About ICBA

Mission
The ICBA mission is to demonstrate the value of saline water resources for the production of environmentally and economically useful plants and to transfer the results to national research services and communities in the Islamic world and elsewhere.

Mandate
The ICBA mandate is to develop sustainable management systems to irrigate food and forage crops and ornamental plants with saline water, and to provide a resource of salt-tolerant plants for socio-economic development in arid and semi-arid salt-affected areas of the Islamic world and elsewhere.

Contents
This report documents ICBA’s activities in 2003. Highlights of 2003 feature in the first section and are followed by more detailed reports of Technical Program Division projects and activities. The main activities of the Administration and Finance Division during the year are then summarized. The Appendices provide details of the Center’s genebank holdings, finances, publications and other information.

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Salinity ranges targeted by ICBA programs

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<th>Salinity</th>
<th>Production system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slightly saline</td>
<td>&lt;5 dS/m</td>
</tr>
<tr>
<td>Moderately saline</td>
<td>5-15 dS/m</td>
</tr>
<tr>
<td>Highly saline</td>
<td>15-25 dS/m</td>
</tr>
<tr>
<td>Very highly saline</td>
<td>&gt;25 dS/m</td>
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<tr>
<td>Seawater</td>
<td>40-60 dS/m</td>
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dS/m: decisiemens per meter
Foreword

Water is critically important to development and stability and there is global concern over scarce water resources. In the Middle East and North Africa region alone agriculture, although it accounts for only 5% to 20% of gross domestic product, consumes 90% of the water in the region. If business as usual continues, water scarcity will become the largest impediment to agriculture in an increasing number of areas.

Water is a key agricultural production resource. However, there are significant water resources that are not utilized. The International Center for Biosaline Agriculture was established to investigate how currently unused brackish and salty water can productively and sustainably be used in agriculture. Future productivity increases in agriculture are likely to come, not from prime irrigated agricultural land and fresh water, as in the green revolution, but from increasing the productivity of lower quality land and water resources.

In developing countries, investment in rural development and agriculture declined by more than 50% between 1986 and 1998. At the same time, loan commitments for agriculture and rural development dropped significantly.

ICBA thus faces formidable challenges. Funding for research and development in the region, including agricultural research and development, is among the lowest in the world. Moreover, research and development is a long-term undertaking and requires significant investment and sustained commitment. Building human capabilities and institutionalizing these capabilities in centers of excellence will be instrumental in addressing the challenges of both water and land use for productive agriculture. I hope that ICBA will become a leading example of such a center of excellence in the region.

I am acutely aware that for the Islamic Development Bank’s contribution to bear fruit, we need concerted cooperation from governments. I urge policy and decision-makers to commit funds to support research and development efforts to maximize use of hitherto unused resources, including saline water and saline soil, for agricultural production. With few exceptions, agricultural growth is the most effective path to reducing hunger and poverty in most of our IDB member countries.

Unless there is commitment to research and development by governments everywhere, the Millennium Development Goals will not be met. All of us should provide the strongest support to make the best use of all the resources available to us for agriculture.

Finally, I would like to extend the Bank’s thanks and appreciation to the host country, the United Arab Emirates, for their continued support of ICBA and the Center’s programs in biosaline agriculture.

Dr. Ahmad Mohamed Ali
President, Islamic Development Bank, and Chairman, ICBA Board of Trustees
Message from the Chairman, Board of Directors, and Director General

The year 2003 saw ICBA being increasingly recognized regionally and globally for its role in developing and promoting the sustainable use of brackish and saline water for crop production.

Key audiences for the Center’s outputs are decision and policy-makers, as their support is vital to the sustainable development of saline water resources. The Center’s keynote paper on ‘Saline water as a resource for the future in Arab countries’ in the session on ‘Non-conventional water resources’ at the Third World Water Forum, Kyoto, Japan, in March, co-sponsored and co-organized by Algeria, the Islamic Development Bank (IDB), and the World Bank, attracted a large number of participants to discuss potential uses of saline water for agricultural purposes. ICBA’s efforts in using saline irrigation water on marginal lands were acknowledged and supported by many.

ICBA’s mandate calls on the Center to work for “socio-economic development in arid and semi-arid areas”. In pursuit of this aim, in 2003 ICBA began to develop and build partnerships with national programs and research centers in Central Asia where arid and salt-affected regions are widespread. A mission to Kazakhstan and Uzbekistan was undertaken with a view to exploring the potential for developing collaborative research projects in biosaline agriculture in the region. As a result ICBA is presently collaborating with the International Water Management Institute (IWMI) and the International Center for Agricultural Research in the Dry Areas (ICARDA) in developing a large proposal for Central Asia with support from the Asian Development Bank.

During the year ICBA also put in place measures to strengthen collaboration in ICBA’s host country, the United Arab Emirates (UAE). The assignment of two scientists from the UAE Ministry of Agriculture and Fisheries, one seconded to ICBA and the other working in partnership on ICBA research projects, is a major impetus for strengthening collaborative research to increase productivity from saline water in the UAE. The Municipality of Abu Dhabi also called on ICBA to provide technical assistance in waterlogged and salinity-affected areas.

The preferred model for ICBA’s capacity development activities is as a component of larger projects. Capacity development needs to be market driven rather than supply driven as has often been the case until recently. The year 2003 has seen ICBA’s capacity development activities respond to needs in Central Asian Countries by holding the first training course on biosaline agriculture in Tashkent, Uzbekistan, in collaboration with the International Center for Agricultural Research in the Dry Areas (ICARDA). In another development, ICBA and ICARDA collaborated to provide four months’ on-the-job skills development for three agriculturalists from Afghanistan.

Work on production and management systems in saline agriculture is now sufficiently advanced on-station at ICBA to begin to take these technologies for further trials in farmers’ fields and national agricultural research system stations in developing countries. During the year ICBA has devoted much effort to developing a multi-country, multi-donor mega-project to take salt-tolerant forage production systems to six developing countries in the region. The design mission for the project has already been funded and prospects for the project are bright.

The major effort in 2004 will be focused on a review of the outcomes of ICBA’s first Strategic Plan 2000-2004 and development of the second Strategic Plan 2005-2009. The external review will assess the impacts of the Center’s work to date in consultation with the Center’s collaborators and the end-users of ICBA’s research and development. The findings of the review will be incorporated in the development of ICBA’s second Strategic Plan 2005-2009.

In conclusion, I would like to especially thank ICBA’s Chairman, Board of Trustees, Dr. Ahmad Mohamed Ali, and Islamic Development Bank Vice President for Operations, Mr. Amadou Cisse. With the foresight and leadership of the Islamic Development Bank management and the Center’s other donors, and the generous cooperation of ICBA’s host country, the United Arab Emirates, the Center is set to be a model strategic center of excellence for research and development cooperation in the region.

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The nine-member Board of Directors, appointed by the Islamic Development Bank and the Center’s host country, the United Arab Emirates, is responsible for ICBA’s governance and policies. ICBA’s Director General, Dr. Mohammad Al-Attar, chairs the Board of Directors. The Board of Directors is responsible to the Board of Trustees, which is chaired by the IDB President, Dr. Ahmad Mohamed Ali.

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Highlights 2003

In 2003, significant achievements have been made in terms of ICBA's projects, outreach programs, capacity building, communications, publications and networking, and mobilizing resources for financial support of the Center.
Introduction

The Center’s portfolio of research is undertaken in the four Programs of the Technical Programs Division:

- Plant Genetic Resources Program
- Production and Management Systems Program
- Communication, Networking and Information Management Program, and
- Training, Workshops and Extension Program.

The work of the Technical Programs Division is supported by the Administration and Finance Division.

In 2003, ICBA’s four Programs advanced substantially towards achieving the goals for the first five years of operations as set out in the ICBA Strategic Plan 2000-2004 and this section of the report summarizes the highlights for the year.

Salt-tolerant Plant Genetic Resources

In 2003, attention focused on obtaining further germplasm of the cereals that have already shown promise (barley, pearl millet and sorghum), with a view to increasing the diversity of genetic material under test. ICBA also continued to obtain new forage species, including browse trees and shrubs. As in the past, the aim was to acquire most of the new germplasm from existing genebanks.

**Acquiring salt-tolerant germplasm**

New germplasm acquired included 275 accessions of sorghum, 103 accessions of pearl millet, 23 accessions of groundnut and 376 and elite lines of barley and 146 of wheat. The new introductions bring the total strength of the germplasm collection to 8,141 accessions of 237 species.

**Evaluating how salt-tolerant germplasm adapts to local conditions**

Of the materials that have already undergone initial evaluation, work concentrated on barley (*Hordeum vulgare*), buffelgrass (*Cenchrus ciliaris*) and lablab (*Lablab purpureus*) for which adequate quantities of seed have been produced for evaluation of salinity tolerance. In addition, increasing seed of accessions of sorghum and pearl millet that are at more advanced stages of screening and evaluation of productivity continued.

The performance of forage beets was very positive. The 50 accessions of beet proved to be a mixture of vegetable types, mangels and sugar beet. All grew extremely well through the cool season, producing good quantities of foliage and substantial tubers.

Production and Management Systems

Work at ICBA is now sufficiently advanced to demonstrate that, at the research station and pilot scale, saline production systems are productive and economic.

Sustainable use of saline land and water

Evaluating the indigenous salt-tolerant grass *Cenchrus ciliaris*

In the Arabian peninsula there are salt-tolerant indigenous grasses that can be developed as forage. Indigenous species are already adapted to the prevailing conditions, however, little is known about the agronomic practices (establishment, fertilizer regimes, crop management and harvesting) needed for sustainable production.

Since 2001, ICBA has been comparing the productivity of two indigenous species, *Coelachyrum piercei* and *Cenchrus ciliaris*, with the productivity of the forage grass *Chloris gayana* (Rhodes grass) which is widely grown in the region.

Overall, *C. ciliaris* has shown the best establishment, highest productivity and best salt-tolerance followed by *C. gayana* and *C. piercei*. *C. ciliaris* produced three promising cuts at 10 dS/m. Screening of *C. ciliaris* is continuing in order to determine the long-term effects of different treatments on seed production and viability.

Mangroves for coastal greening

Mangroves are important coastal species in the Arabian Gulf and provide breeding grounds for shrimp and fish. The main species of mangrove along the coast of the United Arab Emirates is *Avicennia marina*. *Ceriops tagal*, *Rhizophora mucronata* and *Rhizophora stylosa*, mangrove species from Pakistan and Japan, were investigated for their suitability for introduction to increase the biodiversity of mangroves in the UAE. Based on the data collected in the trials the three species were introduced in the coastal zone of Abu Dhabi Emirate.
Successful adaptation of halophyte grasses to intensive production

The halophyte grasses, *Sporobolus virginicus* and *Distichlis spicata* have been successfully adapted to intensive irrigated production using highly saline water (up to 30 dS/m) in on-station field trials at ICBA.

