	-	10	30
Libya	1	1	-	-	-	3	9	-	3	-	-	1	18
Morocco	-	4	5	1	30	-	27	62	36	12	82	58	317
Oman	-	2	-	-	-	-	-	-	-	1	2	-	5
Qatar	-	-	-	-	-	-	1	-	-	-	-	-	1
Sudan	-	2	7	12	4	13	8	13	29	25	15	25	153
Saudi Arabia	-	-	2	-	-	-	1	2	1	-	46	-	52
Syria	10	16	8	19	41	41	70	53	55	72	67	110	562
Tunisia	-	3	5	2	11	13	6	9	37	20	39	30	175
Turkey	2	2	7	-	-	-	-	4	57	11	36	10	129
Yemen A.R.	-	2	-	-	-	2	3	4	11	4	41	15	82
P.D.R. Yemen	-	1	2	2	2	3	4	5	3	5	6	7	40
United Arab Emirates	-	-	-	-	-	-	-	-	-	1	-	-	1
Total	25	52	44	47	107	113	170	176	346	248	461	429	2218
Asia and the Pacific													
Afghanistan	-	4	3	-	4	1	-	-	1	-	-	-	13
Bangladesh	-	3	2	1	-	-	2	1	1	-	1	-	11
China	-	-	-	1	-	-	3	2	4	3	6	3	22
India	1	2	1	1	-	-	1	1	1	3	3	-	14
Malaysia	-	-	-	-	-	-	-	-	-	-	1	-	1
Nepal	-	-	-	-	-	-	-	1	-	1	1	23	26
Pakistan	-	-	3	2	5	4	20	28	7	4	6	24	103
Total	1	9	9	5	9	5	26	33	14	11	18	50	190
Industrialized Countries													
France	-	-	-	-	1	-	-	-	-	-	-	-	1
Greece	-	-	-	-	1	-	-	-	-	1	-	-	2
Netherlands	-	-	-	1	-	-	-	2	2	2	2	3	12
Spain	-	-	-	-	1	1	1	-	2	2	2	1	10
United Kingdom	-	1	-	-	-	-	-	2	-	1	3	1	8
United States	-	-	-	-	-	-	1	-	-	-	-	-	1
West Germany	-	-	-	-	5	1	1	1	5	8	12	9	42
Total	-	1	-	1	8	2	3	5	9	14	19	14	76
Grand total	26	66	55	55	125	128	203	223	397	313	590	525	2706

Information Dissemination

Integral with the Center's continuing process of review, realignment, and strengthening, in 1989 its communication-information group entered a transitional period of shifts in emphasis and activity. Increased attention was paid to assure the quality of information and its subsequent dissemination and utilization.

Appendix 3 lists the titles published during 1989. The Annual Report for 1988, published in 1989, heralded significant improvements in presentation and production quality. Over 41 journal submissions were processed, of which 31 had been published by the end of 1989.

The year saw the benefits of speed and quality with increased use of microcomputers.

The Center participated in the CG's Public Awareness Association meeting in Bonn, and in Frankfurt Book Fair. Efforts were intensified to widen contacts with media both within WANA and beyond, focusing on the vital issues of ICARDA's Strategy. The formal opening of ICARDA's new buildings at Tel Hadya, 35 km southwest of Aleppo, drew the attention of local press, radio, and television. A journalist from the Christian Science Monitor and another from West Germany visited ICARDA.

There was a steady expansion of library holdings and a continual increase in photocopying services in response to requests. The first ever library inventory was conducted. A library database was developed and put on-line as a first step toward providing improved service to scientists at ICARDA and within the region.

ICARDA produced a variety of publications in 1988/89 to meet the information needs of its wide-range audiences.

As part of the cooperative arrangement with other CGIAR libraries, ICARDA implemented a scheme of publication depositories with libraries in industrialized countries. Five out of 13 libraries contacted have responded positively. The Center continued its active participation in AGRIS/CARIS.

The three crop-oriented periodicals--FABIS (on faba bean), LENS (on lentils), and RACHIS (on cereals)--continued to offer an alternative channel, particularly to WANA scientists, for dissemination of information.

To facilitate communication with target audiences in WANA, numerous publications were translated into or from Arabic. The results of a survey on translation issues were summarized and shared with the CG as well as a number of non-CG centers.

Impact Assessment and Enhancement

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

The Center has identified three key areas of research on impact assessment. First, methods are being developed for determining production impact through a combination of technology testing on farmers' fields and farm surveys of adoption, as well as constraints faced by farmers. Second, the future interface between agricultural labor and changes in farming technology is being assessed. Extensive regional overviews and country-specific studies on this issue have been conducted. Third, a regional overview of production and policy trends is being developed to assist both in determining research priorities and assessing the actual and potential impact of new technology.

A selection of highlights of the progress made by ICARDA in 1988/89 in its impact assessment and enhancement studies is reported here.

Adoption Dynamics of Winter-Sown Chickpea in Morocco

Chickpea is the second most important food legume crop in Morocco. Production is concentrated in dryland areas to the west of the Atlas mountains that receive more than 300 mm average annual precipitation. The farming systems of these areas are characteristically dominated by cereal and livestock production, but chickpea usually fulfils an important role in the two-course rotations with winter cereals and, to a much lesser extent, vegetables and forage crops. Local landrace varieties are predominant and are traditionally sown in spring (late February-March) for harvest in summer (June-July). Yields vary greatly from year-to-year, from region to region, and from farmer to farmer.

Fig. 38 presents aggregates of chickpea yields and area planted during 1970-1985. When examined against the rainfall data, the fluctuation in both yield and area planted corresponded closely with variation in rainfall.

The last two decades witnessed a marked change in the geographical distribution of chickpea production in Morocco. In the formerly highly productive regions to the south and southwest of Casablanca, the total area planted to chickpea has considerably reduced, and many farmers have abandoned the crop. The retreat is attributed to two causes: a prolonged drought and the ravages of *Ascochyta* blight. Another factor cited by farmers and researchers throughout Morocco is the high

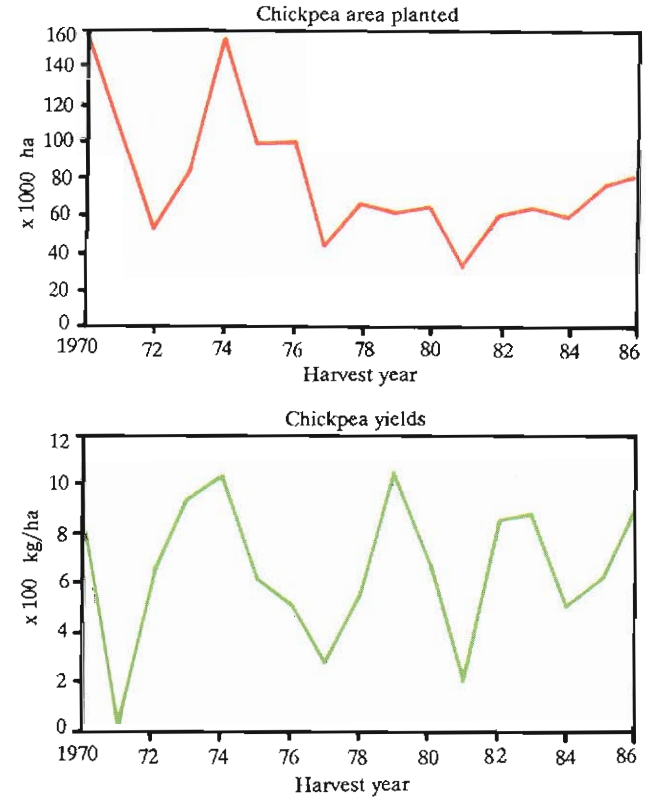


Fig. 38. National trends in chickpea production in Morocco.

cost of managing and harvesting the crop using hand labor. Cereals appear clear victors over chickpea in planting decisions based on considerations of risk and labor costs.

Moroccan authorities have given considerable attention to winter sowing of chickpea with a view to stabilizing production and reversing past trends. In particular, winter sowing technology is viewed as a means of reclaiming old production areas and expanding into new ones. If farmers adopted the new technology, the country could benefit through: (i) improved farm income, (ii) increased foreign income through exports, (iii) increased domestic protein consumption, and (iv) enhanced soil nitrogen content.

Demonstration of winter-sown chickpea in farmers' fields was started in Morocco in 1985/86. In 1987/88, two varieties, ILC 482 and ILC 195, were released and the demonstration program was expanded. During 1989, ICARDA and Moroccan scientists conducted a major survey of adoption dynamics of winter chickpea.

Four target areas were selected: Safi and Settat provinces in the south, and Fez and Khemisset in the north (Fig. 39). The northern provinces represent current principal producing areas of dryland spring chickpea. The two southern provinces grew chickpea in the past, but it is hoped that the new technology will facilitate the reintroduction of the crop to these provinces.

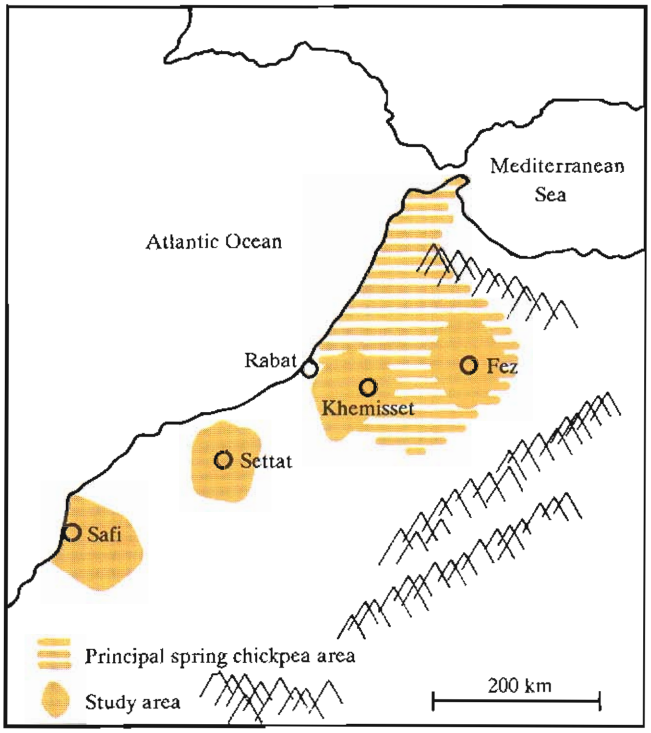


Fig. 39. Winter chickpea study regions in Morocco, 1989.

Data were collected through a farmer survey. From a total of 112 farmers interviewed, four categories were identified:

I. Non-adopters: Farmers who participated in previous demonstrations but had decided not to grow winter chickpea.

II. Trial farmers: Farmers in the process of evaluating winter chickpea through current demonstrations.

III. Adopters: Farmers who had started growing winter chickpea independent of the demonstration program.

IV. Neighbors: Farmers who had never grown winter chickpea, but had seen nearby demonstrations.

Economic Performance of Chickpea in 1989

The 1988/1989 was a poor season for chickpea production in Morocco. Although seasonal rainfall totals were close to the long-term average, poor distribution resulted in both heavy weed infestations and severe outbreaks of *Ascochyta* blight in all areas, except Safi province. Yields of both winter- and spring-sown chickpea were low, and winter-sown varieties, ILC 482 and ILC 195, only outperformed local spring cultivars by a small margin (Table 22).

Table 22. Summary of winter and spring chickpea yields (x100 kg/ha) in Morocco, 1988/89 (based on survey results).

Province	% with blight	Yield range		Average yield	
		Winter	Spring	Winter	Spring
Safi	27%	0-22	NA	13.5	NA
Settat	90%	0-12	0-16	8.0	11.6
Khemisset	44%	0-20	5-10	6.3	8.1
Fez	70%	4.4-20	2-11	10.1	7.4
Mean for farms	54%			9.7	8.4
weighted by area				10.3	8.6
Mean for 1987/88				15.3	NA

Gross margins for winter chickpea production for the 41 farmers in Categories II and III ranged from as high as 4,670 DH/ha to as low as -1,215 DH/ha (USD 1 = 8.5DH approximately). Of the 10 farmers who had negative gross margins, nine were from Khemisset province. Not surprisingly, their yields were low and their costs high due to weed infestations. In contrast, seven of the top 10 gross-margin-per-hectare producers were Category III farmers, and five of the top 10 were from Safi province where weeds were not a problem in 1988/89.

Farmers often cited labor requirements as their biggest cost. The most labor-demanding operations were reported to be weed control and harvesting, including postharvest threshing and bagging. In general, about 62% of labor was devoted to weed control in two periods of peak demand: the first, about four to six weeks after planting and the second, about six to eight weeks before harvest.

The importance of weed control was also evident from the relative labor expenditure devoted to it by the top 10 least-cost farmers: it accounted for 83% of their labor. Their lower labor cost for harvesting, however, was due partly to the fact that three of them used mechanical harvesting, accepting some yield loss in preference to high labor costs.

The average farm-gate price for winter chickpea in June and July of 1989 was DH257/100 kg (approximately USD 30/100 kg). This was slightly higher than the 1988 price of DH233/100 kg and the 1987 price of DH212/100 kg. The lowest price received in 1989 was DH185 and the highest DH400. Over 50% of producers sold their harvests in local markets, and about 13% to neighbors who intended to plant winter chickpea next year. The reported farm-gate price for the larger-seeded local spring chickpea was between DH300 and DH350 per 100 kg, or about 25% higher than the winter chickpea price.

Trends in Legume Production

The general view that food legume production has been declining in dryland areas was borne out by the survey (Table 23). Overall, 56% of farmers reported a decrease, and 22% an increase, in land sown by them to food legumes in the past five years.

Table 23. Reported changes in area under food legumes in Morocco over the past five years (1984/85-1988/89)

Farmer group	Percentage of farmers reporting			
	Increase in area	Decrease in area	No change in area	Net farmers changing
All farms	22%	56%	22%	-34%
Safi province	38%	38%	24%	0%
Settat province	13%	69%	18%	-56%
Khemisset province	14%	62%	24%	-48%
Fez province	30%	50%	20%	-20%
Category I	6%	63%	31%	-57%
Category II	20%	60%	20%	-40%
Category III	32%	52%	16%	-20%
Category IV	26%	52%	22%	-26%

When asked the reasons for decreasing or keeping stable food legume area planted, 44% of farmers cited diseases and pests, particularly *Orobanche* for faba bean, rust for lentil, and *Ascochyta* for chickpea. A further 30% stated that high labor costs made food legumes less profitable than cereals. The remainder gave other reasons, or no reason at all, but only 4% asserted that food legumes received poor prices in the market.

Advantages of Winter Chickpea

All farmers were asked to compare winter with spring chickpea along a number of dimensions. Seven farmers in Category IV felt they did not know enough about either crop, but the remaining 105 gave their opinions. The poll showed winter chickpea a clear winner (Table 24) in many respects, but with regard to seed quality, seed size, and market prices, most farmers still preferred the spring-sown varieties.

Table 24. Comparison of winter and spring chickpea in Morocco.

Characteristics	Number of farmers reporting		
	Winter better	Spring better	Do not know
Plant stand and growth	91	12	2
Amount of straw	90	12	3
Yield	65	29	11
Less risk of crop failure	59	25	21
Resistance to diseases	52	35	18
Seed quality	26	52	27
Market prices	6	72	27
Seed size	5	91	9

Problems and Constraints

Farmers were asked to name a maximum of three major problems of winter chickpea production and to rank these according to degree of severity. The most serious problem was given a weighted value of three points; somewhat serious, two points; and least serious, one point. Thus, the weighted value for each problem was the sum of points it received for being named according to severity. Table 25 ranks the problems according to

Table 25. Problems encountered in producing winter chickpea (responses by farmers in categories I, II, and III) in Morocco.

Problem	Most serious	Somewhat serious	Least serious	Frequency mentioned	Weighted value
Small seed size	27	17	2	46	117
Diseases and pests	22	7	1	30	81
Weeds	11	1	8	20	43
Market and prices	2	14	6	22	40
Labor costs	4	1	1	6	15
Uncertain yield	3	3	0	6	15
Conflict with cereals	1	2	1	4	8
Need information	1	2	1	4	8
Seed availability	1	1	0	2	5
Need new equipment	0	0	1	1	1

weighted values. Small seed size, diseases (particularly *Ascochyta* blight), and pests, in that order, proved to be the three major production constraints. Small seed size fetches a lower price in the market, the farmers reported. Diseases occupied a high ranking probably because of a high incidence of *Ascochyta* blight in 1988/89. The problem of weeds also received a high ranking.

The farmers were optimistic about the potential of winter chickpea, but they generally emphasized the need for more extension education about the new technology (Table 26).

Table 26. Factors limiting adoption of winter chickpea (responses by farmers in all categories) in Morocco.

Limiting factor	Most limiting	Somewhat limiting	Least limiting	Frequency mentioned	Weighted value
More information	43	9	0	52	147
Small seed size	14	11	1	26	65
Seed availability	7	12	1	20	46
Market and prices	6	6	1	13	31
Diseases and pests	4	2	2	8	18
Land availability	2	3	0	5	12
Labor costs	3	1	0	4	11
Uncertain yield	1	1	1	3	6
Conflict with cereals	2	0	0	2	6
Weeds	0	1	3	4	5

Putting Survey Results to Work

The 1988/89 survey indicates a number of areas for further action and research. Clearly, the DPV (Direction de la Production Vegetale) demonstration plot program of Morocco has been effective and should continue. The importance of winter chickpea grown by farmers where it can be seen by other farmers cannot be over-stressed, as illustrated by the responses of the Category III farmers. Herbicide treatments will be added to the demonstration program. It is necessary to test an alternative to hand weeding to increase farmers' gross margins. When asked how many hectares of winter chickpea they would plant if an effective herbicide was available, 17 of 81 (or 21%) farmers said they would increase their area. Over half of these 17 farmers do not presently grow winter chickpea.

In terms of on-station work, first priority should be given to large seed size, but not at the expense of losing *Ascochyta* blight resistance in the material. Already, a few new lines which combine large seed size with high resistance to *Ascochyta* blight are being evaluated. It should be noted that *Fusarium* wilt is also a potential problem. Not only did the vast majority (80-96%) of Category II and III farmers say they would grow more winter chickpeas, 80% of the non-adopters in Category I claimed that larger-seeded varieties would make the difference between adopting and not adopting the new technology.

At present, a number of the adopters are using combines to reduce labor costs and harvest time considerably. The economic and technical evaluation of mechanical harvesting options should be made carefully. This is an avenue through which the recognized benefit of taller plants could be enhanced.

To deal with the information constraint, the Moroccan national program and ICARDA will hold an in-country training course for extension agents on winter chickpea agronomy and production methods during the 1989/90 season. Also, Moroccan scientists are organizing the production of a short video tape on winter chickpea cultivation for the benefit of farmers.

The problem of seed availability is more complex and needs careful consideration. First, there is the issue of having enough seed to meet demand. Then, there is the question of quality control and certification. Third, there are questions about which lines to multiply for release to farmers and when and where they should be released. Perhaps the involvement of the more successful adopters in certified seed production schemes could be helpful in future years.

In addition to the demonstration plots, on-farm work should continue to monitor the process of adoption. This may involve return visits to the Category II and III farmers covered in the 1988/89 survey, and inclusion of next year's demonstration-plot farmers in the general data base.

Assessment of Risk Associated with Increasing Sheep and Feed Supplies in Syria

Current Strategies

The WANA countries will continue to rely heavily on barley production as a major source (grain, straw, and often green grazing of immature crop) to meet the increasing feed demand of their expanding sheep flocks. In addition, they will also continue to depend on natural pastures which are seasonally available on marginal lands. Such lands are unsuitable for cultivation, either due to their topographical features, or because they occur in areas too dry for sustainable agriculture. Since barley is also largely produced in the drier and lower potential agricultural systems of the region, it is clear that much of the projected increase in sheep feed supply must come from the region's most fragile and vulnerable environments.

As well as barley grain, straw and stubble are a valuable source of feed during the summer and autumn months.

Rising demand for livestock products has resulted in a dramatic increase in national sheep flock size (3.1 to 13.3 million) over the past 35 years (Fig. 40).

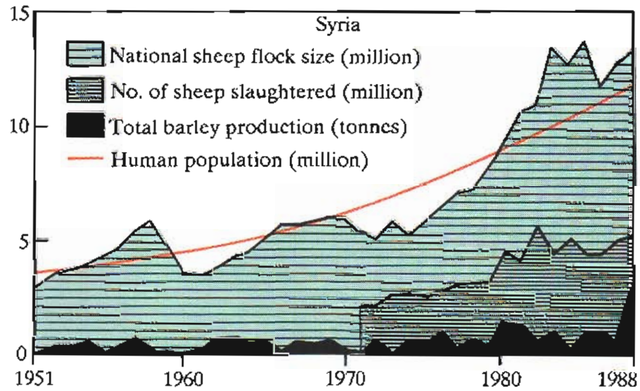


Fig. 40. National trends in sheep number, human population, and barley grain production in Syria, 1951-1988.

The derived demand for barley grain and straw has caused an equally dramatic increase in the area sown to barley which has risen from 0.75 million in 1960 to 2.9 million ha in 1988/89, but yields have largely remained stagnant (Fig. 41). Analysis of secondary data of area, yield, and production in terms of sheep feed equivalents (SFE)[1] showed that 30 years ago, Syria would have expected a sheep feed equivalent deficit of 3.0 million SFE only once in 10 years, whereas the current estimates indicate that the deficit would exceed 4.0 million SFE in nine years out of 10. This is reflected in Syria's barley trade figures which indicate that Syria has turned from being a frequent exporter to a frequent importer of barley in the last 25 years, and the fact that natural pastures of the country are becoming exhausted through overgrazing.

