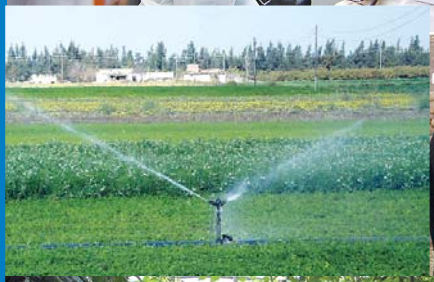
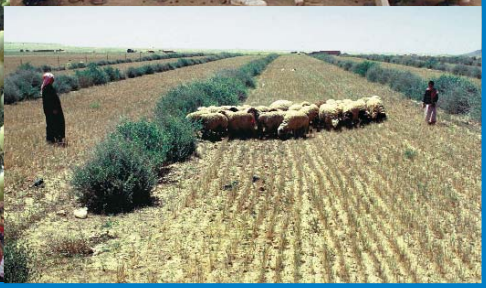
The Arab Fund for Economic and Social Development (AFESD) and ICARDA

Ties That Bind

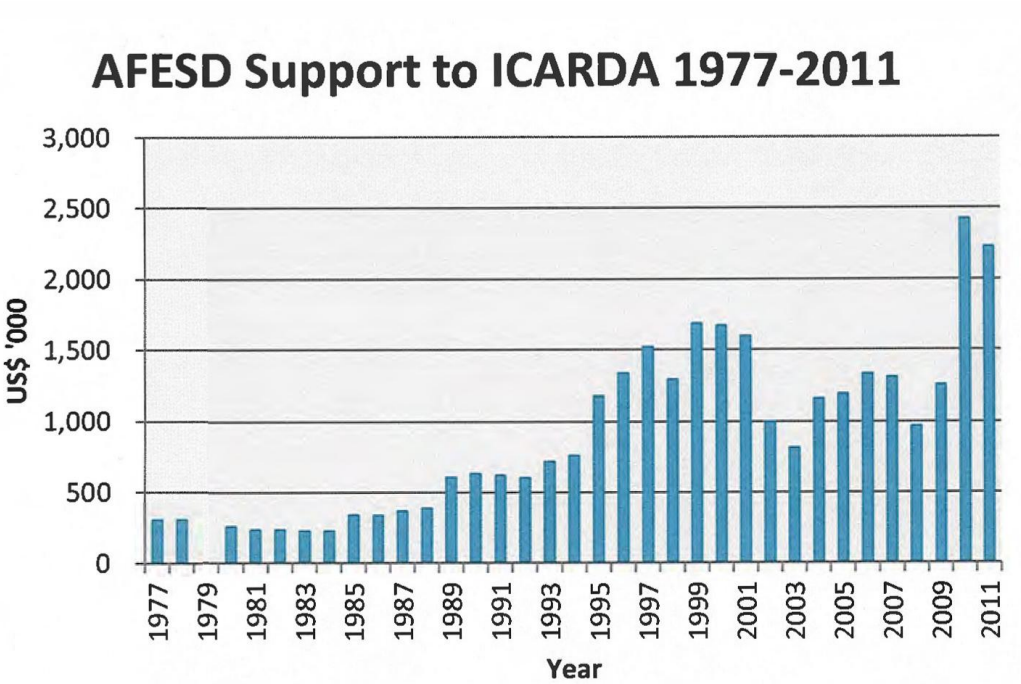




ICARDA

International Center for Agricultural Research in the Dry Areas


AFESD Support to ICARDA 1977-2011
US$ '000
3,000
2,500
2,000
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0
1977
1979
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Year

Dedicated to the

Arab Fund
for Economic and Social Development
(AFESD)

Board of Directors
and
H.E. Mr. Abdulatif Y. Al-Hamad
Director General and Chairman
of the Board of Directors

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Ties that Bind

No. 24

International Center for Agricultural Research
in the Dry Areas

Contents

Foreword

The Arab Fund for Economic and Social Development (AFESD) and the International Center for Agricultural Research in the Dry Areas (ICARDA) share a common mission of alleviating poverty and promoting economic and social development in developing countries. The Arab Fund has, therefore, been a supporter of ICARDA since the Center's inception in 1977, and has continued to support its research and capacity building activities, particularly in Arab countries of the West Asia and North Africa (WANA) region. Besides its financial support over the past 30 years, the Arab Fund has also contributed to the governance of the Center through its representation on the Board of Trustees of ICARDA. The late Dr Mervat Badawy served as a Board member from 1992 to 1997, and Dr Isamil El-Zabri from 1998 to 2003, and both of them actively contributed to the growth and development of ICARDA.

The AFESD assists the economic and social development of Arab countries through (1) financing development projects, with preference given to overall Arab development and to joint Arab projects; (2) encouraging the investment of private and public funds in Arab projects; and (3) providing technical assistance services for Arab economic and social development. ICARDA meets these criteria through its research-for-development and capacity building projects in Arab countries.

With the AFESD's highly valued support, ICARDA has successfully implemented a number of collaborative projects to build the capacity of human resources and national institutions in advanced science and technology (S&T). This is in recognition of the fact that national programs can only be effective as equal partners if they have the required expertise and physical facilities to address the multiple challenges of agriculture in the dry areas of the region. In addition, these projects have developed and delivered new technologies and options to improve the livelihoods of resource-poor farmers in the region, thus contributing to the economic and social development in the Arab world.

THE ARAB FUND AND ICARDA

ICARDA is grateful to the Board of Directors and the Chairman of the Board and Director General of AFESD, H.E. Mr. Abdulatif Y. Al-Hamad, for their unwavering support. Mr. Abdulatif Y. Al-Hamad's personal interest in the development and progress of the Arab world has been reflected in supporting ICARDA as a Center of Excellence in research and capacity building to contribute to the mission of the Arab Fund.

This booklet briefly describes the achievements and impacts of the various research-for-development and training projects financially supported by the Arab Fund, and implemented by ICARDA and its national partners throughout the Arab world.

