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# **Spain and ICARDA**

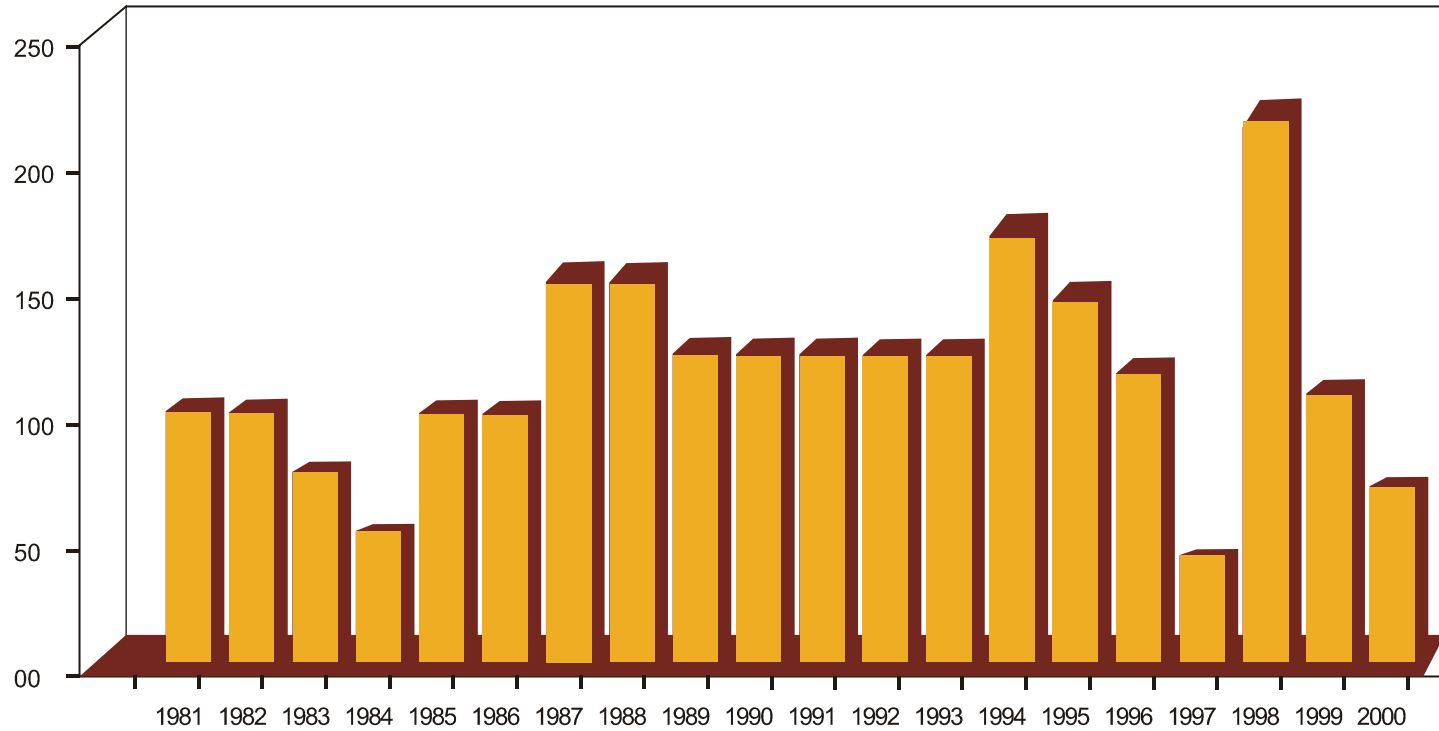
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**Ties that Bind**



**International Center for Agricultural  
Research in the Dry Areas**

## Funding from Spain 1981-2000 US\$ (000)



# Spain and ICARDA

## Ties that Bind

No. 14



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Research in the Dry Areas  
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# Spain and ICARDA

## Partners – Yesterday, Today and Tomorrow

**L**inks between ICARDA and Spain are long established. A glance at any map of the Mediterranean will help explain why both have benefited from this collaboration. Spain is an active member of the European Union but it is also separated geographically by just a handful of kilometers from part of ICARDA's mandate area—North Africa. In history, the connection has been even closer, both politically and culturally, when southern Spain came under the influence of the Arab world.