The data indicate that the rapid increase in the barley area has been achieved by expanding cultivation into more and more fragile and marginal environments, and through the adoption of barley monoculture (Table 27). National average yields have not increased, but there are clear indications of increased yield variability. Currently, barley cultivation occupies two-thirds of the arable land in Zones 2 to 5.

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[1] Conversion of barley production to SFE assumes an energy content of barley grain and straw of 11.5 MJ/kg and 5.5 MJ/kg, respectively, and an annual energy requirement of 4,200 MJ/ewe. SFE deficits indicate the extent to which the feed requirements of national flocks must be met by sources other than barley.

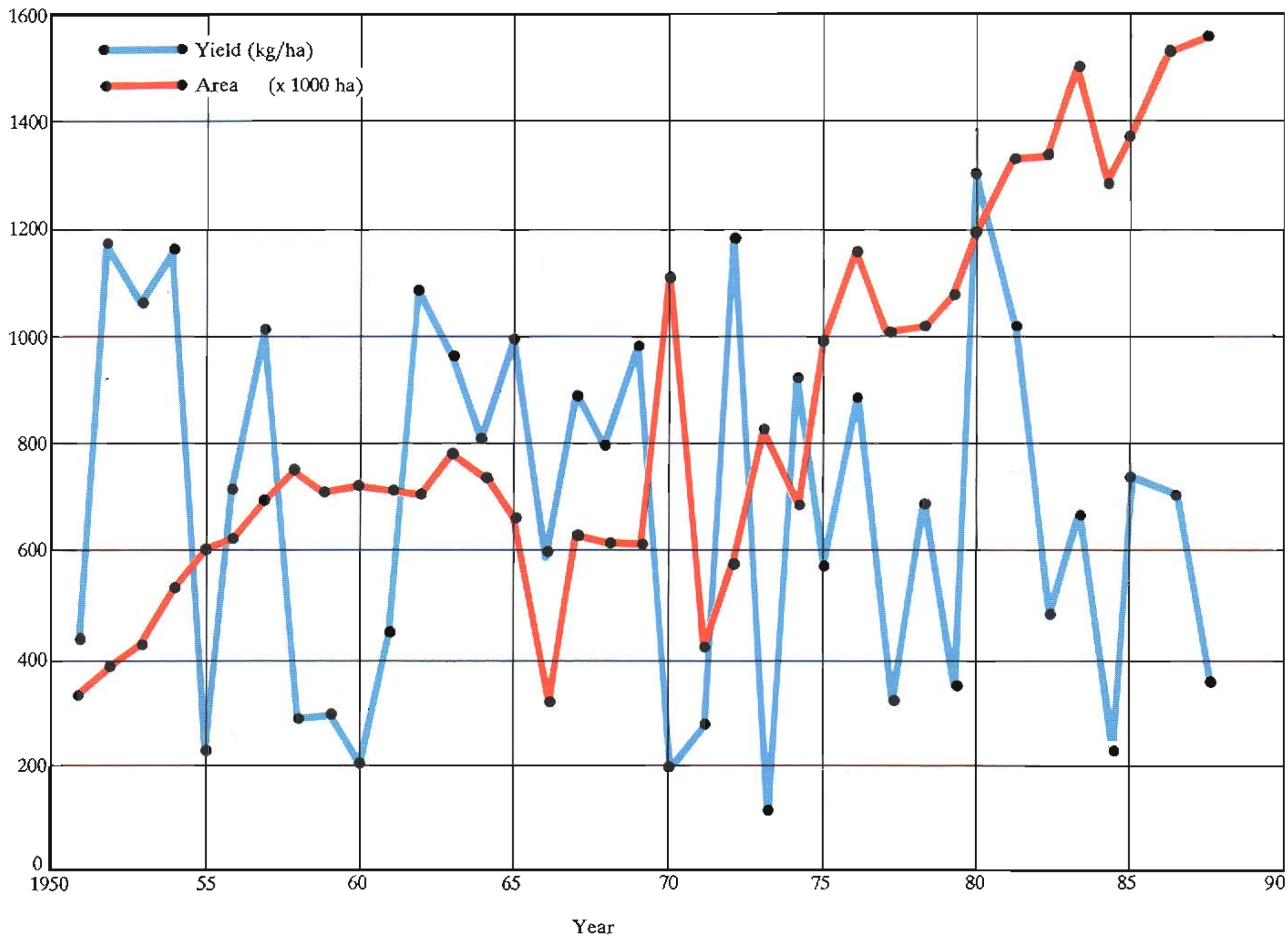
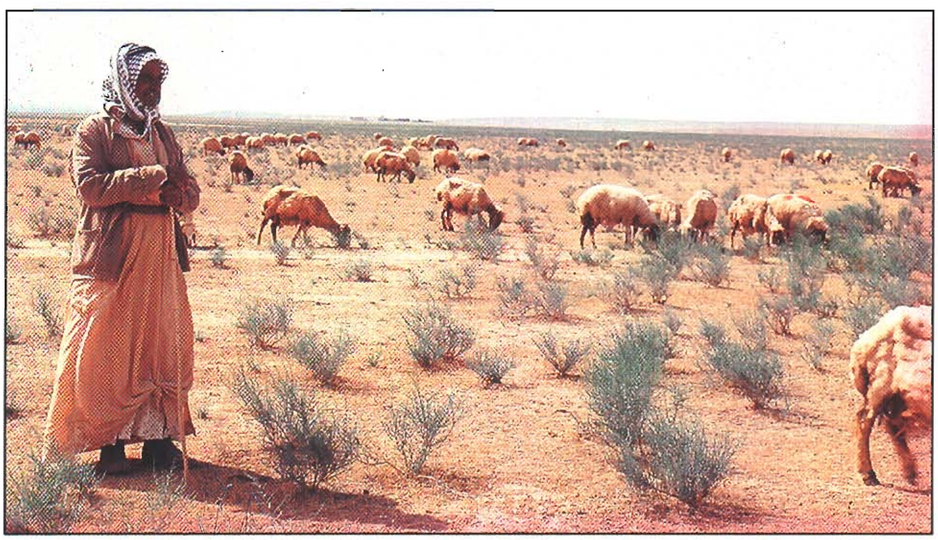


Fig. 41. Barley production in Syria, 1951-1987.



Natural pasture and rangelands in Syria are becoming severely degraded due to overgrazing, and are shrinking in size as they are being increasingly placed under cultivation.

Table 27. Barley production strategies for Syria, 1979-1989.

Zone[1]	1	2	3	4	5
Total arable land (x1000 ha)	1710	1878	859	998	563
Under barley 1979	110	270	285	323	100
1989	87	807	634	806	541
Planned for 1990	-	645	580	867	400
Average yield 1979-1989 (kg/ha)	1370	885	575	480	359
CV (%)	37	51	81	103	114
% Years of no harvest	0	9	36	45	64

Zone 1: Rainfall between 350-600 mm and not less than 300 in 2 years out of 3.
Zone 2: Rainfall between 250-350 mm and not less than 250 in 2 years out of 3.
Zone 3: Rainfall greater than 250 mm and not less than this in one year out of 2.
Zone 4: Rainfall 200-250 mm and not less than 200 mm in one year out of 2.
Zone 5: Rainfall less than 200 mm.

Potential Barley Production from Improved Practices

In 1984, the Syrian Soils Directorate and ICARDA initiated a collaborative research project to assess the biological and economic effects of the use of nitrogen and phosphate fertilizer on barley, through multiple-season multiple-location trials on farmers' fields in the agricultural stability Zones 2 and 3 of northern Syria. The trials have been conducted over four years (1984/85 - 1987/88) on 75 sites which represent a range of soil type and depth, rainfall and rotation, including land in both barley/barley (B/B) and barley/fallow (B/F) rotations. Although the trials were restricted to Zones 2 and 3, two of the four years were extremely dry, representing conditions normally prevailing in Zone 4 (see also "Resource Management and Conservation" section in this Report).

Results from these on-farm trials (OFT) were used, in conjunction with data on national average rainfall and barley areas, to assess the potential of improved barley production practices to meet feed requirements. Yield data were analyzed for four of the OFT treatments representing the two rotations without fertilizer (Bo/Bo and Bo/F) and with 20 kg N/ha and 60 kg P_2O_5/ha applied in the barley phase (Bnp/Bnp and Bnp/F). The treatments without fertilizer still included improved practices of seed dressing and drill planting. The fertilizer treatment of 20 kg N/ha and 60 kg P_2O_5/ha was selected because it is close to the rate recommended from results from the trials and currently being demonstrated to farmers.

Yields (grain and straw) per hectare were converted to SFEs, as noted earlier, and the relationships between SFE/ha and the seasonal rainfall (R) recorded at each OFT site were estimated, with the following results:

$$\text{Bo/F: SFE/ha} = -11.05 + 0.1008\,R - 0.00011\,R^2 \quad (\text{Adj } R^2=0.552)$$

$$\text{Bnp/F: SFE/ha} = -11.09 + 0.1136\,R - 0.00013\,R^2 \quad (\text{Adj } R^2=0.632)$$

$$\text{Bo/Bo: SFE/ha} = -7.68 + 0.0664\,R - 0.00007\,R^2 \quad (\text{Adj } R^2=0.507)$$

$$\text{Bnp/Bnp: SFE/ha} = -12.47 + 0.1073\,R - 0.00012\,R^2 \quad (\text{Adj } R^2=0.649)$$

Twenty-seven years of climatic records of seasonal rainfall totals from over 25 meteorological stations within the barley growing areas of Syria were used to calculate a mean national average rainfall for each of the years from 1961 to 1986.

The estimated response relationships above, and the mean national average rainfall estimates were used to predict the "potential national average SFE/ha" obtainable from each of the four selected treatments for each of the 27 years.

To estimate the potential production from these treatments requires some assumptions to be made on the area planted to barley, the rotation in which it will be planted, and whether or not fertilizer will be applied. To illustrate this, three contrasting potential strategies were selected.

Strategy A: Utilizes the planned barley area for 1990 (Table 27), but excludes Zone 5, first because it was not included in OFT and, secondly, because the principal concern which prompted this research was to investigate means of reducing feed deficits while at the same time halting the expansion of cultivation into the fragile environments of the dry zones. Barley is assumed to be grown as a continuous crop, but without fertilizer (Bo/Bo). This represents a reduction in the cultivated area in only the very driest areas, and minimum improvements in production practices (seed dressing and drill sowing).

Strategy B: Further reduces the area planted to barley in the driest parts of Zone 4 from 867,000 to 499,000 ha, and reintroduces fallow into the rotation with fertilizer being added (Bnp/F). In this strategy, the area under barley in each zone was halved to allow for the fallow year.

Strategy C: Retains the same reduced area as in strategy B, but allows continuous barley with fertilizer to be grown (Bnp/Bnp).

The outcome of these three strategies, expressed in million SFE is presented as cumulative frequency distributions in Table 28. In evaluating the strategies, it is assumed that the national flock of Syria is retained at an average level of 12 million, and that barley grain and straw would continue to be required to meet the traditional level of 60% of the annual energy requirements of sheep.

By adding improved practices of seed dressing and drill planting to continuous barley production on the current planned area in Zones 2 to 4 (Strategy A), Syria would achieve or exceed 60% of its feed requirements (7.2 million SFE) in approximately 75% of years. However, the same result would be achieved by applying fertilizer in a barley/fallow rotation on a reduced area (Strategy B). The crossover point between the distributions from Strategies A and B occurs at approximately 6.5 million SFE. Below this crossover point, in drier years, potential production would be higher under Strategy B. Strategy C, applying fertilizer to continuous barley on a reduced area, illustrates that potential production is higher in all but the very dry years. Sixty percent of national feed requirements would be achieved or exceeded in approximately 80% of years.

Any distinction made between the three strategies depends on the criteria used. If the objective is to maximize the probability of meeting national flock feed requirements, then Strategy C is preferred. If, on the other hand, the objective is to maximize the SFE obtained in the poorest of years, then Strategy B is preferred (but only marginally). For equating risk with variability, Bnp/F (Strategy B) would be preferred (compare CVs in Table 28).

Table 28. Cumulative frequency distributions of potential production (million SFE) from three different barley production strategies in Syria.

Deciles	National average rainfall (mm)	Predicted SFE (million)		
		Strategy A	B	C
0.1	168	2.9	3.9	3.8
0.2	197	5.3	5.6	7.1
0.3	268	9.9	9.0	13.6
0.4	278	10.5	9.4	14.3
0.5	286	10.9	9.7	14.9
0.6	294	11.3	10.0	15.4
0.7	326	12.6	10.9	17.3
0.8	355	13.5	11.6	18.6
0.9	392	14.4	12.1	19.7
Mean		9.8	8.9	13.5
CV(%)		42.2	33.9	42.4

The analysis demonstrates that there are alternatives to the current strategy of expanding cultivation into more and more marginal areas. Reducing the area under barley in the marginal areas of Zones 4 and 5 and improving production practices on the remaining area (by encouraging fertilizer use and maintaining a barley/fallow rotation) would reduce the probability of drastically low production in dry years from land under continuous barley, and increase the stability of production over time.

Changes in Lentil Production Technology in Syria

In 1978/79 and 1979/80, ICARDA conducted a lentil production survey in northern Syria. Ten years later, in 1988/89, the Center conducted a similar survey as part of an on-farm survey training course. Although the geographical areas covered differed slightly in the two surveys, some interesting observations on the evolution of lentil production practices over 10 years were possible.

Even after 10 years, most lentil farmers in northwest Syria still grow local varieties and harvest their crop by hand.

In general, farmers have increased the land preparation effort, with the bulk of them (65%) now cultivating twice. They have also increased the seed rate from an average of 144 kg/ha to 185 kg/ha, but seeding method (70% manual, 30% mechanical) has remained largely unchanged. Similarly, the varieties used are the same (80% local small red, 20% local white large). Farmers sow the crop several weeks later than they did 10 years ago.

The average rate of phosphate application has increased from 64 to 145 kg/ha. Ten years ago, 50% of farmers applied no P, whereas now only 13% use no fertilizer. This is clearly attributable to the relatively low price of fertilizer at which it is now available to farmers. All farmers interviewed still harvest by hand.

Agricultural Labor and Technological Change

Within the purview of its Agricultural Labor and Technological Change Project, ICARDA conducted regional overviews and eight case studies during 1986/87-1988/89 in close cooperation with NARSs. The Project completed its final year in 1989 when these studies were finalized for publication. Here, the principal findings of the eight case studies are summarized.

Agricultural Changes on Private Farms in Algeria

Are farmers attempting to make more use of family labor on their farms through intensification in the Tiaret area of Algeria where the availability of off-farm employment has declined ? A survey found that intensification of the predominant cereal cultivation is occurring but to a limited extent. Rotations with other crops are scarcely seen. Improved cultivation and input use are found but primarily on large farms. Irrigation is adopted whenever it is feasible, and opportunities are expected to increase in the future. However, due to the market situation and poor technical practices, irrigated market gardening is often a parallel commercial activity rather than a part of an integrated family farm.

The most popular approach to increasing on-farm employment is through livestock. Of the surveyed farms, 69% had substantial numbers of sheep, cattle or poultry. On large farms sheep can be fed from ample crop residues and barley, but on small and medium farms raising sheep involves both growing and buying feed. While providing some employment, livestock enterprises are not enough to solve the problems of unemployment. Nevertheless, the changes which farmers have initiated demonstrate their active involvement and interest in intensification, and the challenge for research is to present technical solutions which improve employment and are accessible to small and medium sized farms.

Implications of Technological Change for Labor and Farming in the Karia Ba Mohamed District, Morocco

This study of a highly productive rainfed area of Morocco documents the effect of eight years of focused effort by the government, with the World Bank support, to improve agricultural productivity and rural living conditions.

Based on a sample survey researchers found that 10% of the farms have become "modern"--market-oriented, and use high levels of mechanization and inputs to maximize productivity. Further, 50% of them have adopted such practices to a significant degree. Labor makes up a smaller proportion of total costs on these farms compared to traditional farms. However, because mechanization was introduced in combination with diversification and intensification, overall demand for labor has actually increased and many semi-skilled, relatively steady jobs have been created.

Mechanization and Agricultural Employment in Arid and Semi-Arid Zones of Morocco: The Case of Upper Chaouia

In a study of a dry-farming area southeast of Casablanca, mechanization was found to exist side-by-side with animal traction and manual techniques as an option for farmers. This study demonstrates that the choice of mechanization is part of a range of choices including several options for crops, leasing of land, and off-farm employment as well. Choices depend on land and labor available to the households and the consumption requirements of the farm families.

Farm strategies can be understood in terms of a limited number of basic farm types, ranging from the microfarm of less than 5 hectares, dependent upon outside income, through the small-, medium- and large-sized farms in which the availability of labor or finances are differentiating variables, to agribusinesses at the other extreme.

Leasing of land is shown to be an important factor allowing farmers with surplus labor or machinery to more effectively use it. Labor-intensive practices and crops continue to be economically attractive for farmers with adequate land and sufficient family labor. Mechanical techniques are chosen to maximize profitability on larger farms, to free up labor for employment on smaller farms, and often to complement labor or free labor for other agricultural activities on medium farms; it is also important in special circumstances such as the recent drought which reduced the stock of draft animals.

Acceptance and Rejection of Agricultural Innovations by Small Farm Operators: A Case Study of a Tunisian Rural Community

In a community study of Lorbous, northwestern Tunisia, it was found that small farm size and low incomes were the major factors affecting technology adoption by farmers. In addition, a series of agricultural projects which have failed to benefit small farmers have generated a negative and passive attitude towards innovation.

Low availability of farm labor results from emigration of rural populations as a result of the poor situation of rural areas and agriculture generally and, thus, is not a primary cause of low adoption of technology. On small farms labor requirements are low and non-farm sources of income are of much greater importance in maintaining the household. Many family members work off-farm and young people in general are not interested in agriculture.

Farm Mechanization and Socioeconomic Changes in Agriculture in a Semi-Arid Region of Tunisia

In a rainfed area of northern Tunisia, mechanization has proceeded under the influence of government policy for some decades, and since 1969 mechanization by private farmers has been encouraged. Ownership of machinery is mostly found on the medium and large farms. Large farms have benefited most from mechanization in terms of improved farm economics. On medium-sized farms the owners do not have sufficient land to fully utilize the machinery, and must rent it out in order to maximize their profits. On smaller farms, hiring of equipment has become a major cash cost in farming while reducing the demand for labor. Smaller farms use more labor per hectare, by diversifying into legumes, tree crops, and livestock, but labor remains in surplus.

Household cash needs lead to part-time farming by men with increased labor on the farm by women. In spite of higher labor use small farms have lower crop yields because of inability to afford optimal amounts of cultivation, fertilizer, herbicide, improved seed, and fallowing. The small holding cannot be used as a significant source of income and so the small farm production strategy is limited to subsistence.

Impact of Technology on Employment in the Rainfed Farming Areas of Irbid District, Jordan

Rainfed areas of Jordan have seen a low level of technology adoption and productivity growth. However, due to emigration of farm labor to urban areas and abroad, labor-saving technologies, primarily mechanization, have been widely adopted. Hired labor, both skilled and manual, is predominant, contributing 81% of farm labor hours, including 33% by migrant workers. In a sample survey, total labor input increased with area farmed and number of males in the family, but was less in families with absentees and students, so the effects of emigration are not eliminated by hired labor.

Women contribute less than 20% of total labor and are primarily involved in weeding, harvesting, winnowing, and cleaning; women of the farm family participate at lower levels of operations. Skilled labor is mostly hired locally and is commonly associated with farm machinery. Migrants were most active as unskilled workers. Legumes require more labor, mostly unskilled, than cereals and this labor is mostly provided by migrants.

Labor Use on Farms in Dry-Farming Areas of Konya Province, Turkey

An analysis of current farm practices in Konya Province, Turkey, documented high rates of idle labor on rainfed farms, particularly severe on the small- and medium-sized farms. Small farms are more diversified, growing greater amounts of legumes, vegetables, and industrial crops, and depending more on livestock. Although they support smaller families and earn more than larger farms from off-farm income, small farms have the highest levels of idle labor.

Under existing technology, changes in crop choice and livestock numbers can increase incomes and labor use particularly on small and medium sized farms. With more intensive use of improved farm technology, unemployment could be further reduced and income increased. Thus, the extension services have important roles to play in advising farmers of these possibilities.

Social and Economic Aspects of Decision-Making Related to Labor Utilization and Choice of Technology: A Case Study of a Turkish Village

An interdisciplinary study of a village in rainfed central Turkey documents the interaction of the economics and social organization of farming. With adequate land and capital, farming can be expected to provide a reasonable livelihood in years of average or better rainfall. However, for many farmers repairs or payments on capital equipment, high interest on loans of operating capital, and debts incurred in poor seasons make farm income much more precarious. Further, land is not sufficient, and sharecropping, rental or purchase may be employed to increase the holding size. From the farmers' point of view, what is needed are ways to increase the productivity of land to enable independent farm households to continue to exist.

Due to land shortages, males are often educated so that they can find off-farm employment, so women are taking on a greater share of farm activities. Labor exchange within the village makes up for some seasonal shortages and hired labor is also employed. Equipment is purchased by farmers to replace family labor, and as tractors can do much more than people they replace, there is an excess of machinery.

Outreach Activities

The success of ICARDA's programs largely depends on the active participation of the countries it seeks to serve. Since its establishment, the Center has diligently worked to develop partnerships within WANA and beyond. The progress in establishing partnerships and carrying the collaborative programs forward has moved at varying paces determined by several factors including the Center's own resources.

During the course of developing its Strategic Plan, ICARDA reviewed its on-going collaborative activities in the region with a view to consolidate them. This was dictated by the need for resource-effectiveness, eliminating duplication of effort, balancing activities according to the identified needs of each country, exploiting the spillover of research results from one region to another with similar agroecologies and infrastructure and, above all, a long-term vision of the impact of the overall effort in the region.