These two grass species provide good feed for sheep, goats and camels. Even in hay produced at high salinities, the salt content remains low.

Grasses such as these could help millions of small farmers whose farms are affected by salinity. By growing halophyte grasses as an animal feed crop, these farmers could maintain the productivity of their farms with water that is becoming increasingly brackish or saline.

ICBA’s work on developing sustainable and productive management systems for naturally occurring halophyte grasses could help farmers to produce animal feed and continue farming even though their water and land is salty.
Salt-tolerant varieties of conventional crops selected

Barley is a species adapted to a wide range of environments and is well known for its tolerance to salinity and wide genetic diversity. ICBA, in collaboration with the International Center for Agricultural Research in the Dry Areas (ICARDA) is working to identify the most salt-tolerant varieties and has found some that still produce yields within the economic range for barley production even at high salinity.

Sorghum and pearl millet accessions that have been identified as salt-tolerant are now undergoing on-station field trials and are being tested off-station in farmers’ fields in several countries in the region.

Elite pearl millet varieties developed by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) have been tested at high salinities at ICBA. Several varieties showed good potential for both seed and biomass production.

The performance of forage beets tested at ICBA at medium and high salinity is very positive. The 50 accessions of beet all grew extremely well through the cool season, producing good quantities of foliage and substantial tubers.
Making productive use of salt-affected land and saline groundwater

Salt-affected land and saline groundwater are resources which can be put to productive use. In the late 1990s, the International Atomic Energy Agency (IAEA) began funding a project to investigate the use of salt-affected land and saline groundwater to grow salt-tolerant plants. Twenty-two species that have potentially productive uses, for example as forage, fodder, wood, or for ornamental purposes, were identified and are being tested at ICBA with highly saline water. The shrubs and trees, Acacia ampliceps, Salvadora persica and Casuarina glauca have shown the highest growth rates to date.

Management techniques for salt-affected land

Worldwide, salinity and water logging is widespread on irrigated agricultural land. In the United Arab Emirates, many newly developed agricultural coastal areas in Abu Dhabi Emirate are affected, some after just two years of operation, and severely affected farms have been abandoned. Following a pilot project to improve drainage on affected farms, ICBA is now providing technical assistance for a drainage system being installed on a further 55 km².

Using salty oil process water for biosaline agriculture at Nimr for Petroleum Development Oman

During the year, a biosaline agriculture pilot project was established for PDO at Nimr, Oman, to demonstrate production of grasses, shrubs and trees in an integrated system using biologically cleaned oil process water. The grass species Paspalum vaginatum and Sporobolus arabicus established successfully and rapidly multiplied, despite the harsh climate and poor quality water. Nearly 100% of the Atriplex shrubs established and grew rapidly, as did the tree species Conocarpus lancifolius and Acacia ampliceps.

Assessing the amount of salty groundwater available for biosaline agriculture in West Asia and North Africa

A study, on behalf of the International Fund for Agricultural Development (IFAD), to assess the quantities of available brackish water suitable for irrigated biosaline agriculture found that in Syria, Oman, Yemen, Jordan, Algeria, Tunisia and Libya, brackish and saline water is available to irrigate 332,000 hectares. The potential for saline agriculture is greatest in absolute terms in Algeria, Syria and Tunisia, and in relative terms, in Oman, Jordan and Algeria. The information from this study will form the basis for development of biosaline agriculture projects in the WANA region, in particular, the location and scope.

Field and forage crop production

The crops on which production system research is most advanced at ICBA are salt-tolerant forage grasses, pearl millet, sorghum, barley and the salt-bush Atriplex.

Sustainable production system for the halophyte grasses Sporobolus virginicus and Distichlis spicata

The long-term field study on the feasibility and sustainability of production of two non-conventional salt-tolerant grasses Sporobolus virginicus and Distichlis spicata with highly saline water continues. The trial, established in 2001, is now showing that production systems can be successful in saline environments at the research station level.

Over the 2002-2003 season, the plants were assessed at three salinity levels, three irrigation regimes, three plant densities and six fertilizer treatments. A mechanical harvesting trial was completed and plant samples are being analyzed for chemical composition for the different treatments. The forage produced is being fed to sheep, goats and camels in trials at the United Arab Emirates University farm, Al Ain, and samples are being analyzed to determine the nutritional value of the feed.

In 2003, the first large-scale harvesting of Sporobolus and Distichlis produced, over four cuts, an average yield over the three salinity levels of 37 tonnes per hectare for Distichlis, and 35 tonnes per hectare for Sporobolus.

To date, the results indicate that Sporobolus and Distichlis can be extremely productive under saline irrigation and that the quality of the forage is almost equivalent to that of green barley biomass when managed appropriately. Over the next few years, field investigations will focus on improving management strategies to raise the yield ceiling further.

Salt-tolerant genotypes of pearl millet and sorghum

Sorghum and millet are important feed and food crops, well-known for their drought tolerance, and have great
potential for expansion into many parts of the world, particularly the West Asia and North Africa region. ICBA trials, in collaboration with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), have now identified particular salt-tolerant sorghum and millet lines that produce more than acceptable biomass.

In 2003, 49 pearl millet accessions and 42 pearl millet elite varieties were evaluated at three salinity levels. The salt-tolerant genotypes are now available for use by collaborating national programs in the region, and also for further evaluation of productivity.

Salt-tolerant barley

In 2002 sufficient quantities of barley seed were obtained to enable large-scale field screening in 2003 at the pilot scale. At 15 dS/m, some lines produced 2-3 tonnes of seed per hectare. Thus, at this scale, the selected barley of lines are still meeting the economic production threshold for stressed environments.

Collaborative projects to build capacity in biosaline agriculture in developing countries

Pakistan

Salinity in Pakistan has significant economic and social implications. In 2003, ICBA and the Pakistan Agricultural Research Council (PARC) began collaborative projects in Pindi Bhattian, Bhawal and Thatta to test management strategies for fruit, green manure, and forage species for silvo-horticultural systems using poor quality water and salt-affected soils.

Iran

In Iran, a collaborative project was initiated with the National Salinity Research Center (NSRC) at Yazd. Earlier studies had demonstrated the successful establishment of shrub and tree halophytes for forage. This project builds on the previous results and investigates agronomic techniques for economic production of the shrub and tree halophyte species as animal fodder.

Bangladesh

Bangladesh, with a population of 140 million inhabitants, has an estimated 0.88 million hectares of salt-affected lands. During the dry months of March and April, salinity problems, resulting from seawater intrusion, are acute. Seawater intrudes into the fields as a result of the near sea-level topography of coastal areas.

Profitable crops, such as mustard and tomatoes, can be grown with proper management of soil and water. One management technology is drip irrigation on raised beds, which permits leaching of salts from the root zone.

The experiment was designed in 2002, and in 2003 a baseline survey of the selected districts in Southern Bangladesh, Noakhali and Sonagazi, was conducted.

Jordan

Approximately 11,400 hectares in the main irrigated areas of the Jordan valley are saline. These represent approximately 15% of the available irrigated land. Date palm is a high value crop that is in demand in Jordan and is known to be salt tolerant.

This project, in collaboration with the National Center for Agricultural Research and Technology Transfer (NCARTT), will explore the potential for expanding the area of date palm cultivated in Jordan. Eighteen varieties of date palm will be tested at two locations in the Jordan Valley. At the same time, the optimum agronomic practices for establishing date gardens on saline soils will be investigated. The establishment trials will serve as demonstrations for farmers, extension staff and researchers.

Communication, Networking and Information Management

ICBA aims to establish formal (Memorandum of Understanding or similar agreement) or informal (project-based or individual contacts) collaboration to access technology and to develop joint programs/projects for the delivery of biosalinity technology. Communication activities aim at exchanging information and establishing networks of individuals and agencies with a common interest in biosalinity.

Memoranda of Understanding

In 2003, ICBA signed five Memoranda of Understanding with the Desert Research Center (DRC), Egypt, Nakheel, UAE, NyPa Incorporated, United States of America,
Needs-based capacity development

ICBA’s capacity development activities are increasingly needs-based, linked with its research agenda, and are moving away from the traditional supply-driven approach. Collaborative projects encourage partners to strengthen their knowledge and skills in an interactive and participatory way.

In addition to intensive courses on aspects of biosaline agriculture at headquarters, ICBA, in collaboration with the International Center for Agricultural Research in the Dry Areas, developed specialized capacity development activities for Central Asian Countries and Afghan agriculturalists.

ICBA establishes formal Memoranda of Understanding and informal project-based contacts for collaboration. These agreements assist partners to access technology and develop joint programs and projects for the delivery of biosaline technologies.
National Academy of Science, Kazakhstan and HH President of UAE’s Private Office

The Memoranda of Understanding assist in building relationships with these organizations for developing collaborative projects to deliver biosaline technology.

Managing and disseminating information on biosaline agriculture

In 2003, the Library continued to develop ICBA’s collection of printed and electronic material and to provide information services for Center staff, collaborators and members of its networks.

Cataloguing the library collection to internationally recognized standards began and compilation of data on salt-tolerant plants, shrubs and groundcover, continued.

Networking among biosaline agriculture researchers, developers and practitioners

By establishing international networks in biosaline agriculture, ICBA aims to promote collaborative projects between the Center and other agencies involved in biosaline agriculture research and development.

The Inter-Islamic Network on Biosaline Agriculture (INBA) promotes the exchange of information and experience among those involved in saline agriculture research, development, and training. As coordinator of INBA, ICBA produced an information brochure and the Statutes of INBA in 2003, and hosted two workshops.

The web-based Global Biosaline Network is a data bank of professionals involved in biosaline agriculture. At the end of 2003, the network had 284 registered members from 55 countries. With funds provided by the OPEC Fund, the network provides members free access to online agricultural research bibliographic databases.

Developing capacity in biosaline agriculture

In 2003, IAEA, the OPEC Fund and ICBA provided funding for three intensive courses at ICBA:

- Quality evaluation of salt-tolerant forages, February 2003
- Salinization of irrigated lands and reclamation, April 2003

- In-situ conservation of plant genetic resources, October 2003

In addition, the first course to be held outside the Center took place in Tashkent, Uzbekistan, in collaboration with the International Center for Agricultural Research in the Dry Areas (ICARDA):

- Biosaline agriculture and sustainable production systems, May 2003

A total of 94 participants from 28 countries took advantage of these courses.

Three agriculturalists from the Afghanistan Ministry of Agriculture and Animal Husbandry took part in four months of on-the-job skills development at ICBA (Dubai) and at the International Center for Agricultural Research in the Dry Areas (ICARDA, Aleppo, Syria) on sustainable irrigated agricultural production on degraded and saline land from May to August 2003. USAID provided funds for the skills development through the Short-Term High Impact Program coordinated by ICARDA, and the UAE government provided logistical support.