Parts of southern and central Spain are remarkably similar in climate to some of the agricultural areas of Morocco. Farmers in many regions of southern and central Spain face similar ecological conditions to farmers in parts of Central and West Asia and North Africa (CWANA) where ICARDA works with national programs to improve bread and durum wheats, chickpea and farming systems. The main problem faced by farmers in southern Spain, WANA and Central Asia is unreliable and low rainfall. This means scientists in Spain and ICARDA are working towards similar goals. For example, producing new types of wheat and barley that can grow well even when rainfall is very low during the growing season.

Because of those historical and cultural connections dating back over many centuries, Spanish cooking has evolved to employ many of the same principal ingredients used in food preparation in WANA. Both in Spain and in WANA food manufacturers and scientists are frequently interested in improving the processing quality of the same crops for similar end uses. One example is durum wheat for use as pasta.

In 1997, Spain's population was around 39 million, and the country's rate of population increase very small—around 0.18% a year. The total land area of Spain is 49 million hectares (ha) of which 30 million ha are

agricultural land and 20 million ha of those are arable land under permanent agriculture.

Because of these strong similarities between the continental dry areas of Spain and the Mediterranean areas of WANA, collaborative research to improve crops in terms of characteristics and yield is of benefit to both partners—and that is good news for the farmers, consumers and others in Spain and WANA.

## Spain and ICARDA

Spain is a donor member of the Consultative Group on International Agricultural Research (CGIAR) where it is represented by the Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria (INIA).

INIA is an important partner for ICARDA, which has worked with it on:

- barley stress physiology
- race identification of *Fusarium oxysporum* f.sp. *ciceri* in chickpea in the Mediterranean region
- exchange of fodder, pasture and range plant germplasm
- reclamation of marginal soils

In addition to funding specific sub-projects on these topics, INIA supports ICARDA with core funding and continues to develop additional joint cooperative research projects. Both institutions also benefit from the interchange of scientific personnel and genetic material, and the interchange of scientific and technical information through publica-



***Breeding for disease- and stress-resistant chickpea is a key part of ICARDA/Spain collaboration.***

tions, reports and other documents. They also jointly organize and finance conferences, seminars, studies, workshops and training visits.

This collaboration has been an important focus for ICARDA's collaboration with other organizations and institutions in Spain, including the University of Córdoba, which has been an important partner in work on chickpea, barley, durum wheat, Orobanche (broomrape) resistance in faba bean, and soil studies. Other universities with which ICARDA has worked in the past include the University of Granada (isolation of VAMycorrhiza from forage legumes, and use of molecular markers for mapping grain yield characters) and the Polytechnical University in Madrid on the improvement of the energy efficiency of medic rhizobia.

## **Board of Trustees**

**I**CARDA is governed by an independent Board of Trustees drawn from distinguished scientists and administrators from many countries. Dr José Ignacio Cubero, of the Escuela Técnica Superior de Ingenieros Agrónomos at Córdoba, served for two three-year terms on the BoT from 1983. He was chairman of the Board of Trustees between 1986-89.



***Dr J.I. Cubero  
Chairman,  
ICARDA Board  
of Trustees  
1986-89***

## **Research Collaboration and Achievements**

### **Barley**

Spain's national barley breeding program has resulted from the merger of three main breeding programs: Lérida, Zaragoza and Valladolid. The three centers are located in the main barley growing areas, which represent almost 90% of the barley area in Spain. The Ministry of Agriculture funds breeding activities, while the Ministry of Science and Education supports other associated research.

In 1987, Spain released Resana (Rihane-03), a variety produced from ICARDA germplasm, which has since been taken up by a number of other countries, including Algeria, Iraq, Lebanon and Morocco. In 1999 the new variety Aicara was submitted for registration



***New drought tolerant barley varieties have benefited Spain and CWANA countries.***

with the Spanish Office of Plant Varieties (Oficina Española de Variedades Vegetales). Aicara, which was selected from F2 lines produced by ICARDA, is particularly well adapted for autumn sowing in a number of areas in Spain.

One of the main problems facing farmers in CWANA, as well as farmers in southern Spain is the problem of unreliable and low rainfall. So scientists at ICARDA have been working to develop plants that respond best when the most rain water is available and the weather is at its coolest, so less water is likely to be lost into the air through evaporation. Desirable plant characteristics, determining water use efficiency, are those that help the plant take up more of the available water and lose less from the leaves, for example, or through evaporation from the soil. Severe drought affects plant capacity to put on yield and scientists at ICARDA and at the University of Barcelona are examining the plant characteristics that help some varieties to continue to develop fully in drought conditions. Identifying these characteristics will help them to develop new, improved varieties with the required traits.