ICARDA's 1988 Annual Report outlined its strategy to group its outreach activities into six regional programs. These six programs were formally established in 1989, based on commonalities of geography, ecology, and constraints to production in each region. The programs are:

1. The Highland Regional Program
2. The Arabian Peninsula Regional Program
3. The West Asia Regional Program
4. The Nile Valley Regional Program
5. The North Africa Regional Program
6. The Latin America Regional Program

These programs link scientists both within countries and within the region; promote leadership at the national and regional levels; engender cooperation in solving problems common to a group of countries; capitalize on complementarities between countries; acquire, pool, and optimize the use of scarce resources; and encourage self-reliance in research and development.

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

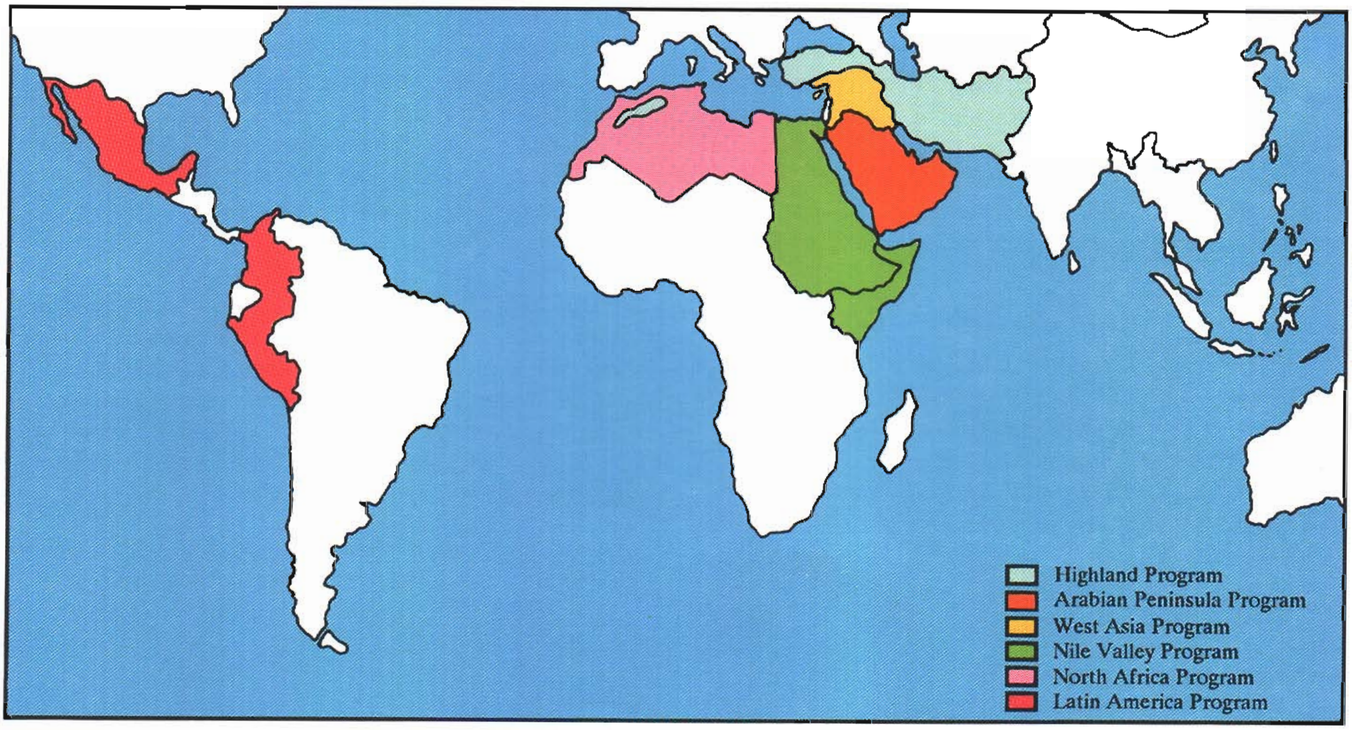


Fig. 42. ICARDA has grouped its outreach activities into six regional programs, based on commonalities of geography, ecology, and constraints to production in each region.

Detailed information on the research and training activities of the regional programs can be found in Program Reports for 1989 and other documents published by ICARDA. The following text presents only the highlights of each regional program's activities.

The Highland Regional Program

This Program focuses on the highlands of WANA, which constitute about 40% of the total agricultural land and contribute nearly 30% of the region's production. However, the potential of highlands remains unexploited by research and development programs because, among other reasons, they are subject to extremes of weather conditions, are not easily accessible, and their soils are degraded. In WANA, highlands are found in Turkey, Iraq, Afghanistan, and Pakistan in the east; and in Algeria and Morocco (the Atlas mountain range) in the west. Of these countries, ICARDA has made considerable progress in its cooperative activities with Turkey, Iran, and Pakistan, and active efforts have begun to increase the participation of other countries as rapidly as possible.

In Pakistan, a USAID-supported MART/AZR Project has enabled ICARDA to make substantial progress. The project completed its first four-year phase at the Arid Zone Research Institute (AZRI), Quetta, Balochistan, in November 1989, and was renewed by USAID for a further three-year period. In its second phase, the Project will concentrate on three interlinked areas: livestock management and rangeland rehabilitation; agronomic management, including improved techniques of water harvesting; and agricultural economics of the farming systems of highland Balochistan. The Project's somewhat sharper focus in the second phase results from experiences gained in the cold and arid environment of the western highlands of Pakistan. The highlights presented here follow the five specific research areas around which the Project was structured, and broadly cover the Project's first phase.

Farming Systems

Secondary statistics relating to the production of small ruminants, as well as the statistics for dryland crop production, were compiled and utilized to develop a formal survey of household agricultural production systems. The results confirmed the importance of livestock rearing as the principal subsistence agricultural

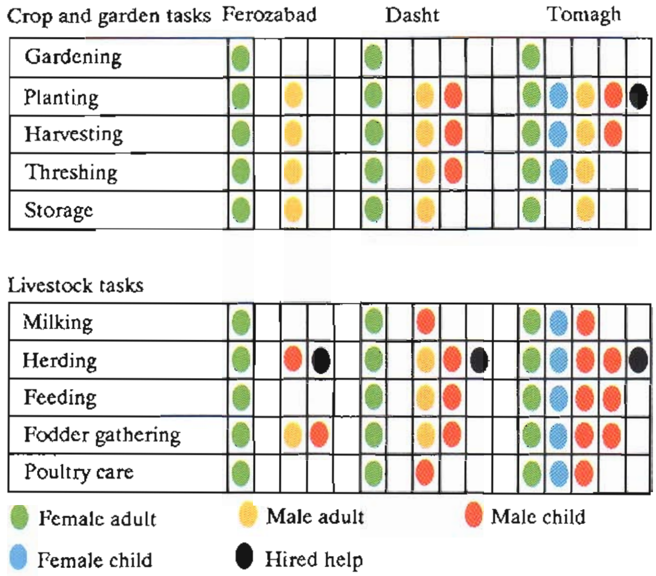


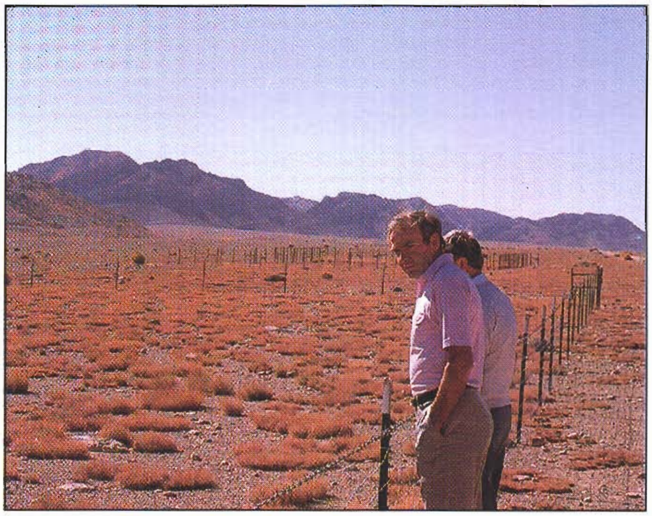
Fig. 43.Allocation of agricultural activities by gender in Balochistan.

activity. The study of the role of women in agricultural activities received special attention in the survey.

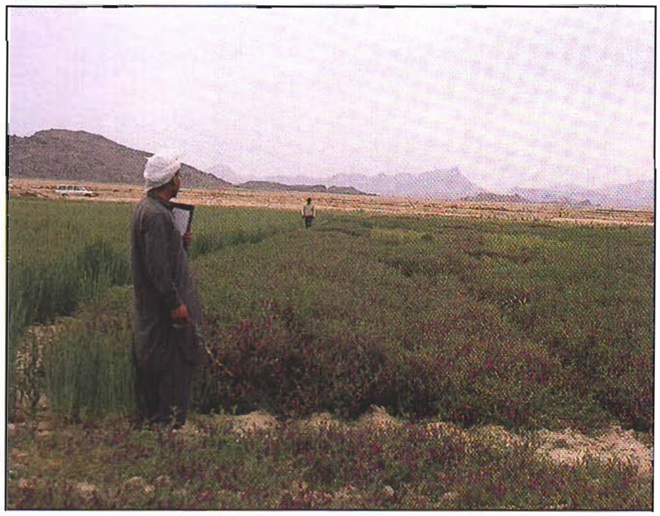
A specialized survey of wheat and barley producers investigated why, though barley is more adapted to the arid highland environment, wheat was the predominant and often only crop grown. Food security for farming families is the fundamental consideration at present, but the ever increasing demand for livestock feed and the incapability of the rangelands to supply it in their current degraded state, implies that AZRI's barley research may soon have an important impact on Balochi farming communities. Severe overgrazing of natural rangeland vegetation has compounded the problem of feed supply and quality; only better resource management can provide a solution.

Range and Livestock Management

Productivity of the two principal types of range vegetation in highland Balochistan--an *Artemisia-Haloxylon* shrub steppe and a *Cymbopogon-Chrysopogon* grassland--was observed to be low, even with periodic protection. AZRI is therefore concentrating on rehabilitation of rangelands through the introduction of new grass and shrub species. The initial efforts aim at creating feed reserve areas where proper grazing management can be assured, such as those near farm dwellings, rather than on large-scale rangeland management.



A *Chrysopogon* grassland showing only limited regrowth even after receiving complete grazing protection for two years. Efforts are therefore being made for rangeland rehabilitation using new grass and shrub species.



Wooly pod vetch, growing at Khuzdar at 1,250 meters above sea level, has proved to be a successful introduction to the highland areas of Balochistan.

One successful example of this approach has been the introduction of the fodder shrub *Atriplex canescens* which has proved to be well adapted to the highland environment. Studies on palatability, digestibility, productivity, and regrowth of this shrub provided encouraging results. Other studies demonstrated the need for prophylactic health care against internal parasites that are ubiquitous in local sheep flocks.

Agronomy

Initial studies on dryland production of forage and dual-purpose crops indicate that conventional agronomic interventions, such as the addition of fertilizers, weed control, etc., would not be economically viable without additional water. Local farmers already embank their fields to either preserve rainfall or permit additional run-on water from ephemeral streams to be trapped and utilized. AZRI is investigating how these local water harvesting systems can be improved. Results suggest that grading the upper sloping portions of the field to encourage run-off onto lower cultivated sections can be considerably advantageous, particularly in dry years.

Studies on forage crops suggest that introduced Syrian landraces of barley are more productive than the local variety. With enhanced disease resistance, introduced varieties can provide even higher productivity. In addition, introduction of woolly pod vetch (*Vicia villosa* spp. *dasycarpa*) showed promise of good forage productivity, particularly in slightly wetter years. Wheat and lentil improvement research results, including the improved varieties, have been inconclusive due to the need for additional water.

Germplasm Evaluation

The harsh environment of highland Balochistan makes the task of finding suitably adapted crop germplasm very difficult. However, AZRI has successfully selected short-maturity wheat and barley genotypes suitable for spring sowing. Some progress has also been made with the selection of winter wheat genotypes. For winter barley, Syrian landraces seem promising. The local lentil landrace, though more productive than the introduced genotypes, has the major disadvantage of being very small seeded (<1.5g/100 seeds)--the consumer preference is for larger seed. Two of ICARDA's lentil introductions, ILL 5865 and ILL 5677, which have about twice the seed size of the local landrace, are being tested as the possible candidates to meet the consumer preference.

Good progress was also made in the introduction and selection of annual-sown forage legumes. Vetch genotypes have been the most productive, particularly lines of *Vicia villosa*, when sown in winter. This species has shown a considerable degree of resistance to cold, surviving air temperatures as low as -19 °C. It is expected that improved vetch lines will soon be introduced widely into local farming systems as a reliable source of animal feed.

Agricultural Extension

In the past four years AZRI has sought to develop close linkages with the extension services of the provincial Agriculture, Livestock, and Forest Departments. The goal is to ensure that AZRI's improved technologies reach the farming communities as quickly and effectively as possible.

A major survey was undertaken to identify social and communication barriers to extension. Extensive field activities were undertaken for the testing of AZRI technologies through farmer-managed trials and mass prophylactic health care of small ruminants.

The Arabian Peninsula Regional Program

Though ICARDA has collaborated with the Arabian Peninsula countries in past years to varying degrees, activity gained momentum in 1988 with support from the Arab Fund for Economic and Social Development. A Coordinator was appointed and a well-defined Arabian Peninsula Regional Program (APRP) established in 1989. The major objectives of the Program are to strengthen research and provide necessary training for improving wheat, barley, food legumes, pasture, forage, and livestock production and the related farming systems, and to bridge the yield gap between the researcher-managed and farmer-managed plots. The countries participating in this program are: the United Arab Emirates (UAE), Bahrain, Qatar, Kuwait, Saudi Arabia, the Sultanate of Oman, the Yemen Arab Republic (YAR), and the People's Democratic Republic of Yemen (PDRY).

The constraints common to agricultural development in this region are drought, heat, salinity, weeds, pests and diseases, and lack of trained personnel.

The APRP activities during 1989 focused on germplasm and information exchange, seed production, and training. Several wheat, barley, food legume, and forage nurseries were provided for a wide range of agroecological conditions. ICARDA's bread wheat variety Doha 88 was identified for release in Qatar; another bread wheat variety, Cham 2, introduced to Saudi Arabia and UAE, performed well. A varietal description booklet on the local and improved wheat and barley varieties grown in YAR was also produced. The number of trainees registered for ICARDA training courses for 1988/89 from the participating countries also increased. Two consultancy missions were organized upon requests from the Sultanate of Oman and Saudi Arabia.

The Second Annual Coordination Meeting was held in Aleppo, Syria, in which high ranking officials and scientists from participating countries as well as representatives from UNDP, AFESD, ACSAD, GCC, CIMMYT, the University of Aleppo, and GOSM (Syria) participated. The meeting reviewed the 1988/89 research and training activities and developed work plans for 1989/90. The UAE announced its offer to host the Office of the Arabian Peninsula Regional Program, which ICARDA gratefully accepted.

Doha 88, a new bread wheat variety, in prerelease multiplication in Qatar.

The West Asia Regional Program

ICARDA's on-going activities in Syria, Jordan, Iraq, Lebanon, Cyprus, and lowland areas of Turkey were consolidated into a West Asia Regional Program (WARP). In July 1989, a Program Coordinator was appointed and an office established in Amman, Jordan.

WARP is also responsible for the execution of ICARDA's Mashreq Project, supported by UNDP and the Arab Fund for Social and Economic Development, for increasing the productivity of barley, pastures, and sheep in critical rainfall zones of Syria, Jordan, and Iraq. The activities of this project follow ICARDA's strategy to pay greater attention to the drier areas of the region.

Cooperation with Jordan was strengthened. The First Coordination Meeting between ICARDA and Jordan took place in August, and work plans for 1989/90 were developed and implemented. The research areas covered include crop rotation, tillage and residue management in wheat-based systems, legume inoculation, weed and sitona weevil control, vetch and lathyrus germplasm evaluation, medic inoculation, and rhizobial selection.

A major development was the establishment of cooperation with Iraq; the Program Coordinator, in cooperation with colleagues from Iraqi institutions, investigated the areas in which ICARDA's support could be utilized. Requests from Iraq for seed and germplasm were met.

Cooperation with the Syrian national program progressed with increased enthusiasm. The eighth Annual Coordination Meeting was held at ICARDA headquarters and was opened by the Syrian Minister of Agriculture and Agrarian Reform. The meeting expressed satisfaction with the achievements made in 1988/89, and developed work plans for the 1989/90 season.

The Mashreq Project made a good start. Work plans for the 1989/90 season were developed in cooperation with each of the three participating countries. In Syria, demonstration trials for barley and forage crops were conducted on farmers' fields in Hama, Raqqa, and Hasaka governorates. In Jordan, similar trials were conducted in Mafraq, Madaba, Rabba, and Shawbak. Farmers in both countries cooperated enthusiastically. Work on barley was initiated in central Iraq, and will be expanded to northern areas next season. Sheep productivity improvement research will soon be addressed in all three countries following a crop-animal integration approach. In cooperation with headquarters, WARP designed appropriate training courses and workshops for 1990.

The Nile Valley Regional Program

From NVP to NVRP

The Nile Valley Project (NVP) on faba bean, successfully operated by ICARDA in Egypt and the Sudan from 1979 to 1988, and in Ethiopia from 1985 to 1988, was expanded in 1989 and renamed the Nile Valley Regional Program (NVRP). In addition to faba bean, the new Program covers research and training activities to improve the production of other cool-season food legumes (chickpea and lentil, and field pea for only Ethiopia) and cereals (wheat, in cooperation with CIMMYT, and barley). Like NVP, the activities of NVRP are built around a multidisciplinary, multi-institutional, and problem-oriented approach that makes full use of the expertise, human resources, and infrastructure available in the participating countries. ICARDA, in collaboration with the three countries, prepared project proposals and succeeded in obtaining funding from the EEC for Egypt, the Government of the Netherlands for the Sudan, and SAREC of Sweden for Ethiopia.

Faba Bean

Adoption of the recommended package in Egypt increased seed yields by 24, 27, and 43% in Minia, Fayoum, and Behaira governorates, respectively. In Behaira, 70% of the farmers surveyed confirmed that the increased productivity was due to the adoption of the recommended package. Over the last five years, the faba bean area in Egypt has increased by 32% and the national productivity by 0.22 t/ha. Prerelease multiplication of four new disease-resistant lines, in addition to Reina Blanca identified earlier as promising, was carried out.

A faba bean line, developed from an ICARDA cross (NEB 207 x 74 TA74-6D), in national yield trials in a mid-altitude area of Ethiopia.

In the new areas of the Sudan where faba bean has been recently introduced, variety Selaim Medium (SML) was found well-adapted, and consumers were happy with its cooking quality. Seed yields ranging from 2.3 to 5.5 t/ha were obtained in demonstration plots in Gezira, with a substantial average net return. More farmers are now interested in growing faba bean. The Gezira Scheme management, impressed with farmers' response, has decided to provide necessary services and inputs.

In Ethiopia, early sowing was established as the most important factor in faba bean production in Menagesha, Yerer-Kereyu, and Salale zones of the Central region, whereas fertilizer was important in the Chilalo zone of the southeast region. Pure lines have been developed from the Ethiopian faba bean landraces which are ready for multilocation yield evaluation. A line developed from the ICARDA cross, NEB 207 x 74 TA74-6D, performed well in the mid-altitude areas of the country. Resistance to chocolate spot was confirmed in five faba bean lines from ICARDA.

Lentil

With the introduction of lentil to the Delta Region, the area under this crop has expanded in Egypt. The use of the recommended package increased seed yield by 21%, and at one location it exceeded 3 t/ha. Lentil lines resistant/tolerant to aphids and water-logging were identified. The variety Precoz responded well to irrigation.

Seed yields of up to 3 t/ha were obtained in the Rubatab area in the Nile Province of the Sudan. Efforts to establish a decortification facility for lentil will be made.

Kabuli Chickpea

Grain yield increases of more than 1.2 t/ha were obtained in demonstration plots in the Sudan's Rubatab area. The superiority of Shendi 1, a recently released variety, was established. Variety NEC 2486 also proved promising.

Wheat

Use of the recommended package provided 18-59 % increase in grain yields in pilot production plots in Upper Egypt. Results demonstrated that wheat could be grown in the Northwest Coastal Region of Egypt, with bread wheat varieties Sakha 69 performing well in the west and Sakha 8 and G 155 in the east of Marsa-Matroh, respectively.

In durum wheat, Sohag 1 and 2 outyielded the standard variety, Cham 1, by 0.5 and 0.4 t/ha, respectively. Genotypes Vee 'S' and Giza 160 performed well in the high temperature stress areas of Egypt.

In the Sudan, grain yields of up to 4.6 t/ha were achieved in large production plots on farmers' fields with the improved production package, reflecting a three-fold increase over the present farmers' yields in the area. The improved production package was highly cost-effective and, therefore, attractive to farmers in the area. In the New Halfa area and the Selaim Basin of North Sudan, the increase was two-fold. Variety S 9448A-SV7 is ready for release to the farmers of Gezira and Menagil area of the central region.

Barley

Grain yield increases of 75-250% were obtained in the Northwest Coastal Region of Egypt by adopting improved varieties, Giza 123 and 144, and CC 89. Two lines with high and stable grain yields were identified for drought-prone areas. Procedures for seed production of two of the promising barley varieties were demonstrated to farmers to help them produce their own seed from certified seed.