ICBA’s management and staff organized, participated in, and made presentations at seminars throughout the year. The Director General was invited as a guest speaker at the session on ‘Non-conventional water resources’ at the Third World Water Forum, Kyoto, Japan in March.

Resource mobilization

Resource mobilization activities generated US$654,400 during 2003. In addition, considerable progress was made towards developing a major four-year multi-country, multi-donor project.

Infrastructure development

Work on the expansion of the irrigation and drainage system at ICBA, funded by the Arab Fund for Economic and Social Development (AFESD), began in December 2002 and was completed in October 2003.

The expansion of the irrigation system is crucial for evaluating increasing accessions of germplasm and seed multiplication.
Introduction

The work of ICBA’s four Programs in the Technical Program Division is organized through projects, each with clearly defined problems (research) or needs (information, networking and training) that are addressed.

The broad structure for ICBA consists of four functional programs:

- Plant genetic resources;
- Production and management systems;
- Communication, networking and information management and;
- Training, workshops and extension.

The following pages briefly describe the activities and achievements for 2003 in each of ICBA’s four Programs.

Projects and activities 2003

**Genetic Resources Program Projects**

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<tr>
<th>Project code</th>
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<td>GR01</td>
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<td>Seed increase of salt-tolerant germplasm</td>
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<td>Development and submission of germplasm description of unique Salicornia species produced by BEHAR</td>
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**Production and Management Systems Program Projects**

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<td>PMS09</td>
<td>ICBA, BARI</td>
<td>BARI</td>
<td>Demonstration of biosaline agriculture in salt-affected areas in Bangladesh</td>
<td>2003-2004</td>
</tr>
<tr>
<td>PMS10</td>
<td>IFAD</td>
<td></td>
<td>Assessment of saline water resources in the WANA region</td>
<td>2002-2003</td>
</tr>
<tr>
<td>PMS13</td>
<td>IAEA, MAF (UAE)</td>
<td>IAEA, MAF (UAE)</td>
<td>Sustainable utilization of saline groundwater and wastelands for plant production</td>
<td>2000-2005</td>
</tr>
<tr>
<td>PMS21</td>
<td>ICBA, PARC</td>
<td>Pakistan Agricultural Research Council</td>
<td>Use of low quality water for productive use of desert and sub-affected areas in Pakistan</td>
<td>2003-2005</td>
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</tbody>
</table>
### Field and forage crop production

<table>
<thead>
<tr>
<th>Project code</th>
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<th>Collaborators</th>
<th>Project title</th>
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<tbody>
<tr>
<td>PMS02</td>
<td>ICBA</td>
<td>ICRISAT</td>
<td>Screening and evaluation of salinity tolerance, growth, yield potential and forage quality in selected cultivars/accessions of pearl millet and sorghum under field conditions. Next phase PMS15</td>
<td>2002-2003</td>
</tr>
<tr>
<td>PMS03</td>
<td>ICBA</td>
<td>ICBA, UAEU</td>
<td>Optimizing management practices for maximum production of two salt-tolerant grasses: Sporobolus virginicus and Distichlis spicata</td>
<td>2002-2006</td>
</tr>
<tr>
<td>PMS04</td>
<td>ICBA</td>
<td>ICBA, UAEU</td>
<td>Optimizing management practices for maximum production of three Atriplex species under high salinity levels</td>
<td>2002-2006</td>
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<tr>
<td>PMS05</td>
<td>ICBA</td>
<td>MAF (UAE)</td>
<td>Application of biofuel agriculture in a demonstration farm in the Northern Emirates of the UAE</td>
<td>2003-2006</td>
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<tr>
<td>PMS15</td>
<td>ICBA, ICRISAT, OPEC Fund</td>
<td>ICRISAT</td>
<td>Development of salt-tolerant sorghum and pearl millet varieties for saline lands</td>
<td>2003-2006</td>
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<tr>
<td>PMS16</td>
<td>UAEU</td>
<td>ICBA, UAEU</td>
<td>Development of sustainable salt-tolerant forages for sheep and goat production. Component of PMS03, PMS04</td>
<td>2003-2006</td>
</tr>
<tr>
<td>PMS17</td>
<td>ICARDA</td>
<td>ICARDA</td>
<td>Evaluation of salinity tolerance and yield in 240 barley varieties and accessions</td>
<td>2003-2004</td>
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<tr>
<td>PMS18</td>
<td>ICRISAT</td>
<td>ICRISAT</td>
<td>Screening for salt-tolerance among selected pigeonpea and groundnut varieties under controlled conditions</td>
<td>2003-2006</td>
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<tr>
<td>PMS19</td>
<td>ICBA, ICARDA</td>
<td>ICBA, ICARDA</td>
<td>Screening for salt-tolerance among large collections of buffalograss (Cenchrus ciliaris), safflower, fodder beet and lablab</td>
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### Halophyte production

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<td>PMS01</td>
<td>ICBA</td>
<td>ICARDA-APRP, MAF (UAE)</td>
<td>Evaluation of irrigation practices and fertilizer requirements for optimizing productivity of three indigenous grass species</td>
<td>2000-2004</td>
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<td>PMS12</td>
<td>ICBA</td>
<td></td>
<td>Water use and salt balance of halophytic species</td>
<td>2000-ongoing</td>
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<tr>
<td>PMS14</td>
<td>ICBA, ERWDA</td>
<td>ERWDA</td>
<td>Increasing biodiversity of mangrove species in the United Arab Emirates: Introduction and adaptation of non-native species</td>
<td>2002-2004</td>
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<tr>
<td>PMS22</td>
<td>ICBA, NSRC</td>
<td>NSRC</td>
<td>Production of halophytes in Iran</td>
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### Horticultural crop production

<table>
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<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>PMS06</td>
<td>ICBA</td>
<td>MAF (UAE)</td>
<td>Investigation of elite date palm and olive varieties for salt-tolerance</td>
<td>2001-2006</td>
</tr>
<tr>
<td>PMS23</td>
<td>ICBA, NCARTT</td>
<td>NCARTT</td>
<td>Expanding date palm cultivation under saline conditions in Jordan</td>
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</tr>
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### Communication, networking and information management activities

<table>
<thead>
<tr>
<th>Resources (cash or in kind)</th>
<th>Collaborators</th>
<th>Activity</th>
<th>Duration</th>
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<tbody>
<tr>
<td>ICBA</td>
<td>International organizations, national research institutions</td>
<td>Memoranda of Understanding</td>
<td>Ongoing</td>
</tr>
<tr>
<td>ICBA</td>
<td>International programs, national research institutions</td>
<td>Collaboration</td>
<td>Ongoing</td>
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<tr>
<td>ICBA</td>
<td>Information management</td>
<td>Information management</td>
<td>Ongoing</td>
</tr>
<tr>
<td>ICBA</td>
<td>Publications, events and media</td>
<td>Publications, events and media</td>
<td>Ongoing</td>
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<tr>
<td>ICBA</td>
<td>COMSTECH</td>
<td>Networks</td>
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### Training, workshop and extension activities

<table>
<thead>
<tr>
<th>Resources (cash or in kind)</th>
<th>Collaborators</th>
<th>Activity</th>
<th>Duration</th>
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</thead>
<tbody>
<tr>
<td>ICBA, OPEC Fund, USAID, ICARDA, IDB, Private Office of HH President of the UAE, DFID (UK)</td>
<td>OPEC Fund, USAID, ICARDA, IDB, Private Office of HH President of the UAE, DFID (UK)</td>
<td>Training</td>
<td>Ongoing</td>
</tr>
</tbody>
</table>
Genetic Resources Program

The overall objective of the Genetic Resources Program is to promote agricultural production and environmental greening under saline conditions. Immediate objectives are to identify and acquire germplasm of new species, and to generate sufficient plant material for screening for salinity tolerance.
Acquisition, collection and conservation of plant genetic resources (GR01)

Duration: Ongoing

Collaborators: National and international genebanks

Resources: ICBA, national and international genebanks

Background

Developing saline irrigated agriculture systems depends on the availability of plant species and varieties that will grow and produce economic yields in saline conditions. To identify such germplasm, ICBA acquires species and varieties with proven or potential salinity tolerance for testing in different saline environments. The germplasm collection thus created, together with information on the salinity tolerance of individual accessions, provides a resource for scientists interested in saline agriculture to identify and acquire new test materials suitable for their conditions.

Objectives

1. Identify and acquire plant species and varieties with potential for use in saline irrigated agriculture.

2. Create a well-documented germplasm collection as a resource for agricultural scientists and other beneficiaries.

Achievements 2003

New germplasm received during the year includes 275 accessions of sorghum, 103 accessions of pearl millet and 23 accessions of groundnut. In the latter part of the year, 376 elite barley lines from ICARDA and 146 wheat lines from CIMMYT were received. The wheat lines are introgression lines derived from crosses of elite cultivars with wild relatives of wheat that have proven in the past to be good sources of stress resistances. In addition, 15 lines each of Vicia sativa, V. narbonensis, V. ervilia and Lathyrus sativa were received from ICARDA.

A one-year collaborative activity with the Ministry of Agriculture and Fisheries, United Arab Emirates, has been initiated for the collection of samples of plant species from saline coastal areas in the UAE. Collection was initiated in mid-2003. The collection will be continued at regular intervals until mid-2004 when plans will be made for evaluation for productivity and salinity tolerance.

The new introductions bring the total strength of the germplasm collection to 8,141 accessions of 237 species.

Plans 2004

Acquisition and introduction of new plant materials will be continued according to the needs of the ICBA programs. Collection of germplasm will be continued in the UAE in collaboration with the Ministry of Agriculture and Fisheries. Opportunities for germplasm collection in other countries will be explored.
Seed increase of salt-tolerant germplasm (GR02)

Duration: Ongoing

Collaborators: National and international genebanks

Resources: ICBA

Background
New germplasm acquired by ICBA comes in very small quantities. In the vast majority of cases, only a few grams of seed are supplied. In order to have sufficient seed for testing for salinity tolerance at ICBA, for conservation in the genebank and for distribution to interested collaborators, the initial introduction has to be grown for seed increase. Seed increase plots are grown with low salinity water (2,000-2,500 ppm) and do not attempt to evaluate the germplasm’s reactions to salinity. However, the adaptation of the particular species and accessions of germplasm to the growing conditions in Dubai is also studied.

Objectives
1. Multiplication of new germplasm accessions to provide seed for conservation, testing in ICBA trials and nurseries, and for distribution to collaborators.
2. Initial evaluation of the adaptation of species and accessions to the conditions of the Arabian Peninsula.