Mahmoud Solh
Director General
ICARDA

The Arab Fund for Economic and Social Development (AFESD) and ICARDA

Common Mission

The Arab world has the distinction of being the birthplace of agriculture and a treasure trove of agrobiodiversity. Many of the food, feed, vegetable and fruit crops, which provide over 40% of the world's food, originated here and their wild relatives are found in the region even today. Not too long ago, the region was famous as the breadbasket of the old world, but is falling behind in protecting its food security and, indeed, is turning into one of the largest food importers in the world. Agriculture in the region faces multiple challenges. These include high population growth, rural to urban migration, acute water scarcity, land degradation, loss of biodiversity, climate change, diversity of agroecologies, weak research capacity and infrastructure,

AFESD funding has played a key role in efforts by ICARDA and its partners to strengthen national research capacity across the Arab world.

inadequate investment in agricultural research, and weak information technology infrastructure and expertise. Poverty in the region is widespread--one in every five Arabs still lives on US$2 a day. This fact is masked by the oil-rich countries, which account for only 5% of the region's population.

The mission of the Arab Fund for Economic and Social Development (AFESD) is to promote economic and social development in Arab countries. ICARDA's mission is to promote better

livelihoods in the dry areas through its research-for-development programs globally. Since the Arab countries constitute a major proportion of the dry areas, both AFESD and ICARDA, thus, have a common mission for the Arab world. The AFESD has, therefore, been a strong supporter of ICARDA since the inception of the Center in 1977.

Projects Supported by the Arab Fund

1. Capacity Building of Human Resources and Institutions

Since ICARDA's inception, AFESD has been providing financial support for training programs for human resource development and institutional strengthening. Under these programs, scientists and students from Arab countries are provided advanced training in various technologies at ICARDA.

Over the last 35 years, some 18,726 researchers from over 100 countries have benefited from ICARDA training programs. Of these, over 12,355 were researchers from Arab countries, who participated in long-term, short-term and individual non-degree courses, and 448 young Arab researchers who have completed or are working towards MSc or PhD degrees. Several participants in ICARDA training programs supported by the Arab Fund now occupy leading positions in their respective countries, as scientists, heads of institutions, and national decision-makers. They continue to play a key role in enhancing the contribution of research to agricultural development throughout the Arab world.

ICARDA training categories supported by AFESD

- **Long-term courses.** These 4- to 18-week courses are held at ICARDA headquarters during the cropping season from March to June. They are designed for researchers and technicians currently working in national agricultural research programs. Course participants should have a BSc in agriculture; however, candidates with a high school diploma and some research experience are also considered.
- **Specialized short courses.** These 1- to 3-week intensive courses focus on specialized problems or topics of interest to national agricultural research programs, and are conducted at ICARDA headquarters or

at other sites. Specialized short courses can be regional, sub-regional or in-country.

- **Research fellowship.** This non-degree training program is offered to junior researchers. The program is tailored to meet individual needs and may range from one week to one year.
- **Senior research fellowship.** This program is designed for senior researchers from national agricultural research programs, who typically have an MSc or BSc and several years of experience. They work at ICARDA headquarters or elsewhere in the region with ICARDA scientists for a few weeks to a few months on non-degree specialized training.
- **Graduate research training.** A candidate registered for an MSc or PhD at a university can conduct part or all of his/her thesis research at ICARDA. The research topics must relate to ICARDA's mandate and have direct relevance to the candidate's national agricultural research program. Graduate research students at ICARDA are supervised by a senior scientist who acts as a member of the candidate's advisory committee.

Participation from Arab countries in training programs

Tables 1, 2 and 3 show the scope of ICARDA training programs supported by AFESD, and the wide-ranging participation from different countries in the region.

Table 1. Number of participants from Arab countries in the ICARDA training categories, supported by AFESD, 1978 to 2012.

Training category	No. of participants
Long-term courses	483
Specialized short courses	9700
Research fellowships	1682
Senior research fellowships	22
Graduate research training	448
Total	**12335**

Table 2. Participants from Arab countries in ICARDA training programs, supported by AFESD, 1978 to 2012

Year	Headquarters training courses			Non-headquarters courses	Total
	Group training courses	Individual non-degree	Individual degree*	Subregional & regional in-country training courses	
1978	21				**21**
1979	43				**43**
1980	33	02	1		**36**
1981	23	04	2	14	**43**
1982	48	09	6	41	**104**
1983	69	09	6	35	**119**
1984	119	17	6	20	**162**
1985	78	28	3	56	**165**
1986	90	56	14	115	**275**
1987	91	57	7	67	**222**
1988	93	49	10	269	**421**
1989	128	100	11	114	**353**
1990	171	76	6	252	**505**
1991	192	86	11	250	**539**
1992	143	100	18	295	**556**
1993	104	72	7	335	**518**
1994	92	77	17	205	**391**
1995	69	69	19	332	**489**
1996	118	74	18	268	**478**
1997	115	82	16	299	**512**
1998	145	82	13	446	**686**
1999	128	73	20	298	**519**
2000	95	79	16	181	**371**
2001	73	54	22	140	**289**
2002	88	77	12	80	**257**
2003	112	47	22	96	**250**
2004	100	41	17	79	**237**
2005	279	43	29	222	**573**
2006	135	17	25	112	**281**
2007	233	20	12	126	**391**
2008	198	16	14	96	**324**
2009	246	58	18	110	**450**
2010	281	68	20	123	**492**
2011	182	35	15	388	**620**
2012		27	15	566	**608**
Total	**4153**	**1704**	**448**	**6030**	**12335**

* The numbers under individual non-degree in each year requested newly admitted students in the specific year, and not the total number of individual degree students enrolled with ICARDA

Table 3. Arab countries represented in ICARDA training programs supported by AFESD,1978 to 2012

Country	Headquarters training courses			Non-headquarters courses	Total
	Group training courses	Individual non-degree	Individual degree	Subregional & regional in-country training courses	
Algeria	171	77	11	389	**648**
Bahrain	7			36	**43**
Djibouti	1				**1**
Egypt	455	90	12	1056	**1613**
Iraq	621	112	15	503	**1251**
Jordan	253	81	53	265	**652**
Kuwai	11	1	-	49	**61**
Lebanon	176	68	18	326	**588**
Libya	122	56		235	**454**
Mauritania	11	5		18	**35**
Morocco	182	100	26	690	**1014**
Palestine	31	20	1	75	**167**
Qatar	11	1	-	95	**107**
Saudi Arabia	28	4	-	104	**136**
Somalia	11		2	2	**15**
Oman	64	15		215	**294**
Sudan	228	120	42	242	**626**
Syria	1208	798	236	982	**3224**†
Tunisia	232	91	10	346	**679**
Yemen	205	63	21	335	**624**
U.A.E	3	2	1	67	**104**
Total	**41253**	**1704**	**448**	**6030**	**12335**

† Higher number because training costs for local participants are low.