The North Africa Regional Program

The North Africa Regional Program (NARP) covers Algeria, Libya, Morocco, and Tunisia. In addition to a Program Coordinator located in Tunisia, the ICARDA team in North Africa has five scientists representing the major research thrusts of the cooperative activities. They include a breeder and a pathologist in faba bean, transferred from headquarters in 1989 to Morocco, in line with ICARDA's strategy to phase out faba bean improvement activities from its core program and hand them over to Morocco. The two scientists have established an office at the Douyet station in Fez.

NARP is also responsible for executing a UNDP-supported project on cereal and food legume disease monitoring and germplasm enhancement in Algeria, Morocco, and Tunisia; and a Government of Italy/IFAD-supported Technology Transfer Project to increase barley, food legumes, and livestock production in Algeria, Libya, Morocco, and Tunisia.

In 1989, NARP took a step forward in strengthening collaboration with the Agricultural Research Center, Libya. The ICARDA and Libyan scientists exchanged visits and a well-defined collaborative program started taking shape. A draft agreement, prepared through mutual discussions, was ready for signatures at the end of 1989.

A supplement to the 1980 agreement with Tunisia was signed in 1989. It allows ICARDA to base its NARP regional office in Tunisia.

Necessary preparations were made to have the 1986 agreement with Algeria ratified.

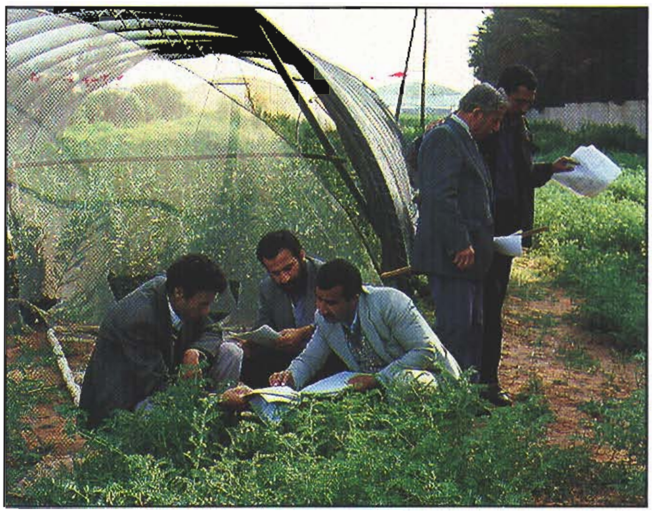
The annual coordination meetings to review the research results of the past season and develop work

Douyet research station in Morocco where ICARDA's faba bean scientists, transferred from headquarters, are based to develop a Regional Faba Bean Improvement Program for North Africa.

plans for the 1989/90 season were held in September with Algeria, Morocco, and Tunisia. The first Coordination Meeting with Libya, which focused on cereals and food legumes, was held in Tripoli in October.

As of 1989, through the collaborative efforts between NARP and national programs, Algeria had released one variety of barley, four of durum wheat, two of bread wheat, and two of chickpea; Morocco had released six varieties of barley, four of bread wheat, and two of chickpea; and Tunisia had released four varieties of barley, one of durum wheat, one of bread wheat, and three of chickpea (Appendix 2). In 1989, a number of promising lines were identified for prerelease testing.

NARP initiated specialized regional trials and nurseries that were distributed to the four countries, and facilitated the exchange of advanced germplasm between those countries.



Characterization of chickpea genotypes by Algerian, Moroccan, and Tunisian scientists in a regional training program in Morocco.

Theme-oriented cereal networks, established for germplasm and information delivery, provided the framework for a series of Maghreb cooperative activities: disease survey in Morocco; ICARDA/Maghreb in-country training on insect identification, damage evaluation and note taking in Morocco; and cereal traveling workshop and joint selection work in Algeria.

The adoption study of winter sowing of chickpea, involving 112 Moroccan farmers, confirmed the merits of the technology in spite of unfavorable weather conditions

ICARDA/Maghreb in-country training in insect identification, damage evaluation, and note taking in Morocco.

in the 1988/89 season. In Tunisia, 50-84% higher yields were obtained in demonstration trials using this technology.

Seed of the local genotypes of *Medicago orbicularis, M. aculeata*, and *M. truncatula*, collected during ecogeographic surveys, was multiplied for further evaluation. Trials with vetches from ICARDA and local selections provided promising results. The maximum dry-matter production occurred in May for all genotypes, with nearly 6 t/ha for Acc. 1812 which was selected as a possible candidate for release.

A naturally occurring stand of *Medicago truncatula* and *M. aculeata* near Beni Mellal, Morocco.

NARP also actively cooperated in two important studies: one, conducted jointly by ICARDA and IFPRI, on the role of food legumes in farming systems; and the other, conducted jointly by UNDP, IFPRI, and ICARDA, on the economics of barley in the Middle East and North Africa.

The Latin America Regional Program

This program is still at its early stages of development. An ICARDA scientist based at CIMMYT in Mexico has been focusing on barley improvement activities, but the possibility to include food legumes is being considered in consultation with ICRISAT. In the meanwhile, active working relationship has been developed for food legume research and training with the Andean countries through the Programa Cooperativo de Investigacion y Transferencia de Technologia para la Subregion Andina (PROCIANDINO), Quito, Ecuador.

Seed Production

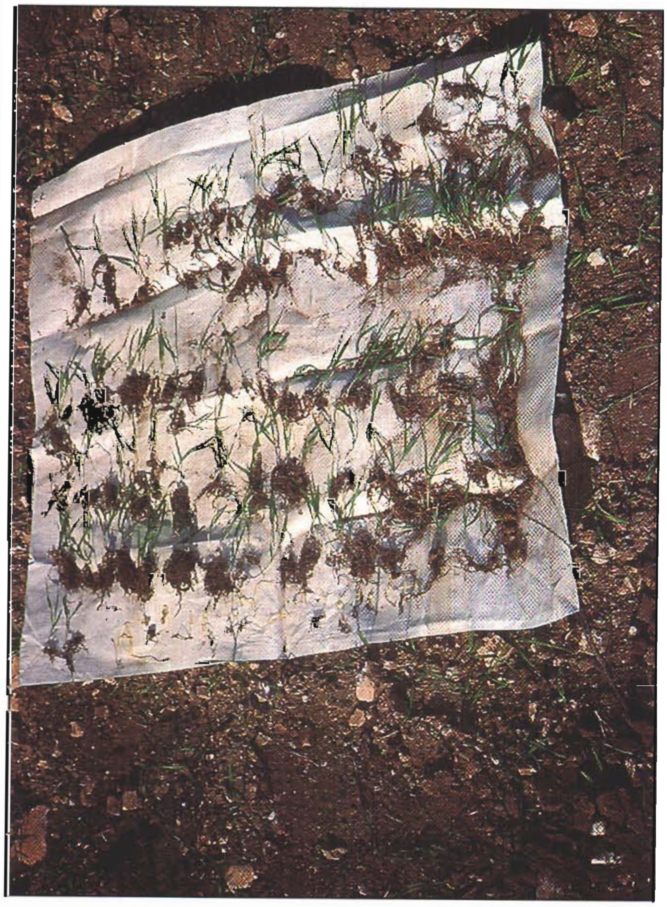
Where farmers fail to adopt improved technology, lack of adequate quantities of quality seed at the right time is almost invariably reported to be one of the major factors. Recognizing the crucial role of quality seed in making its recommended technology packages successful, ICARDA maintains a modest Seed Production Project supported by the Governments of the Netherlands and the Federal Republic of Germany. The Project aims at strengthening seed programs in WANA through training, assistance in infrastructure development, and providing small quantities of quality seed, on request from NARSs, for multiplication and distrubution to farmers. The Project also serves the commodity programs of the Center by cleaning, treating, and quality testing their seed, and manages the Central Seed Store of ICARDA.

In view of its direct relevance to NARSs, the Seed Production Project is included in the outreach activities of ICARDA and operates in close cooperation with the Center's regional programs.

In 1989, three training courses were held, two in-country and one at headquarters. In addition, 27 individuals were trained at headquarters: 12 in seed testing techniques and 15 in seed processing and storage. Three round-table discussions were held in Morocco and Egypt on food legume seed production, rules and standards for field inspection, and morphological description of varieties. The Project has developed morphological descriptions of 45 varieties of wheat and 17 of barley.

Post-control plots (plots planted with seed taken from seed lots that were approved in the previous season) were initiated in Egypt as part of the Seed Certification System.

In 1989, the Project produced 10.8 tons of quality seed of wheat, 11.8 tons of barley, 1.8 tons of chickpea, 0.2 ton of lentil, and 390 kg of medic for distribution in the region.



Quality seed production needs strengthening throughout North Africa. Here, a low germination percentage resulted in poor crop establishment. The seedlings uprooted from 1 sq m area indicated that only 50% of the seed had germinated.

Resources for Research and Training

Finance

ICARDA's programs are funded by its generous donors. In 1989, the Center operated its core actitivities on funds totalling 21.356 million USD, compared to 23.105 million USD in 1988. The sources of these funds are summarized in Table 29.

Table 29. Sources of funds for ICARDA's core programs and capital requirements (x 1000 USD), 1989.

Arab Fund	512a	Netherlands	535
Australia	349	Norway	440
Austria	175	OPEC	60a
Canada	797	Spain	125
		Stabilization mechanism fund	490
China	30	Sweden	572
Denmark	285		
Ford Foundation	170	United Kingdom	899
France	345a	USAID	4696a
Germany	2325a	Exchange gain (net)	1771b
IBRD (World Bank)	4250		
IDRC	122a	Earned income	1153c
India	25		
Italy	1230a	Total	21,356

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

[b] Sum of exchange gains of USD 1,999 and losses of USD 228 on transactions in other foreign currencies. The Central Bank of Syria permitted ICARDA to convert 50% of its U.S. dollars transferred to the country at the official rate of SYP 11.2 to 1 USD, and the other 50% at an encouragement rate, which was SYP 20.00 to 1 USD in 1989. This resulted in an effective exchange rate of SYP 15.60 for local currency purchase. The gain of USD 1,999 represents the difference between the official rate used for accounting purposes and the effective exchange rate.

[c] Net of investment income.

In addition, ICARDA received 3.646 million USD for 35 special projects (see Appendix 6). The special projects exploit ICARDA's capacities and accumulated experience, but do not represent a commitment beyond the duration of funding. These projects are particularly useful for cooperative activities with national programs, where an ICARDA involvement may be needed for a few years, but for which the national programs will themselves be responsible once the immediate objectives have been fulfilled.

Staff

During the year, the following senior staff joined ICARDA: Mr Andre Briet, Director of Finance; Mr Allan Deutsch, Head of Communication, Documentation, and Information Unit; Dr Jan Valkoun, Head of Genetic Resources Unit; and Dr Murari Singh, Senior Biometrician.

Six senior staff members proceeded on sabbatical leave: Dr Philip Cocks, Leader, Pasture, Forage, and Livestock Program; Mr Khaled S. El-Bizri, Director, Computer Services; Dr Habib Ibrahim, Senior Training Scientist; Dr Thomas Nordblom, Agricultural Economist; Dr Omar Mamluk, Plant Pathologist; and Dr J Dieckmann, Farm Manager.

The following staff left ICARDA during 1989: Mr Samir El-Fayoumi, Director of Administration; Dr Thomas Stilwell, Agronomist; Dr Cemal Talug, Extension/Communications Specialist; Dr David Rees, Agronomist; Mr Mouhannad Ismail, Financial Controller and Treasurer; Dr Bhal Somaroo, Leader, Genetic Resources Unit; and Mr John Woolston, Leader, Scientific and Technical Information Program.

A list of senior staff as of 31 December 1989 is given in Appendix 13, and a summary of the list is presented in Table 30.

Table 30. Staff of ICARDA at various locations on 31 December 1989.

Location		International professional	Regional professional	Other staff	Total
Syria	Aleppo-Tel Hadya	51	43	502	596
	Damascus	-	1	6	7
	Lattakia	-	-	1	1
Ethiopia	Addis Ababa	1	-	-	1
Egypt	Cairo	1	-	6	7
Italy		-	-	8	8
France		-	-	1	1
Jordan		-	-	1	1
Lebanon	Beirut	-	1	6	7
	Terbol	-	-	26	26
Mexico	CIMMYT	1	-	-	1
Morocco	Rabat	3	-	2	5
	Fez	2	-	-	2
Pakistan	Quetta	1	-	1	2
Tunisia	Tunis	1	-	2	3
Total		61*	45	562	668

* Includes senior scientists seconded from other organizations.

Farms

ICARDA operates six sites in Syria and two in Lebanon (Table 31). These sites represent a variety of agroclimatic conditions, typical of those prevailing in West Asia and North Africa.

Table 31. ICARDA sites in Syria and Lebanon.

Site	Location		Area (ha)	Approximate elevation (m)	Average precipitation (mm)
SYRIA					
Tel Hadya	36°01'N	36°56'E	944	284	350
Bouider	35°41'N	37°10'E	35	268	210
Ghrerife	35°50'N	37°15'E	2	320	280
Breda	35°56'N	37°10'E	76	300	280
Jindiress	30°24'N	36°44'E	10	210	470
Lattakia*	35°26'N	35°57'E	5	60	930
LEBANON					
Terbol	33°49'N	35°59'E	39	890	600
Kfardane	34°01'N	36°03'E	50	1080	430

* Closed down in 1989.

A new site of approximately 200 hectares is managed jointly by ICARDA and the Steppe Directorate of the Ministry of Agriculture and Agrarian Reform, Syria. It is located about 120 km southeast of Aleppo, and receives an average annual precipitation of 200 mm. This site is proposed to be used for marginal land rehabilitation research, using edible shrubs.

The field crops faced difficult growing conditions due to the below-average rainfall in the 1988/89 season, and frost from January to March (58 frost nights, measured at ground level).

The use of low-pressure tires was extended to carry out seed bed preparation and top dressing of fertilizer.

The new greenhouse facility at Tel Hadya became fully operational after some modifications in the heating and cooling systems. The Center is evaluating various options for making a provision for large quantities of water that the cooling system will require during the warmer part of the years. On a hot day with 40° C ambient temperature, about 100,000 liters of water may be required for the 7,500 m² of the greenhouse facility.

Low ground-pressure tires used for seed bed preparation and fertilizer top dressing. Pressure: 0.35 bar instead of the standard 1.6 bars.

The greenhouse facility at Tel Hadya.

Farm Machinery Development

A tractor-pulled medic harvester was fabricated in collaboration with ACSAD, and its performance evaluated in the field. The harvester will be further improved based on the observations made from its field evaluation.

An Australian design was adapted to fabricate a rain-out shelter to meet ICARDA's need for screening drought-resistant material. The key adaptation involved the use of the semi-conductor technology to sense the first drop of rain to provide an impulse to the 12-volt motor to close the 25 m x 6.5 m shelter within 25 seconds. Within five minutes after the rain stops, the sensor activates the motor to open the shelter. The motor is powered by two 12-volt batteries, which are charged using a wind-powered automobile alternator.

Rain-out shelters at Tel Hadya for screening drought-resistant material.

Laboratories

With the completion of the four new laboratories in the Genetic Resources Building, the total number of laboratories at ICARDA headquarters rose to 43. These laboratories provide state-of-the-art facilities for research in a wide range of disciplines.

Small Ruminants Unit

A research flock of over 700 Awassi sheep is maintained at Tel Hadya. The sheep are used in large-scale grazing trials, research on nutritive value of feeds, and studies on improved husbandry. Modest research facilities are also available for feeding trials, measurement of digestibility and feed intake, and counting of helminth parasites. Thirty-five goats of the Syrian Shami breed were added to the flock in 1989 for research on management of pastures using mixed ruminant species.

The small ruminants unit at Tel Hadya.

Computers

Hardware Upgrade

With the addition of 50 personal computers (PCs) during 1989 to research programs and administrative units, the number of PC's at the Center rose to 80. The additional PCs, mostly IBM PS/2's, have not only supplemented the Mainframe computing capacity but also made it possible to use a range of commercially available software. Introduction of the new technology has benefited the users at headquarters, as well as ICARDA's regional offices and School.

The additional computer facilities address the following areas: graphics, desk-top publishing, and CD-ROM.

Microcomputing Support

To enable the users to efficiently exploit the potential of the new technology, a series of training courses were held both for headquarters and outreach offices personnel. (Table 32).

Table 32. Microcomputing training courses offered during 1989.

Software	Frequency	No. of participants
DOS	5	65
WordPerfect	5	70
Lotus 1-2-3	2	10
dBASE III Plus	3	60
PageMaker	1	5

In addition to providing training and user support, the Computer Services evaluated and identified a number of application software for their suitability to meet the Center's needs.

Biometric and Experimental Aids

The biometrical service provided to ICARDA's researchers included consultancy on planning of experiments, analysis of data, and interpretation and reporting of results. A review of six major PC-based statistical packages was completed and GENSTAT 5, MSTATC and SPSS/PC+ were recommended for use at the Center. A number of custom-made GENSTAT procedures were written to address the need of some researchers for specialized analysis of their datasets.

Other specialized statistical software on PC's provided to the researchers included: (i) PCSMP from Wageningen University, the Netherlands, (ii) ANOFT from Schwarzbach Plant Breeding, Austria, (iii) REML, ALPHAGEN, and ALPHANAL from Scottish School of Agriculture, and (iv) MATMODEL from Cornell University, USA.

A training course on "Biometrical Methods with Computer Applications in Agricultural Research" was developed. The course has two components, lectures on theoretical methods and practicals using statistical packages on PC's, and will be offered to headquarters and NARS scientists in 1990.

During 1989, the following new statistical methods were developed:

1. **Analysis of a series of yield trials with common checks.** This method addresses the need to adjust the yields of uncommon test entries when an experiment with a large number of entries is split into more than one trial in the adjacent fields. It can also assess the genotype x environment interaction derived from such trials. The method is applicable to the general non-orthogonal checks as well as incomplete block designs for individual trials.

2. **Estimation of growth reduction dose.** Asymptotic variance was evaluated for an estimate of the growth reduction dose from the quantitative dose-response polynomial relationship. The response at the control dose was considered a random variable. The method was evaluated with the experimental data on chickpea.

3. **Computation of incomplete diallel in incomplete blocks.** This technique has been scheduled for inclusion in the training course on Biometrical Methods for Cereal Breeders.

Administrative Applications

In 1989, a number of existing modules were revised, and new ones added to MAS, ICARDA's Management Accounting and Information System, to improve the efficiency of the various aspects of accounting and reporting.

Stock Control System

Upgrading of Stock Control System was carried out to provide additional features to make it more flexible to meet the user needs. The modifications addressed the following major areas: Stock File Management, Use of Forms, and Efficient Reporting. Most of the routines in the system were converted to modular forms.

The modified Stock Control System is compatible with, and accessible to, the Order Entry System and MAINSYS, ICARDA's Workshop Management and Control System. It allows the management of non-stock items, such as spares, fixed assets, services, etc. Multiple users can access the Stock file from more than one terminal.

Order Entry System

The Order Entry System was evaluated in cooperation with the Purchasing and Supplies Department. Most of the desired revisions were carried out in 1989.

MAINSYS System

The Fixed Assets Register component in MAINSYS (Workshop and Equipment Management System) is now fully implemented. The data input files of this Register were screened for anomalies and corrected. A facility to create and print the log of all modifications to the Register was added for better security and integrity of the Register. Also, the file structure was modified to include more information. The staff from Vehicle Workshop, Mechanical Engineering Workshop, and Purchasing and Supplies Department participated in training on the use of MAINSYS system.

Graphic Facility

The graphic software, ICAGRAPH, developed at ICARDA for the VAX Mainframe, was further improved by the addition of Mixed Graphs, Multi-Graphs, a Second Scale on the right side, a Grid to position and control graph sizes, and an on-line Help facility.

A Graphic Work-Station, using the 35mm Express software, was established in the users' area in Computer Services, and Harvard Graphics was installed on the PC's of Communication, Documentation, and Information Unit. Computerized graphics and slide making facilities were extensively used at the Center in 1989.

Appendixes

Contents

Appendix 1

Precipitation (mm) in 1988/89

	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	TOTAL
SYRIA													
Tel Hadya													
1988/89 season	0.0	41.2	60.8	83.9	10.0	5.8	17.8	0.0	14.9	0.0	0.0	0.0	234.4
Long-term average (11 seasons)	0.5	27.7	46.3	58.4	62.8	51.6	44.4	28.8	14.4	3.4	0.0	0.1	338.4
% of long-term average	0	149	131	144	159	104	40	0	103	0	n/a	0	69
Breda													
1988/89 season	0.0	52.8	45.6	65.4	1.2	2.0	12.6	0.0	14.2	1.0	0.0	0.0	194.8
Long-term average (31 seasons)	1.4	14.5	30.0	52.6	47.2	27.8	32.7	32.5	15.7	1.6	0.2	0.0	256.2
% of long-term average	0	364	152	124	3	7	39	0	90	63	0	n/a	76
Bouider													
1988/89 season	0.0	20.6	56.6	74.2	5.5	0.4	25.7	1.0	2.4	2.6	0.0	0.0	189.0
Long-term average (17 seasons)	1.5	14.3	23.0	36.6	41.3	36.4	27.1	19.0	9.7	0.8	0.2	0.0	209.9
% of long-term average	0	144	246	203	13	1	95	5	25	325	0	n/a	90
Ghrerife													
1988/89 season	0.0	72.7	50.0	62.4	0.4	1.8	13.0	0.0	1.2	0.0	0.0	0.0	201.5
Long-term average (5 seasons)	0.0	44.8	36.5	39.6	50.8	36.1	41.8	15.3	19.2	3.5	0.2	0.0	287.8
% of long-term average	n/a	162	137	158	0	5	31	0	6	0	0	n/a	70
Jindiress													
1988/89 season	0.0	61.6	125.6	117.1	11.6	1.2	32.1	0.0	5.0	0.0	0.0	0.0	354.2
Long-term average (30 seasons)	1.3	29.5	54.5	99.2	89.5	73.4	64.8	43.4	18.9	3.2	0.0	0.9	478.5
% of long-term average	0	209	230	118	13	16	50	0	26	0	n/a	0	74
Lattakia *													
LEBANON													
Terbol													
1988/89 season	0.0	38.2	48.8	145.6	36.2	22.2	39.4	7.2	6.0	0.0	0.0	0.0	343.6
Long-term average (9 seasons)	0.0	29.5	59.3	90.0	122.0	101.8	99.8	24.4	10.9	1.3	0.0	0.0	539.2
% of long-term average	n/a	129	82	162	30	22	39	30	55	0	n/a	n/a	64
Kfardane *													

* Data not available.