Dr Salvatore Ceccarelli and Dr Stefania Grando, from ICARDA's Germplasm Program, have been working with Prof. José Araus (a visiting scientist with the Germplasm Program between March 1995 and March 1996, and still a regular annual visitor for informal collaboration)



and Dr Jordi Bort, of the University of Barcelona. Their research is aimed at identifying indicators of water-use efficiency in plants so improved varieties can be developed for use in drought-prone areas.

Interesting results are already coming through from their research on the relationship between leaf structure and carbon isotope discrimination in barley. They have found that barley varieties with leaves that are thicker, or closer together (compact), or both, can use water more efficiently. They need less water to grow, and they can still produce good crop yields. The research results so far also suggest there is a lot of variability in barley for these characteristics. This could be an important breakthrough in producing new varieties that can return good yields in spite of low rainfall. Good news indeed for the scientists and farmers working in the dry areas.

Dr Grando, barley breeder with ICARDA, has met with Prof. José-Luis Molina-Cano from the University of Lleida, Instituto de Recerca i Tecnologia Agroalimentaries (UdL-IRTA), to discuss possible areas of collaboration between the University and ICARDA. The group in Llerida is currently working on three major research topics:

- seasonal adaptation mainly response to photoperiod and temperature
- physiology of germination as related to malting quality
- protein content in grain in relation to malting

The three topics are tackled both at field and molecular level. At least one mapping population has been developed for each topic.

Prof. Molina-Cano is setting up a Spanish barley core collection. He is the first scientist to find and collect *H. spontaneum* in Morocco where he may collaborate with ICARDA on barley collection. UdL-



***University of Barcelona scientists measure radiation in a barley field at ICARDA, Syria.***

IRTA and ICARDA may also collaborate on the assessment of biodiversity and adaptation of barley landraces from the Mediterranean countries.

## **Durum wheat**

Durum wheat (*Triticum turgidum*, L. var. *durum*) is one of the most important and valuable combinable crops grown in Spain and the Mediterranean countries of WANA. The WANA region alone accounts for nearly 80% of the total durum wheat produced in the developing world. More than 500,000 ha of durum wheat are grown in Spain, mainly in the south in Andalusia and Extremadura but also in more northerly Aragon.

In Spain, durum flour is generally used in bread and in pasta while elsewhere in the Mediterranean region it is used for processing into semolina for couscous, for pasta, flat breads, burghul and frike (immature green grains). Durum products are, therefore, a key part of the staple diet in Mediterranean countries. The high quality of the flour, particularly its valuable gluten content, makes it particularly suitable for blending with lower quality flours for local breads. It is prized in the manufacturing industry and durum is one of the highest-priced grains trading on the world market at a sizeable premium over bread wheat.

Growers in Spain expect 5-6 tonnes per hectare in the irrigated areas but on dry lands they will not achieve much beyond 3 tonnes. Average yield in a dry country such as Syria is about 2.7-3 t/ha but can vary from 1 t/ha to 6-7 t/ha in some places. Quality is always paramount. Cooks prefer high yellow pigmentation and the cooked grain shouldn't be sticky.



***Burghul made from durum wheat is part of the diet in many Mediterranean countries.***

## **Why cooperate?**

Only a handful of research institutes worldwide work on durum wheat so cooperation between Spain and countries and institutions in WANA is valuable and sensible. Recent progress in developing high yielding and stress-resistant durum is reflected in yield increases in the Mediterranean region.

The Spanish INIA and CIMMYT/ICARDA durum research programs are making a joint effort to improve dryland durum productivity and use in Spain and Morocco in several ways. This includes cooperation on identifying and transferring resistances to abiotic and biotic stresses, particularly drought stress; improving grain quality for semolina and pasta, with particular emphasis on gluten strength; and degree training and joint visits to research stations.

Spanish landraces and Moroccan wild relatives are frequently used in crossings under this program. Elite germplasm is evaluated for quality traits at Lérida in Spain, Tetouan in Morocco and Tel Hadya in Syria.