Thematic areas of training offered by ICARDA

*Crop improvement (2907)**

- Crop genetic improvement, including participatory plant breeding, pathology, entomology and integrated pest management

* No. of persons trained

- Genotype x Environment interaction
- On-farm trials and demonstrations
- Technology transfer methods and approaches

Agronomy and crop management (722)*

- Physiology, stress tolerance
- Biological nitrogen fixation, inoculant production
- Mechanization

Genetic resources conservation and utilization (572)*

- Agro-biodiversity conservation (*in situ* and *ex situ*), germplasm collection and maintenance, utilization of wild species
- Molecular characterization of biodiversity
- Genetic resources policies and rights issues

Biotechnology applications (581)*

- Molecular markers, electrophoresis, fingerprinting
- *In-vitro* techniques, genetic transformation
- Biosafety and detection of GMOs

Seed production systems (1949)*

- Seed production, processing and storage, seed health testing, certification standards
- Seed policy and regulatory reforms
- Development and management of small-scale seed enterprises and community-based production

Water and other natural resources management (1892)*

- Water management (including water-use efficiency, water harvesting, irrigation methods, use of non-conventional water resources)
- Rangeland management
- Participatory Integrated Natural Resources Management
- Soil fertility, degradation: measurement and control
- Farm resource management (e.g. rotations, fallow replacement)
- Desertification, drought preparedness and mitigation
- Hydrology
- Soil and plant analysis
- Livelihood characterization and impact assessment
- Farm surveys: design, implementation and data analysis
- Gender issues

* No. of persons trained

Livestock production (928)*

- Livestock nutrition and management (including animal health, alternative feed resources, crop-livestock integration)
- Forage/pasture crops: breeding, management, quality
- Livestock market studies

Experimental station management (231)*

- Operations management for experimental trials

Protected agriculture (171)*

- Greenhouse fabrication, installation and maintenance
- Greenhouse crop production, hydroponics, fertigation
- Integrated management of greenhouses

Statistics and other advanced tools (1006)*

- Biometrical tools, specialized techniques and software for data analysis
- Design and implementation of field experiments
- Agroclimatic analysis, agroecological characterization
- GIS techniques, use of satellite imagery
- Crop modeling
- Statistical modeling of spatial variability
- Sampling methods

Socio-economics (839)*

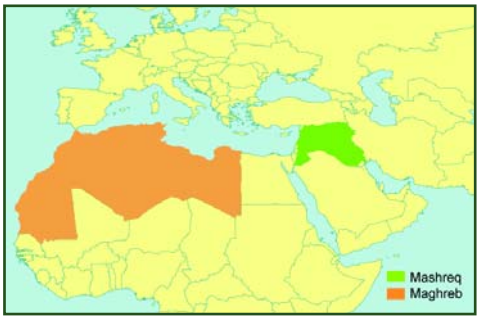
- Technology adoption and impact assessment
- Livelihood characterization and poverty analysis
- Farm survey techniques and data analysis, participatory research methods, community approach and characterization
- Economics of production systems and water resources, economics of seed production, seed policy and regulator reforms

Communication and information technology (537)*

- Use of information technology and 'Expert Systems'
- Scientific writing and presentation
- Development of project proposals
- Multi-media use in rural communication
- Library management, use of web-based tools and databases
- Production and management of electronic documents and databases

* No. of persons trained

2. Mashreq and Maghreb Project: Development of Integrated Crop/Livestock Production Systems



The Mashreq and Maghreb regions, focus of a multi-country, multi-partner initiative supported by AFESD and led by ICARDA.

Initiated in 1995 and supported by AFESD, IFAD and other donors, the Mashreq and Maghreb (M&M) Project is an adaptive research program for the development of integrated crop/livestock production in low-rainfall areas. The project is targeted towards resource-poor communities in agropastoral systems of the dry areas of the WANA region. It covers two sub-regions: the Mashreq sub-region, including Iraq, Jordan, Lebanon and Syria; and the Maghreb sub-region, including Algeria, Libya, Morocco and Tunisia.

The objective of the M&M Project is to generate opportunities that empower local communities and their institutions, for better management of common resources, and improvement of livestock productivity to enhance rural incomes and improve livelihoods. It contributes directly to the development of regional and national strategies by providing options for interventions in the dry areas.

The project addresses problems from technical, socioeconomic, cultural, and institutional and policy perspectives, with the full participation of the intended beneficiaries and other stakeholders. It supports the development strategy of selected communities by addressing needs identified by the communities themselves.

The project is implemented jointly by the eight national programs, ICARDA, and the International Food Policy Research Institute (IFPRI).

Increasing on-farm feed production

New barley cultivars were selected by farmers and grown in demonstration fields, such as Rihane, Zenbaka and Tadmor in Iraq; Roho,

Rihane, an improved barley variety, offers significant advantages in feed/forage production.

Arabi Abiad and SLB-6 in Jordan; Furat in Syria; and Barjouj and ACSAD 176 in Libya. Growing forage legumes in rotation with barley improved soil fertility and sustainability of the production system.

Enhancing small-ruminant productivity

The project research showed how production cost of animal feed could be reduced by reducing the use of concentrates, and relying more on on-farm feed production and other alternative feed sources that are cheap and locally available. Using vetch as supplementary feed substituted 50% of the traditional concentrate feed without reducing the performance of ewes during pregnancy and lactation.

Advancing the breeding age of yearling Awassi ewes through feed block supplementation resulted in 82% of the yearlings being successfully mated at the age of 12–13 months compared with the usual 16–18 months.

In Jordan, early weaning of lambs resulted in 14 kg of

Improved husbandry methods are helping to improve livestock productivity and growth rates while reducing feeding costs.

additional milk per head, creating extra income for farmers. Similar results were achieved in Syria.

The project has developed a genetic improvement strategy to improve small-ruminant productivity at the community level. Improved rams were introduced in order to reverse inbreeding and improve growth rates.

Better animal nutrition increases milk output, directly impacting on the incomes of poor households.

Providing alternative feed resources

Nutrition of small ruminants was improved by using alternative feed sources, and feed supplementation was an important objective of the program. Also, spineless cactus has been introduced as animal feed in several countries that face shortages of natural vegetation.