Note: The long-term average is subject to some fluctuation as each year's new data are averaged in. For location, elevation, etc. of these sites, see Table 31 on page 86.

Appendix 2

Cereal and Food Legume Varieties Released by National Programs

Country	Year of release	Variety
Barley		
Algeria	1987	Harmal
Chile	1989	Leo/Inia/Ccu
China	1986	Gobernadora
Cyprus	1980	Kantara
	1989	(Mari/Aths*)
Ecuador	1989	Shirt
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
	1989	Tessaout
		Aglou
		Rihane
		Tiddas
Nepal	1987	Bonus
Pakistan	1985	Jau-83
	1987	Jau-87
	1987	Frontier 87
Peru	1987	Una 87
		Nana 87
Portugal	1982	Sereia
	1983	CE 8302
Qatar	1982	Gulf
	1983	Harma
Saudi Arabia	1985	Gusto
Spain	1987	Rihane
Syria	1987	Furat 1113
Thailand	1987	Semang 1 IBON 48
		Semang 2 IBON 42
Tunisia	1985	Taj
		Faiz
		Roho
	1987	Rihane"S"
Yemen AR	1986	Arafat
		Beecher
Durum Wheat		
Algeria	1982	ZB S FG'S'/LUKS GO
	1984	Timgad
	1986	Sahl
		Waha
Cyprus	1982	Mesoaria
	1984	Karpasia
Egypt	1979	Sohag I
	1988	Sohag II
		Beni Suef
Greece	1982	Selas
	1983	Sapfo
	1984	Skiti
	1985	Samos
		Syros
Jordan	1988	Korifla = Petra
		Cham 1 = Maru
		N-432 = Amra
		Stork = ACSAD 75
Lebanon	1987	Belikh 2
Libya	1985	Marjawi
		Ghoudwa
		Zorda
		Baraka
		Qara
		Fazan
Morocco	1984	Marzak
	1989	Sebou
		Oum Rabia
Pakistan	1985	Wadhanak
Portugal	1983	Celta
		Timpanas
	1984	Castico
	1985	Heluio
Saudi Arabia	1987	Cham 1
Spain	1983	Mexa
	1985	Nuna
Syria	1984	Cham 1
	1987	Cham 3
		Bohouth 5
Tunisia	1987	Razzak
Turkey	1984	Susf bird
	1985	Balcili
Bread Wheat		
Algeria	1982	Setif 82
		HD 1220

Egypt	1982	Giza 160
	1988	Sakha 92
		Giza 162
		Giza 163
		Giza 164
Ethiopia	1984	Dashen
		Batu
		Gara
Greece	1983	Louros
		Pinios
		Arachthos
Iran	1986	Golestan
		Azadi
	1988	Saludan
		Darab
		Quds
Jordan	1988	Nasma = Jubeiha
		L88 = Rabba
Libya	1985	Zellaf
		Sheba
		Germa
Morocco	1984	Jouda
		Merchouche
	1989	Saba
		Kanz
Pakistan	1986	Sutlej 86
Portugal	1986	LIZ 1
		LIZ 2
Sudan	1985	Debeira
	1987	Wadi El Neel
Syria	1984	Cham 2
	1986	Cham 4
	1987	Bohouth 4
Tanzania	1983	T-VIRI-Veery 'S'
		T-DUMA-D6811-Inrat
		69/BD Tunisian release.
Tunisia	1987	Byrsa
Yemen AR	1983	Marib 1
	1987	Mukhtar
	1988	Aziz
		Dhumran
Yemen PDR	1983	Ahgaf
	1988	SW/83/2

Kabuli Chickpea

Algeria	1988	ILC 482
		ILC 3279
Cyprus	1984	Yialousa (ILC 3279)
	1987	Kyrenia (ILC 464)
France	1988	TS 1009
		TS 1502
Italy	1987	Califfo (ILC 72)
		Sultano (ILC 3279)
Lebanon	1989	Janta 2 (ILC 482)
Morocco	1987	ILC 195
		ILC 482
Oman	1988	ILC 237
Portugal	1989	Elmo (ILC 5566), Elvar
Spain	1985	Fardan (ILC 72)
		Zegri (ILC 200)
		Almena(ILC 2548)
		Alcazaba (ILC 2555)
		Atalaya (ILC 200)
Sudan	1987	Shendi (FLIP 85-17C)
Syria	1982/86	Ghab 1 (ILC 482)
	1986	Ghab 2 (ILC 3279)
Tunisia	1986	Chetoui (ILC 3279)
		Kassab (FLIP 83-46C)
		Amdoun 1 (Be-sel-81-48)
Turkey	1986	ILC 195, Guney Sarisi 482 (ILC 482)

Lentil

Australia	1989	ILL 5750
Algeria	1987	Syrie 229
	1988	Balkan 755
		ILL 4400
Chile	1989	Centinela
Canada	1989	Indian head
Ecuador	1987	INIAP-406 (FLIP 84-94L)
Ethiopia	1984	ILL 358
Lebanon	1988	Talya 2
Morocco	1989	ILL 4605
Syria	1987	Idleb 1 (78S 26002)
Tunisia	1986	Neir (ILL 4400)
		Nefza (ILL 4606)
Turkey	1987	Firat'87 (75kf 36062)

Faba bean

Iran	1986	Barkat (ILC 1268)
Portugal	1989	Favel (80S 43977)

Dry Peas

Sudan	1989	Karimi-1

Appendix 3

Publications

Articles in scientific journals

Augustin, B. and R.A. Sikora. Studies on host range of the normal and giant faba bean races of *Ditylenchus dipsaci*. Nematologia Mediterranea 17(1): 63-66.

Beale, P.E.B. Legumes 1. clover (d) *Trifolium suberraneum* var. *brachycalycinum* (Katzn. et Morley) Zohary and Heller (subterranean clover) cv. Rosedale. Australian Journal of Experimental Agriculture 29(2): 295.

Billar, M. Survey of alfalfa diseases in the Ghouta of Damascus, Syria, (1981, 1982, 1985 and 1986). Arab Journal of Plant Protection 7(1): 1-7 (in Arabic, English summary).

Brown, S., P.J. Gregory, P.J.M. Cooper, and J.D.H. Keatinge. Root and shoot growth and water use of chickpea (*Cicer arietinum*) grown in dryland conditions: effects of sowing date and genotype. Journal of Agricultural Science (Cambridge) 113(1): 41-49.

Capper, B.S., E.F. Thomson, and S. Rihawi. Voluntary intake and digestibility of barley straw as influenced by variety and supplementation with either barley grain or cottonseed cake. Animal Feed Science and Technology 26(1-2): 105-118.

Ceccarelli, S. Wide adaptation: How wide? Euphytica 40(3): 197-205.

Ceccarelli, S. and S. Grando. Efficiency of empirical selection under stress conditions in barley. Journal of Genetics and Breeding 43(1): 25-31.

Clarke, J.M., I. Romagosa, S. Jana, J.P. Srivastava, and T.N. McCaig. Relationship of excised-leaf water loss rate and yield of durum wheat in diverse environments. Canadian Journal of Plant Science 69(4): 1075-1081.

Diekmann, M. and Siham Asaad. Comparison of agar and freezing blotter test for detection of *Fusarium* spp. in seeds of lentil, chickpea and barley. Journal of Plant Diseases and Protection 96(2): 134-139. (German summary).

Elenin, R.S., S.I. Bishara, M.A. Hariri, G.S. Youssef, I.A. Moneim, and R.H. Miller. Evaluating cereals for aphid resistance in Egypt. Arab Journal of Plant Protection 7(1): 72-74. (Arabic summary).

Erskine, W., Y. Adham, and L. Holly. Geographic distribution of variation in quantitative trials in a world lentil collection. Euphytica 43(1-2): 97-103.

Hanounik, S.B. and L.D. Robertson. Resistance in *Vicia faba* germplasm to blight caused by *Ascochyta fabae*. Plant Disease 73(3): 202-205.

Makkouk, K.M., I. Barker, and J. Skaf. Serotyping of barley yellow dwarf virus isolates on cereal crops in countries of West Asia and North Africa. Phytopathologia Mediterranea 28(5): 164-168.

Malhotra, R.S. and K.B. Singh. Detection of epistasis in chickpea. Euphytica 40(1-2): 169-172.

Matar, A.E. and S.C. Brown. Effect of rate and method of phosphate placement on productivity of durum wheat in Mediterranean environments I. Crop yields and P uptake. Fertilizer Research 20(2): 75-82.

Matar, A.E. and S.C. Brown. Effect of rate and method of phosphate placement on productivity of durum wheat in Mediterranean environments II. Root distribution and P dynamics. Fertilizer Research 20(2): 83-88.

Sarraj, W. Search of a substitute for fallow and concentrated international efforts. Journal of Agriculture and Development 3(8): 58-62.

Sarraj, W. On agricultural and allied terminology. Journal of Arab Agricultural Engineer 25: 78-80.

Sarraj, W. Methodology for agricultural science writing in Arabic. Journal of Arab Agricultural Engineer 26: 71-73.

Sauerborn, J., K.H. Linke, M.C. Saxena, and W. Koch. Solarization; a physical control method for weeds and parasitic plants (*Orobanche* spp.) in Mediterranean agriculture. Weed Research 29(6): 391-397.

Sauerborn, J., M.C. Saxena, and A. Meyer. Broomrape control in faba bean (*Vicia faba* L.) with glyphosate and imazaquin. Weed Research 29(20): 97-102.

Silim, S.N., M.C. Saxena, and W. Erskine. Effect of cutting height on the yield and straw quality of lentil and on a succeeding wheat crop. Field Crops Research 21(1): 49-58.

Singh, K.B. and M.V. Reddy. Genetics of resistance to *Ascochyta blight* in four chickpea lines. Crop Science 29(3):657-659.

Singh, K.B., M. di Vito, N. Greco, and M.C. Saxena . Reaction of wild *Cicer* species lines to *Heterodera ciceri:* Nematologia Meditarranea 17(2):113-114.

Singh, K.B., R. S. Malhotra, and M.C. Saxena. Chickpea evaluation for cold tolerance under field conditions. Crop Science 29(2): 282-285.

Stapper, M. and H.C. Harris. Assessing the productivity of wheat genotypes in a Mediterranean climate, using a crop-simulation model. Field Crops Research 20(2): 129-152.

Tahhan, O. and H.F. van Emden. Biology of *Bruchus dentipes* Baudi (Coleoptera: Bruchidae) on *Vicia faba* L. and a method to obtain gravid females during the imaginal quiescence period. Bulletin of Entomological Research 79(2): 201-210.

Tahhan, O. and H.F. van Emden. Resistance of faba bean, *Vicia faba* to *Bruchus dentipes* Baudi (Coleoptera: Bruchidae). Bulletin of Entomological Research 79(2): 211-218.

van Leur, J.A.G., S. Ceccarelli, and S. Grando. Diversity for disease resistance in barley landraces from Syria and Jordan. Plant Breeding 103(4): 324-335.

Wahbi, A. and P.J. Gregory. Genotypic difference in root and shoot growth of barley (*Hordeum vulgare*). I. Glass-house studies of young plants and effects of rooting medium. Experimental Agriculture 25(3): 375-387.

Wahbi, A. and P.J. Gregory. Genotypic differences in root and shoot growth of barley (*Hordeum vulgare*). II. Field studies of growth and water use of crops grown in Northern Syria. Experimental Agriculture 25(3): 389-399.

Weising, K., F . Weigand, A.J. Driesel, G. Kahl, H. Zischler, and J.T. Epplen. Polymorphic simple GATA/GACA repeats in plant genomes. Nucleic Acids Research 17(23): 10128.

Weltzien, E. Differentiation among barley landrace populations from the Near East. Euphytica 43: 29-39.

Yau, S.K., M.S. Mekni, and I. Naji. Effects of green-stage grazing on rainfed barley in Northern Syria. I. Tiller production and other agronomic characters. Experimental Agriculture 25(4):493-500.

Yau, S.K., M.S. Mekni, I. Naji, and J.P. Srivastava. Effects of green-stage grazing on rainfed barley in Northern Syria. II. Yield and economic returns. Experimental Agriculture 25(4):501-507.

Media Coverage

Syrian Minister Inaugurates New Genetic Resources Unit at ICARDA. Diversity 5(4): 7.

Databases in Wheat Centre of Origin. Geneflow (July): 12-13.

Ley Farming at ICARDA. BBC Farming World. 03.01.1989.

ICARDA's research on *Orobanche*. BBC Farming World. 11.01.1989.

Lentil harvest mechanization and supplementary irrigation research at ICARDA. BBC Farming World. 16.11.1989.

ICARDA's durum wheat collection. BBC Farming World. 23.11.1989.

Contributions to Conferences

January

Karadj IR*. National Cereal Research Conference

Ortiz-Ferrara, G. Breeding for drought tolerance in rainfed environments.

February

Gottingen DE. XIIth EUCARPIA Congress

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* See Appendix 15 for country codes.

Malhotra, R.S., W. Erskine, and M.C. Saxena. Yield and stability of performance of lentil (*Lens culinaris*) genotypes in different environments.

Nachit, M.M. Moisture stress tolerance and yield stability in durum wheat (*Triticum turgidum* var. *durum*) under Mediterranean dry land conditions.

Singh, K.B., S. Weigand, M.P. Haware, M. di Vito, R.S. Malhotra, O. Tahhan, M.C. Saxena, and K. Holly. Evaluation of wild species to biotic and abiotic stresses.

Yau, S.K., M.M. Nachit, and H. Ketata. Classification of durum wheat growing sites in West Asia, North Africa and Mediterranean Europe.

Weigand, F. and M.C. Saxena. Crown gall tumour formation on chickpea induced by wild strains of *Agrobacterium*.

March

Aleppo SY. Consultancy Meeting on Breeding for Disease Resistance in Kabuli Chickpea

Saxena, M.C. Current status and prospects of kabuli chickpea production.

Singh, K.B., M.V. Reddy, and M.P. Haware. A review of the kabuli chickpea disease resistance breeding research at ICARDA.

Andhra Pradesh IN. Consultancy Meeting on Uses of Grain Legumes

Saxena, M.C., K.B. Singh, and P.C. Williams. Utilization of chickpea in the Mediterranean region of West Asia and North Africa.

Williams, P.C., K.B. Singh, and M.C. Saxena. Factors affecting quality parameters in the kabuli chickpea.

Tunis TN. Agrometeorology of Rainfed Barley-Based Farming Systems

Jones, M.J. Barley-based farming systems of the Mediterranean.

Wahbi, A., M.J. Jones, E. Jabbour, K. el-Hajj, and A. Safee. Fertilizer trials on barley in Northern Syria.

April

Obregon MX. CIMMYT Wheat Breeders' Conference

Ortiz Ferrara, G. Bread wheat breeding for the dry land areas of West Asia and North Africa.

Rome IT. FAO/FIAC Fertilizer Industry Advisory Committee-Technical Sub-Committee Annual Meeting

Matar, A.E. Agronomic aspects of plant nutrition management in rain dependent food crop production systems in West Asia and North Africa.

May

Aleppo SY. International Symposium on Evaluation and Utilization of Genetic Resources in Wheat Improvement

Damania, A.B., L. Pecetti, J.P. Srivastava, and S. Jana. Variability for useful genetic traits in primitive and wild wheats.

Jana, S., J.P. Srivastava, A.B. Damania, J.M. Clarke, R.C. Yang, and L. Pecetti. Phenotypic diversity and associations of some drought-related characters in durum wheat in Mediterranean environments.

Pecetti, L., S. Jana, A.B. Damania, and J.P. Srivastava. Issues in large-scale germplasm evaluation.

Tahir, M. Transfer of desirable agronomic traits of wild *Triticum* and *Aegilops* spp. for the improvement of *T. turgidum* var. *durum*.

Williams, P., M. Tahir, F.J. Haramein, A. Sayegh, and J.P. Srivastava. Utilization of genetic resources in crosses for the improvement of quality in durum wheat.

Ankara TR. International Workshop on Soil and Crop Management for Improved Water Use Efficiency in Rainfed Areas

Acevedo, E. Crop architecture and water use efficiency in Mediterranean environments.

Cooper, P.J.M. Fertilizer use, crop growth, water use and water use efficiency in Mediterranean rainfed farming systems.

Harris, H.C. Implications of climatic variability for water use efficiency.

Silim, S. and M.C. Saxena. Winter sowing chickpea - a case study.

Fresno US. International Conference on Soil Testing and Plant Analysis

Pala, M. The effect of crop management for increased production through improved water use efficiency at sowing.

Hangzhou CN. International Symposium on Faba Bean

Makkouk, K. Major faba bean diseases.

Robertson, L.D. A review of various breeding procedures for varietal improvement in faba bean.

Robertson, L.D. Genetic resources of faba bean at other national and international centers.

Saxena, M.C. Faba bean production and research--a global perspective.

Weigand, S. and O. Tahhan. Major insect pests of faba bean.

Oeiras, PT. OECD Workshop: Photosynthesis and Growth under Mediterranean Conditions: Influence of Dryness and Salinity.

Acevedo, E. Morphological and physiological aspects of barley improvement for drought resistance in rainfed Mediterranean environments.

June

Saragoza ES. Workshop on Present Status and Future Prospects of Faba Bean Production and Improvement in the Mediterranean Countries

Beck, D. and G. Duc. Rhizobium inoculation and nitrogen nutrition in faba bean.

Hanounik, S.B. and I. Bisrai. Status of diseases of faba bean in the Mediterranean region and their control.

Perrino, P., L.D. Robertson, and M. Solh. Maintenance, evaluation and use of faba bean germplasm collections-problems and prospects.

Robertson, L.D. and A. Filippetti. Alternative plant types in faba bean.

Saxena, M.C. Status and scope for production of faba bean in the Mediterranean countries.

Saxena, M.C., S.N. Silim, and A.E. Matar. Agronomic management of faba bean for high yields.

Weigand, S. and S. Bishara. Status of insect pests of faba bean in the Mediterranean region and their control.

July

Montpellier FR. International Symposium on Physiology/ Breeding of Winter Cereals for Stressed Mediterranean Environments

Acevedo, E. Improvement of winter cereal crops in Mediterranean environments. Use of yield, morphological and physiological traits.

Acevedo, E. and A. Wahbi. Root growth, water uptake and dry matter partitioning in a group of barley genotypes.

Harris, H.C. The relative impacts of water and temperature constraints in lowland areas of West Asia and North Africa.

Ketata, H., S.K. Yau, and M.M. Nachit. Relative consistency of varietal performance across environments.

Nachit, M.M. and H. Ketata. Selection of morphological traits for multiple abiotic stress resistance in durum wheat (*Triticum turgidum* L. var. *durum*).

Ortiz-Ferrara, G., S.K. Yau, and M. Assad Mousa. Identification of agronomic traits associated with yield under stress conditions.

August

Fresno US. International Conference on Soil Testing and Plant Analysis

Matar, A.E., M. Pala, D. Beck, and S. Garabet. Nitrate as a guide to N fertilization of wheat in the Mediterranean region.

Juarez AR. Reunion Sobre Mejoramiento Para Resistencia a Seguia Marcos

Acevedo, E. Analysis de methodologies disponibles para mejoramiento y seleccion para resistencia a sequica.

Ortiz-Ferrara, G. Estrategias de mejoramiento para estabilidad de rendimiento en areas de sequica.

Obermarchtal DE. International Workshop on *Orobanche*

Linke, K.H. and M.C. Saxena. Study on viability and longevity of *Orobanche* seed under laboratory conditions.

Linke, K.H. and M.C. Saxena. Towards an integrated control of *Orobanche* spp. in some legume crops.

Sauerborn, J., G. Wyrwal, and K.H. Linke. *Orobanche* seed population in naturally infested fields and their interaction with crop plants.

Singh, K.B., S. Weigand, M.P. Haware, M. di Vito, R.S. Malhotra, O. Tahhan, M.C. Saxena, and K. Holly. Evaluation of wild species to biotic and abiotic stresses.

Tsukuba JP. VIth International Congress of Sabrao

Singh, K.B. Breeding chickpea (*Cicer arietinum* L.) for stress resistance.

September

Amman JO. Third Regional Workshop on Soil Test Calibration

Abdel Monem, A., A. Azzaoui, M. el Gharous, J. Ryan, and P. Soltanpour. Residual nitrogen and phosphorus for dryland wheat in Central Morocco.

Abdel Monem, A., A. Azzaoui, M. el Gharous, J. Ryan, and P. Soltanpour. Response of dryland wheat to nitrogen and phosphorus in some Moroccan soils.

Jones, M.J. and A. Matar. A note on the effect of regular fertilizer use within different two-year cropping rotations on soil phosphate and organic matter status.

Matar, A. A descriptive model for prediction of residual P in soil after phosphate fertilization.

Matar, A. and J. Ryan. Protocol for cooperative soil test calibration in limited rainfall zones.

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

Somel, K., A. Matar, and K. el-Hajj. Fertilizer use on barley in northern Syria. The value of soil nutrient information.