Achievements in 2003
Barley (Hordeum vulgare): Based on initial evaluation during the 2001/2002 season, 280 barley lines were selected for further study and multiplication. Selection was based on grain productivity and duration to flowering. Of the total number of lines, 236 were derived from a single landrace from Oman, and the remaining 44 were improved barley breeding lines from ICARDA. The complete set was evaluated for salinity tolerance (see Project PMS17 in this report) and also grown for further characterization and seed multiplication. Single plots of each of the lines were sown in November 2002 and harvested in April/May 2003. Data was collected for a range of agronomic traits (days to 50% heading, plant height, grain yield) and barley germplasm descriptors.

Grain yields per plot averaged 720 g for the Omani landrace lines and 580 g for the ICARDA lines, so that ample seed was produced for conservation, trial use and possible dissemination. The new seed was transferred to the genebank after processing.

In the autumn of 2003, 376 newly acquired lines of barley, together with 363 lines obtained earlier but not previously studied, were sown in observation plots for initial evaluation of their adaptation and seed increase. These trials will carry over to 2004.

Buffelgrass (Cenchrus ciliaris): The collection of 858 buffelgrass accessions sown in 2001 was maintained during the first half of 2003. Following harvest of seed from 150 accessions in late 2002, the plants were cut back early in 2003 and allowed to regrow in anticipation of a fresh flush of seed during April/May. However, the heading and seed production of the plots was poorer than expected and seed was only obtained from a further 128 accessions. The quality of the seed has still to be determined. The timing and level of cutting back the plants may have reduced and delayed flowering. The plants were removed from the field and the trial terminated in mid-2003.

Individual spaced plants of the same set of 858 accessions of Cenchrus ciliaris were established late in 2003 to provide an ongoing source of seed and other propagation material.
One hundred and sixty one accessions of *Cenchrus ciliaris* that are being screened in pots for salinity tolerance were planted out in the latter half of 2003 for seed increase. Ten plants of each accession were planted. The objective of this exercise is to have adequate seed of the lines selected from the pot screening to go to field-plot screening at ICBA and to take them to other locations.

*Sorghum* (*Sorghum bicolor*): Three hundred and five accessions of short-statured and short-duration grain sorghum were sown in early 2003. Germination and early seedling growth were excellent, but the crop rapidly began to show severe micronutrient deficiency symptoms and stunted growth. Various steps were taken to alleviate the symptoms. Micronutrients were applied as foliar spray and as drenches. Organic acid fertilizers were applied in an attempt to reduce the soil pH and acid mineral fertilizers were also used later for top dressing the crop. These remedial actions mitigated the micronutrient deficiency effects slightly but were too late to prevent severe damage to much of the crop. Growth continued to be severely stunted and flowering was delayed until the hot months when heat damage was observed on panicles and poor seed set obtained.

Good seed has been harvested from 125 lines that were unaffected by the problem or only slightly affected. Irrigation to the remainder of the plot continued through the hot months and the crop continued to grow. New flowering took place from tillers and seed was obtained from most of the accessions. It has not been possible to discriminate between the different accessions, however, sorghum appears poorly adapted to the alkaline soils of the region.

The 125 sorghum lines that provided good seed were resown in October to evaluate their potential to produce good quality seed during the cool season. This second sowing was not affected by the same deficiency symptoms, probably due to a heavy application of organic fertilizer to the field plot used. The quantity and quality of seed obtained was much superior to that obtained during the hot months.

*Rhodes grass* (*Chloris gayana*): The 116 accessions of Rhodes grass sown in November 2002 grew vigorously throughout the year. All have headed copiously although little seed set was observed.

*Echinochloa* (9 species): The 149 accessions of nine *Echinochloa* species planted in November 2002 showed the same severe micronutrient deficiency symptoms as described for sorghum above. The same remedial steps were attempted but with limited success. Many of the accessions were on the point of death. Open pollinated seed was harvested from most of the lines before terminating the trial.

*Sporobolus* (16 species): Seventy-six accessions of 16 *Sporobolus* species were sown in November 2002. Germination was poor and early seedling growth was extremely slow. At one point, it looked as though all the plants would die. However, as temperatures and radiation levels picked up early in 2003, growth began to improve and the plants eventually established well. Heading was excellent and seed set was obtained on uncovered heads. No pollination control was implemented to obtain seed for conservation.

*Alfalfa* (*Medicago sativa*): The 250 accessions of alfalfa sown in early 2002 were maintained during 2003. Attempts were made to control pollination of selected accessions by caging the lines of interest to exclude insects. However, in spite of copious flowering there was no seed set in the cages. Reduced airflow around the plants may have led to unfavorable temperature and humidity inside the cages that prevented seed set and development. Thus, it was not possible to achieve seed multiplication with the controlled pollination required to maintain the integrity of the different accessions. Outside the cages, with open
pollination, seed did develop, although it was in many cases small and shriveled. Because of the number of entries that died and reduction in general vigor, this trial was terminated in the middle of the year.

**Lablab** (*Lablab purpureus*): The 44 accessions carried forward from 2002 continued to grow luxuriantly throughout the early part of the year. Fresh flushes of flowers and seeds were produced. Insect pests caused severe damage to one crop of seeds by sucking on the developing seedpods and causing them to shrivel and dry up. The plants were removed from the field to make space for other trials in the middle of the year.

**Melilotus** (*Melilotus albus* and *Melilotus officinalis*): A set comprised of 241 accessions of *M. albus* and 240 accessions of *M. officinalis* was sown in November 2002. The early growth of both sets of germplasm was poor, possibly due to low temperatures. Both species also suffered severely from damage and burial by blowing sand. A group of 36 annual *M. albus* and 3 *M. officinalis* accessions grew well and flowered as temperatures began to rise in March and April. Seed set was good in the early part of the season but both quantity and quality of seeds produced fell dramatically in May and June. These annual accessions completed their growth and senesced by mid-year. The remaining accessions all failed to survive the heat of July and August.

**Hedysarum** (5 species): The 16 *Hedysarum* accessions planted in November 2002 proved poorly adapted to the conditions. All 16 failed to thrive and suffered severe damage from blowing sand. All the accessions failed to survive the heat of July and August.

**Beet** (*Beta vulgaris*): The 50 accessions of beet proved to be a mixture of vegetable types, mangels and sugar beet. All grew extremely well through the cool season, producing good quantities of foliage and substantial tubers. Partial or complete premature flowering occurred in several accessions, which were discarded from further consideration. Insect damage was severe late in the season and chemical protection was necessary.

**Pearl millet**: As reported above for sorghum, an October planting of pearl millet was undertaken to test the scope to produce good seed during the cool season. As for the sorghum, much better seed quantity and quality were produced than in the hot months when bagging of heads to prevent cross-pollination resulted in very poor seed set.

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**Plans 2004**

Evaluation of perennial germplasm that is still in the field (*Chloris gayana* and *Sporobolus* species) will be continued. Evaluation of new germplasm will concentrate on conventional crop species (barley, wheat, sorghum, pearl millet). Methods of pollination control for insect-pollinated legumes and for cross-pollinated grasses will continue to be investigated to identify methods that achieve both pollination control and good seed production in the hot and humid environment of Dubai. Trials on dates of sowing and their effects on seed production and quality will be carried out for selected species.
Development and submission of germplasm description of unique *Salicornia* species produced by BEHAR (GR03)

**Duration:** 2001-2003

**Resources:** BEHAR

**Background**
For several years, BEHAR, a private company in Saudi Arabia, has been promoting the cultivation of *Salicornia bigelovii*, irrigated with pure seawater, as a potential new crop for coastal areas of Saudi Arabia. BEHAR seeks intellectual property protection of the varieties that it has developed and contracted ICBA to assess and describe its experimental varieties for preparation of crop or germplasm registrations.

**Objectives**
1. Assess 24 lines of *Salicornia bigelovii* for uniformity and suitability for crop or germplasm registration.
2. Prepare variety descriptions of selected lines for registration.

**Achievements 2003**
Initial evaluation of the 24 lines of *Salicornia* took place in 2002. On the basis of this evaluation, five lines were selected for further study in 2003.

The selected lines were sown directly into the field in early November of 2002. Single plots were sown for each of the five study lines. Plant population was adjusted to give approximately 600 plants per plot. Data was collected on approximately 200 individual plants per line during flowering and maturity phases. The traits studied included qualitative and quantitative characteristics of the plants and spikes. Seed yields and seed characteristics were also measured after harvest and threshing of the study plants in July/August 2003. Data collection, entry and analysis were completed and a final report on the project was submitted to BEHAR.
Production and Management Systems Program

The objective of the Production and Management Systems Program is to evaluate and select new and improved varieties of field and forage crops and halophytes and to investigate sustainable and improved management techniques for their ability to sustain economic production under irrigation with moderately to highly saline water.
The work of the Production and Management Systems Program is organized under four sub-programs.

Sustainable land and water use

The objective of the sustainable land and water use sub-program is to develop irrigation and soil-salinity management strategies for the sustainable use of moderately to highly saline water for crop production.

Field and forage crop production

The objective of the field and forage crop production sub-program is to evaluate and select new and improved varieties of field and forage crops and to investigate improved management techniques for their ability to sustain economic production under irrigation with moderately to highly saline water.

Halophyte production

The objective of the halophyte production sub-program is to evaluate and select new and improved varieties of halophytes for agricultural production and greening projects. Plants selected will persist and produce at salinities of 15,000 ppm and greater.

Horticultural crop production

The objective of the horticultural crop production sub-program is to identify a wide selection of horticultural crops and techniques for their management under highly saline conditions.
Sustainable land and water use

Sustainable utilization of saline groundwater and wastelands for plant production (PMS13)

Duration: 2000-2005

Collaborators: International Atomic Energy Authority (IAEA); Ministry of Agriculture and Fisheries (MAF), United Arab Emirates

Resources: ICBA, IAEA, MAF (UAE)

Background
Domesticating wild species has been one approach to using salt-affected land and saline water for agricultural production. This approach involves selection and evaluation of wild salt-tolerant species to determine their salt tolerance and productivity. Once selected and evaluated the potential species can be tested under different management practices, including irrigation, fertilization, pre- and post-harvest methods, to optimize productivity and increase the quality of the product.

In 1995, the International Atomic Energy Authority (IAEA) prepared a Concept Paper on 'Economic utilization of salt-affected land and saline groundwater to grow salt-tolerant plant species'. This led to the approval and execution of a six-year project in Morocco, Tunisia, Egypt, Syria, Iran, Pakistan and the UAE.

This project includes evaluation and monitoring of native and introduced species in the first phase and optimizing productivity in the second phase. Monitoring of groundwater quality and soil salinity are important aspects of the project.

Objectives
The project has four major objectives:
1. Introduction and demonstration of salt-tolerant plants in each participating country.
4. Transfer of technology to end users.

Achievements 2003
In 2003, efforts continued to introduce and evaluate further salt-tolerant species under local conditions at ICBA. In addition to the plants established earlier, the tree species *Tamarix stricta*, *Conocarpus erectifolius*, *Casuarina equisetifolia*, *Acacia arabica* and *Zizyphus jujuba* were introduced and irrigated with highly saline water (~30 dS/m) (Figure 1).