Feed blocks: The M&M Project revived interest in feed block technology and promoted it among sheep owners over vast semi-arid areas of WANA in order to improve animal performance and reduce feeding costs. In Iraq, more than 20 feed block manufacturing plants producing 37,000 tons had been established by the private sector by 1999. In Jordan, three manufacturing units were imported from Iraq and two were locally fabricated in 1999. This number increased to nine units in 2000, which were producing 55 tons of feed blocks by June 2000. In Tunisia, feed blocks are manufactured nationwide, while in Morocco it was started in cooperation with an NGO working in the project area. The research and development

Feed block technology introduced by the project has been widely adopted in several countries.

Large-scale production of feed blocks is helping small-scale farmers to reduce feed costs and improve livestock productivity.

association has funded a community-based feed block manufacturing unit in Sidi Boumehdi. Algeria has moved faster; feed blocks were rapidly adopted and local investors built a feed block production unit. Banks around the project communities have shown interest in financing this activity. Egypt, Saudi Arabia, Eritrea and Turkey, which are not participating in the M&M project, have shown interest in the technology.

Cactus: Cactus (*Opuntia* spp.) is well adapted to the harsh environments of the dry areas and is a valuable feed source, particularly when other sources are unavailable. Cactus has long been planted in the Maghreb countries (Tunisia and Algeria) and used as animal feed. However, in the Mashreq countries, it is not common, and is grown in limited areas for its fruits. The second phase of the project has had a strong multiplier effect on cactus plantation by transferring the experience of the Maghreb countries to the Mashreq countries and to

Cactus plantations are expanding rapidly in North Africa, thanks to efforts by ICARDA and its partners.

Libya. Jordan has started a national project to promote spineless cactus production, Syria has begun some activities in spineless cactus plantation.

Cactus, along with other fodder shrubs, was also used in rangeland rehabilitation. Where water harvesting and utilization techniques were applied, crop productivity substantially increased.

Sheep feeding on harvested cactus – a low-cost, nutritious supplement.

Alley-cropping: Alley-cropping is an agro-forestry practice in which perennial crops (cactus, *Atriplex*) are grown simultaneously with a grain crop. In Tunisia the new government strategy calls for extending the technology to 44,000 hectares.

A bio-economic model has been developed to identify the conditions needed to support the development of this system in agropastoral communities in North Africa. Scenarios relating to different types of institutional support, either monetary or informational, were analyzed. The results revealed larger cash flows, more livestock and less cereal cultivation on marginal land.

Alley-cropping offers substantial advantages to both crop and livestock producers, as documented by impact studies in Morocco and Tunisia.

Fostering an enabling policy and institutional environment

Community models were developed to evaluate the effects of different policy reforms and technologies on community welfare and resource allocation. This included an innovative decision making tool for conducting *ex-ante* analyses of the potential effects of technical, policy, and institutional options. The decision support tool is a bio-economic model designed to represent farmers, herders, and household

Farmer participation is key – and has helped ensure strong community support for project activities.

behavior. It indicates the probable way that different members of a community will respond to the introduction of a new technology, resource management strategy or policy reform, and the effect of these responses on productivity, incomes, income distribution, and the sustainability of the natural resource base. The tool links activities at different scales, from macroeconomic reforms to the behavioral response of farmers at the community level. This is one of the key instruments used in the Integrated Natural Resource Management approach.

Community modeling, along with multi-market and public policy discussions, has resulted in a shift from emergency relief efforts by governments, towards more investment in feed blocks, improved rams and increased fertility, more drought-tolerant plants, and other technologies to improve livestock production.

Enhancing capacity building and networking in crops/ rangelands/livestock production systems

The M&M project promoted a human resources development approach for building the capacity of local populations to plan and manage local development. Over 14,000 farmers, technical staff and extension workers participated in different activities in Phase II of the project (Table 4).

Table 4. Participation of farmers in M&M Phase II activities, by country

	Algeria	Iraq	Jordan	Lebanon	Libya	Morocco	Syria	Tunisia	Total	%
Field days	350	283	425	200	752	650	3890	255	6805	47
Workshops	120	644	452	105	12	583	339	150	2405	17
Training	165	178	428	80	42	820	159	450	2322	16
Household surveys	120	100	882	200	47	500	450	558	2857	20
Total	**755**	**1205**	**2187**	**585**	**853**	**2553**	**4838**	**1413**	**14389**	**100**

In addition, the program has developed mechanisms to enhance regional activities and exchange of expertise and experiences. These have included regional/subregional workshops, seminars and training; farmers' traveling workshops; transfer of technologies and management practices between communities and subregions; exchange of expertise between countries; and backstopping from ICARDA and IFPRI.

Empowering and involving women in community development

The M&M Project has raised awareness among researchers, policy makers and the development community about the participation of women in sustainable rural poverty alleviation. The program initiated pilot activities aimed at assessing women's role in food production and household food security.

The M&M Project makes special efforts to involve women in planning and implementation – ensuring they reap the benefits as well.

The work on the role of women in development was implemented in four countries: Jordan, Morocco, Syria and Tunisia. The research focused on identification and description of the roles of men and women in agricultural production; and production-related constraints.

Studies under the project show that women are not necessarily confined to domestic and para-domestic activities. Depending on socio-cultural factors in each country, women may have access to agricultural and/or pastoral land; and many of them have demonstrated their abilities in farming and livestock herding and production.

3. ARABIAN PENINSULA REGIONAL PROGRAM ON SUSTAINABLE AGRICULTURAL DEVELOPMENT

The Arabian Peninsula is a water-stressed region with extreme aridity and limited renewable water sources, and corresponding impacts on lives and livelihoods. In 1988, ICARDA initiated a special program for the Arabian Peninsula aimed at identifying and introducing cultivars that suited the climatic conditions, and sustainable methods to manage natural resources. The AFESD has funded three phases of ICARDA's Arabian Peninsula Regional Program, involving the following activities:

- **Strengthening barley and wheat research and training in the Arabian Peninsula**. The project concentrated primarily on identifying cultivars of ICARDA's mandate crops that could withstand the environmental constraints in the Arabian Peninsula. The most important constraints are the abiotic stresses associated with high temperature, water scarcity, and salinity. Although this project was aimed primarily at improving wheat and barley production in the Peninsula,

it has served an important function in identifying priority needs and current gaps in agricultural research.