Southampton GB. International Conference on Supplemental Irrigation

Perrier, E.R. and A.B. Salkini. Scheduling of supplemental irrigation on spring wheat using water balance methods.

Tsu, JP. International Symposium on Production of Vegetables in the Tropics and Sub Tropics

Saxena, M.C. Research on faba bean, lentil and kabuli chickpea at the International Center for Agricultural Research in the Dry Areas (ICARDA).

October

Amman JO. First Jordanian Plant Protection Conference

Tahhan, O. and S. Weigand. Importance and distribution of seed beetles on lentil and chickpea seeds in Jordan.

December

Andhra Pradesh IN. Chickpea in the Nineties Workshop

Bejiga, G. Recent advances in chickpea improvement and prospects for the nineties in Eastern Africa.

Cubero, J.I., M.T. Moreno, and M.C. Saxena. Recent advances in chickpea improvement and prospects for the nineties-Mediterranean region of Europe.

Kamal, M. and M. Solh. Dual season chickpea.

Malhotra, R.S. and H. Harris. Zoning chickpea environments.

van Rheenen, H.A., N.P. Saxena, K.B. Singh, S.C. Sethi, and Gallogos. Breeding for resistance against abiotic stresses.

Rupela, O.P. and D.P. Beck. Prospects of optimizing biological nitrogen fixation in chickpea.

Saxena, M.C. Problems and potential of chickpea production in the nineties.

Singh, K.B., J. Kumar, M.P. Haware, and S.S. Lateef. Disease and insect resistance breeding in chickpea: which way to go in the nineties.

Singh, K.B., N.P. Saxena, O. Singh, F. Saccardo, N. Acikgoz, and E.J. Knight. Breeding chickpea for new applications.

Weigand, S. and O. Tahhan. Chickpea insect pests in the Mediterranean zones and new approaches to their management.

Rome IT. FAO/TAC/IARC Meeting on Future Utilization of Grain and Seed

Williams, P.C and M.C. Saxena. Methods of food grain and seed analysis and their significance in predicting functionality.

Publications produced at ICARDA

Scientific Reports

High-elevation research in Pakistan: the MART/AZR project annual report 1988. 83 pp. ICARDA-138.

Meteorological reports for ICARDA experiment stations in Syria: 1987/88. 152 pp. ICARDA-139.

Jones, Michael. Barley rotation trials at Tel Hadya and Breda stations. A summary of biological yield data 1981-87. 30 pp. ICARDA-140.

Seed production project annual report 1988. 21 pp. ICARDA-141.

Farm resource management program annual report 1988. 205 pp. ICARDA-142.

Genetic resources program annual report 1988. 54 pp. ICARDA-143.

Pasture, forage, and livestock program annual report 1988. 284 pp. ICARDA-144.

Cereal improvement program annual report 1988. 187 pp. ICARDA-145.

Food legume improvement program annual report 1988. 363 pp. ICARDA-146.

Verification and adoption of wheat production technology in farmers' fields in the Sudan: proceedings of the third coordination meeting, 4-6 Sept 1988, Wad Medani, Sudan. 54 pp. ICARDA-147.

Thomson, E.F., F.A. Bahhady, and A. Martin. Sheep husbandry at the cultivated margin of the North-west Syrian steppe. 104 pp. ICARDA-148.

van Gastel, A.J.G., S. Varma, and S. Abdul Elah Hamood (editors). Seed Production in the Arabian Peninsula: proceedings of the workshop on seed production in the Arabian Peninsula, 16-18 Mar 1988, Sana'a, YAR, and selected papers presented at the general seed production course, 13-31 Mar 1988, Dhamar, YAR. 76 pp. (also Ar, 86 pp). ICARDA-149.

Keatinge, J.D.H. and K. Somel. Agronomic management and economic interpretation of small plot crop rotation trials in Northern Syria. 28 pp. ICARDA-150.

Regional program for barley and wheat research training in the Arabian Peninsula: proceedings of the first regional coordination meeting of barley and wheat scientists in the Arabian Peninsula, 18-20 Oct 1988, Sana'a, Yemen Arab Republic. 80 pp. (Ar/En). ICARDA-151.

Sarraj, Walid (editor). Genetic resources of range and forage plants: proceedings of the second Arab training course on plant genetic resources in dry areas, sponsored by IBPGR, ICARDA, and ACSAD, 21 Mar-11 Apr 1988, Aleppo, Damascus, Syria. 217 pp. (Ar). ICARDA-152.

Sustainable agriculture for the dry lands: ICARDA's strategy. 118 pp. ICARDA-153.

Medium-term plan 1990-1994: consolidation and change. 149 pp. ICARDA-154.

Fadda, Nasrat. Sustainable agriculture for the dry lands. ICARDA's strategy and medium-term plan. A presentation at Centers Week 1989, Washington DC, USA. 35 pp. ICARDA-155.

International food legume testing program on lentil, faba bean and kabuli chickpea. 20 pp. ICARDA-156.

Technical Manuals

Forage production under irrigation. Technical Manual No. 16. 73 pp.

Periodicals

ICARDA quarterly progress report. No. 1/89, 17 pp., No. 2/89, 19 pp.,No. 3/89, 5 pp.

Faba bean in AGRIS. Vol 4 1988 (Cumulation), 49 pp. Vol 5 1989, Nos. 1/2, 34 pp.

Lentil in AGRIS. Vol 3 1988, 26 pp.

FABIS Newsletter. No. 22, 56 pp., No. 23, 52 pp., No. 24, 52 pp.

LENS Newsletter. Vol 15, No. 2, 44 pp., Vol 16,No. 1, 54 pp.

RACHIS Newsletter. Vol 7, Nos. 1/2, En, 68 pp., Vol 8, No. 1, En, 34 pp.

Other Publications

ICARDA in the news 1988. 88 pp.

Journal articles from ICARDA: supplement 1988. 8 pp.

Faba bean pathology progress report 1987/88. 26 pp.

Studies on nematodes of food legumes. Progress report 1986/87. 16 pp.

Studies on nematodes of food legumes. Progress report 1987/88. 15 pp.

Report of the third food legume coordination meeting, Rabat, Morocco, 26-27 Sept 1988. 34 pp.

Collaborative research project report on fertilizer use on barley in Northern Syria 1987/88. 63 pp. (Ar/En).

Collaborative research project report on fertilizer use on wheat in Northern Syria 1986-1988. 116 pp. (Ar/En).

Pasture, forage, and livestock program: preschedules for the 1988/89 season. 123 pp.

Farm resource management program: core research and training plans 1988/89. 77 pp.

Collaborative research and training program: annual report 1987/88. 377 pp. (Ar).

International nursery report no. 11. Food legume nurseries 1986/1987. 506 pp.

ICARDA annual report 1988, 117 pp. (En), 114 pp. (Ar).

Annual report for the regional durum wheat nurseries 1987/88. 254 pp.

Annual report for the regional bread wheat nurseries 1987/88. 259 pp.

Annual report for the heat tolerance observation nurseries 1987/88. 22 pp.

Annual report for the international barley nurseries 1987/88. 246 pp.

International cereal nurseries 1989/90. List of cooperators and nursery distribution. 33 pp.

ICARDA library catalogue of serials holding 1989. 60 pp.

Progress report on the recommendations of the 1988 external program and management reviews. 25 pp.

MART/AZR Project Publications

Rees, D.J., F. Rehman, A. Samiullah, J.G. Nagy, G.F. Sabir, J.D.H. Keatinge, and S.H. Raza. Barley production under suboptimal conditions in upland Baluchistan: agronomic and socio-economic considerations. Research Report No. 24. 26 pp.

Keatinge, J.D.H., B. Roidar Khan, C. Talug, R.S. Aro, and D.J. Rees. Dryland agriculture in upland Baluchistan: the potential for improvement through effective research and extension. Research Report No. 25. 16 pp.

Nagy, J.G., G. Farid Sabir, Nisar Ali Shah, M. Afzal, D.J. Rees, and J.D.H. Keatinge. Barley production and its scope for improvement in the high elevation rainfed farming systems of Baluchistan. Research Report No. 26. 44 pp.

Atig-ur-Rehman, Kn., R.S. Aro, M. Asghar, and M.I. Sultani. Effect of the flushing and late-gestation supplementary feeding on fertility and productivity of Harnai ewes. Research Report No. 27. 11 pp.

Nagy, J.G., G. Farid Sabir, and J.M. Stubbs. Descriptive and diagnostic studies of sheep and goat production in the farming systems of upland Baluchistan. Research Report No. 28. 23 pp.

Ahmad, Sarfraz, B. Roidar Khan, J.D.H. Keatinge, and Asghar Ali. The potential of new barley varieties in the high elevation dryland of Baluchistan. Research Report No. 29. 19 pp.

Talug, C., C. del Castillo, M.B.A. Chowdhry, Arshad Ali, G.F. Sabir, and M. Islam. The scope for improved agricultural extension in the dryland farming areas of upland Baluchistan. Research Report No. 30. 98 pp.

Rees, D.J., M. Islam, A. Samiullah, Z. Qureshi, S. Mehmood, F. Rehman, J.D.H. Keatinge, H. Raza, and B.R. Khan. Water harvesting and nitrogen fertilizer application as a means of increasing crop water use efficiencies in suboptimal conditions in upland Baluchistan. Research Report No. 31. 10 pp.

Keatinge, J.D.H., A. Ali, B. Roidar Khan, A.M. Abd El Moneim, and S. Ahmed. Germplasm selection strategy under environmental conditions marginal for crop growth: the example of annual forage legumes in upland Baluchistan. Research Report No. 32. 21 pp.

Keatinge, J.D.H. and S. Sheierling. ICARDA cereals research in the highlands 1980-85. Research Report No. 33. 38 pp.

Keatinge, J.D.H., B. Roidar Khan, R.S. Aro, C. Talug, and D.J. Rees. Development plan for the Arid Zone Research Institute. Research Report No. 34. 14 pp.

Nagy, J.G., J.M. Stubbs, and E.R. Mallorie. Ex-ante economic technology evaluation for research and extension program design: sheep production improvement in Baluchistan. Research Report No. 35. 21 pp.

Ali, Asghar and Sarfraz Ahmed. Germplasm evaluation in the arid highlands of Baluchistan: annual report 1987/88. Research Report No. 36. 43 pp.

Atiq-ur-Rehman, Kn. Shahid Rafique, and R.S. Aro. Fourwing saltbush as a winter maintenance forage for sheep in upland Baluchistan. Research Report No. 37. 18 pp.

Talug, C., M.B.A. Chowdhry, A. Ali, and M. Islam. Linking agricultural research and extension. Research Report No. 38 (Rev.). 17 pp.

Rees, D.J., S. Samiullah, F. Rehman, C.H.R. Kidd, J.D.H. Keatinge, and S.H. Raza. Precipitation and temperature regimes in upland Baluchistan: their influence on dryland crop production. Research Report No. 39. 20 pp.

Rees, D.J., Z.A. Qureshi, S. Mehmood, F. Rehman, and S.H. Raza. Catchment basin water harvesting as a means of improving the productivity of rainfed land in upland Baluchistan. Research Report No. 40. 18 pp.

Talug, C., M. Islam, A. Ali, M. Bilal, and A. Chowdhry. The role of extension in FSR. Research Report No. 41. 16 pp.

Talug, Cemal. Agricultural extension at the Arid Zone Research Institute 1986-89: rationale and future prospects. Research Report No. 42. 21 pp.

Masood, M. Asif, Shahid Rafique, and K. Mahmood. Livestock production and related statistics in Baluchistan. Research Report No. 43. 47 pp.

Aro, R.S. Range-livestock research at the Arid Zone Research Institute, 1985-89: rationale, results and future direction. Research Report No. 44. 25 pp.

Mahmood, K., S.M. Khan, and M. Afzal. Production and marketing of potatoes in upland Baluchistan: a preliminary survey. Research Report No 45. 48 pp.

Ali, A., S. Ahmad, B.R. Khan, and J.D.H. Keatinge. Germplasm evaluation in the arid highlands of Baluchistan: annual report 1988/89 of the AZRI germplasm research group. Research Report No. 46. 30 pp.

Sabir, G.F., J.G. Nagy, and C. del Castillo. Women's participation in the high elevation rainfed farming systems of Baluchistan, Pakistan. Research Report No. 47. 32 pp.

Rees, David. Agronomy at the Arid Zone Research Institute, 1985-89: rationale, results and future direction. Research Report No. 48. 15 pp.

Ahmad, S., J.D.H. Keatinge, B.R. Khan, I. Begun, and A. Ali. Evaluation and selection of barley lines for the Baluchistan highlands, Pakistan. Research Report No. 49. 11 pp.

Buzdar, N., J.G. Nagy, G. Farid Sabir, and J.D.H. Keatinge. Animal raising in highland Baluchistan: a socio-economic perspective. Research Report No. 50. 27 pp.

Rees, D.J., A. Samiullah, M. Islam, Z. Qureshi, and S.H. Raza. Rainfed crop production systems of upland Baluchistan: 1. wheat (*Triticum aestivum*). Research Report No. 51. 23 pp.

Rees, D.J., M. Islam, F. Rehman, A. Samiullah, and S.H. Raza. Rainfed crop production systems of upland Baluchistan: 2. Barley (*Hordeum vulgare*). Research Report No. 52. 24 pp.

Rees, D.J., F. Rehman, M. Islam, S. Mehmood, and S.H. Raza. Rainfed crop production systems of upland Baluchistan: 3. forage legumes (*Vicia* species). Research Report No. 53. 18 pp.

Buzdar, N., J.G. Nagy, G.F. Sabir, J.D.H. Keatinge, and K. Mahmood. Rainfed agriculture in highland Baluchistan: a farming systems perspective. Research Report No. 54. 29 pp.

Buzdar, N., J.D.H. Keatinge, G.F. Sabir, M. Afzal, N.A. Shah, and A. Ali. Lentil production in highland Baluchistan: current status. Research Report No. 55. 15 pp.

Nile Valley Regional Program (NVRP) Publications

Workplan and budget, Ethiopia 1989. ICARDA/ NVRP-DOC-003. 46 pp.

Appendix 4

Graduate Theses Produced with ICARDA's Assistance

Master's Theses

DE* Universitaet Hohenheim

Christiane Scheibel (DE). Untersuchung zur Wirkung Pathogener Pilzarten auf *Orobanche*. (Study on the effect of fungal pathogens on *Orobanche*). 58 p. (In German).

Doris Vetterlein (DE). Wirkung von vesikulaer-arbuskulaerer Mykorrhiza auf Wachstum und Trockenstresstoleranz der Kichererbse (*Cicer arietinum* L.). (Effect of vesicular-arbuscular mycorrhiza on the growth and drought tolerance of chickpea (*Cicer arietinum* L.). 103 p. (In German).

*See Appendix 15 for country codes.

JO University of Jordan, Amman

Hani Zulkiful Shehadeh Ghosheh (JO). Evaluation and inheritance of several characters in durum wheat (*Triticum turgidum* L. var. *durum*) crosses. 183 p. (Arabic summary).

Nidal Naneesh (JO). Lentil residue and nitrogen application effects on succeeding barley crop. 164 p.

SY Damascus University

Yassin Swedan (SY). Screening annual medics *Medicago* spp. for resistance to nematodes. 93 p. (In Arabic, English summary).

US Montana State University

Fatima Zine Elabidine (MA). The effect of powdery mildew on barley under simulated Mediterranean drought conditions. 52 p.

Appendix 5

ICARDA Calendar 1989

January

23-26 Aleppo. 16th Program Committee Meeting
28 Aleppo. Extraordinary Executive Committee Meeting
29-30 Aleppo. Extraordinary Board of Trustees Meeting

May

16 Aleppo. Extraordinary Program Committee Meeting
16-18 Aleppo. 23rd Board of Trustees Meeting
29 - June 2 Canberra. CGIAR Mid-Term Meeting

June

19-21 Rome. Center Directors Meeting
19-24 Rome. 49th TAC Meeting
26-30 Perugia. Workshop on Introducing the Ley-Farming Systems into the Mediterranean Basin

July

3- 6 Montpellier. International Symposium on Physiology/Breeding of Winter Cereals for Stressed Mediterranean Environment

August

19-20 Amman. Jordan-ICARDA Coordination Meeting
27-29 Aleppo. 2nd Annual Coordination Meeting (Arabian Peninsula)

September

3-6 Sudan. Coordination Meeting
9-11 Egypt. Coordination Meeting
11-13 Algeria. Coordination Meeting
14-16 Tunisia. Coordination Meeting
19-21 Morocco. Coordination Meeting
24-25 Aleppo. Planning Meeting - FRMP
26-27 Aleppo. Planning Meeting - PFLP
28 Aleppo. Planning Meeting (STIP/GRU/Training/Seed Production)

October

3-5 Aleppo. Coordination Meeting - ICARDA/SMAAR
7-8 Aleppo. Planning Meeting - Cereals
9-10 Aleppo. Planning Meeting - FLIP
11-12 Aleppo. 17th Program Committee Meeting
15 Aleppo. Outreach Activities Meeting
23-27 Washington. 50th TAC Meeting
30-Nov. 3 Washington. International Centers Week

November

6-7 Washington. 20th Executive Committee Meeting

Appendix 6

Special Projects

During 1989, the following activities were in progress utilizing funds that various organizations had provided separately from ICARDA's core budget.

ANERA (American Near East Refugee Aid)

Seed Production Cooperation Project in Lebanon. This grant is for a period of one year beginning from July 1988 (5,000 USD in 1989).

AFESD (Arab Fund for Economic and Social Development)

Arabian Peninsula. Grant for strengthening barley and wheat research and training in the Nile Valley and Arabian Peninsula (95,000 USD in 1989).

AFESD and UNDP (United Nations Development Programme)

Mashreq Project. This five-year project aims at improving production of rainfed barley, forages, pastures, and livestock (mainly sheep) in the 200-350 mm average annual rainfall zones of Syria, Iraq, and Jordan. The project concentrates on the transfer of available technology (59,000 USD in 1989).

DGIS (Directorate General for International Cooperation), the Netherlands

Collection and Characterization of Wild Relatives of Wheat. This project funds a taxonomist at ICARDA in cooperation with the Laboratory for Plant Taxonomy and the Center for Genetic Resources in the Netherlands. The work centers on collection and characterization of wild relatives of wheat (96,000 USD in 1989).

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 focuses on virus diseases of cereals and food legumes (8,000 USD in January 1989, then on core budget).

DGIS and GTZ (German Agency for Technical Cooperation), Federal Republic of Germany

Seed Production. For a period of three years from 1985 and extended for a second phase of three years, this project provides for the employment of a seed production specialist and a program of work and training to enhance the capacities of national seed organizations (418,000 USD in 1989).

EEC (The Commission of the European Communities), the Government of the Netherlands, and SAREC (Swedish Agency for Research Cooperation with Developing Countries), Sweden

Nile Valley Regional Program. This program , in Egypt, Sudan, and Ethiopia, covers research and training activities for the improvement of the production of cool-season food legumes (faba bean, chickpea and lentil, and field pea for only Ethiopia) and cereals (wheat in cooperation with CIMMYT, and barley). The program activities in Egypt are supported by EEC, in the Sudan by the Netherlands Government, and in Ethiopia by SAREC (744,000 USD in 1989).

FAO (Food and Agriculture Organisation of the United Nations)

FAO and ICARDA jointly organized a traveling workshop on cereals (wheat and barley) in Turkey, 11-16 June 1989 (15,000 USD).

Ford Foundation

Agricultural Labor and Technological Change. This grant, ended in December 1989, provided 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 (30,000 USD in 1989).

Graduate Fellowships. This four-year grant supports ICARDA's graduate fellowships program (117,000 USD in 1989).

Post-Doctoral Fellowships. This grant is to support graduate and post-doctoral fellowship programs in agricultural research for students from the Middle East and North Africa, for a period of three years beginning from July 1988 (66,000 USD in 1989).

France

Associate Expert. This project supports an Associate Expert at ICARDA for three years (August 1988 - July 1991) to conduct research on the development of doubled haploids of wheat and barley through anther culture technique (44,000 USD in 1989).

IBPGR (International Board for Plant Genetic Resources)

***Aegilops* and wild *Triticum*.** This grant is for the establishment of a global data base utilizing the passport data from major genebanks and from herbaria surveys, and for data analysis to identify duplicates and plot the geographical distribution of species (17,000 USD in 1989).

Forage Germplasm. This project aims at filling the gaps in the data base that has been established by IBPGR and plotting the geographic distribution of forage germplasm of the Mediterranean Basin and adjacent semi-arid and arid areas (23,000 USD in 1989).

Perugia Meeting. This grant supported the cost of a one-day meeting at the University of Perugia for discussions on the genetic resources of the genus *Medicago* (19,000 USD).

IBRD (International Bank for Reconstruction and Development)

Food Legumes, Ethiopia. The grant provides for an ICARDA breeder/pathologist to be stationed with the Highland Pulses Program of the Institute for Agricultural Research in Ethiopia (125,000 USD in 1989).

IDRC (International Development Research Centre)

Lentil Harvest Mechanization. This project, extended for the fourth year in 1989, covered the work in Algeria, Iraq, Jordan, Morocco, Syria, and Turkey and included a training course at Tel Hadya (7,000 USD in 1989).

Mechanization and Rural Employment (Morocco). This project, agreed in November 1987, is to enable ICARDA to support studies at the Institut Agronomique et Veterinaire Hassan II (49,000 USD in 1989).

Rhizobial 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 (28,000 USD in 1989).

Yellow Dwarf Virus. ICARDA cooperates with the Laval University in Canada and the Instituto Nacional de Investigaciones Agropecurlas (INIA) in Chile to develop production techniques for rhizobia and methods of inoculation of chickpea, particularly for areas where this crop is being newly introduced (28,000 USD in 1989).

