

Morocco and ICARDA

Collaboration since 1977

Ties that Bind



International Center for Agricultural Research
in the Dry Areas

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No. 7
(second, revised and updated version)



International Center for Agricultural Research in the Dry Areas (ICARDA)

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Citation: ICARDA (International Center for Agricultural Research in the Dry Areas). 2005. Morocco and ICARDA: Collaboration since 1977. Ties that Bind, No.7 (second, revised and updated version). ICARDA, Aleppo, Syria, vi+28 pp.

ISBN: 92-9127-165-X

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Donors to the Morocco/ICARDA Program

The Morocco/ICARDA collaborative research program covers such areas as production of cereals and food legumes, integrated crop and livestock systems, water management and capacity building. Several components of the research program have been generously supported by the following donors.

Donor (s)	Collaborative project
IFAD, AFESD, IDRC, CAPRI, FEMISE	Integrated crops and livestock production systems in the low rainfall areas of the Mashreq and Maghreb region
IFAD	West Asia and North Africa Durum Dryland Improvement Network (WANADDIN)
IFAD	Integrated Research and Durum Economics Network (IRDEN)
SDC	Sustainable management of the agro-pastoral resource base in Oujda region
SDC	Sustainable management of the agro-pastoral resource base in Tendara region
SDC	Improving the livelihoods of rural communities and natural recourse management in the mountains of the Maghreb
IDRC	Farmer participation in barley breeding - North Africa

Partners in the Morocco/ICARDA Program

Right from the beginning, the Institut National de la Recherche Agronomique du Maroc (INRA-Morocco) has been ICARDA's key partner. However, the progress made by INRA and ICARDA attracted several other partners to join the collaborative program. They are all listed below.

Ministère de l'Agriculture

Institut National de la Recherche Agronomique du Maroc (INRA-Morocco)

Institut Agronomique et Vétérinaire Hassan II (IAV Hassan II)

Ecole Nationale d'Agriculture de Meknès (ENA Meknès)

Université Qadi Ayyad de Marrakech

Université Hassan I de Settat

Directions Provinciales d'Agricultures (Settat, Safi, Khrouribga, Khemisset, Marrakech, Boulemène, Oujda, Figuig)

Offices Régionaux de Mise en Valeur Agricole: Tadla, Moulouya (ORMVA)

Seed Production and Distribution (SONACOS)

Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT), Mexico

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India

International Food Policy Research Institute (IFPRI), USA

Morocco and ICARDA

Agriculture contributes about 20% of Morocco's gross domestic product (GDP), but this proportion varies widely depending on rainfall. The country has about 8.5 million hectares of good agricultural land, of which nearly 90% is rainfed. However, irrigated areas are expanding rapidly. The agricultural sector in Morocco is expected to ensure food security for the country, enable sustainable livelihoods for farm households and contribute to natural resources conservation.

To achieve the country's objectives for the agricultural sector, Morocco has had fruitful collaboration with ICARDA since 1977. Starting with exchange of germplasm for crop improvement, visits and training in the period 1978-1985, collaborative activities were consolidated by two reviews of the cereals breeding program (1982 and 1986) that led to direct involvement of ICARDA in Morocco.

The posting of cereal and food legume regional scientists in 1986 and a forage specialist from 1988 to the early 1990s gave INRA-Morocco (Institut National de la Recherche Agronomique) the necessary support in planning and ensuring continuity of research.

In the period 1994-2004, the collaborative activities included decentralized breeding, outsourcing, strong involvement in the development of ICARDA strategies (medium- and long-term planning), development and implementation of regional projects, use of Moroccan expertise in West Asia and North Africa (WANA), and technical backstopping by ICARDA scientists to national projects. The Morocco/ICARDA Collaborative Grants Program that started in 2004 is an additional opportunity to strengthen the collaboration.

As a result of the long collaboration, mutual benefits have been obtained through germplasm exchange, screening for pest and disease resistance, natural resources management, training, and exchange of visits and publications.