- **Strengthening agricultural research and human resource development in the Arabian Peninsula**. This project covers rangelands, water, and protected agriculture, in response to the collective priorities determined by the seven countries of the Arabian Peninsula. In addition, work on agroecological characterization is also emphasized as it has a great impact on all these three themes.
- **Sustainable management of natural resources and improvement of major production systems of the Arabian Peninsula**. This project focuses on sustainable management of natural resources and improvement of major production systems, with an emphasis on applied research on water resources management, forage/range management, protected agriculture, and agroecological characterization.

Indigenous forage crops conserved in the Arabian Peninsula

Large areas of the Arabian Peninsula suffer from desertification, to varying degrees. The primary cause is overgrazing – which reduces the productivity and the nutritional (forage) value of the ecosystem. Because rangelands do not provide sufficient forage, farmers extract groundwater to produce irrigated forage – further exacerbating water shortages in this very dry region.

ICARDA's Arabian Peninsula Regional Program is promoting indigenous forage species that can improve livestock nutrition and

Farmers identify useful forage species at a meeting with scientists in Sharjah.

Indigenous forage species in Oman offer higher production, better adaptation, and lower water consumption.

simultaneously rehabilitate degraded rangelands. Collection missions have been carried out in different countries in the Peninsula. Several of the species collected have high water-use efficiency and great potential value as forage crops.

The new forage Buffel grass or Leybid (*Cenchrus ciliaris*) is fast becoming popular with farmers in UAE's Central Agricultural Region. To cope with the increasing demand, ICARDA and the Ministry of Agriculture are using direct seeding, rather than planting seedlings. This method requires frequent irrigation and good weed/pest control. However, once established, Leybid can be harvested ten times per year, with an average dry matter yield of up to 20 t/ha.

The water-use efficiency of Leybid (quantity of water to produce 1 kg of dry matter) is 25 to 50% higher than Rhodes grass, a popularly used forage. The Dhaid Research Station has intensified seed production of Leybid and Da'e (*Lasiurus scindicus*); around 1.7 tons were produced. The station's seed unit – jointly established in 2002 by ICARDA and the UAE Ministry – is also producing several other indigenous forages.

Similarly, in Saudi Arabia, ICARDA and the Ministry of Agriculture are establishing a seed technology unit to enhance seed production

of native range plants, particularly shrubs. A seed scarifier and a seed cleaner have been installed, and additional equipment for the unit is being procured.

Cactus management training at Rumais Station, Oman. The project has helped create a cadre of trained researchers and extension staff throughout the Arabian Peninsula.

In Oman, varieties of spineless cactus introduced from Tunisia in 2004, are now well established at the Rumais Research Station; and will be distributed to other countries in the Peninsula. Leybid seed is being multiplied at the Livestock Research Center in Rumais, for an ongoing program to re-seed degraded rangelands. Sixteen sites (0.25 ha each) were seeded in December 2004, and are being monitored.

In Yemen, rangeland rehabilitation efforts in the Wallan community are continuing, using a combination of indigenous shrubs and water harvesting techniques. Pasture productivity has increased by 260% in 3 years – from 0.5 t/ha in 2003 to 1.8 t/ha in 2005.

Enhancing water-use efficiency through soilless production systems for high-value crops

In much of the Arabian Peninsula, traditional agriculture is simply not viable. Given the harsh weather conditions, acute scarcity of water

Producing high-quality cucumber using hydroponics at a private farm in Oman.

and lack of good arable land, crops are likely to fail in most years. One alternative is to produce high-quality cash crops using soilless culture or hydroponics – the focus of a collaborative project by ICARDA and the NARS of seven countries in the Peninsula.

Hydroponic strawberry production at Rumais Research Station in Oman.

Hydroponics allows growers to tightly control the environment, and schedule their harvests precisely, thus improving yield, quality and price. One key objective is to maximize quality and quantity of production per unit of water. Since the year 2000, ICARDA has conducted several joint studies in collaboration with research centers in Oman, Saudi Arabia, Bahrain and Kuwait.

These studies have examined different hydroponics systems at research centers in order to identify the best options (which crop, what management technique) for each region. Best-bet options identified at research centers are now being transferred to pilot growers for further on-farm studies. Growers have found that, as on research stations, hydroponics results in high water-use efficiency, large savings in fertilizers and water, increased production per unit area, better quality produce, earlier-maturing and more uniform plants, compared to production on soil. It also eliminates the need for costly operations such as sterilization, seed-bed preparation and weed control. Productivity per unit of water increased by over 70% in protected agriculture, compared to normal soil-based systems.

The vertical soilless production technique for strawberry, which increases production, reduces cost and saves water, has been studied for four years in Oman and Kuwait. A study in Kuwait showed that hydroponics cut production costs by 60% compared to soilbed cultivation.

Protected agriculture: saving water, increasing farmers' incomes

ICARDA and its NARS partners have successfully developed and promoted 'protected agriculture' systems, i.e. cultivation of cash crops in low-cost greenhouses. These technologies, developed and refined in

the Arabian Peninsula, have also been successfully used by ICARDA in countries like Afghanistan and Pakistan.

In Yemen, a pilot project in collaboration with the Agricultural Research and Extension Authority has introduced new technologies for small-scale irrigation (bubblers) and protected horticulture. The new technologies are being simultaneously tested and demonstrated at a greenhouse, and scaled out to pilot farmers.

Greenhouse cucumbers in Yemen: not only profitable but also environment-friendly.

This is part of efforts to increase the incomes of poor farmers in Yemen's mountain terraces – thus helping to maintain these vital areas. A number of greenhouses have been constructed in farmers' fields at different locations, and farmers familiarized with drip irrigation methods. Using this intensive production system, poor Yemeni farmers are now producing high-quality vegetable crops with minimal water. Farm incomes, as well as production per unit of water and area, have increased significantly. For example, average income per square meter of land, from cucumber cultivation, was 51.5 Yemeni Rials from open field production, versus 276.6 Rials from a greenhouse. A cost-benefit analysis has shown that the total cost of a greenhouse can be recovered within three seasons.

Protected agriculture technology is being complemented by the

Protected agriculture, using integrated production methods, has substantially improved farmers' incomes in Yemen.