![Graph showing plant height at 6, 20, and 36 months after transplantation](image)

Figure 1. Plant height of species grown with highly saline water (~30 dS/m) 6, 20 and 36 months after transplantation.
The grass species, *Paspalum vaginatum*, *Leptochloa fusca*, and *Sporobolus arabicus* established very well under irrigation with highly saline water (~30 dS/m).

![Newly established *Paspalum vaginatum* (left), *Leptochloa fusca* (center) and *Sporobolus arabicus* (right)](image)

![Growth of A. amplus (left), an individual tree (center) and after cutting (right)](image)

<table>
<thead>
<tr>
<th>Parameters</th>
<th><em>Acacia amplus</em> (after 30 months)</th>
<th><strong>Salvadora persica</strong> (after 36 months)</th>
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<tbody>
<tr>
<td>Plant height (m)</td>
<td>3.528</td>
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<tr>
<td>Crown diameter (m)</td>
<td>4.152</td>
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<td>Basal circumference (cm)</td>
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<td>7.058</td>
</tr>
<tr>
<td>Average number of leaves/plant</td>
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<td>Average number of branches</td>
<td>34</td>
<td>26</td>
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<table>
<thead>
<tr>
<th>Biomass (tonnes/ha)</th>
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<tbody>
<tr>
<td>Fresh weight of leaves</td>
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<td>2.89</td>
</tr>
<tr>
<td>Air dry weight of leaves</td>
<td>2,911</td>
<td>1.45</td>
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<tr>
<td>Oven dry weight of leaves</td>
<td>1,164</td>
<td>0.63</td>
</tr>
<tr>
<td>Ash free dry weight of leaves</td>
<td>0.934</td>
<td>0.43</td>
</tr>
<tr>
<td>Fresh weight of stem (branches)</td>
<td>3,101</td>
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</tr>
<tr>
<td>Dry weight of stem (branches)</td>
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</tr>
<tr>
<td>Oven dry weight of stem (branches)</td>
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<td>0.56</td>
</tr>
<tr>
<td>Ash free dry weight of stem (branches)</td>
<td>1,136</td>
<td>0.51</td>
</tr>
</tbody>
</table>

Plant biomass has been estimated in tonnes/ha for 3 x 3 m inter-plant spacing. *Plants were harvested at 1.5 m above ground level; branches = 5.2 cm* 
**Circumference of branches harvested 1 m above ground level**

Among the shrubs and trees tested since 2001, *Acacia amplus*, *Salvadora persica* and *Casuarina glauca* showed higher growth rates. The former two species were also subjected to moderate cutting for forage (Table 1). *A. amplus* seems to be more productive both for leaves and twigs as forage, and also woody stem as fuel wood.

**Preparation of Feasibility Report and National Program** IAEA approved the Strategic Document for UAE in 2002 and, in 2003, ICBA and the Ministry of Agriculture and Fisheries (MAF) initiated the preparation of the Feasibility Report as follows:

- Nominations for project committee members were finalized for both the Ministry of Agriculture and ICBA.
- Committee meetings were held to follow up on the completion of the Feasibility Report and the National Program.
- Data for the Feasibility Report was collected by Ministry scientists for the approval of the committee.
- The committee is awaiting confirmation of UAE participation from IAEA and for the release of funds.

**Plans 2004**

The following project activities will continue in 2004:

2. Implementation of part of the National Program for the UAE on the basis of the Strategic Plan that ICBA and the UAE have submitted to IAEA.

The current trials will also be continued as part of ICBA’s *Strategic Plan 2000-2004* to introduce and evaluate species of economic importance.
Demonstration of biosaline agriculture at Nimir, Sultanate of Oman (PMS07)

Duration: 2001-2004
Resources: Petroleum Development Oman

Background
Petroleum Development Oman (PDO) generates 550,000 m³/day of saline process water as part of the oil production process. This process water is not readily usable as it contains oil and heavy metal contaminants. Currently, the process water is injected into deep aquifers, a costly and energy-intensive process. In an attempt to reduce production costs, PDO is investigating the development of an environmentally-friendly solution to water disposal using inexpensive biological treatment systems and biosaline agriculture.

In 2002, PDO contracted ICBA to design and implement a biosaline agriculture pilot project to treat process water to an acceptable level and demonstrate the use of treated process water in a biosaline agriculture pilot project. The system was commissioned in early January 2003.

Objectives
1. To treat contaminated saline water through biological systems.
2. To use treated process water in a biosaline agriculture pilot project.

Achievements 2003
A comprehensive evaluation of the performance of process water biological treatment systems was completed in 2002 and the biosaline agriculture pilot project was established in 2003. The pilot project is a multiple-cropping system in which grasses are integrated with shrubs and trees. Grass species are primarily used for forage, whereas trees and shrubs may be used for forage, wood and agroforestry.

Two grass species (Paspalum vaginatum and Sporobolus arabisus) established and multiplied successfully under the prevailing harsh climatic conditions and poor quality irrigation water. Shrubs (a variety of species of Atriplex) established almost 100% with a very fast growth rate. Tree species (Conocarpus lancilobus and Acacia ampliceps) also exhibited a very rapid growth rate (Figures 2, 3 and 4).

Soil salinity measurements have been conducted in reference to the different plant species and production systems (Figure 5).

Figure 2: Survival and growth of shrub and tree species grown with treated process water (EC 10-15 dS/m). SBC refers to Saline Biological Concentration plots where drainage water is reused to irrigate halophytes, Nimir, Sultanate of Oman.

Figure 3: Shoot volume of Atriplex species irrigated with saline processed water, Nimir, Sultanate of Oman.
Salt-tolerant shrubs and trees thriving on treated process water in the pilot biosaline agriculture demonstration, Nimr, Sultanate of Oman.
Figure 4. Survival and growth of shrub and tree species irrigated with saline processed water, Almri, Sultanate of Oman.
Figure 5. Effect of processed saline water irrigation on soil salinity for low irrigation and high irrigation production systems, Nimm, Sultanate of Oman
Managing salinity and waterlogging in coastal agricultural areas in Abu Dhabi, United Arab Emirates (PMS08)

**Duration:** 2002-2003

**Resources:** Sewerage Projects Committee (SPC), Abu Dhabi, United Arab Emirates

**Background**

Salinity and waterlogging affect many of the new agricultural developments in coastal areas in Abu Dhabi Emirate. Lack of rainfall, combined with poor natural drainage, has resulted in the accumulation of brackish irrigation water in natural depressions and a rise in soil salinity. In some areas, these problems have appeared just two years after agricultural operations began and have led to the abandonment of severely affected farms. Following successful reclamation of a 55 hectare pilot area in Al Ajban agricultural area, the Sewerage Projects Committee (SPC), Abu Dhabi, contracted ICBA to advise on reclamation of two other farming areas, Al Nahda and Al Shahama, in addition to the remainder of the Al Ajban farming area. The total area under reclamation in the year 2003 was about 55 km².

**Objectives**

1. To identify and determine patterns of groundwater movement causing waterlogging and subsequent salinity.
2. To recommend the most appropriate reclamation systems. These systems range from chemical amendments and leaching, to drainage networks and developing concept solutions.

**Achievements 2003**

Following the success of the pilot project in reclaiming salt-affected farms in Al Ajban, a proposal was submitted and approved for reclamation of an area of approximately 55 km² in Al Nahda and Al Shahama.

Hydrogeological investigations and modeling determined the movement of saline water in both Al Nahda and Al Shahama and, based on the results (Figure 6), a concept drainage design was prepared for Al Nahda (Figure 7).

The installation of the drainage network in Al Nahda was completed in December 2003. The concept design for Al Shahama area is currently being prepared.

**Figure 6. Hydrogeological model tracking saline water movement**

**Figure 7. Concept drainage design for Al Nahda, Abu Dhabi, United Arab Emirates**

**Plans 2004**

1. Implement monitoring programs to evaluate the effectiveness of the installed drainage networks in mitigating salinity problems.
2. Tackle new areas with salinity problems, namely Al Wathba area.
Assessment of saline water resources in West Asia and North Africa (PMS10)

Duration: 2002-2003

Collaborators: N/a

Resources: International Fund for Agricultural Development (IFAD), NARS of Algeria, Jordan, Libya, Oman, Syria, Tunisia and Yemen

Background

This study assessed the quantity of brackish water available for irrigated biosaline agriculture in seven countries in the West Asia and North Africa (WANA) region on behalf of IFAD. Assessments were made in Syria, Oman, Yemen, and Jordan in West Asia; and Algeria, Tunisia, and Libya in North Africa.

The study was the first to consider brackish water as a resource. Existing hydrogeology studies either did not consider brackish water as a resource or considered brackish water as a waste product of no useful value in agriculture.

Objectives

1. Assess the underground and surface saline waters that could be economically mobilized for irrigation using the available technology for biosaline agriculture being generated by ICBA.

2. Quantify the water resources at three salinity levels: moderate (less than 3,000 ppm), brackish (3,000-6,000 ppm), and highly saline (6,000-15,000 ppm).

Achievements 2003

The final report Assessment of saline water resources in the West Asia and North Africa (WANA) region was submitted to IFAD in March 2003.

The study found that the potential for saline agriculture is greatest in absolute terms in Algeria, Syria and Tunisia, and in relative terms, in Oman, Jordan, Yemen and Algeria (Table 2). The total amount of brackish and saline water may be underestimated due to two factors. First, the study excluded water resources with salinities less than 3,000 ppm. Second, available data on water resources focuses on freshwater and data on brackish and saline water is limited.

Plans 2004

The information obtained through this study will form the basis for the implementation of biosaline agriculture projects in selected countries in the WANA region, in particular, the location and scope of pilot projects.

<table>
<thead>
<tr>
<th>Country</th>
<th>Usable brackish water resources (million m³/year)</th>
<th>Salinity range (ppm)</th>
<th>Basin(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jordan</td>
<td>246</td>
<td>3,000-10,000</td>
<td>Jordan Valley, Wadi Arabe, Southern Ghors</td>
</tr>
<tr>
<td>Syria</td>
<td>768</td>
<td>4,000-8,000</td>
<td>Palmyra, Sewwanah</td>
</tr>
<tr>
<td>Oman</td>
<td>320</td>
<td>6,000-15,000</td>
<td>Najd, Central Region</td>
</tr>
<tr>
<td>Yemen</td>
<td>3,000</td>
<td>3,000-8,000</td>
<td>Tihama Plain</td>
</tr>
<tr>
<td>Algeria</td>
<td>470</td>
<td>4,000-16,000</td>
<td>Souf Valley, Ouehil Basin, Oued Rhir Valley</td>
</tr>
<tr>
<td>Libya</td>
<td>208</td>
<td>&gt;5,000</td>
<td>Ghadames Area</td>
</tr>
<tr>
<td>Tunisia</td>
<td>333</td>
<td>5,000-7,500</td>
<td>South and Central Regions</td>
</tr>
<tr>
<td>Total</td>
<td>2,645</td>
<td>3,000-16,000</td>
<td></td>
</tr>
</tbody>
</table>
Demonstration of biosaline agriculture in salt-affected areas in Bangladesh (PMS09)

Duration: 2003-2004
Collaborators: Bangladesh Agricultural Research Institute (BARI)
Resources: ICBA, BARI

Background
Bangladesh is a developing country with a population of 140 million inhabitants. To help meet the food demands of the increasing population, crop production on salt-affected lands, estimated at 0.88 million hectares, must be improved.