Highlights of Achievements in Collaborative Research

Genetic Resources

Morocco is an important center of diversity for a number of species including those under the mandate of ICARDA. The collaboration between Morocco and ICARDA in areas related to genetic resources conservation and utilization started in the early 1980s with the acquisition of a large number of cereal and legume accessions tested in Morocco. ICARDA has participated in ten collection missions in Morocco, which have resulted in more than 2900 new accessions that are currently conserved at ICARDA's genebank. Total accessions of Moroccan origin at ICARDA's genebank exceed 4500 (Table 1). Some of this germplasm is already used by the crop improvement and range-land projects at ICARDA.

In 2004, a joint INRA/ICARDA collection mission in the Atlas Mountains was conducted to enrich and expand the genetic resources. The objective was to explore the most remote and inaccessible high altitude areas along the western and eastern escarpment of the high Atlas. A total of 143 accessions were collected. One hundred of these accessions were cereal landraces and their wild relatives while the rest (43 accessions) were food legumes and forage species.



*Joint INRA /
ICARDA collect-
ing mission in
the High Atlas
Mountains
(2004).*

Future collaboration aims at strengthening Morocco's capacity to conserve, characterize and document national genetic resources and agrobiodiversity using the synergies between ICARDA and Morocco. INRA has recently developed appropriate facilities for medium- and long-term conservation which, when operational, could serve as a national center for conservation of genetic resources. It is hoped that the ICARDA/INRA collaboration will help to ensure that the new national genebank at INRA meets international standards for the conservation, collection, documentation, genetic characterization and exploitation of genetic resources.

Table 1. ICARDA accessions of Moroccan origin.

Crop	Number of accessions
<i>Aegilops</i> spp.	66
Barley	780
Bread wheat	298
Durum wheat	321
Primitive wheat	7
Wild <i>Hordeum</i>	10
Faba bean	248
Chickpea	235
Lentil	111
<i>Pisum</i> spp.	47
<i>Vicia</i> spp.	516
Forage and range	817
<i>Trifolium</i> spp.	338
<i>Lathyrus</i> spp.	152
<i>Medicago</i> spp.	637
Total	4583

Germplasm exchange

There has been an on-going flow of genetic materials between ICARDA and Morocco for common key crops. In the period 1984 to 2000, ICARDA provided a total of 10,700 accessions from its genebank to Moroccan scientists for utilization in research and breeding programs.

In addition to the flow of unimproved plant genetic resource accessions, there have been a total of 1979 sets of germplasm nurseries supplied by ICARDA to Morocco since 1986 (Table 2) from the ICARDA breeding programs. This reflects the significant contribution of genetic materials from ICARDA to the Moroccan program.

Table 2. Sets of germplasm nurseries supplied by ICARDA to Moroccan national programs during the period 1986 to 2003.

Crops	Species	Number
Cereals	Barley	316
	Durum wheat	562
	Bread wheat	405
	Sub-total	1283
Food legumes	Chickpea	277
	Lentil	194
	Faba bean	143
	Sub-total	614
Forage legumes	Sub-total	82
	Grand total	1979

Barley

Decentralization of selection and farmer participatory research—that enable development of cultivars for specific adaptation—are effective strategies to tackle the challenge of breeding barley for less favorable environments. The objective is to improve barley productivity under small farmers' conditions by exploiting specific adaptation and by making use of indigenous knowledge in selecting for low-yielding environments.

The collaborative barley breeding program is being implemented through a process of decentralized breeding, involving Moroccan scientists as equal partners. ICARDA ensures continuous flow of genetic variability, and selection is made in the target environments of Morocco. Another important aspect is the participation of farmers in early selection of segregating populations, to enable increased exploitation of specific adaptation. This has resulted in the selection of lines that meet the needs of farmers and are adapted to the specific environments in which they are grown.

In addition to the use of genetic material from ICARDA in the Moroccan breeding program, data from ongoing ICARDA field trials, disease and pest screening nurseries, molecular maps and molecular markers have been important inputs into the barley breeding program. Regular contacts and exchange of visits are also crucial to the success of the program.