Greenhouse production of high-value vegetables such as tomatoes is helping to increase the incomes of poor farmers in the Arabian Peninsula.

development of Integrated Production and Pest Management (IPPM) methods. IPPM techniques have been adopted by growers in several countries in the Arabian Peninsula, and NARS continue to play a key role in their promotion. Use of IPPM reduces the use (and thus the harmful health and environmental effects) of chemicals to control pests and diseases, and thus greatly increases farmers' profits. In IPPM, for example, humidity is kept low and irrigation water is used sparingly. Use of resistant varieties, good management and regular monitoring ensure that pests and diseases are cost-effectively controlled. In Yemen, for example, IPPM methods were tested on cucumbers grown in plastic houses with drip irrigation. This approach substantially improved water-use efficiency (irrigation efficiency was as high as 93%), yield and profitability, and reduced pesticide use by two-thirds. Greenhouse cucumber crops were sprayed only twice with a safe chemical, compared with the 26 applications typical in greenhouses without IPPM.

Assessing genetic relationships among date palm varieties

Until 1991, Iraq was the leading producer of dates and had the world's largest date 'forest', on the Fao Peninsula. However, many date palms were destroyed as a result of war and, later, drainage of marshes. These losses threaten to erode genetic diversity in this economically and culturally important crop.

Little research has been done to characterize date palm germplasm. Such characterization is important, however, to identify varieties, breed improved cultivars, conserve genetic diversity; and subsequently, utilize this diversity in breeding programs.

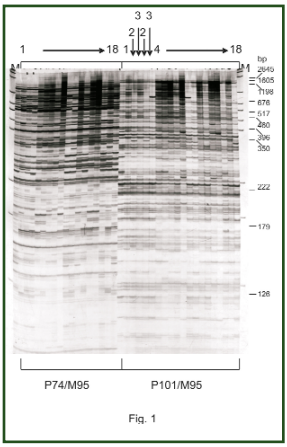


Fig. 1

AFLP banding patterns of 18 date palm varieties from Iraq. Primer combinations and fragment size of molecular markers are also indicated.

As a spin-off benefit from a training program supported by AFESD, ICARDA, in collaboration with its partners, is developing molecular markers to help characterize date palm varieties. These activities are supported by the Gulf Cooperation Council (GCC)

In the initial phase, research focused on 18 reference varieties collected from the Ministry of Agriculture farm at Al-Latifia, Iraq. Researchers extracted DNA from the young leaves of these varieties, and used amplified fragment length polymorphism (AFLP) markers to characterize the varieties and estimate their genetic relationships. These studies have developed molecular methods to uniquely identify each of these varieties; and clarified – for the first time – the nature of genetic relationships between them. They have also laid the foundation for similar studies that will use molecular markers to study and characterize the region's date palm genetic resources.

Enhanced NARS capacity and networks in Arabian Peninsula countries

The capacity of research scientists to design and conduct research experiments has improved significantly.

Another major achievement of the APRP has been the development of networking among national programs and scientists. The bringing together of scientists, researchers and team leaders of member countries in annual meetings and workshops, as well as participation in training courses, have contributed significantly to the dissemination of knowledge and to the building of national research capacities.

4. COPING WITH INCREASED WATER SCARCITY IN AGRICULTURE IN WEST ASIA AND NORTH AFRICA

Water scarcity has reached alarming proportions in the WANA region. In 2004, ICARDA initiated this project with support from the Arab Fund, to find ways to increase the adoption of improved technologies, and thus improve water productivity and livelihoods, in environments where water is scarce. The project targeted three environments: marginal rangelands (*badia*), rainfed cropping systems, and irrigated areas. In each environment, a pilot research site was established to test and demonstrate new technologies; and two or more 'satellite' sites for complementarities and wider dissemination. The key pilot sites are in Jordan, Morocco and Egypt for *badia*, rainfed and irrigated systems respectively. Research focused on the key water-related issues (or opportunities) in each environment.

Water benchmark sites in WANA

Badia benchmark site

The Benchmarks Project has helped introduce a new concept – mechanized microcatchment water harvesting – that is now being widely scaled out in *badia* areas in Jordan and Syria. The Vallerani system is a spe-

The Vallerani system builds furrows or basins that trap runoff water, allowing rapid establishment of fodder shrubs.

cially designed tractor-drawn plow that mechanizes the construction of semicircular water-harvesting bunds. The plow creates, simultaneously, a ridge to stop runoff water, and a furrow or basin to hold the water. This does two things: prevents water erosion, and allows farmers to channel runoff water (which would otherwise be wasted) to grow fodder shrubs and fruit trees, or rehabilitate natural vegetation.

The willingness of *badia* farmers to adopt these technologies has tripled since the Benchmark Project began. The impact of this large-scale intervention in the *badia* has attracted decision makers to visit and monitor the communities' positive involvement.

Rainfed benchmark site

On-farm trials in the Tadla area of Morocco have shown that wheat yields increased by 30% by applying 50 mm of supplemental irrigation to early-sown crops. The project is also promoting supplemental irrigation in another context. Rainfed crops in the Mediterranean region are often stressed in late spring. Project trials have shown that limited supplemental irrigation at this time substantially increases yield and water productivity.

Judicious use of supplemental irrigation is helping to increase yields as well as water-use efficiency in Morocco.

Policy changes are needed for supplemental irrigation. The Office Regionale de Mise en Valeur Agricole de Tadla (ORMVAT), the agency responsible for water allocation in Tadla, is a partner in the Water Benchmarks Project and is participating in the analysis to identify how to maximize the returns from the limited water available. Reallocation of surface and groundwater on the basis of this analysis will not only increase water productivity but also help in drought preparedness and mitigation.

Irrigated benchmark site

The raised-bed system is becoming popular in Egypt, with farmers benefiting from higher yields and improved management.

Most farmers in the benchmark communities have already adopted the new Raised-Bed System (RBS) introduced by the project. Many farmers in neighboring communities have adopted it, or have requested technical support for implementation. Other development projects in the Egypt's Delta region have adopted it too, and report substantial farmer interest in many areas.

Publications, database, and website

The project produced regular publications including annual reports, posters, workshop proceedings, a regular newsletter, consultancy reports, extension bulletins and fact sheets. In each country an electronic database was developed and updated regularly. The database is accessible to researchers and interested specialists at the national level.

The project also developed a website that contains information about project activities. We plan to further develop the site to accommodate information and technical messages from each benchmark site.

Institutional strengthening, training, and networking in water management

The project is implemented with a multi-disciplinary team approach within countries, and inter-country exchange of material and results. This encourages complementarities and efficiency of research. The networking concept has been the main foundation of the project, which has established a multinational, multidisciplinary network

among researchers and extensionists from the nine participating countries. This network has had considerable success in reducing the potential risks inherent in implementing a multinational multiinstitutional technology transfer program.