ICARDA's main vehicle of cooperation with Spain on durum wheat research has been the Center's durum breeding program run jointly with Mexico-based CIMMYT (Centro Internacional de Mejoramiento de Maiz y Trigo). The CIMMYT/ICARDA germplasm adapts well in continental dry areas where drought stress is high during the terminal grain filling stages, and many of these lines have already been used in Spanish breeding programs. Spain's southern zone has average annual precipitation of 450mm but terminal drought stress is still the main climatic constraint. In the north, rainfall is lower and more erratic. In the central area near Madrid, the climatic conditions are very similar to those at ICARDA's Tel Hadya headquarters in Syria.

## **Achievements**

Yield has been the prime beneficiary of the improvements to drought tolerance gained over 10 years of improving durum varieties in the Mediterranean dryland. Newly developed durum lines are now showing a yield increase of one tonne per hectare over typical local varieties.

Breeding programs at L rida, Madrid, Badajoz, C diz and Zaragoza all have used CIMMYT/ICARDA durum wheat germplasm. Five new varieties derived from this germplasm have been released in Spain. Mexa (released in 1983) was rapidly adopted to take more than 80% of the Spanish durum area during the mid-1980s. It has since been overtaken in the south by Jabato (1989) and in the north by Anton (1991). Nuna (1985) and Roqueno (1991) were also based on CIMMYT/ICARDA germplasm.

Material from the CIMMYT/ICARDA Program is continually improved, with the routine use of PCR-primers and the SDS-page electrophoresis as screening tools. The objective is to identify markers for nutritional and processing grain quality, using seed storage proteins and molecular markers (STS-primers, RFLPs, Microsatellites, RAPDs, and AFLPs). Other collaborators are C rdoba University, and Cornell University in the USA. Funding for the program comes from Spain as well as from the CIMMYT/ICARDA core-budgets, IFAD (International Fund for Agricultural Development), and from other countries. This program is funded from 1995 to the year 2001.

## **WANADDIN**

The on-going WANADDIN (West Asia and North Africa Dryland Durum Improvement Network) was originally a three-year regional project involving the national agricultural research programs of Algeria, Morocco, Syria, Tunisia, and Turkey; CIMMYT/ICARDA; and the donor IFAD. Dr Miloudi Nachit, durum breeder based at ICARDA and also CIMMYT regional representative in the Mediterranean region, is coordinator of collaborative research carried out under the wings of both the WANADDIN and SEWANA (see below) networks.

WANADDIN promotes resource pooling between partner national agricultural research systems (NARS), with technical and scientific support from the CIMMYT/ICARDA durum project. This networking effort is expected to lead, in the long run, to the release of more improved and adapted germplasm in less time than would be possible if the NARS

were working in isolation from each other. The overall project objective is to gain sustainable improvement in productivity and production of durum wheat in the dryland areas of WANA.

This will also be of significant advantage to durum wheat growers in the continental dry areas of Spain. During 1999 collaborative studies on moisture stress tolerance have continued between ICARDA/CIMMYT and Dr Conxita Royo de Calpe, durum wheat breeder at the University of Lleida, Dr José Araus, from the University of Barcelona, and the Servicio de Investigaciones Agrarias research station at Jerez de la Frontera.

Researchers are also surveying farmers to find out in which crop characteristics they are most interested. Breeders will be able to use this information to develop improved durum cultivars which not only produce more, but will also meet farmers' specific needs for grain and straw, as well as consumer preferences. And, the surveys will look at both men and women's needs. As the major staple of dryland Mediterranean environments of WANA, durum production and use rely, to a large extent, on women's input, especially with respect to local traditional processing of durum for household consumption. Therefore, it is important to know which are the characteristics women look for in durum wheat.

## **SEWANA**

Spain is one of the 13 countries working together in the southern Europe, West Asia and North Africa (SEWANA) Integrated Durum Research Network. The CIMMYT/ICARDA durum breeder coordinates this network. It brings together durum breeders and crop improvement scientists from Spain, Algeria, Jordan, Lebanon, Morocco, Tunisia, Turkey and Syria, to ensure they complement each other's work in developing techniques and breeding varieties designed to grow well in the Mediterranean and produce the good grain required by processors. Several PhD students from Córdoba University have carried out work in ICARDA's biotechnology laboratory as part of SEWANA. The Network holds regular meetings for interested scientists, and publishes proceedings.