*Participatory
barley breeding.*

Durum wheat

The Moroccan durum wheat program has a close bilateral relationship with the joint ICARDA/CIMMYT Durum Wheat Improvement Program based at ICARDA. This program aims at assisting Morocco to enhance durum wheat production by using landraces and wild relatives to identify traits for resistance to drought, cold, heat, disease, insects and viruses that can be incorporated in breeding material, and the development of breeding methodologies that are more efficient and better adapted to the Moroccan environmental conditions.

In the period 1988-1993, 72% of durum varieties released in Morocco were derived from ICARDA/CIMMYT crosses, while 28% had an ICARDA/CIMMYT parent (Table 3). The reverse was true in 1994-1999, reflecting the improved capacity of the Moroccan program in breeding for crop improvement as a result of human resource development efforts undertaken jointly with ICARDA.

Table 3. Cereals varieties released in Morocco based on ICARDA and ICARDA/CIMMYT germplasm since 1984.

Species	Variety and year of selection
Barley	‘Asni’ (1984), ‘Tamellalt’ (1984), ‘Tissa’ (1984), ‘Aglou’ (1988), ‘Tiddas’ (1988), ‘Annoceur’ (1991), ‘Massine’ (1994), ‘Taffa’ (1994), ‘Oussama’ (1995), ‘Amira’ (1996), ‘Igrane’ (1996), ‘Amalou’ (1997), ‘Firdaws’ (1998), ‘Adrar’ (1998)
Durum wheat	‘Marzak’ (1984), ‘Sebou’ (1988), ‘Oum Rabia’ (1988), ‘Tensift’ (1988), ‘Sarif’ (1988), ‘Brachoua’ (1992), ‘Oum Rabia 5’ (1992), ‘Anouar’ (1993), ‘Jawhar’ (1993), ‘Yasmine’ (1993), ‘Ourgh’ (1995), ‘Marjana’ (1996), ‘Tomouh’ (1997), 1793 (2000)
Bread wheat	‘Jouda’ (1984), ‘Marchouch’ (1984), ‘Saba’ (1988), ‘Kanz’ (1988), ‘Achtar’ (1988), ‘Tilila’ (1993), ‘Mehdia’ (1993), ‘Massira’ (1993), ‘Rajae’ (1993), ‘Amal’ (1993), ‘Aguilal’ (1996), ‘Arrehane’ (1996)

Other activities in the ICARDA and Morocco durum wheat improvement program include: international testing of breeding lines, exchange of data on quality, disease resistance, abiotic stress adaptation, molecular marker testing and agronomic characteristics, screening and selection for resistance to insect pests such as Russian wheat aphid and Hessian fly, access to molecular markers, exchange of information, contacts with the international scientific community and training.

A major breakthrough in Moroccan durum improvement

As a result of pioneering research in durum wheat improvement in the Mediterranean region, genetic resistance to the Mediterranean biotypes of the Hessian fly was identified and successfully incorporated into modern durum germplasm for the first time. This achievement was reached after intensive research spanning many years, which has required a great deal of patience and hard work on the part of the research team from INRA in collaboration with ICARDA. Five Hessian fly resistant varieties were released in Morocco in 2003.

This is considered a breakthrough because the Hessian fly is a widespread and devastating pest in the region, causing an estimated US\$ 200 million damage annually. Durum wheat in the Mediterranean region is known for its lack of resistance to the Hessian fly.

This accomplishment provides clear evidence that the sustained and strategic durum research collaboration between INRA and ICARDA—significantly strengthened by the implementation of two regional projects funded by IFAD (WANADDIN and IRDEN)—is bearing fruit.



*Wheat lines
resistant to
Hessian fly and
a susceptible
line in the
middle.*

Spring bread wheat

Morocco is a partner in the ICARDA/CIMMYT spring bread wheat improvement effort in WANA. Moreover, several key activities of interest to the whole region are led by Moroccan researchers and are supported by ICARDA's core budget. These include decentralized entomology research, breeding for Hessian fly, *Septoria* and Russian wheat aphid, and doubled haploid breeding.