Network activities have included information exchange, training, regional study tours and workshops, and the personal and professional relationships established among scientists – which have all enhanced the institutional linkages generated by the project activities.

The project conducts a variety of regional, subregional and in-country training courses.

5. DEVELOPMENT OF BIOTECHNOLOGY RESEARCH IN THE ARAB STATES (PHASE 1) AND ESTABLISHMENT OF A CONTAINMENT FACILITY(PHASE 2).

Supported by the AFESD, the objective of these projects was to develop infrastructure for biotechnology research in the national programs of the Arab states. They sought to provide countries with **the establishment of laboratories, advanced biotechnology tools and techniques, and trained personnel able to exploit these techniques** to enhance efficiency and precision of their crop improvement programs.

Training in biotechnology: AFESD support is helping to ensure that the region will not be left behind by the biotechnology revolution.

Ten country projects were carried out in six countries for the development of doubled haploid (DH) breeding lines in cereals and the use of DNA markers for biodiversity evaluation and genetic mapping; and one project in genetic engineering of lentils.

Settat, Morocco. The infrastructure of the laboratory facilities was already available at the Arid Land Agriculture Research Center of the National Institute for Agricultural Research (INRA) at Settat. The project demonstrated a practical application of the DH technique for breeding purposes. DH lines were produced from crosses that were set

up to introgress Hessian fly and *Septoria* resistance into Moroccan durum and bread wheat breeding lines. The combination of the DH technique with screening for insect resistance is a very powerful tool to develop Hessian fly resistant germplasm much faster than would be possible with more conventional approaches.

Rabat, Morocco. When the project began, no established biotechnology laboratory was available at INRA-Morocco (National Institute for Agricultural Research). ICARDA conducted a training course on DNA marker applications at INRA to emphasize the importance of using biotechnology tools for crop improvement. The INRA management decided to establish a National Center for biotechnology in Rabat. Within the project, the genetic diversity of barley and durum landraces has been evaluated for agronomic traits, as well as for AFLP and SSR markers. Collections of Hessian fly have been carried out. Mapping of populations segregating for host-plant resistance to Hessian fly has been initiated.

ICARDA decided to out-post one of its biotechnology staff, Dr S.M. Udupa, to the facility at INRA, in Morocco, to provide further training to the national staff and to help the laboratory become competitive on an international level.

Wad Medani, Sudan. A tissue culture laboratory was available at the Agricultural Research Corporation (ARC) of Sudan in Wad Medani. After extended training at ICARDA, Dr A. Ali and Ms H. Elalmein managed to establish the technology to produce DH (doubled haploid) lines within one year in Sudan for practical application. The major stress in Sudan is drought (and heat). DH lines were produced from crosses combining the necessary resistance. Surprisingly, the Sudanese wheat material responded quite well to the anther culture technique at ICARDA – and even in Sudan, despite the absence of proper controlled-environment facilities.

The facilities were further developed through many other projects that followed subsequently. Two of the lines developed under the AFESD project were released for cultivation in 2006.

Drought-tolerant doubled haploid lines being field-tested in Sudan.

Tunis, Tunisia. At the onset of the project, laboratory facilities were already available at the National Agricultural Research Institute of Tunisia (INRAT). AFLP markers as a new technology have been established throughout the project period. The scientific quality of the experiments conducted was very high.

Amman, Jordan. A functional laboratory was available at the National Centre for Agricultural Research and Technology Transfer (NCARTT) at the beginning of the project. The project scientist was trained at ICARDA in AFLP and SSR marker techniques. Jordanian durum landraces were evaluated for agronomic traits and were analyzed using RAPD and SSR markers.

Algiers, Algeria. No laboratory was available at the start of the project. The project scientist, Mr A. Abdelguerifi, made considerable efforts to establish the laboratory infrastructure at the Institute National Agronomique, Algiers. RAPD markers were used to clarify the taxonomic classification of the *Medicago* complex. The laboratory is now functioning and has received substantial national and international funding.

National research staff at the Institute National Agronomique in Algiers, Algeria, receiving training on the use of biotechnology tools for analysis of genetic diversity.

Iraq. At the onset of the project, no established laboratory was available at the IPA Agricultural Research Center. ICARDA conducted a training course on DNA marker application at IPA to help lay the foundation. The project scientist, Dr J. Jubrael, successfully established a laboratory despite extreme difficulties. Besides the project activities on barley, Dr J. Jubrael carried out DNA marker analysis on chickpea (with STMS marker), on date palm (with AFLPs), and on animals.

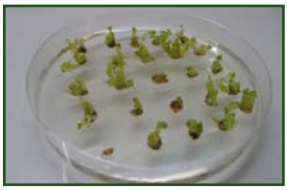
The laboratory was destroyed and does not exist anymore. However, Dr Jubrael established a new biotechnology center in Dohuk University, Kurdistan, of which he is the director. He is also the focal point of the cooperation between Dohuk University and ICARDA and continues to participate in joint activities.

Tishreen, Syria. At the beginning of the project no laboratory facility was available at Tishreen University of Syria. During the project period, Dr W. Choumane has managed to establish a small laboratory facility in Lattakia and to train local staff. Due to the slow progress in securing equipment and chemical supplies, most of the research was carried out in ICARDA laboratories. Lentil germplasm with DNA markers was evaluated for resistance to *Sitona*. Candidate markers linked with the resistance were identified using bulk-segregant analysis.

Dr Wafa Choumane in her biotechnology laboratory at Tishreen University, Syria.

The laboratory continued to develop, with the support of many subsequent projects. In 2007, a fully established molecular marker laboratory became available and many trainees and students are being trained in the laboratory. Dr Choumane is still the scientist responsible and is working in collaboration with ICARDA.

Cairo, Egypt. The Agricultural Genetic Engineering Research Institute (AGERI) of the Agricultural Research Center (ARC) of Egypt, has the best biotechnology laboratory infrastructure in the region. Egypt is also the only country in the region that has biosafety regulations established that permit transgenic research. The project scientist, Mrs B. Ghazal, was trained in lentil transformation at CLIMA, Australia. Lentil transformation has not been performed anywhere else successfully. Mrs Ghazal tried to establish the lentil transformation technology at AGERI. Dr J. Barton, CLIMA, helped to adapt the protocol to the conditions at AGERI. Despite setbacks, the technology was developed. At the end of this project transgenic plants were transferred



AGERI in Egypt has developed transgenic lentil, and is now working to develop transgenic varieties of other crops.

back to ICARDA. ICARDA and AGERI continued to cooperate on transformation technology. The new focus in 2007 is on genetic transformation of wheat and barley.