## Gene mapping

Many scientists in Spain benefit from an association with the CIMMYT/ICARDA durum breeding program. They include Dr Luis Martin, of the Department of Genetics, University of Cordoba, and Dr Antonio Martin, of the Department of Agronomy and Plant Breeding at the Institute of Sustainable Agriculture of Cordoba. Both supervise CIMMYT/ICARDA PhD students. Cordoba. Data and germplasm from CIMMYT/ICARDA is shared with Spanish scientists.

Among recent students registered at the University of Cordoba was Ismahane El-Ouafi, of the CIMMYT/ICARDA durum program, working on a project entitled, “The Use of Molecular Markers to Identify Improved Grain Quality in Durum Wheat (*T. dicoccoides*) Hybrids.” She worked on interspecific hybridization, grain quality, and molecular markers and mapped the genes of quality in durum. *Triticum dicoccoides* is a potential donor for nutritional and technological quality genes. Its protein content can reach up to 35%, compared with around 13% in durum.



*Ms Ismahane El-Ouafi, a graduate student in the CIMMYT/ICARDA durum breeding program*

## Hessian fly

Both bread wheat and durum wheat varieties in Spain and Morocco come under regular threat from the Hessian fly which lays its eggs on the growing plant leaving the larvae to hatch and suck the nutrients which should be flowing up the stem to aid grain filling. Thanks to ICARDA's biotechnology expertise and collaboration with INRA in Morocco, the first durum wheat crosses with Hessian fly



*Hessian fly adult.*

resistance are being released in Morocco where non-resistant wheats lose on average about 35% of their potential yield. Spanish farmers will benefit too when the new resistance to this major pest is incorporated into suitable varieties for their growing conditions.

## **Disease**

Breeding programs in Spain and other parts of southern Europe have not previously placed strong emphasis on disease resistance in durum wheat. However, Spain has problems with severe leaf rust (*Puccinia recondita*), powdery mildew (*Erysiphe graminis*) and other leaf and ear diseases. The availability of CIMMYT/ICARDA material with suitable resistances is a welcome addition to the crossing programs at a number of breeding stations. Indeed, at the Jerez de la Frontera research station, which has the largest durum breeding program in Andalucía, breeders work almost exclusively with the international germplasm. It is used directly to identify cultivars for farmers. Recent releases have included Waha which is known in Andalucía as Arahal. In other regions of Spain, Waha has been introduced as Jabato and Aldura.

## **Chickpea**

Chickpea is the third most important pulse crop in the world, but its yield is generally low and unstable. These modest yields are largely due to the low genetic potential of most existing chickpea lines. Climate and disease influence fluctuations in yield. Scientists from ICARDA and Spain have been working to overcome some of these constraints by breeding higher-yielding and drought- and disease-resistant chickpea. In both North Africa and Spain, large-seeded chickpeas are valued for cooking and are used whole, so the breeding program is offering some good lines for farmers.

Furthermore, research on the two main diseases affecting chickpea in the Mediterranean area – *Fusarium* and *Ascochyta* blight – looks promising. ICARDA is working with Prof. Rafael Diaz, of the University of Córdoba, and with the Institute of Sustainable Agriculture (CSIC) on race identification of *Fusarium oxysporum* f.sp. *ciceri*. At

Córdoba, biotechnology is being used to identify genetic markers for the molecular characterization of *Fusarium* races. Spain is among countries with more than one race of *Fusarium* wilt. Research is also in progress on characterization of non-pathogenic isolates from chickpea roots, while a fast and simple test has been devised for detection of the wilting pathotype in soil.



***Chickpea—grown and eaten in Spain and North Africa.***

The collaboration with

Spain on *Fusarium* wilt has also resulted in the selection of a number of resistant lines that have been supplied to more than 15 countries for further assessment or inclusion in breeding programs.

Another major breeding thrust has been to recombine large seed size with *Ascochyta* blight resistance to allow winter sowing instead of the traditional spring sowing. The ability to plant chickpea in the autumn/winter will mean the seedling is more certain of receiving adequate moisture during the early development stages. However, the longer exposure to disease from winter sowing brings additional risks. Pyramiding of genes for resistance to *Ascochyta* blight has resulted in lines with improved horizontal resistance but more needs to be done to overcome inadequate agronomic performance and seed quality.