As a result of this partnership, Moroccan scientists are collaborating in identifying resistance to Hessian fly and Russian wheat aphid and distributing genetic stocks with sources of resistance to these insect pests to other countries of the region. Several Hessian fly resistant bread wheat varieties have been developed in Morocco and released to farmers.

Chickpea

With the establishment of ICARDA in 1977, a joint research program was started with ICRISAT to enhance the productivity and yield stability of chickpea. In the Mediterranean region, chickpea is traditionally spring sown, and encounters heat and drought stresses towards maturity, which results in low and variable yields. Work under this program soon established that winter sowing could double the yield. However, the winter sown crop is prone to damage by *Ascochyta* blight and cold. Therefore, a breeding program to combine resistance to *Ascochyta* blight and cold tolerance was established.

The chickpea program at ICARDA has carried out international yield trials in collaboration with INRA since 1979. ICARDA has continued to supply germplasm to Morocco for chickpea breeding. An extensive testing program, spanning over a decade, conducted at different agroecological locations enabled the release of several chickpea varieties exhibiting resistance to cold and *Ascochyta* blight (Table 4).



On-farm demonstration of winter chickpea technology.

The relatively small seed size of the varieties adapted to winter sowing is the main reason why, in spite of its proven benefits, the diffusion of winter chickpea technology has been below expectations. Nevertheless, winter sowing has lately been gaining ground in Morocco due to the fact that the newly released varieties have larger seed size and can be mechanically harvested.

Lentil



Newly released varieties of lentil.

The objectives of the collaborative work on lentil breeding are to improve yield potential and stability, drought tolerance/avoidance, disease resistance (rust and *Fusarium*), plant erectness for mechanical harvesting, and seed quality (color, shape, proteins, cooking time, etc.). The Morocco/ICARDA collaboration has led to the release of better-adapted, improved varieties, which all emanated from ICARDA-supplied germplasm. While 'Bakria,' 'Bichette,' 'Hamria' and 'Zaaria' varieties were developed through direct selection from ICARDA nurseries, 'Chaouia' and 'Abda' were selected from Moroccan crosses made from ICARDA and Moroccan germplasm (Table 4).

Faba bean

The collaborative research work on faba bean has concentrated on addressing the constraints imposed by diseases, mainly chocolate spot, *Ascochyta* blight and rust, and by the parasitic weed *Orobanche* spp., as well as on the improvement of the level and stability of yields. Screening of inbred lines produced from the germplasm collection has revealed lines with resistance to chocolate spot and other diseases and pests. Intensive work at ICARDA is underway to combine resistance to diseases, especially chocolate spot, and resistance to *Orobanche*.

Table 4. Food legume varieties released in Morocco based on ICARDA germplasm since 1984.

Species	Variety and year of selection
Chickpea	ILC 482 (1987), ILC 195 (1987), 'Rizki' (1992), 'Douyet' (1992), 'Farihane' (1994), 'Moubarak' (1994), 'Zahor' (1994)
Lentil	'Bakria' (1989), 'Bichette' (2000), 'Hamria' (2000), 'Zaaria' (2004), 'Chaouia' (2004), 'Abda' (2004)
Faba bean	'Deffes' (1985), 'Karabiga' (1985), 'Lobab' (1985), 'Alfia 5' (1986), 'Alfia 17' (1986), 'Alfia 21' (1986)

A continuing contribution in terms of germplasm flows of these promising lines would help in identifying and selecting lines that can be of great importance to Moroccan agriculture. Since the beginning of the collaborative research, several faba bean lines with improved levels of resistance to abiotic and biotic stresses have been released (Table 4).