IFAD (International Fund for Agricultural Development) and Italy

Maghreb Project. The overall objective of this three-year (1989-91) project is to strengthen the research capacity of the national programs in Algeria, Libya, Morocco, and Tunisia through collaboration with ICARDA (3,000 USD in 1989).

IMPHOS (Institut Mondial de Phosphate)

Study of Soil Test Calibration in Limited Rainfall Areas. This project seeks to standardize the methods of soil chemical tests in the project area, calibrate these soil chemical test methods under various soil and climate conditions, and establish better criteria to make nitrogen and phosphorus fertilizer recommendations to farmers in the region based on the results of soil analyses (2,000 USD in 1989).

Iran

Scientific and Technical Cooperation. This project for a duration of three years emphasizes on strengthening scientific and technical cooperation between the Government of Iran and ICARDA (40,000 USD in 1989).

Italy

Development of Chickpea Germplasm with Combined Resistance to *Ascochyta* Blight and *Fusarium* Wilt Using

Wild and Cultivated Species. This project, in collaboration with four Italian institutions, will operate for four years (1987-1990). Its main objectives are to combine resistance to *Ascochyta* blight and *Fusarium* wilt, identify races of *A. rabiei* in the Mediterranean region, and exploit annual wild *Cicer* species for chickpea improvement (283,000 USD in 1989).

Enhancing Wheat Productivity in Stress Environments Utilizing Wild Progenitors and Primitive Forms. This is a five-year project in collaboration with the University of Tuscia, Italy, to study the genetic variability in the wild progenitors and primitive forms of wheat, identify desirable wheat germplasm, and train regional scientists (177,000 USD in 1989).

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 (29,000 USD in 1989).

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 (49,000 USD in 1989).

Rockefeller Foundation

Social Science Research Fellowship. This grant, for two years from September 1988, supports research on adoption and impact of technology (33,000 USD in 1989).

UNDP (United Nations Development Programme)

Soil and Plant Analyses. This project supported the cost of a course on Soil and Plant Analyses, held at Tel Hadya, 5-16 February 1989 (9,000 USD).

Soil Test Calibration. This grant supported the cost of a workshop on soil test calibration held in Amman, Jordan, 3-8 September 1988 (21,000 USD).

UNDP and AFESD

Surveillance of Diseases and Germplasm Enhancement for Cereals and Food Legumes. This regional project for five-years deals primarily with the development of agricultural research for cereal and food legume pathology. The work is conducted by researchers of the Maghreb countries (Algeria, Morocco, and Tunisia) with ICARDA providing scientific and administrative support (1,000 USD in December 1989).

UNDP and France

Use of Biotechnology for Improvement of ICARDA mandated Crops. This five-year project is intended to strengthen the institutional and scientific capabilities of ICARDA to enable the Center to exploit biotechnology in agricultural research as well as impart training to national program scientists from the WANA region (317,000 USD in 1989)

USAID (United States Agency for International Development)

MART/AZR Project, Balochistan. ICARDA is contracted by USAID for the Management of Agricultural Research and Technology (MART) component of its MART/AZR Project in Balochistan. This component aims at strengthening Pakistan's Arid Zone Research Institute (AZRI) and involves interdisciplinary research in the harsh high-elevation environments (695,000 USD for the final year of Phase I, ended in November 1989).

Phase II of the Project, for 22 months, started in December 1989 (25,000 USD for December 1989).

Appendix 7

Research Networks Coordinated by ICARDA

Title	Coordinator	Donor	Subject/objectives	Countries
Inoculation of pasture and forage legumes	L. Materon	Core funds	1. Identify need for inoculation of pasture and forage legumes. 2. Evaluate response to inoculation with introduced and native strains of *Rhizobium* spp. 3. Biological nitrogen fixation studies. 4. Training of national program scientists in WANA.	11, in WANA 5, outside WANA
Barley pathology	J. van Leur	USAID	Research on the epidemiology, virulence and resistance of pathogens of importance to barley cultivation in the ICARDA region.	7, in WANA
Durum germplasm evaluation	A. B. Damania and L. Pecetti	Italy	Following a Durum Germplasm Consultation meeting at Viterbo, Italy, a set of 200 selected accessions from the genetic resources collection was sent to national programs in 11 countries. The evaluators will score economically important agronomic and disease resistance characters at ecologically different locations in their own countries and report back to ICARDA. The pooled information will be provided to interested scientists and the germplasm recommended to breeders for use in their crossing programs. Very useful data have already been received from Ethiopia, Pakistan, Tunisia, and Canada.	6, in WANA 5, outside WANA
Barley, durum wheat, and bread wheat international nursery system	S.K. Yau	Core funds	Evaluation of the barley, durum wheat, and bread wheat advanced lines, parental lines and segregating populations developed by ICARDA and CIMMYT, and by national programs themselves.	50, worldwide
Screening wheat and barley for resistance to aphids	R. Miller	Egypt, EC, Sudan, Ethiopia, SAREC	Wheat and barley seedlings are screened against *Rhopalosiphum padi* and *Schizaphis graminum* in a laboratory in Egypt. Promising lines are then retested against natural populations of aphids in Upper Egypt and in the Sudan. Resistant germplasm is recommended to breeders in Egypt, Sudan, Ethiopia, and ICARDA.	Egypt Sudan Ethiopia
Screening wheat and barley for	R. Miller and M. Mekni	ICARDA/ MIAC	Differential nurseries containing the known resistance genes for Hessian fly are planted in six countries. Annual surveys are performed	Morocco Algeria Tunisia

resistance to Hessian fly			in the Maghreb countries. A training workshop, sponsored by ICARDA, MIAC, INRA, and INRAT, will be held in Morocco for trainees from North Africa. Germplasm is being exchanged.	
Biological nitrogen fixation in food legumes	D. Beck	IDRC (Chickpea only)	1) Evaluate the necessity for inoculation in chickpea, lentil, and faba bean. 2) Evaluate response to rhizobial inoculation with network strains 3) Quantification of N fixed using ^{15}N to evaluate legume N input into farming systems.	9, in WANA
Nile Valley Faba bean Aphid Screening	S. Weigand	SAREC, EEC, DGIS	A joint screening program for host plant resistance to aphids in faba bean with the aphid screening laboratory at Giza Research Station, Egypt, serving as a center for screening faba bean lines from the three countries and ICARDA. Promising material based on its origin is field-tested by the respective national programs and finally a "regional aphid screening" nursery will be established and tested in the three countries.	Egypt Sudan Ethiopia
International Food Legume Testing Network	R.S. Malhotra	Core funds	The network provides for dissemination of genetic material and improved production and plant protection practices to the national program scientists for evaluation and use under their own agroecological conditions. It also permits multilocation testing of material developed by the national programs and assists in developing better understanding of genotype and environmental interaction as well as agroecological characterization of major food legume production areas.	25, world-wide
Soil Test Calibration	A. Matar	Core funds, UNDP, IMPHOS	To standardize the methods of soil and plant analysis used in the WANA region and promote training and soil sample exchange. To evaluate the relationships between laboratory determination of soil fertility status and crop responses to the major plant nutrients, nitrogen and phosphorus. To establish procedures to integrate soil, climate and management to optimize fertilizer recommendations.	12, in WANA

Appendix 8

Agreements

The following is a list of important agreements* relating to the establishment of ICARDA, its cooperation with national governments, universities, regional and international organizations, and others.

Agreements for the establishment of ICARDA

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

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

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

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

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

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

14-07-1977. 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.

27-10-1977. With the Government of JORDAN (En).

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

29-03-1978. With the Government of EGYPT (En).

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

05-02-1979. With the Government of CYPRUS (En).

11-03-1980. With the Government of TUNISIA (Ar).

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

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

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

18-01-1985. With the Kingdom of MOROCCO (Ar).

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

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

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

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

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

01-09-1987. With the Government of the ISLAMIC REPUBLIC OF IRAN (En).

09-12-1987. With the Government of the YEMEN ARAB REPUBLIC (Ar, En).

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

23-02-1989. With the Government of the ISLAMIC REPUBLIC OF IRAN (En).

20-11-1989. With the Government of the REPUBLIC OF TUNISIA (Ar, En).

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

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

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

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

15-12-1986. With the Indian Council of Agricultural Research, ICAR, INDIA, (En, Hi).

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

29-09-1987. With the Tropical Agricultural Research Center, TARC, JAPAN (En).

28-02-1988. With the Institute of Plant Introduction and Genetic Resources, IPIGR, Sadovo, BULGARIA (En).

12-05-1988. With the Indian Council of Agricultural Research, ICAR, INDIA, (En).

02-08-1988. With V.I. Lenin All-Union Academy of Agricultural Sciences-VASKhNIL, Moscow, USSR (En, Ru).

30-08-1988. With the National Agricultural Research Co-ordination Committee, NARCC, NEPAL (En).

19-05-1989. With V.I. Lenin All-Union Academy of Agricultural Sciences-VASKhNIL, Moscow, USSR (En, Ru).

27-05-1989. With the Institute of Plant Introduction and Genetic Resources, IPIGR, Sadovo, BULGARIA (En).

13-11-1989. With the Chinese Academy of Agricultural Sciences, CAAS, CHINA (Ch, En).

Agreements with international and regional organizations (not including agreements for specific work plans)

1978. With the International Crops Research Institute for the Semi-Arid Tropics, ICRISAT, on chickpea research (En).

05-04-1980. With the International Fertilizer Development Center, IFDC (En).

05-04-1982. With the Arab Organization for Agricultural Development, AOAD (Ar).

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

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

15-09-1987. With the Centro Internacional de Mejoramiento de Maize y Trigo, CIMMYT (En).

29-11-1988. With the World Phosphate Institute, IMPHOS (En).

21-02-1989. With the International Center for Advanced Mediterranean Agronomic Studies, CIHEAM (En, Fr).

Agreements with universities

21-10-1978. With the University of Khartoum, Sudan (AR, En).

15-09-1985. With the University of Gizira, Sudan (En).

21-11-1985. With Tishreen University, Syria (Ar).

28-11-1985. With the University of Tuscia, Italy (En).

28-01-1987. With the University of Khartoum, Sudan (En).

14-04-1987. With North Carolina State University, USA (En).

10-09-1987. With the University of Alexandria, Egypt (En).

21-03-1988. With the Jordan University of Science and Technology, Jordan (En).

26-06-1989. With Alemaya University of Agriculture, Ethiopia (En).

18-10-1989. With the University of Saskatchewan, Canada (En).

Appendix 9

The International School of Aleppo

During 1989, the International School of Aleppo (ISA) implemented many positive changes in four interrelated activities:

1. Steps were taken to implement the decision of the Board of Trustees to upgrade ISA to a full high school. It was decided to adopt the International Baccalaureate in the Secondary School in addition to the High School Diploma. The development of both programs will begin in the fall of 1990. The school also contracted additional staff members both at the Secondary and Elementary School levels in support of a full program from Kindergarten through Grade 12.

2. As an integral part of the preparations for establishing a full program, 18 different curricular areas were thoroughly reviewed, assessed, developed, and written during 1989. By the end of the 1989-90 school year in June 1990, all curricular areas will have been fully developed and written.

3. In a parallel thrust to curriculum development and writing, ISA embarked upon an active approach to reach accreditation. Initial indications from an accreditation institution showed that ISA required strengthening in certain areas to qualify for accreditation. Those areas, including the development of curriculum, facilities, staff, policy, and student services, and hiring of new staff, have all been realized or are in the process of being finalized. ISA will receive an Accreditation Candidacy Visit in 1990 from the Middle States Association of Schools and Colleges in Philadelphia, Pennsylvania, USA.

4. Several changes were implemented in staffing, involving training and development of existing staff, hiring of new staff, and terminating or upgrading certain individual positions. This enabled ISA to achieve an overall upgrading of standards to approach equality with its peers in the international community of education.

Appendix 10

Visitors to ICARDA

The Visitors' Services section, established in 1980, completed 10 years in 1989. Fig. 44 shows the number of visitors to the Center over the 10-year period. In 1989, the Center received 1674 visitors, of which 55% came from Syria and 45% from 53 countries around the world.

As in previous years, April was the peak month for visitors to arrive at ICARDA to see the crops maturing and discuss the results of field experiments.

Among other events during the year that attracted visitors were the following: inauguration of ICARDA's new buildings, the consultancy meeting on breeding for disease resistance in kabuli chickpea, the workshop on evaluation and utilization of genetic resources in wheat improvement, and the second coordination meeting of the Arabian Peninsula Regional Program.

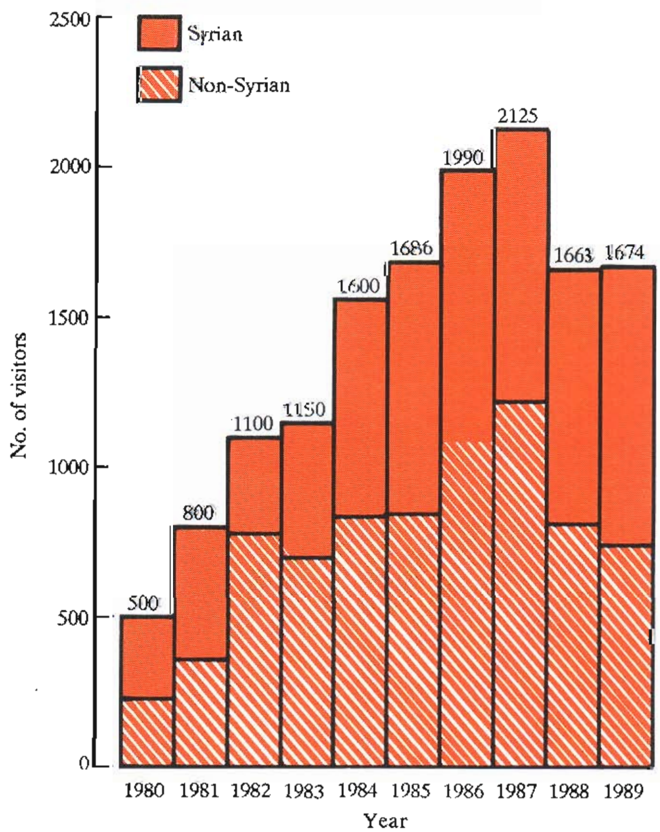


Fig. 44. Visitors to ICARDA, 1980-89.

Appendix 11

Statement of Activity

For the Year Ended 31 December 1989

(x 000 USD)

	1989	1988
REVENUE		
Grants	22,078	20,191
Exchange gains	1,771	4,717
Investment income	1,230	963
Other income	(77)	47
	25,002	25,918
EXPENSES		
Research		
Farm resource management	2,125	2,049
Cereal improvement	2,806	2,568
Food legume improvement	2,596	2,579
Pasture, forage and livestock	1,950	1,868
	9,477	9,064
Research support	3,541	3,002
Cooperative programs	704	691
Training	628	644
Information	1,021	1,045
General administration	2,850	2,746
General operations	2,699	2,941
EMR/EPR	-	279
	20,920	20,412
Special projects	3,050	2,737
Capital expenditure	3,375	884
Special projects capital	596	76
	27,941	24,109
EXCESS OF REVENUE OVER EXPENSES	(2,939)	1,809
ALLOCATED TO		
Operating funds	-	-
Locally-generated fund	(2,939)	1,809
	(2,939)	1,809

Statement of Grant Revenue

For the Year Ended 31 December 1989

(x 000 USD)

	Current year grants	Funds received	Receivable 31 Dec 1989	(Advance) 31 Dec 1989
CORE UNRESTRICTED				
Australia	349	(349)	-	-
Ausria	175	(175)	-	-
Canada	797	(797)	-	-
China	30	(60)	-	-
Denmark	285	(285)	-	-
Ford Foundation	170	(150)	-	(100)
Germany	1,075	(1,075)	-	-
India	25	(24)	1	-
International Bank for Reconstruction and Development (World Bank)	4,250	(4,250)	-	-
Italy	436	(436)	-	-
Netherlands	535	(535)	-	-
Norway	440	(440)	-	-
Spain	125	(125)	-	-
Stabilisation Mechanism Fund	490	-	490	-
Sweden	572	(572)	-	-
United Kingdom	899	(899)	-	-
United States Agency for International Development	4,292	(4,292)	-	-
	14,945	(14,464)	491	(100)
CORE RESTRICTED				
Arab Fund for Economic and Social Development	512	(253)	259	-
France	345	-	216	(68)
Germany	1,250	(1,075)	-	(541)
International Development Research Center	122	(232)	19	(209)
Italy	794	(764)	-	(662)
The OPEC Fund for International Development	60	(18)	42	-
United States Agency for International Development	404	(328)	-	(81)
Closed Projects	-	(829)	-	-
	3,487	(3,499)	536	(1,561)

	Current year grants	Funds received	Receivable 31 Dec 1989	(Advance) 31 Dec 1989
SPECIAL PROJECTS				
American Near East Refugee Aid	5	-	-	-
Arab Fund for Economic and Social Development	95	-	-	(51)
Food and Agricultural Organisation	15	(20)	-	(5)
Ford Foundation	213	(224)	-	(170)
France	44	-	8	-
German Agency for Technical Cooperation	151	-	182	-
Institut Mondial de Phosphate	2	-	-	(8)
International Board for Plant Genetic Resources	59	(69)	2	(13)
International Development Research Center	72	(48)	9	(1)
Iran	40	(204)	-	(164)
Italy	460	(1,159)	-	(1,499)
Maghreb Project	3	(150)	-	(147)
Mashreq Project	59	-	59	-
Near East Foundation	29	(20)	-	(9)
Netherlands	371	(332)	109	-
Nile Valley Project	9	-	50	(37)
Nile Valley Regional Programme	744	(1,425)	97	(778)
The OPEC Fund for International Development	49	(10)	39	-
Rockefeller Foundation	33	-	8	-
United Nations Development Programme	348	-	348	-
United States Agency for International Development	720	(633)	366	-
World Bank	125	-	161	-
Closed Projects	-	(72)	55	(1)
Less: Provision for doubtful accounts	-	-	(184)	-
	3,646	(4,366)	1,309	(2,883)
GRAND TOTAL	22,078	(22,329)	2,336	(4,544)

Appendix 12

Collaboration in Advanced Research

ICARDA received Special Project funding for some of its collaborative activities with advanced institutions in industrialized countries. Such items have already been detailed in Appendix 6. ICARDA's participation in the following activities was, however, financed out of core or restricted-core funds.

International Centers and Agencies

International Atomic Energy Agency, Vienna, Austria
- Studies of biological nitrogen fixation in food and forage legumes, employing the isotope-dilution method with nitrogen-15

International Center for the Improvement of Maize and Wheat, Mexico
- Wheat and barley improvement: CIMMYT has seconded three wheat breeders to ICARDA, and ICARDA has seconded a barley breeder to CIMMYT.

International Crops Research Institute for the Semi-Arid Tropics, Hyderabad, India
- Chickpea improvement:ICRISAT has seconded a chickpea breeder to ICARDA.

Canada

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

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

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

France

Institut National de la Recherche Agronomique and Ecole Nationale Superieure d'Agronomie, Montpellier
- Study of biological nitrogen fixation and nitrogen assimilation in food legumes as a function of genotype
- Study of chickpea rhizobia and drought and cold tolerance
- Inoculation of medics in southern France

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

Federal Republic of Germany

University of Bonn
- Decline in cereal yield in continuous cropping systems
- Chocolate spot and *Ascochyta* blight disease control in faba bean
- Wide crossing in lentil

University of Giessen
- Weed control and water-use efficiency in peas
- Control of *Orobanche* in food legumes

University of Gottingen
- Development of a lentil-pulling machine

University of Hohenheim
- Economics of irrigated food-legumes production by small-holders in Sudan
- Physiological factors as determinants of yield in durum wheat
- 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
- Genetics of phosphate uptake in chickpea

Max-Planck Institute for Biochemistry, Munich
- Resistance mechanisms in chickpea to leafminer

University of Frankfurt and Max-Planck Institute of Psychiatry, Munich
- RFLP analysis in chickpea and lentil

University of Frankfurt
- Genetic engineering: *Agrobacterium tumefaciens* as a gene vector system in lentil and chickpea

Italy

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

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

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

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

University of Tuscia, Viterbo
- Enhancing wheat productivity in stress environments utilizing wild progenitors and primitive forms

University of Napoli; ENEA, Rome; Ministry of Agriculture, Sicily; Department of Pathology, Ministry of Agriculture, Rome
- Development of chickpea germplasm with combined resistance to *Ascochyta* blight and *Fusarium* wilt using wild and cultivated species

Japan

Tropical Agriculture Research Center, Tskuba, Ibaraki
- Eco-physiological studies for improvement of high-yielding wheat varieties
- Haploid breeding in wheat using *Hordeum bulbosum*

Netherlands

DGIS: The Directorate General for International Cooperation
- Agronomic characterization of germplasm collections on the basis of information on the environment in the regions of collection, and evaluation of data

Portugal

Estacao National de Melhoramento de Plantas, Elvas
- Screening cereals for resistance to yellow rust, scald, *Septoria* and powdery mildew
- Developing lentil, faba bean and chickpea adapted to Portugal conditions

Spain

University of Cordoba
- Effect of environmental stresses on nitrogen fixation
- Developing *Orobanche* resistance in faba bean
- Developing wilt resistance in chickpea

University of Cordoba and INIA
- Barley stress physiology

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

Polytechnical University, Madrid
- Improvement of the energy efficiency of medic rhizobia

United Kingdom

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

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

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

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

University of Reading
- Root studies of barley, wheat and chickpea
- Studies of the effects of photoperiod and temperature on the development of different genotypes of barley, lentil and faba bean
- Investigation of seed dormancy in plant populations on grazed marginal land

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

United States

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

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

University of Pennsylvania
- Phylogenetic studies of *Rhizobium meliloti.*

Washington State University, Pullman
- Transfer of *Bacillus thuringiensis* gene in *Rhizobium* for the control of *Sitona* larvae in lentil and peas

Appendix 13

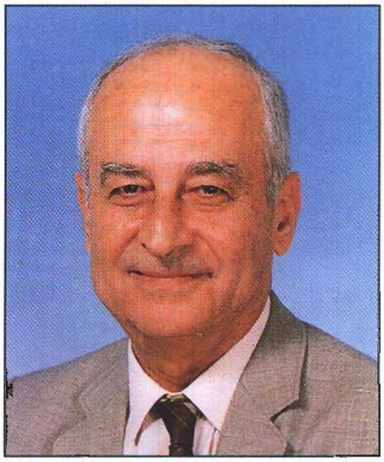
Board of Trustees

Four trustees completed the term of their office in 1989: Dr Jose Ignacio Cubero, Chairman; Dr Joseph Haraoui; Ms Naima Shayji; and Mr Hamid Merei. During their trusteeship these members also served on the various committees of the Board. At its 1989 annual meeting, the Board paid tribute to all four members for their significant contributions to the development of ICARDA.