Training of specialized personnel

Throughout the project and subsequently, ICARDA conducted specialized training courses on tissue culture, DNA markers for crop improvement, and transformation technologies. During the project period 175 scientists attended group training activities. Two specialized workshops were conducted on 'Development and harmonization of biosafety regulations in WANA'. Five training courses at ICARDA headquarters and three in-country training courses in Iraq, Morocco, and Sudan were conducted on 'DNA marker technology for crop improvement'. A sub-regional training course was conducted in Cairo on 'DH production, cytogenetics and genetic transformation'.

NARS research at ICARDA

NARS scientists actively worked in the research program at ICARDA. Studies included evaluation of genetic resources using RAPD, STMS, and AFLP markers, development of EST-derived microsatellite markers in durum wheat, interspecific hybridization in chickpea, characterization of major pests and pathogens of crops using DNA markers, development of DH lines in barley and bread wheat, localization of quantitative trait loci (QTLs), and establishment of transformation systems for lentil and chickpea. Thirteen individual trainees worked within these research projects. In summary, the project has significantly strengthened national research programs by providing facilities and training on new tools for breeding programs.

Looking Ahead

AFESD and ICARDA share a long-term commitment to science-based agricultural development, and the goals of improving rural welfare and alleviating poverty. Strong support from AFESD has enabled ICARDA to initiate, coordinate and facilitate research, training and rural development activities in several Arab countries. The results have been encouraging. National agricultural research programs are gaining in strength, particularly in advanced scientific areas such as biotechnology and GIS applications.

In January 2000, after several years of negotiations, the Extraordinary Conference of Parties (COP) to the Convention on Biological Diversity (CBD) adopted the so-called Cartagena Protocol on Biosafety. This Protocol, which came into force in 2003, is the first binding document arising from the CBD, signed by more than 170 countries, which addresses the need to generate tools and modalities for protecting the environment and biodiversity for future generations. The adoption of the Cartagena Protocol expects the member countries to develop, as a minimum requirement, national biosafety regulations to control trans-border movement of genetically modified living organisms.

With support from the AFESD, improvement of the biotechnology infrastructure through development of a containment facility at ICARDA would provide the basis for a regional approach to testing of, and advanced research on, genetically modified organisms (GMO) in the Arab world. National agricultural research and crop improvement programs will use the facilities at ICARDA to test their material until national facilities are developed or until the materials can be tested in field trials in national programs not located in the center of diversity. The facilities will also be used by visiting scientists from the national programs to conduct joint research at ICARDA on the development of improved germplasm, and provide specialized workshops and training courses to build the necessary expertise in the national programs.

In 2007, the AFESD approved a 3-year grant to support the Borlaug Global Rust Initiative (BGRI), an international research-for-development consortium led by ICARDA and CIMMYT (International Maize and Wheat Improvement Center), in partnership with national programs of over 30 countries. It was launched in September 2005, following the disastrous outbreak of a new strain of wheat stem rust, Ug99, first identified in Uganda in 1999. BGRI is currently supported by AFESD, USAID, Canada and India.

Wheat stem rust, caused by the fungus *Puccinia graminis*, caused huge losses and even famines in the first half of the 20th century. In 1950 it destroyed nearly 70% of wheat plantations in North America. But new wheat varieties were developed to defeat the rust. However, the sudden outbreak of stem rust in 1999 caused heavy losses in East Africa; small-scale farmers in Kenya lost half of their crop. Scientists fear the pathogen could spread to the Middle East, Asia and the Americas, because the pathogen spores can be transported over long distances by wind.

Arab countries, including Egypt, Sudan and Yemen, participated in the 1st International Workshop of the BGRI in October 2006 in Alexandria, Egypt. All countries gave high priority to combating the threat of Ug99. It was recognized that the greatest threat in the region is the potential spread of Ug99 to other countries, including Yemen, Sudan and Egypt and additional activities, particularly in pathogen surveillance, monitoring and early warning systems, were agreed by the participants. Subsequently, based on recent information on the spread of the disease, Saudi Arabia was added as a highly vulnerable country.

In order to avert the threat of Ug99 and the development of more dangerous races of stem rust, BGRI is establishing a monitoring and surveillance system in close collaboration with NARS, advanced research institutions and international organizations. The program includes testing of biological trap nurseries, development of GIS maps similar to those developed for locust monitoring, development of new wheat varieties resistant to rust, and rapid seed dissemination mechanisms for replacement of susceptible varieties.

The project will also enhance the capacity of the national crop improvement programs in applying sustainable rust control strategies. Scientists participating in the project will benefit from increased knowledge of wheat rusts. The development of a network of scientists will support NARS capacity in surveillance and rust management. Wheat germplasm with durable resistance developed in this project will likely be used in the future by national wheat breeders.

Ultimately, the development of early warning systems and the replacement of susceptible cultivars with new cultivars with durable resistance to stem rust will reduce the risk of rust epidemics, improve the stability of wheat production, and enhance food security in the region.

About ICARDA and the CGIAR

Established in 1977, the International Center for Agricultural Research in the Dry Areas (ICARDA) is one of 15 centers supported by the CGIAR. ICARDA's mission is to improve the welfare of poor people through research and training in dry areas of the developing world, by increasing the production, productivity and nutritional quality of food, while preserving and enhancing the natural resource base.

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 West and Central Asia and North Africa (CWANA) region for the improvement of bread and durum wheats, chickpea, pasture and forage legumes, 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, regional and international agricultural research and development systems.

The Consultative Group on International Agricultural Research (CGIAR) is a strategic alliance of countries, international and regional organizations, and private foundations supporting 15 international agricultural Centers that work with national agricultural research systems and civil society organizations including the private sector. The alliance mobilizes agricultural science to reduce poverty, foster human well being, promote agricultural growth and protect the environment. The CGIAR generates global public goods that are available to all.

The World Bank, the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP), and the International Fund for Agricultural Development (IFAD) are cosponsors of the CGIAR. The World Bank provides the CGIAR with a System Office in Washington, DC. A Science Council, with its Secretariat at FAO in Rome, assists the System in the development of its research program.

Ties that Bind

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