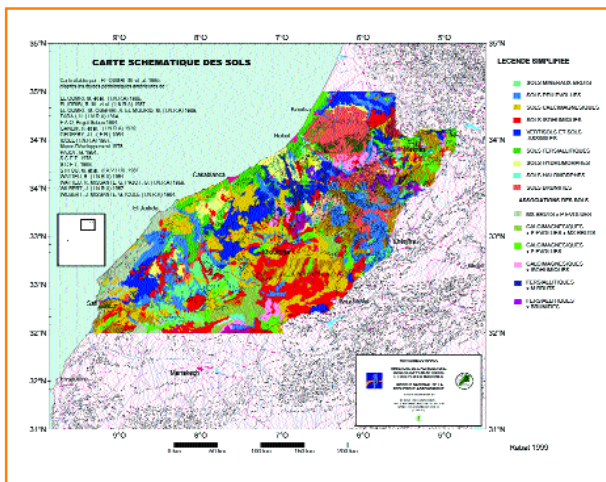
In addition to the traditional areas of collaboration on genetic improvement for enhanced yield potential and for resistance to biotic and abiotic stresses, other activities in the ICARDA/Morocco collaboration are focusing on the interactions between productivity improvement and natural resources management. Examples of such collaborative projects are presented below.

Agroecological Characterization (1989-1994)

In order to identify areas at risk of various kinds and different degrees of moisture deficit that require different agricultural production strategies, ICARDA and Morocco initiated work on agroecological characterization in 1989. The objective was to make available to national institutions tools for the characterization of variable agroecological conditions and their impact on agricultural systems.

This project helped in developing a climatic database; series of maps at scale 1:500,000, including soils, length-of-growing-period, rainfall, temperatures and drought risk; better targeting of technology transfer activities; and better assessment of key constraints to agricul-

tural production. Besides, it played a catalytic role in encouraging multidisciplinary intra- and inter-institutional collaboration and in developing Land Suitability Maps to evaluate the potential of the land for the production of major commodities and to provide a solid base for national land use planning.



in 2000, which led to a methodology for participatory agroecological characterization at community level. In 2000, ICARDA and INRA jointly undertook GIS work leading to an initial agroecological and socioeconomic characterization of the northeastern rangelands and their state of degradation.

Research and Technology Transfer Project on the Production System of Cereals, Food Legumes and Forages (1989-1995)

Promoting the introduction of improved agricultural technologies into the barley-based livestock systems was the backbone of this project. The key themes included improving the production of barley, food legumes and associated pasture, forage and livestock in rainfed semi-arid regions; strengthening the capacity and effectiveness of research through targeted surveys; and the monitoring of on-farm trials.

This project led to the development of improved varieties of barley, lentil, faba bean, and winter chickpea crops; crop management techniques that enable farmers to take full advantage of the new, improved varieties; and potential 'technological packages' for the various commodities.

West Asia and North Africa Dryland Durum Improvement Network (WANADDIN 1997-1999)

The WANADDIN project enabled the establishment of partnerships to strengthen on-going collaborative ICARDA/CIMMYT/NARS durum research in the region. The consolidation of this durum research network has enabled researchers to adequately cover the three main durum agroecological environments encountered in the region. A different research thrust was associated with each environment.

The major objectives of the WANADDIN project were to continue the development of improved germplasm by incorporating new sources of tolerance and/or resistance against the major abiotic and biotic stresses; to increase self-reliance of the NARS in germplasm and associated technology development; and to strengthen activities for the transfer of technology by NARS to dryland durum wheat farmers.

The collaborative research work has contributed to the identification of a number of durum varieties combining tolerance to drought, cold, and terminal stresses, enhanced disease and insect resistance, and better



Screening durum wheat for resistance to stresses.

grain quality. The WANADDIN project was also instrumental in strengthening inter-disciplinary and inter-institutional collaboration among scientists and other stakeholders in durum production and utilization. Through a closer research/farmer/extension interaction, the program succeeded in rejuvenating the process of technology transfer through new modes of communicating with all stakeholders and their effective participation in setting the research agenda.

Mashreq/Maghreb (M&M) Project: The Development of Integrated Crop-Livestock Production Systems in the Low Rainfall Areas of Mashreq/Maghreb (1995-2002)

Problems faced by rural populations living in marginal areas cannot be solved only by improved technologies; and given the increasing population, such problems are likely to worsen unless significant policy and institutional changes occur. The Mashreq/Maghreb project aimed at fostering crop-livestock production systems integration in low rainfall areas using an applied "innovative" community development approach. The project went through two phases and was highly beneficial to integrated rural development, rangelands and herders. The project was conducted as a joint program with IFPRI.