The average annual rainfall in Bangladesh is estimated at 3,000 mm. However, most of this precipitation occurs in the monsoon season, starting in June. During the dry months of March and April, salinity problems, resulting from seawater intrusion, are acute. Seawater intrudes into agricultural fields as a result of the near-sea-level topography of coastal areas.

Profitable cash crops, such as mustard and tomatoes, can be grown in these areas in the dry season with proper management of soil and water. One useful technology for these conditions is drip irrigation on raised beds. Raised beds permit adequate leaching of salts from the root zone.

Experimental sites in the districts of Noakhali and Sonagazi in Southern Bangladesh were selected for demonstrating production of cash crops using raised bed techniques. In 2002, the experimental design was set up and, as a precursor to the implementation of the experimental treatments, a baseline survey was conducted to assess the socio-economic conditions of farmers.

Objectives
1. Introduction of new techniques for soil and water management in salt-affected areas.
2. Demonstration of economically sustainable biosaline agriculture in salt-affected areas.

Achievements 2003
A baseline survey of 100 farmers was conducted in both Noakhali and Sonagazi. Data collected included land use, cropping patterns, and the extent and nature of salinity problems. Soil and water samples were also collected from the project sites for further laboratory analysis.

Survey results indicated that the average cultivated area is about 1.4 hectares per household. The soil type varies from sandy loam to clay loam and the major water source is rainfall. Rice is the major crop (var: T. Aman). About 54% of respondents had no plough and 67% of the respondents in one area did not take any measures to mitigate salinity problems. The family size in the targeted areas varies between 7.6 and 8.6 members.

Plans 2004
Two experimental sites will be established in the Sonagazi and Noakhali districts. Four crops, tomato (var: Ratan), chili (var: BARI Lanka-1), barley (var: BARI Barley-4) and mustard (var: BARI sharisha-6) will be studied. Tomato and chili will be grown under (i) drip irrigation and raised beds, (ii) ridge, furrow and (iii) no irrigation treatments. Barley and mustard will be grown with (i) furrow irrigation (ii) beds, furrows and no additional irrigation, which is the common practice amongst farmers in Bangladesh. Yield will be measured for each treatment along with periodic measurements of soil salinity. Field days will be organized in March 2004 and towards the end of the experiment to disseminate the results.

Low cost drip system for irrigation with saline water, Bangladesh
Use of low quality water for desert and salt-affected areas in Pakistan (PMS21)

**Duration:** 2003-2005

**Collaborator:** Pakistan Agricultural Research Council (PARC)

**Resources:** ICBA, PARC

**Background**

Pakistan has a population of 140 million, and most of the country has an arid or semi-arid climate. Of the total area of about 79.6 m ha, 22 m ha is cultivated. Of the total cultivated land, 6.8 m ha are salt affected, whereas, salinity and waterlogging coexist in an area of 1.1 m ha. Salinity has significant economic and social implications especially for small farmers in affected areas. Such areas constitute about 47% in Sindh and more than 15% in Punjab. In these areas, the underground water in general is of poor quality and is the main cause of salinity problems. Moreover, conventional crops cannot be grown as good quality canal water is scarce. Therefore, there is a need to develop appropriate farming systems for desert and salt-affected lands.

ICBA, in collaboration with the Pakistan Agricultural Research Council, began this project in January 2003.

**Objectives**

1. To select and adapt appropriate species for silvo-horticultural systems.
2. To evaluate irrigation techniques for efficient utilization of low quality water.
3. To monitor soil salinity under different management strategies.
4. To develop management strategies for marginal lands and water.

**Progress 2003**

Work began at three salinity sites representative of different ecological regions in Pakistan.

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Evaluating water management strategies for silvo-horticultural systems in salt-affected soils. *Grewia asiatica* (left) and *Sesbania sesban* (right), at Field Camp, WRRI, Pindi Bhattian Site

1. **Evaluation of water management strategies for silvo-horticultural systems in salt affected soils**

   The first trial site at Field camp, WRRI, Pindi Bhattian Site, has clay loam soil with an EC in the soil profile ranging from 3.4 to 15.5 dS/m. Groundwater has an EC of 1.22 dS/m (781 ppm). However the soil is highly sodic (SAR ranging from 16.18 to 79.14) and the water has a RSC value of 3.9 meq.1

   Two species, *Grewia asiatica* and *Sesbania sesban* were transplanted in March 2003, as fruit and green manure plants respectively. Irrigation with both ground and canal water is applied separately and conjunctively. Data on survival, plant height and stem girth have been recorded for *Grewia*. For the first six months, *Sesbania* were cultivated for green manure and were ploughed in to improve soil porosity. They will be again re-planted for forage production.

2. **Performance of silvo-horticultural systems under various irrigation treatments to increase productivity from salt-affected soils**

   The second trial is being conducted at Field Station, WRRI, Bhalwal. The soil at this site is loamy with an EC in the soil profile ranging from 2.6 to 5.3 dS/m, however the soil is highly sodic (SAR ranging from 10.16 to 24.60). Groundwater has an EC of 2.94 dS/m (1882 ppm) with a RSC value from 3.8-4.3 meq.1

   *Sesbania sesban* (as a green manure plant) and *Psidium guajava* were planted in April 2003. Irrigation treatments are based on three evapo-transpiration rates. Germination of *S. sesban* was reported to be only 30% and the crop was ploughed in during July 2003. On the other hand, only 15% of *P. guajava* survived because of poor establishment on very dense soil. New seedlings will be planted.
Highly sodic soil at Field Station, WRRL, Bhaveal (above). Sesbania sesban (below) and P andium guajaval (right) are being assessed for productivity in these soils.

**Plans 2004**

The trials will continue in 2004, and will include evaluation of different inter-cropping systems at the three sites using a range of species.

Data will be collected on survival rate, height and girth (monthly) for tree species, and biomass productivity will be measured for fodder/orage species. In addition, soil samples will be collected periodically for monitoring soil salinity.

A farmers’ day will be organized during the year.
Field and forage crop production

Screening and evaluation of salinity tolerance, growth, yield potential and forage quality in selected cultivars/accessions of pearl millet and sorghum under field conditions (PMS02)

Duration: 2002-2003

Collaborator: International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)

Resources: ICBA, ICRISAT

Background

Cereals are among the priority target crops for the evaluation of salt-tolerant genotypes. In addition to being highly important food and feed sources, many of the important cereal crop species also possess large genetic variations for many traits including salinity tolerance. Since ICBA is not involved in breeding programs to generate appropriate plant materials, it is collaborating with specialized international research organizations to evaluate salinity tolerance in their mandate crops and make use of the material they have already developed. Hence ICBA is collaborating with the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) in the evaluation of salinity tolerance in pearl millet and sorghum. These cereals are two of the most important feed and food crops, and are considered to have great potential for expansion into many parts of the world, including the West Asia and North Africa region.

Objectives

1. Screen and evaluate salinity tolerance in elite germplasm and accessions of pearl millet and sorghum from ICRISAT’s breeding program under field conditions.
2. Select salt-tolerant genotypes for further large-scale field evaluation.
3. Evaluate nutritional values among selected genotypes under different salinity levels.
4. Produce sufficient amounts of seed for further evaluation and dissemination to national programs.

5. Develop nurseries of salt-tolerant pearl millet and sorghum genotypes for field evaluation by targeted national programs.

Achievements 2003

During 2003, 91 genotypes of pearl millet and 142 genotypes of sorghum were evaluated for salinity tolerance under field conditions in a late spring planting at three salinity levels: 5, 10 and 15 dS/m. Fall planting was not undertaken because of poor performance in the previous fall.

Initial assessment of the results showed similar trends to the previous season. Variations among genotypes in salinity tolerance at all salinity levels are evident. Selection of an initial nursery (25-30 genotypes) of each species will be made based on the results of 2002 and 2003.
Pearl millet and sorghum elite genotypes and accessions showed a wide range in yield under all salinity levels. Field yields on a per plant basis are presented in Figures 8-12. Based on high performance under all salinity levels and stability across seasons, 14 elite genotypes and 15 accessions were selected for evaluation in farmers’ fields and several National Agricultural Research Systems (NARS) in the region.
Dry matter production range in 54 elite sorghum genotypes grown at 5 dS/m

Figure 10. Biomass production in 54 sorghum genotypes at 5-15 dS/m

Dry matter production range in 54 elite sorghum genotypes grown at 10 dS/m

Figure 11. Mean dry matter production in high-yielding sorghum genotypes at 5-15 dS/m

Dry matter production range in 54 sorghum elite genotypes grown at 15 dS/m

Figure 12. Dry matter production in 63 sorghum accessions at 10 dS/m

Plans 2004

Nurseries of salt-tolerant genotypes of pearl millet and sorghum will be identified and evaluated for their productivity and nutritional values in response to various salinity levels at ICBA and also in farmers’ fields in both the United Arab Emirates and the Sultanate of Oman.

Field evaluation of pearl millet
Development of salt-tolerant sorghum and pearl millet varieties for saline lands (PMS15)

Duration: 2003-2006

Collaborator: ICRISAT

Resources: ICBA, ICRISAT, OPEC Fund

Background
Soil and irrigation water salinity has emerged as a major crop production problem worldwide. It has been estimated that annually two million hectares of land are lost to agricultural production because of salinization. Engineering and agronomic options have been used in managing salt-affected soils, but these are not practical everywhere, primarily because of the prohibitive costs, or because of agro-climatic conditions. Also, these options provide location-specific solutions and have annual recurring costs. Development and adoption of salt-tolerant crop varieties has been suggested as one cost-effective option to manage salt-affected lands. The goal of this project is to improve agricultural productivity in salt-affected arid and semi-arid environments of the Near East and Asia through the development of pearl millet and sorghum genotypes with high grain and fodder yields and improved salt tolerance.