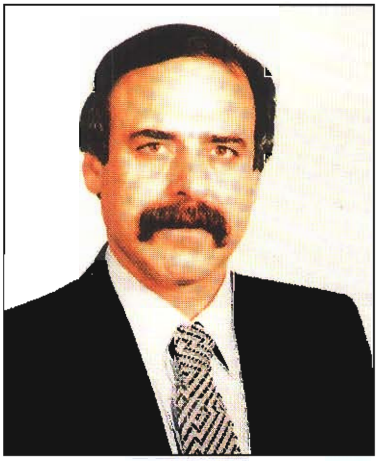
Dr Enrico Porceddu was elected the new Chairman at the 1989 annual meeting of the Board. Sir Ralph Riley and Dr Abdul Rahim Subei joined as new Members.

Dr Jose Ignacio Cubero

Ms Naima Shayji

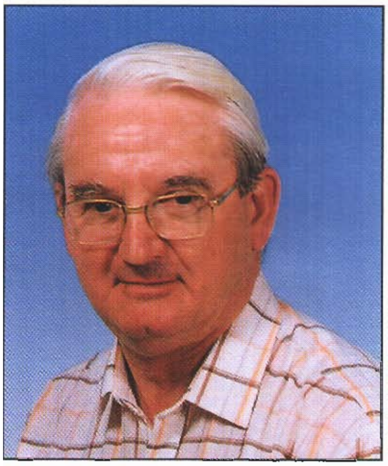


Dr Joseph Haraoui



Mr Hamid Merei

Dr Enrico Porceddu



Sir Ralph Riley

Dr Abdul Rahim Subei

Dr Enrico Porceddu, the new Chairman from 1989, joined ICARDA's Board of Trustees in 1986. A recognized authority in plant breeding and genetics, Dr Porceddu has been deeply involved in a wide range of agricultural research and development activities. In addition to his post at the University of Tuscia, he currently serves as Director of a special Italian government project, "Increasing the Productivity of Agricultural Resources."

Sir Ralph Riley received a B.Sc. in Botany from Sheffield University in 1950. In 1952 he joined the staff of the Plant Breeding Institute at Cambridge University where, three years later, he became Head of Cytogenetics Department. From 1971 to 1978 he served as Director of the Institute, and afterwards was appointed Secretary, then Deputy Chairman of the Agriculture and Food Research Council. He was knighted in 1984 in recognition of his contributions to science, and is currently a Fellow of the Institute of Biology and the Royal Society, and Honorary Fellow of the Royal Agricultural Society of England. His association with the CGIAR began in 1973, when he joined the Board of Trustees of IRRI. In 1976 he chaired CIMMYT's first quinquennial review, and in 1984-85 was a member of the CGIAR's Impact Study Advisory Committee. He also served as a member of the External Program Reviews of IRRI and CIMMYT in 1987 and 1988, respectively.

Dr Abdul Rahim Subei is the Deputy Minister of State for Planning Affairs, Syrian Arab Republic. He received a degree in commerce from the University of Damascus, and continued his studies at Catholic University, Louvain, Belgium, where he was awarded a doctorate in applied economics in 1970.

Prior to his appointment as Deputy Minister, Dr Subei held several senior positions in the Government of Syria, including that of Director of Foreign Economic Relations in the Ministry of Planning. He spent two years in the People's Democratic Republic of Yemen as Senior Economist with the Technical Assistance Team of the Kuwaiti Fund for Arab Economic Development. He was associated with the Arab Mining Company in Amman, Jordan, first as Senior Economist from 1980 to 1986, then as Director of the Economics Department, 1986-1988.

The Board held the following meetings during 1989:

23-26 January	16th meeting of the Program Committee
28 January	Extraordinary meeting of the Executive Committee
29-30 January	Extraordinary meeting of the Board of Trustees
16 May	Extraordinary meeting of the Executive Committee
16-18 May	23rd meeting of the Board of Trustees
11-12 October	17th meeting of the Program Committee
6-7 November	20th meeting of the Executive Committee

At the end of 1989, the membership of ICARDA's Board of Trustees was as follows:

Appendix 14

Senior Staff

(as of 31 December 1989)

SYRIA

Aleppo: Headquarters

Director General's Office

Dr Nasrat R. Fadda, Director General
Dr Aart van Schoonhoven, Deputy Director General (Research)
Dr J.P. Srivastava, Assistant Director General (International Cooperation)
Ms Afaf Rashed, Administrative Assistant to the Board of Trustees

Government Liaison and Public Relations

Dr Adnan Shuman, Assistant Director General (Government Liaison)
Mr Ahmed Mousa El Ali, Public Relations Officer

International Cooperation

Dr Samir El-Sebae Ahmed, National Research Coordinator
Dr A.J.G. van Gastel, Seed Production Specialist
Dr Zewdie Bishaw, Assistant Seed Production Specialist

Finance

Mr Andre Briet, Director of Finance
Mr Suresh Sitaraman, Finance Officer, Financial Operations
Mr Mohamed K. Barmada, Finance Officer, Outreach
Mr Suleiman Is-hak, Finance Officer, Cash Management
Mr Vijay Sridharan, Finance Officer, Financial Reporting
Mr Mohamed Samman, Pre-Audit and Control

Computer Services

Mr Khaled El Bizri, Director (on sabbatical)
Dr Murari Singh, Senior Biometrician
Mr Bijan Chakraborty, Senior Programmer/Acting Director.
Mr Michael Sarkissian, Systems Engineer
Mr C.K. Rao, Senior Programmer
Mr Awad Awad, Senior Programmer

Personnel

Ms Leila Rashed, Personnel Officer

Farm Resource Management Program

Dr Peter J. Cooper, Program Leader/Soil Physiologist
Dr Hazel Harris, Soil Water Conservation Scientist
Dr Michael Jones, Barley-Based Systems Agronomist
Dr Abdullah Matar, Soil Chemist
Dr Thomas Nordblom, Agricultural Economist (on sabbatical)
Dr Mustafa Pala, Wheat-Based Systems Agronomist
Dr Eugene Perrier, Water Management Agronomist
Dr Mohamed Bakheit Said, Senior Training Scientist
Dr Elizabeth Bailey, Visiting Agricultural Economist
Dr Wolfgang Goebel, Post Doc. Fellow/Agro-climatologist
Dr Ammar Wahbi, On-Farm Agronomist-Barley/Livestock Systems
Mr Ahmed Mazid, Agricultural Economist
Mr Abdul Bari Salkini, Agricultural Economist
Dr Richard Tutwiler, Visiting Socioeconomist
Mr Sobhi Dozom, Research Associate
Mr Mahmoud Oglah, Research Associate
Mr Ciro D'Acunzo, Associate Expert (seconded from FAO)

Cereal Improvement Program

Dr Habib Ketata, Senior Training Scientist/Acting Leader
Dr Edmundo Acevedo, Cereal Physiologist/Agronomist
Dr Salvatore Ceccarelli, Barley Breeder
Dr A. B. Damania, Wheat Germplasm Specialist
Dr Guillermo Ortiz Ferrara, Bread-Wheat Breeder (seconded from CIMMYT)
Dr Philippe Lasherme, Biotechnologist
Dr Byrd Curtis, Visiting Senior Scientist (seconded from CIMMYT)
Dr Omar Mamlouk, Plant Pathologist (on sabbatical)
Dr Ross Miller, Cereal Entomologist
Dr Miloudi Nachit, Durum-Wheat Breeder (seconded from CIMMYT)
Dr Muhammed Tahir, Plant Breeder
Dr Joop van Leur, Barley Pathologist
Dr Masanori Inagaki, Senior Researcher (seconded from Japan)

Dr Ahmed Zahour, Visiting Scientist
Mr Issam Naji, Agronomist
Dr Stefania Grando, Research Scientist
Dr Sui K. Yau, International Nurseries Scientist
Mr Luciano Pecetti, Research Associate
Mr Mohamed Asaad Mousa, Research Associate

Food Legume Improvement Program

Dr Mohan C. Saxena, Program Leader/Agronomist-Physiologist
Dr Douglas Beck, Food Legume Microbiologist
Dr William Erskine, Lentil Breeder
Dr Mohamed Habib Ibrahim, Senior Training Scientist
Dr K.B. Singh, Chickpea Breeder (seconded from ICRISAT)
Dr Susan Gerlach, Entomologist
Dr R. S. Malhotra, International Trials Scientist
Dr Karl H. Linke, Post-Doc. Fellow, *Orobanche* (seconded from GTZ)
Dr Said Nahdy Silim, Post-Doc. Fellow, Agronomy-Physiology
Dr Oreib Tahhan, Post-Doc. Fellow, Agronomy/Entomology
Dr Geletu Begiga, Post-Doc. Fellow, Chickpea Breeding
Mr Ihsan Ul-Haq, Assistant Training Scientist
Mr Thomas Bambach, Visiting Research Associate
Mr Stefan Schlingloff, Visiting Research Associate
Mr Edwin Weber, Visiting Research Associate
Mr Bruno Ocampo, Research Associate
Mr Hasan Mashlab, Research Associate
Mr Fadel Afandi, Research Associate

Pasture, Forage, and Livestock Improvement Program

Dr Philip S. Cocks, Program Leader/Pasture Ecologist (on sabbatical)
Dr Euan Thomson, Livestock Scientist/Acting Leader
Dr Ali Abd El Moneim Ali, Senior Training Scientist
Dr Luis Materon, Microbiologist
Dr Ahmed El Tayeb Osman, Pasture Ecologist
Dr Peter White, Post-Doc. Fellow
Mr Faik Bahhady, Assistant Livestock Scientist
Mr Hanna Sawmy Edo, Research Associate
Mr Nerses Nersoyan, Research Associate
Mr Mathio Daily Hunt, Research Associate
Ms Silvia Lorenzetti, Research Associate
Mr Mario Pagnotta, Research Associate
Mr Safouh Rihawi, Research Associate
Mr Luigi Russi, Research Associate
Ms Monika Zaklouta, Research Associate
Dr Munir El-Turk, Research Associate

Genetic Resources Unit

Dr Jan Valkoun, Head
Dr Khaled Makkouk, Plant Virologist
Dr Laszlo Holly, Genetic Resources Scientist
Dr Michael van Slageren, Genetic Resources Scientist
Dr Marlene Diekmann, Visiting Scientist
Mr Bilal Humeid, Research Associate
Mr Ann Elings, Associate Expert
Mr Kevin Powell, Research Associate

Communication, Documentation and Information Unit

Mr Allan Deutsch, Head
Dr Surendra Varma, Head, Editing and Publications
Dr Walid Sarraj, Senior Information Specialist, Arabic
Ms Souad Hamzaoui, Center Librarian
Mr Benjamin Wedeman, Communications Specialist
Mr Nihad Maliha, Information Specialist-FABIS

Training

Dr Lawrence R. Przekop, Head

Visitors' Services

Mr Mohamed A. Hamwieh, Administrative Officer

Travel Section

Mr Bassam Hinnawi, Travel Officer

Farm Operations

Dr Juergen Diekmann, Farm Manager
Mr Ahmed Sheikh Bandar, Assistant Farm Manager
Mr Bahij Kawas, Senior Horticultural Supervisor

Physical Plant

Dr P. Jegatheeswaran, Mechanical Workshop Engineer
Mr Peter Eichhorn, Vehicle Workshop Engineer
Mr Ohannes Kalou, Electrical/Electronic Engineer
Mr Farouk Jabri, Food and General Services Officer
Mr Khaldoun Wafaii, Civil Engineer

Purshasing and Supplies

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

Labor Office

Mr Marwan Mallah, Administrative Officer

International School of Aleppo

Mr Valyn Anderson, Principal
Ms Nida Kudsi, Deputy Principal/Teacher

Damascus

Mr Abdul Karim El Ali, Administrative Offic

ETHIOPIA

Addis Ababa

Dr S.P.S. Beniwal, Food Legume Breeder/Pathologist

EGYPT

Cairo

Dr Bhup Bhardwaj, Director of Administration and Operations

LEBANON

Beirut

Mr Anwar Agha, Executive Manager

Terbol Research Station

Mr Munir Sughayyar, Engineer, Station Operations

MEXICO

CIMMYT

Dr Hugo Vivar, Barley Breeder

MOROCCO

Rabat

Dr Philip Beale, Pasture and Forage Scientist
Dr Salim Hanounik, Faba Bean Pathologist
Dr Mohamed Mekni, Cereal Scientist
Dr Larry Robertson, Faba Bean Breeder
Dr Mahmoud El-Solh, Food Legume Breeder

PAKISTAN

Quetta

Dr John D. Keatinge, Team Leader/Crop Pathologist

TUNISIA

Tunis

Dr Ahmed Kamel, ICARDA Representative/Cereal Pathologist

CONSULTANTS

Dr Hisham Talas, Medical Consultant (Aleppo)
Mr Tarif Kayali, Legal Advisor (Aleppo)
Dr Giro Orita, Veterinary Specialist (Aleppo)
Dr Franz Weigand, Pathology (Aleppo)
Mrs S. Jegatheeswaran, Consulting Nurse (Aleppo)
Dr Edward Hanna, Legal Advisor (Beirut)
Dr Philip Williams, Analytical Services (Canada)

Appendix 15

Acronyms and Abbreviations

ACSAD	Arab Center for Studies of the Arid Zones and Dry Lands (Syria)
AFESD	Arab Fund for Economic and Social Development (Kuwait)
AGRIS	International Information System for Agricultural Science and Technology (FAO, Italy)
AOAD	Arab Organization for Agricultural Development (Sudan)
APRP	Arabian Peninsula Regional Program
AZRI	Arid Zone Research Institute (Pakistan)
BLRV	Bean Leaf Roll Virus
BYDV	Barley Yellow Dwarf Virus
BYMV	Bean Yellow Mosaic Virus
CARIS	Current Agricultural Research Information System
CERES	Crop-Environment Resource Synthesis Nitrogen
CG	Consultative Group
CGIAR	Consultative Group on International Agricultural Research (USA)
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo (Mexico)
DGIS	Directorate General for International Cooperation (the Netherlands)
EEC	European Economic Community
ENSA	Ecole Nationale Superieure d'Agriculture
EMR	External Management Review
EPR	External Program Review
FRG	Federal Republic of Germany
FABIS	Faba Bean Information Service (managed by ICARDA)
FLIP	Food Legume Improvement Program (ICARDA)
FAO	Food and Agriculture Organisation of the United Nations (Italy)
FRMP	Farm Resource Management Program (ICARDA)
GCC	Gulf Cooperation Council (Saudi Arabia)
GRU	Genetic Resources Unit (ICARDA)
GOSM	General Organization for Seed Multiplication (Syria)
GTZ	Deutsche Gesellschaft fur Technische Zusammenarbeit (German Agency for Technical Cooperation, West Germany)
IARCs	International Agricultural Research Centers
IBPGR	International Board for Plant Genetic Resources (FAO, Italy)
IBRD	International Bank for Reconstruction and Development (World Bank, USA)
ICARDA	International Center for Agricultural Research in the Dry Areas (Syria)
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics (India)
IDRC	International Development Research Centre (Canada)
IFAD	International Fund for Agricultural Development (Italy)
IFPRI	International Food Policy Research Institute (USA)
IMPHOS	Institut Mondial de Phosphate

INRA	Institut National de la Recherche Agronomique (Morocco)
IRRI	International Rice Research Institute (Philippines)
ISA	International School of Aleppo
JUST	Jordan University of Science and Technology (Jordan)
LENS	Lentil News Service (managed jointly by ICARDA and the University of Saskatchewan)
MART/AZR	Management of Agricultural Research and Technology/Arid-Zone Research project
NARP	North Africa Regional Program
NARSs	National Agricultural Research Systems
NVP	Nile Valley Project
NVRP	Nile Valley Regional Program
OPEC	Organization of Petroleum-Exporting Countries (Austria)
PDRY	Peoples' Democratic Republic of Yemen
PFLP	Pasture, Forage and Livestock Program (ICARDA)
SAREC	Swedish Agency for Research Cooperation with Developing Countries (Sweden)
SMAAR	Syrian Ministry of Agriculture and Agrarian Reform
STIP	Scientific and Technical Information Program
TAC	Technical Advisory Committee (FAO, Italy)
UAE	United Arab Emirates
UNDP	United Nations Development Programme (USA)
USAID	United States Agency for International Development (USA)
WANA	West Asia and North Africa
WARP	West Asia Regional Program
YAR	Yemen Arab Republic

Units of measurement

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

Languages

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

Countries

AR	Argentina
CN	China
DE	Federal Republic of Germany
ES	Spain
FR	France
GB	United Kingdom
IN	India
IR	Iran
IT	Italy
JO	Jordan
JP	Japan
MA	Morocco
MX	Mexico
PT	Portugal
SY	Syria
TN	Tunisia
TR	Turkey
US	United States

ICARDA Addresses

Headquarters, Syria

International Center for Agricultural Research
in the Dry Areas
P.O. Box 5466,
Aleppo, Syria
Phone: (963-21) 213433, 213477, 234890,
Telex: (0492) 331206, 331208, 331263 ICARDA SY

Damascus Office

Hamed Sultan Bldg., First Floor
Abdul Kader Ghazali Str.
Abu Roumaneh (Next to Al-Malki circle)
P.O.Box 5908
Damascus, Syria
Phone: (963-11) 420482/420483/331455
Telex: (0492) 412924 ICARDA SY

Regional Offices

Egypt

15 G. Radwan Ibn El-Talib Str.
11th Floor, Giza
P.O. Box 2416
Cairo, Egypt
Phone: (20-2) 728099/735829/724358
Telex: (091) 21741 ICARD UN

Jordan

P.O. Box 950764
Amman, Jordan
Phone: (962-6) 682547/682548
Telex: (0493) 23278 ICARDA JO
Fax: (962-6) 690683

Lebanon

Rue Bashir El-Kassar
Dalia Building, 2nd Floor
P.O. Box 114/5055
Beirut, Lebanon
Phone: (961-1) 804071, 813303
Telex: (0494) 22509 ICARDA LE

Mexico

c/o CIMMYT
P.O. Box 6-641
06600 Mexico DF, Mexico
Phone: (1-905) 761-3311, 761-3865
Telex: 1772023 CIMTME
Fax: (52-5) 954-1069
Cable: CENCIMMYT

Morocco

B.P. 6299
Rabat Instituts-Rabat
Agdal, Morocco
Phone: (212-7) 73416
Telex: (0407) 32784 Foodagri M
Fax: (212-7) 73416

Pakistan

c/o Arid Zone Research Institute
Brewery Road
P.O. Box 362
Quetta, Pakistan
Phone: (0092-81) 73248
Telex: (082) 78236 ICARDA PK
Fax: (92-81)73248

Tunisia

Immeuble Saadi, Route de l'Ariana
El-Menzah, Tour C-D, 7th Floor
Apartment No. 25, Tunis
P.O. Box 84
2049 Ariana, Tunisia
Phone: (216-1) 717649
Telex: (0409) 14066 ICARDA TN
Fax: (216-1) 711741

ICARDA Addresses

Headquarters, Syria

International Center for Agricultural Research
in the Dry Areas
P.O. Box 5466,
Aleppo, Syria
Phone: (963-21) 213433, 213477, 234890,
Telex: (0492) 331206, 331208, 331263 ICARDA SY

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Cairo, Egypt
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Jordan

P.O. Box 950764
Amman, Jordan
Phone: (962-6) 682547/682548
Telex: (0493) 23278 ICARDA JO
Fax: (962-6) 690683

Lebanon

Rue Bashir El-Kassar
Dalia Building, 2nd Floor
P.O. Box 114/5055
Beirut, Lebanon
Phone: (961-1) 804071, 813303
Telex: (0494) 22509 ICARDA LE

Mexico

c/o CIMMYT
P.O. Box 6-641
06600 Mexico DF, Mexico
Phone: (1-905) 761-3311, 761-3865
Telex: 1772023 CIMTME
Fax: (52-5) 954-1069
Cable: CENCIMMYT

Morocco

B.P. 6299
Rabat Instituts-Rabat
Agdal, Morocco
Phone: (212-7) 73416
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c/o Arid Zone Research Institute
Brewery Road
P.O. Box 362
Quetta, Pakistan
Phone: (0092-81) 73248
Telex: (082) 78236 ICARDA PK
Fax: (92-81)73248

Tunisia

Immeuble Saadi, Route de l'Ariana
El-Menzah, Tour C-D, 7th Floor
Apartment No. 25, Tunis
P.O. Box 84
2049 Ariana, Tunisia
Phone: (216-1) 717649
Telex: (0409) 14066 ICARDA TN
Fax: (216-1) 711741

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