The first phase concentrated on the characterization of the target environment; assessment of the impact of previous projects in the target areas and similar environments; identification of constraints limit-

ing adoption of technical packages; agricultural development, or the wide scale extension and popularization of improved animal production techniques (prophylaxis, animal nutrition strategies, use of fertility hormones, etc.); and feed crops production and use (planting and use of fodder shrubs, mainly *Atriplex* and cactus, making of feed blocks, straw treatment, use of agro-industrial products in animal feeding, etc.).

During the latter phase, the project, which developed valuable technologies, adopted the community approach in order to foster integration with national teams. It evolved from a technology component testing program to one of integrated adaptive research that addressed technical, socioeconomic, cultural, institutional and policy options for the communities in low-rainfall areas.



Integrated crop-livestock production system.

The major achievements of the M&M project were:

- Characterization of the agroecological environments of the selected communities.
- Studying policy and property rights issues.
- Conducting backup research activities to devise technological solutions for the encountered constraints.
- Developing community modeling tools to evaluate the effects of different policy reforms and technologies on community welfare and resource allocation.

- Formulation of a Negotiated Action Plan for each community on the basis of the encountered constraints and available technological options.
- Elaboration of Community Development Plans for each community based on the results of the testing of the options in the Negotiated Action Plan and the results of the agroecological characterization.
- Developing "best-bet" options that would constitute the foundations of the Community Development Plan.

Increasing the Relevance of Breeding to Small Farmers: Farmer Participation and Local Knowledge in Breeding Barley for Specific Adaptation to Dry Areas (1997-2000)

Participatory breeding is a partnership between researchers and farmers. Researchers generate plant populations with useful variability, and farmers select potentially useful lines from among those populations, on their own farms.

The objectives of the project were to develop a participatory barley breeding approach for stress conditions; select improved barley varieties that meet the needs of poor farmers in the marginal rainfed environments of Morocco; and to enhance adoption rates of new varieties through farmers' participation in selection and testing. The key themes were evaluation and selection by farmers of genetic material in the fields, enhanced farmers' contribution to technology development, identification of farmers' selection criteria, opportunities for mutual learning, and a long-term vision for integrated and farmer sensitive barley breeding activities.

The major achievements of this project were:

- Farmers' preference and desired traits in barley varieties determined
- Gender differences in barley grain and spike assessment established
- Farmers and their wives continue to appreciate old barley varieties
- New barley varieties selected due to their resemblance to old six-row barley types

On-Farm Water Husbandry in WANA (1998-2001)

The productivity of rainwater in the drier environments can be substantially increased with appropriate water-harvesting techniques. The successful blending of available indigenous knowledge with modern technology provides options for developing sustainable and environmentally-friendly agricultural production systems.

The project objective was to improve the rainwater-use efficiency in the drier environments through the integration of appropriate water-harvesting techniques and the conjunctive use of rainfall and other available water resources in the agricultural systems in the region.

The key themes of the project were:

- Water use in the prevailing farming systems, the role of indigenous knowledge and end-users' perception and participation
- Water resources and capture potential
- Options for optimum use of water

Major achievements include:

- Information on water resources in Morocco assembled and published
- An inventory of indigenous water-harvesting techniques published
- Methodology for quantification of runoff potential developed
- Suitable water-harvesting systems (modeling and GIS) identified

Sustainable Management of the Agro-Pastoral Resource Base in Oujda, Morocco (2000-2002)

Rangelands in northeastern Morocco are threatened by increasing demographic and economic pressures. The depletion and degradation of the natural resource base is reaching alarming levels. Rehabilitation of these rangelands is a high priority for the Government of Morocco. Activities are on-going to help stop rangeland degradation, increase farmers' income and stop the rural-urban exodus.



Depletion and degradation of the natural resource base in the project area.

Sustainable management of the remaining natural vegetation in the rangelands of Oujda, northeastern Morocco, requires information on and location of the basic resource variables, development of methods for rangeland evaluation, and participatory activities with agro-pastoral communities for better planning and management of rangeland. The current collaborative project is aimed at adding value to the on-going research and development activities for rangeland management in northeastern Morocco.