Objectives
1. Selection of pearl millet and sorghum genotypes with improved salt tolerance suitable for forage and dual-purpose forage and grain production.
2. Based on selections done at both ICBA and ICRISAT, develop salt-tolerant nurseries consisting of 15-25 genotypes each of the two species, and evaluate the genotypes on-farm in Ras Al Khaimah in the United Arab Emirates, and in Oman, Iran, Yemen, Sudan, and India.
3. Identification of molecular markers for quantitative trait loci (QTLs) affecting salt tolerance.
4. Evaluation of the nutritional values of selected genotypes under various saline conditions.
5. Optimization of the productivity of pearl millet and sorghum in salt-affected environments of the Near East region.
6. Transfer of technologies and crop production packages to national programs and farmers.

Achievements 2003
The project proposal submitted jointly by ICBA and ICRISAT to the OPEC Fund for International Development for funding was approved and supported by a grant for three years starting in July 2003.

A first coordination meeting between the project teams from ICBA and ICRISAT took place in July 2003 at ICRISAT headquarters in India. A detailed work plan and schedule of activities were developed by the project team to meet the objectives and expected outputs of the project.

Plans 2004
An additional 300 sorghum genotypes and 300 pearl millet genotypes will be screened for salt tolerance during the project. ICBA has already received more than 350 genotypes of the two species. Controlled and field evaluation of salt tolerance among the pearl millet and sorghum genotypes will take place at both institutions during 2004. In addition initial sets of selected genotypes will be evaluated in farmers’ fields in both the United Arab Emirates and the Sultanate of Oman in 2004 and subsequent years.

Trials related to the development of optimum production practices will be initiated at ICBA during 2004. Various management practices will be applied to a selected group of salt-tolerant genotypes of pearl millet and sorghum. ICRISAT will also develop mapping populations for future use in identifying molecular markers of QTLs associated with salt tolerance.

Chemical and nutritional analysis will also be performed during 2004.
Optimizing management practices for maximum production of two salt-tolerant grasses: *Sporobolus virginicus* and *Distichlis spicata* (PMS03)

**Duration:** 2002-2006  
**Collaborator:** United Arab Emirates University (UAEU)  
**Resources:** ICBA, UAEU

**Background**
Long-term field studies on the economic feasibility and sustainability of forage production systems that are based on the use of non-conventional salt-tolerant grasses and highly saline waters are very limited internationally, and not available for the region. In order to assess such forage production systems, two highly salt-tolerant grasses, *Sporobolus virginicus* and *Distichlis spicata*, were selected (based on previous evaluations of their salinity tolerance, nutritional value, and suitability for mechanical harvesting and handling for economical large-scale production) and a large field was established for research and demonstration at ICBA’s headquarters.

**Objectives**
1. Determine the yield potential of the two grasses when grown under high salinity levels, and the level at which the productivity remains economical.
2. Determine the optimum irrigation level for maximum production of the two grasses, and the level that minimizes salt accumulation in the soil.
3. Determine the appropriate fertilizer regime for maximum production.
4. Assess the nutritional value of the two species in response to the different salinity, irrigation and fertilizer levels.

**Achievements 2003**
In late 2002 the first cut of both grasses was taken. In 2003 all irrigation, fertility and salinity treatments were applied. Four cuts (March, June, August and November 2003) were completed. Chemical and nutritional analysis of the plant materials is currently underway in collaboration with the UAE University in Al-Ain and the Abu Dhabi Agricultural Laboratory.

**Results**
An initial assessment of the results is presented in Figures 13 to 17.

Figure 13. Biomass production in *Sporobolus virginicus* and *Distichlis spicata*

Figure 13 shows mean biomass production of the two species at three salinity levels and four harvests in 2003. Yields were consistently higher at the high salinity level in both species. The average yield at all salinity levels reached nearly 37 tonnes/ha in *Distichlis* and 35 tonnes/ha in *Sporobolus*.

The spring harvest, which represents the winter growth, gave the least yield among the four cuts. The early summer harvest, which represents spring growth gave the maximum yield in both species. The August harvest, which represents summer growth, gave medium yields between the other two (Figure 14).
When maximum yield is considered, which was consistently the yield at the highest salinity, irrigation and fertility levels, total biomass production from the four cuts reached more than 46 tonnes/ha in *Distichlis* and more than 43 tonnes/ha in *Sporobolus* (Figure 15). This data is very significant considering that the grasses are grown at a high salinity level of 30 dS/m. Initially, it can be seen that management input (irrigation and fertility levels, and cutting management) can lead to a large improvement in yield.

![Application of fertilizer to the halophyte grasses *Sporobolus virginicus* and *Distichlis spicata*](image)

**Figure 14.** Yield dry matter production in *Sporobolus virginicus* and *Distichlis spicata*

**Figure 15.** Dry matter production in *Sporobolus virginicus* and *Distichlis spicata* at high salinity (30 dS/m) and optimal fertility level

**Figure 16.** Effect of fertility level on dry matter production in *Distichlis spicata* at four fertility levels
Increased fertility levels positively influenced biomass production in both species particularly at 10 and 20 dS/m (Figures 15 and 16).

The unique characteristic of both grass species is the low mineral content of the plant tissue even when grown at high salinity. Figures 17 (a-d) show protein and ash percentages for the two species under various salinity and fertility levels. Distichlis generally had higher protein and ash contents than Sporobolus. An increase in salinity level led to higher ash content in both species. Similarly, protein content increased with salinity but was more evident in Distichlis. In contrast to Atriplex shrubs, an increase in fertility levels did not cause a significant increase in ash content. Collectively, such a response makes the two species very good forages even when grown under high salinity levels.

Halophyte grasses Sporobolus virginicus and Distichlis spicata have been developed for large-scale mechanized field production

**Plans 2004**

Four cuts are targeted for 2004. It is expected that the analysis of data on the cumulative effects of salinity, fertilizer and irrigation levels will allow the formulation of solid conclusions about the performance of the two species under various salinity levels and about optimum management practices that lead to maximum and sustainable yield.

Figure 17a-d (Left). Ash and protein percentage for Distichlis spicata and Sporobolus virginicus at three salinity levels
Development of sustainable salt-tolerant forages for sheep and goat production (PMS16)

Duration: 2003-2006
Collaborator: United Arab Emirates University (UAEU)
Resources: ICBA, UAEU

Background
This project aims at improving the sustainability of sheep and goat production systems by increasing the availability of animal feed through the introduction of salt-tolerant forages. It consists of two components. The first component (see project PMS03) focuses on optimizing management practices for large-scale production of two salt-tolerant grasses (Sporobolus virginicus and Distichlis spicata) and three Atriplex shrub species (Atriplex halimus, A. nummularia and A. lentiformis) (see project PMS04). The second component will focus on the performance of indigenous goats (Emirati and Jabi) and sheep (Mahali and Hebsi), fed salt-tolerant forages as the only source of fodder. Productive and reproductive performance, as well as feed intake, will be considered. Also, the adaptive and genetic potential of the species and breeds studied will be evaluated.

It is expected that the results of this project will lead to a significant reduction in the feeding costs of both sheep and goat production systems. Also, the results will help in determining the productive and adaptive capabilities of indigenous breeds, which will contribute to sustainable agriculture in low-input production systems.

Objectives
The overall objective of this research project is to develop salt-tolerant forages, and sheep and goat production systems that are environmentally sustainable in the Gulf Coast region. Specific objectives of the project are:

1. To develop sustainable salt-tolerant forage production systems which are less resource demanding and utilize marginal lands and salt water resources.
2. To develop sustainable sheep and goat production systems based on the use of salt-tolerant forages.

Achievements 2003
The project was jointly funded by ICBA and the United Arab Emirates University at Al-Ain for three years starting from January 2003.

This project is a continuation of projects PMS03 and PMS04, the production of salt-tolerant grasses, already in progress. The second component, feeding trials, began in 2003. Forages produced at ICBA are delivered to the UAEU Farm for use in the feeding trials and for nutritional analysis.

Plans 2004
The project will be fully operational during 2004. Plant production trials and optimization of production of salt-tolerant forage grasses and shrubs will be well established and generate information about the productive potential of these species under salinity and their value in animal feeding. Chemical analysis will be also performed on plant materials produced under various salinity levels. Initial assessment of optimum management practices will also be available at the end of 2004.
Optimizing management practices for maximum production of three *Atriplex* species under high salinity levels (PMS04)

**Duration:** 2002-2006

**Collaborator:** United Arab Emirates University (UAEU)

**Resources:** ICBA, UAEU

**Background**

*Atriplex* is well known for its salt tolerance and its value as a high-protein feed for animals. However, animals do not thrive if they are fed solely on a diet of *Atriplex* because it contains a high concentration of mineral salts. Nevertheless, a mix of salt-tolerant grass and shrubs can provide a balanced diet.

This project assesses the potential production, feasibility and long-term sustainability of a forage production system based on salt-tolerant forage shrubs.

**Objectives**

1. Determine the yield potential under high salinity levels, and the level at which the productivity remains economical.
2. Determine the optimum irrigation level for maximum production and minimum salt accumulation in the soil.
3. Determine the optimum plant density for maximum production at all salinity levels.
4. Determine the appropriate fertilizer regime for maximum production.
5. Assess the nutritional value in response to the different salinity, irrigation and fertilizer levels.

**Achievements in 2003**

In 2003 all treatments were applied and soil moisture and salinity levels under each treatment were monitored. Plant samples are being analyzed for chemical composition and nutritional values. In 2003 two cuts were completed. The results highlighted here are for one cut only.
Total fresh weight in one cut ranged from 3,000 to more than 8,000 kg/ha. *A. lentiformis* achieved the highest biomass among the three species. In all species biomass production was highest at the high salinity level, a true halophyte response (Figure 18). However, biomass partitioning was different among the species. Total leaf weight in *A. lentiformis* and *A. halimus* was similar (Figures 19 and 20). The former usually produces more stems than the other two species. Partitioning also varies according to the season of cut.

Since saline water is used for irrigation of *Atriplex*, a key objective is to achieve maximum biomass production. Therefore, several planting densities were evaluated. As expected, high density led to higher productivity at all salinity levels (Figure 20 a-c). At 10 dS/m and high density, *A. halimus* produced more biomass than other species. However, with increased salinity level, *A. lentiformis* had higher biomass than others at all density levels.

*Figure 20. Higher plant density led to higher productivity at all salinity levels.*

**Plans 2004**

The focus in 2004 will be on monitoring and evaluation of the performance of the three species under the various management practices. In addition, nutritional values will be evaluated and feeding trials with goats and sheep will be undertaken. Assessment of optimal management practices will be determined during 2004.