The area under chickpea in Spain has been increasing—from 62,000 ha in 1990 to 98,000 ha in 1995. Although some of that increase in plantings was designed to offset declining yields resulting from the effects of recent droughts in the southern part of the country, there are indications that this traditional crop is rising in popularity with consumers.

In addition, chickpea is also being examined for its potential as a tasty, high-protein alternative for inclusion in animal feed.

Eight varieties of Kabuli chickpea bred from ICARDA germplasm have been released in Spain. These are: ‘Fardan’ (ILC 72), ‘Zegri’ (ILC



200), ‘Almena’ (ILC 2548), ‘Alcazaba’ (ILC 2555) and ‘Atalaya’ (ILC 200), which were released by the national program in 1985, and ‘Bagda’ (ILC 72 xCA2156), ‘Kairo’ (ILC 72 x CA2156), Athenas (ILC 72x CA2156), which were released in 1995.

## **Land management**

There are many lessons to be drawn from Spanish experience that are of major benefit for land management in the WANA region. In particular, INIA has been supporting ICARDA and the Syrian Olive Bureau in a collaborative project in northwestern Syria on the Stabilization of Marginal Steeplands. This region has traditionally been a center of olive growing since ancient times although it was only in the 1920s that Kurdish immigrants cleared the forest on the mountain slopes at the village of Yakhour to plant olive trees. There are many similarities now being faced there through slope degradation and soil erosion which are similar to those previously experienced in the more marginal olive growing regions of Spain. The Forest Experiment Station in Granada has been particularly helpful with advice.

Just as in Syria, Spanish advisers have difficulties persuading olive growers to maintain a cover crop between trees for moisture and soil conservation. Farmers all over the world prefer to see ‘clean’ fields. But in Spain a number of techniques are being developed which have potential application in WANA.

Medicinal and aromatic plants—with a high income potential – have been planted along contour lines to arrest erosion. The returns are high enough to offset any concerns about the cover competing with the trees for moisture.



***Techniques from Spain will help olive growing under similar conditions in Syria.***

Another method used in Spain to maintain a seed reservoir in the ground between the olive trees is to kill off alternate strips of the cover vegetation with a herbicide. Some growers also use herbicide pre-harvest to create an even mat on which to place nets for catching the fruit. All these husbandry practices are being evaluated for use in WANA countries.

At Yakhour, and at two other villages in the project area, the researchers are putting alternative cultivation and management systems into practice. These are designed to cut erosion and enable more efficient use of rainwater. Inter-cropping between the olive trees with wheat, lentil, faba bean and lathyrus is also being tried out both for soil protection and to boost total income.

## **Rangeland Improvement**

INIA is supporting a joint project for the development of fodder, pasture and range plant germplasm for cold Mediterranean environments. The collaboration with Dr Enrique Correal, of the Centro de Investigación y Desarrollo Agroalimentario (CIDA) in Murcia, started in 1995 and has resulted in ICARDA and CIDA-Murcia assembling the most comprehensive collection of fodder shrubs germplasm ever. This material is now transplanted at Tel Hadya in Syria from where it is being made available to national agricultural research systems throughout the CWANA region.

The exchange of germplasm between Spain and ICARDA involved ICARDA collecting examples of *Artemisia herba-alba*, *Salsola vermiculata* and *Atriplex nummularia* for Spain. In return, Spain supplied ICARDA with *Bituminaria bituminosa* and *Atriplex halimus* collected in Spain and other countries. Germplasm of *Atriplex halimus* was tested for cold tolerance down to -8 °C at Murcia. This demonstrated that material collected in Spain and Syria was the most resistant to cold.

The impact of selection on the nutritive value of fodder shrubs is also being assessed in Spain, together with seed production from isolated clones of well-grazed and cold tolerant shrubs from old plantations.

# Further synergies between ICARDA and Spain

## Genetic Resources Unit

The Centro de Recursos Firtogenéticos y Agricultura Sostenible (CRF), part of INIA, based in Alcalá de Henares, near Madrid has been working with ICARDA and CLIMA (Centre for Legumes in Mediterranean Agriculture) on genetic conservation. The Head of the Genetic Conservation Service at CRF-INIA, Dr Celia de la Cuadra, visited ICARDA to discuss collaborative collection missions with the Center's genetic resource and germplasm scientists.