The major components are: capacity building in rangeland inventory, monitoring and mapping; rangeland resources identification and mapping using GIS/RS; socioeconomic analysis and modelling; strengthening regional cooperation in rangeland management and rehabilitation; development of appropriate rangeland management and restoration procedures in close collaboration with local agro-pastoral communities and respective government authorities; and development of a farm and community-based model to test options for sustainable range and farmland.

Major achievements include:

- Development of human resource capabilities
- Establishment of an operational GIS and Remote Sensing Laboratory
- Identification and mapping of rangeland resources using GIS/RS
- Establishment of a comprehensive database
- Strengthening institutional linkages

CGIAR Systemwide Program on Integrated Pest Management (IPM): Morocco Pilot Site on Integrated Management of Cereal and Legume Pests (2001-2003)

The objective of the project was to develop better models of partnership between farmers, researchers and other stakeholders for the development, evaluation and adoption of IPM approaches, through empowerment of farming communities to manage pests and diseases to increase food security while maintaining the environment using the best of science.

The project aimed at enhancing productivity of cereal and food legume cropping systems in the rainfed areas by the development of sustainable and ecologically-sound IPM systems that reduce crop losses caused by major pests and weeds in such systems, conducting field school days and establishing pilot sites to initiate and orient farmers towards integrated pest management in the cereal and food legume cropping systems.

The major achievements were the establishment of pilot sites; development of an IPM strategy that reduces the use of agricultural chemicals and facilitates sustainable, environment-friendly management practices through a participatory approach; enhancement of farmers' skills and crop management capacity; empowering communities with knowledge; public awareness; and improvement of productivity.



Farmers from IPM pilot sites, scientists and extensionists who participated in an end-of-season workshop.



H.E. the Minister of Agriculture and Rural Development and the Director of INRA visiting one of the IPM pilot sites. A farmer shares his experience with them in 2003.



Field school days and IPM options in cereal food legume systems in the pilot sites.

Optimizing Soil Water Use (1996-2004)

Within the framework of the CGIAR Systemwide Initiative on Soil, Water and Nutrient Management (SWNM) convened by CIAT, four consortia are managing soil erosion, acid soils, soil nutrients, and soil water. The Optimizing Soil Water Use (OSWU) Consortium is convened by ICARDA and ICRISAT, with their national agricultural research system NARS partners including Morocco. The long-term goal of OSWU is sustainable and profitable agricultural production in dry areas based on the optimal use of available water.

The overall objective of the project is to integrate land management techniques that capture and retain rainwater with crop husbandry techniques that maximize productive transpiration and minimize evaporative and drainage losses within water-efficient, productive and sustainable cropping systems, to improve the productivity of cropping systems and welfare of farmers in WANA and Sub-Saharan Africa.

Integrated Research and Durum Economics Network (IRDEN) (2002-2006)

The strategic importance of durum wheat for the well-being of resource-poor smallholder households provides ample justification for supporting efforts to strengthen the research capacity of the NARS in making technology innovations accessible to smallholder farmers in less-favored areas, and to better address their research and development needs in the future.



Farmers, scientists and extensionists in a field day.

The objective is to increase and sustain household durum productivity and economic returns through adoption of low-cost productive technologies and value-added opportunities.



Improved durum varieties, farmers' participation, and seed production and processing.

This collaborative project is expected to:

- Develop improved durum varieties with resistance to drought and of good grain quality.
- Develop efficient technology transfer methods to foster adoption of improved durum varieties and adapted crop management practices and promote sustainable production systems through farmers' participation.
- Develop methods and guidelines to enhance local organizational capacity to engage in seed production, processing, storage and distribution of adapted modern varieties.
- Create understanding of indigenous processing systems and skills and techniques to improve their efficiency and profitability.
- Conduct impact studies showing project-induced benefits.
- Enhance research/development capacity of participating NARS.

Community-based Optimization of the Management of Scarce Water Resources in Agriculture in WANA (2003-2006)

The goal of the project is to improve rural livelihoods by enhancing the productivity of agriculture through efficient and sustainable management of the scarce water resources.

With the full participation of rural communities, the project will develop and test water management options that are economically viable, socially acceptable and environmentally sound to increase water productivity and optimize water use.

The project focuses on specific opportunities for three agroecological systems: supplemental irrigation for the rainfed areas, water harvesting for the drier environments and increased water-use efficiency in fully irrigated areas. Three benchmark sites were established. The benchmark site selected for rainfed agriculture is Morocco.

The objective of the rainfed agriculture benchmark site is to promote the adoption by farming communities of strategies and tested technologies for the optimal conjunctive use of rainwater and scarce water resources in supplemental irrigation systems for improved and sustainable water productivity in rainfed areas.

Sustainable Management of the Agro-Pastoral Resource Base in Tendirara Region (2003-2006)

This collaborative project aims at developing decision-making tools and strengthening the capacities of the NARS in sustainable management of the agro-pastoral base, by building on the methodologies developed and the results obtained in the Oujda project.

The objective is to develop appropriate procedures for range management and rehabilitation with local communities, authorities and other partners. The project is expected to identify degradation indicators, develop vegetal degradation and range cultivation maps (1/100,000), identify water points (location and management, impact on rangeland), develop a database integrating different components and to help the community optimize the use of the agro-pastoral resources.



Human Resource Development

ICARDA has made a significant contribution in building capacity for agricultural research in Morocco by providing training opportunities for scientists and researchers, which continues to be a key element in Morocco/ICARDA collaboration. In the period 1978 to 2004, 824 participants from Morocco benefited from training in short- and long-term training courses, individual degree or non-degree training at ICARDA headquarters, in-country and at regional level. Moreover, support was provided to 11 scientists for degree training (MSc and PhD).

ICARDA has also supported scientists to attend and participate in workshops, conferences, and other scientific activities, and encouraged publications and access to documentation and information.

Through Morocco/ICARDA collaboration, some Moroccan farmers have benefited from visits to ICARDA and regional traveling workshops that enhance farmer/farmer and scientist/farmer interaction.

Prospects for Future Collaboration

Morocco and ICARDA Collaborative Grants Program: New Era of Partnership

There are new opportunities to enhance the Morocco/ICARDA collaboration, especially since the country became a member of the CGIAR. In 2004, the government of Morocco provided US\$ 350,000 through the CGIAR to support five new INRA/ICARDA collaborative research projects including crop improvement, biotechnology, integrated pest management, GIS, the genebank and biodiversity.

The purpose of the program is to develop a cluster of internationally recognized, locally relevant research projects that serve the needs of Morocco's agricultural communities.

This program provides the 'seed' funding needed to attract resources from international donor agencies.

The expected outputs of the program include:

- Enhanced national capacity to develop and utilize knowledge and technology
- Increased research efficiency
- Increased technology transfer efficiency
- Increased extramural funding through jointly prepared and executed integrated projects

The program provides both the framework and the resources needed to initiate focused, fully collaborative, integrated research programs in crop improvement, integrated pest management, agrobiodiversity management and natural resource management.

In a competitive grants program, the following projects were selected for funding in the period 2005-2008:

- Barley improvement in the arid and semi-arid areas of Morocco.
- Development of an integrated natural management framework for sustainable agriculture in central Morocco.
- Integrated pest management in the cereal/food legume cropping system.
- The reinforcement of plant genetic resources conservation and utilization at Settat genebank.

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Acronyms

AFESD	Arab Fund for Economic and Social Development
CAPRI	CGIAR Systemwide Program on Property Rights and Collective Action
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical, Colombia
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo
CWANA	Central and West Asia and North Africa
FEMISE	Euro-Mediterranean Forum of Economic Institutes
GIS	Geographic Information Systems
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDRC	International Development Research Center
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
INRA	Institut National de la Recherche Agronomique
IRDEN	Integrated Research and Durum Economics Network
NARS	National Agricultural Research Systems
SDC	Swiss Agency for Development and Cooperation
WANADDIN	West Asia and North Africa Durum Dryland Improvement Network

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