## Integrated Pest Management

Representatives of the University of Córdoba participated in a task force meeting on integrated pest management (IPM) of soilborne pathogens, part of the System-wide Initiative on IPM, which was held at ICARDA headquarters. They helped develop a draft for a global project on IPM of soilborne pathogens, involving international agricultural research centers, national agricultural research programs and resource institutions.

## Publishing

The SEWANA durum wheat research network has been responsible for a considerable amount of research publications. Among the published work from the collaborations with Spain on durum wheat are:

- Araus, J.L., J. Bort, S. Ceccarelli and S. Grando. 1997. Relationship between leaf structure and carbon isotope discrimination in field grown barley. *Plant Physiology and Biochemistry* 35: 533-541.
- Araus, J.L., T. Amaro, J. Voltas, H. Nakkoul and M.M. Nachit. 1997. Chlorophyll fluorescence as a selection criterion for grain yield in

durum wheat under Mediterranean conditions. Field Crops Research. (In press)

- Araus, J.L., T. Amaro, Y. Zuhair and M.M Nachit. 1997. Effect of leaf structure and water status on carbon isotope discrimination in field grown durum wheat. *Plant Cell and Environment*: 20: 1484-1494.
- Rekika, D., M.M. Nachit, J.L. Araus and P. Monneveux. 1997. Effects of water deficit on photosynthetic rate and osmotic adjustment in tetraploid wheats. *Photosynthetica*: 34. (In press)
- Araus, J.L., T. Ali Dib, and M.M. Nachit. 1997. Some insights about morphophysiological traits associated with cereal yield increases in Mediterranean environments. In: 1995 SEWANA (South Europe, West Asia & North Africa) durum network workshop. ICARDA, Aleppo, Syria.
- Baum, M., H. Sayet, J.L. Araus, S. Grando, S. Ceccarelli, C. Vacker, V. Moher, A. Jahoori and Fischbeck. 1996. QTL analysis of agronomic important characters for dryland conditions in barley by using molecular markers. *Barley Genetics VII* (vol. 1): 241B243.
- Araus, J.L., T. Amaro, J. Casadesus, A. Asbati and M.M Nachit. 1998. Ash content and carbon isotope discrimination in leaves and kernels as integrative parameters associated with durum wheat yield under Mediterranean conditions (submitted).

## Human Resource Development

At least two scientists, who later joined the ICARDA Germplasm Program, have obtained PhDs from the University of Córdoba through research carried out at ICARDA.

Dr Bruno Ocampo wrote his thesis based on research with wild cicer, entitled Study on the interspecific relationships among the annual *Cicer* species for the improvement of chickpea *Cicer arietinum*. His supervisor at Córdoba University was Prof. José Salmerón. The study investigated the possibility of gene flow from annual wild to cultivated *Cicer* species, i.e. chickpea (*C. arietinum* L.). Wide hybridization improves genetic variability and annual wild *Cicer* species are a wealthy reservoir of genes for resistance to biotic and abiotic stresses. Genes for resistance to some stresses are exclusively present in the wild species. A

series of studies examined the possibilities for exploiting wild *Cicer* species to overcome the main difficulty growers face—yields that are low and very variable.

Dr Ocampo's study suggested testing more genotypes for the annual *Cicer* species hybridization before developing a more complex crossing programme. It confirmed the inclusion of *C. reticulatum* in the primary gene pool of chickpea and also suggested the inclusion of *C. echinospermum*. The exclusive presence of sterility in crosses involving *C. echinospermum* confirms the close relationship between the cultigen and *C. reticulatum*.

Dr Alfredo Impiglia completed his PhD research on seed storage proteins and genetic variability in durum wheat landraces through the University of Córdoba, the University of Tuscia, Italy, and ICARDA.

Dr Impiglia looked at the variation and effect of seed storage proteins on gluten strength in durum wheat, and investigated the association between some seed storage protein components and grain quality properties. This involved the identification of molecular markers for gluten strength—important for pasta quality—in durum. Dr Impiglia's supervisors were Prof. Dr Luis Martín and Prof. Dr José Salmerón, of the University of Córdoba and Dr Miloudi Nachit (CIMMYT/ICARDA).

## **Courses and seminars**

**E**xchange of information between Spain and other collaborating countries often takes the form of individual, group or traveling workshop visits. In addition, specialized courses and seminars are held.

### ***Durum Wheat Improvement in the Mediterranean Region: New Challenges***

Spain was the venue for a joint seminar on April 12-14, 2000 on the improvement of durum wheat for growing and processing in the Mediterranean region.

Held at the Instituto Agronómico Mediterraneo de Zaragoza, the seminar was organized by ICARDA, CIMMYT, the International Centre for Advanced Agronomic Studies (CIHEAM) and the Institut de Recerca

i Tecnología Agroalimentaries (Centro UdL-IRTA), the seminar included papers on the agronomy of durum production and on those factors in breeding and crop management that can affect yield and quality.

### ***1998 Iberian-Atlas Durum Traveling Workshop***

Scientists from North Africa and CIMMYT/ICARDA visited breeding programs, research stations and collaborating universities in Spain and Portugal in May 1998 to get a full update on the status of durum breeding and research.

### ***Statistical Methods for Plant Variety Evaluation***

In November 1997, CIHEAM, CIMMYT and ICARDA staged a joint course on Statistical Methods for Plant Variety Evaluation. This was held at the Instituto Agronómico Mediterraneo de Zaragoza (IAMZ) where ICARDA barley breeder Dr Stefania Grando delivered a lecture on field plot techniques.

Participants included 30 scientists, most of them from WANA countries (13) and Spain (8). Spanish scientists attended from Universidad de Valladolid, E.T.S. de Ingenierías Agrarias; Servicio de Investigación, Desarrollo y Tecnología Agraria de Valladolid; Universidad de Córdoba, E.T.S. de Ingenieros Agrónomos y Montes; Servicio de Investigación Agroalimentaria (SIA-DGA), Zaragoza; Appacale, Agrupación Productores Patata de Siembra de Castilla y León, Burgos; Nunhems Semillas, S.A., Valencia; and Universidad de Sevilla, Escuela Universitaria de Ingeniería Técnica Agrícola, Sevilla.

# ACRONYMS

CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical
CIDA	Centro de Investigación y Desarrollo Agroalimentario
CIHEAM	Centre International des Hautes Études Agronomiques Méditerranéennes
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo
CLIMA	Centre for Legumes in Mediterranean Agriculture
IAMZ	Instituto Agronómico Mediterráneo de Zaragoza
ICARDA	International Center for Agricultural Research in the Dry Areas
INIA	Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria
INRA	Institut National de la Recherche Agronomique (Morocco)
NARS	National Agricultural Research System
IAV Hassan II	Institut Agronomique et Vétérinaire Hassan II
SEWANA	Southern Europe, West Asia and North Africa
WANADDIN	West Asia and North Africa Dryland Durum Improvement Network

# About ICARDA and the CGIAR



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 16 centers supported by the Consultative Group on International Agricultural Research (CGIAR).

ICARDA serves the entire developing world for the improvement of lentil, barley and faba bean; all dry-area developing countries for the improvement of on-farm water-use efficiency, rangeland and small-ruminant production; and the Central and West Asia and North Africa region for the improvement of bread and durum wheats, chickpea, and farming systems. ICARDA's research provides global benefits of poverty alleviation through productivity improvements integrated with sustainable natural-resource management practices. ICARDA meets this challenge through research, training, and dissemination of information in partnership with the national agricultural research and development systems.

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 is offered extending from residential courses for groups to advanced research opportunities for individuals. These efforts are supported by seminars, publications, and specialized information services.



The CGIAR is an international group of representatives of donor agencies, eminent agricultural scientists, and institutional administrators from developed and developing countries who guide and support its work. The CGIAR receives support from a wide variety of country and institutional members worldwide. Since its foundation in 1971, it has brought together many of the world's leading scientists and agricultural researchers in a unique South-North partnership to reduce poverty and hunger.

The mission of the CGIAR is to promote sustainable agriculture to alleviate poverty and hunger and achieve food security in developing countries. The CGIAR conducts strategic and applied research, with its products being international public goods, and focuses its research agenda on problem-solving through interdisciplinary programs implemented by one or more of its international centers, in collaboration with a full range of partners. Such programs concentrate on increasing productivity, protecting the environment, saving biodiversity, improving policies, and contributing to strengthening agricultural research in developing countries.

The World Bank, the Food and Agriculture Organization of the United Nations (FAO), and the United Nations Development Programme (UNDP) are cosponsors of the CGIAR. The World Bank provides the CGIAR System with a Secretariat in Washington, DC. A Technical Advisory Committee, with its Secretariat at FAO in Rome, assists the System in the development of its research program.