Results for the first phase of the project will be compiled and presented in late 2004.
Evaluation of salinity tolerance and yield in 280 barley varieties and accessions (PMS17)

**Duration:** 2003-2004

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

**Resources:** ICBA, ICARDA

**Background**

In addition to its adaptation to a wide range of environmental conditions, high productivity, and nutritional value, barley is also well known for its high salt tolerance among conventional crop plants. Wide genetic diversity within the species makes it possible to further improve salt tolerance through breeding and selection. Barley is a very important component in dry land agro-ecosystems. It constitutes a stable source for animal feed in such environments. Therefore, improving the productivity of barley in such environments, where salinity is increasingly a limiting factor to irrigated agricultural systems, is a strategically important objective. ICBA, in collaboration with ICARDA, is targeting improving salt tolerance in barley. A large number of improved barley genotypes and accessions from Oman are being evaluated for salt tolerance under mild winter conditions in the UAE.

**Objectives**

1. Evaluate salt tolerance among 280 genotypes of improved and landrace barley.
2. Select salt-tolerant genotypes for large-scale field evaluation of productivity and optimum management under salinity.
3. Provide national programs in the region with sufficient seed of barley genotypes with improved salt tolerance for field evaluation.
4. Provide collaborator institutes with information about salt tolerance among their barley accessions for further use in breeding for better salt tolerance in barley.

**Achievements 2003**

Two hundred and eighty genotypes, representing elite germplasm from the ICARDA barley breeding program and accessions from local Omani landraces, were evaluated during 2002/2003 for their salt tolerance under field conditions at three salinity levels: 5, 10 and 15 dS/m.

![Graphs showing dry matter production at different salinity levels](image)

Figure 21. Dry matter production in 280 barley genotypes at 5-15 dS/m
Results are still being analyzed, however the initial assessment of data shows a wide range in growth and yield potential of both biomass and seed among the 280 genotypes evaluated. Figures 21 and 22 summarize some of the highlights.

Total dry matter production under low salinity reached high levels that are comparable to other low-stressed environments. Even at high salinity levels some genotypes maintained yield levels of 8-10 tonnes/ha. Seed production was similarly high under medium and low salinity; several genotypes produced more than 5 tonnes/ha. Even at high salinity (15 dS/m) several genotypes had productivity in the range of 2-3 tonnes/ha. This is still within the range of economic return for barley cultivation. Further improvement through management will also lead to improvement of seed and biomass production. Further analysis of the results will be performed later this year.

**Plans 2004**

Based on biomass production and seed yield, a group of 70 genotypes were selected for large-scale field evaluation during 2004. This will include evaluation under the same three salinity levels and assessment of yield and nutritional value among the selected genotypes. Similarly, sufficient seeds of the best performing genotypes will be produced and made available to interested national programs for in-country field evaluation and selection. Additional barley materials will be acquired for further evaluation and expansion of the salt-tolerant gene pool at ICBA.
Screening for salt tolerance among selected pigeonpea and groundnut varieties under controlled conditions (PMS18)

**Duration:** 2003-2006

**Collaborator:** ICRISAT

**Resources:** ICBA, ICRISAT

**Background**

The Production and Management Systems Program focuses on developing forage and crop production systems for salt-affected environments. In highly salt-affected environments, the focus is on non-conventional forage plants and some highly salt-tolerant conventional crop grass species. However, for moderately salt-stressed environments, other crop species with higher economic and nutritional value can be used. Within this strategy, ICBA’s field and forage crop production sub-program is examining potential salinity tolerance among several forage crops, including pigeonpea and groundnut, in collaboration with ICRISAT, the international center responsible for the breeding and improvement of both crops.

**Objectives**

1. Evaluate salt tolerance and productivity of elite pigeonpea and groundnut genotypes from ICRISAT’s breeding program.

2. Select promising genotypes for further field evaluation.

**Achievements in 2003**

During 2003, 73 genotypes of pigeonpea and nine genotypes of groundnut were evaluated for salt tolerance under a controlled screening system. The evaluation will be repeated under an improved field screening system in 2003/2004. Initial results are shown below, and demonstrate that there are variations in salt tolerance among the genotypes that merit further evaluation and assessment of performance of the genotypes under various salinity levels (Figure 23).

**Plans 2004**

As stated above, in 2004 the same set of genotypes of both species will be evaluated at 10 dS/m under field conditions in a screening system of large containers. Subsequent field evaluation on selected genotypes will be at three salinity levels.
Screening for salt tolerance among large collections of buffel grass, safflower, fodder beet and lablab (PMS19)

Duration: 2003-2004
Collaborator: ICARDA
Resources: ICBA, ICARDA

Background

The Production and Management Systems Program at ICBA focuses on developing forage and crop production systems that fit all types of salt-affected environments. Emphasis is placed on species that can be used as forages or for other uses, as in the case of safflower. Each year the Plant Genetic Resources Program introduces and evaluates the adaptation of many potentially salt-tolerant species. Plant species with moderate to high genetic diversity are targeted for selection and evaluation under salinity, with the ultimate objective of improving the productivity of such species under high salinity levels. Within this framework, buffel grass, safflower, fodder beet and lablab were selected for evaluation of salt tolerance.

Objectives

1. Assess performance of 160 accessions of Cenchrus ciliaris, including 8 local races, 250 safflower genotypes, 50 fodder beet, and 25 lablab genotypes, at a moderate salinity level of 10 dS/m.

2. Select promising genotypes for further evaluation at a large scale under field conditions and various salinity levels.

Achievements 2003

Initial screening of the performance of buffel grass and safflower was completed in 2003. Results show that variation in response to salinity among accessions is wide. Selection of genotypes for subsequent field evaluation and improvement of salt tolerance is therefore feasible. Performance of Cenchrus ciliaris genotypes grown at 10 dS/m over three harvests is shown in Figure 24.
Similarly, at 15 dS/m, several genotypes maintained higher yield levels. Those genotypes will be evaluated at a large scale under field conditions.

**Figure 24. Performance of *Cenchrus ciliaris* genotypes grown at 10 dS/m and 15 dS/m**

**Figure 25.** Average dry matter production in top 10 genotypes, two commercial varieties and 8 local accessions of *Cenchrus ciliaris* (Buffel grass) grown at 10 and 15 dS/m

Performance of the international top 10 genotype accessions, local accessions and commercial varieties at 10 and 15 dS/m showed that mean yields of top performing international accessions were significantly higher than the other two groups at both salinity levels (Figure 25).

**Plans 2004**

A second cycle of screening at the same salinity level will be performed on safflower. For buffel grass, as most genotypes examined performed well at 10 dS/m, testing will take place at 15 dS/m and later at 20 dS/m. The best performing genotypes will be selected for further field evaluation.
Application of biosaline agriculture in a demonstration farm, Ras Al Khaimah, Northern Emirates of the United Arab Emirates (PMS05)

Duration: 2003-2006

Collaborator: Ministry of Agriculture and Fisheries (MAF), United Arab Emirates

Resources: ICBA, MAF (UAE)

Background
Irrigated agriculture in the United Arab Emirates has increased dramatically over the last 30 years. Yet few farmers have the skills and techniques required for irrigated agriculture in areas prone to land and groundwater salinization. This project will demonstrate biosaline agriculture techniques to farmers and show how sustainable and profitable plant production is possible on farms affected by moderate to high levels of salinity. The demonstration farm will be a model for the management of salt-affected farms in the region.

Objectives
1. Apply integrated farm management methods suitable for salt-affected farms in the Northern Emirates.
2. Demonstrate the principles of biosaline agriculture for producing conventional and non-conventional forage crops.
3. Study and monitor the physical, chemical and productive aspects of the demonstration farm, including soil, water and forage production, over a three-year period.
4. Involve local farmers and technicians in the evaluation of the project and organize field days.

Achievements 2003
- Committee members were nominated for the project by both the Ministry of Agriculture (MAF) and ICBA.
- The agreement was signed between the owner of the farm, ICBA and MAF to carry out the project.
- Installation of the irrigation and drainage systems was completed.

Plans 2004
- Planting will start in late 2003 or early 2004.
- Data will be collected as per the plan of the experiment.
- Initial assessment of data and adjustment of work plan accordingly.
Halophyte production

**Evaluation of irrigation practices and fertilizer requirements for optimizing productivity of three indigenous grass species (PMS01)**

**Duration:** 2000-2004

**Collaborators:** ICARDA-APRP, Ministry of Agriculture and Fisheries (MAF), United Arab Emirates

**Resources:** ICBA, MAF (UAE), ICARDA

**Background**

Forage is a major agricultural product in the United Arab Emirates and the Gulf Cooperation Council countries. However, due to deteriorating water quality and the low water-use efficiency of most forage species, there is an urgent need to introduce species which are more salt and drought tolerant, and have high water-use efficiency. Indigenous species are likely candidate species as they are already adapted to the prevailing conditions in the Arabian Peninsula.

Two native species, *Coelachryum piercei* and *Cenchrus ciliaris* are being evaluated against the currently widely-grown forage grass *Chloris gayana*. The evaluations, at different salinity levels, fertilizer and irrigation treatments, will provide information on the extent of salt tolerance in these species and enable management practices to be developed to optimize their productivity.

**Objectives**

1. Evaluate water-use efficiency, salinity tolerance, and fertilizer requirements of *Coelachryum piercei*, *Cenchrus ciliaris*, and *Chloris gayana*.

2. Determine an appropriate irrigation system and irrigation management practices for the above species.

**Progress 2003**

Growth and productivity of the three species have been evaluated since 2001 to assess plant establishment and forage productivity after repeated harvests.
Figure 26. Total above ground dry biomass of *C. ciliaris*, *C. piercei* and *C. gayana* grass species as affected by salinity, irrigation and fertilizer treatments. Data from the total of three cuttings.
Figure 27. Predicted soil salinity (ECe) estimated through EM-38 measurements for C. ciliaris, C. piercei, and C. gayana with reference to different treatments.
Plant cuts at each harvest and at different treatments in 2003 have shown that *C. ciliaris* has better salt tolerance and water-use efficiency compared to the other two species at the higher salinity level (15 dS/m, 10,500 ppm). Productivity for all three test species was highest at a N-fertilizer application rate of 40 kg/ha (Figure 26). Overall, *C. ciliaris* showed the best establishment, highest productivity and best salt-tolerance, followed by *C. gayana* and *C. pierceii*.

Soil salinity was measured by systematic soil sampling at different periods of growth and by determining the salinity of a soil suspension (1:5). In addition, EM-38 measurements were taken throughout the rhizosphere for all plants at all treatments. Soil EC was equal to or less than that of the irrigation water at 10 and 15 dS/m (Figure 27). Among the three species, no significant variation was observed in soil salinity for the different treatments applied. Seasonal variation in soil salinity, measured at 75 and 150 cm soil depth in soil suspension, was evident and was relatively higher in summer and lower in winter (Figure 28a-c).

**Plans 2004**

As this is a long-term study to evaluate the responses of plants to continued salt stress and to optimize productivity through irrigation and fertilization management, the trial will be continued in 2004. Plant productivity will be assessed through repeated harvests and soil salinity will be monitored periodically.

**March 2003**

Figure 28a. Seasonal variation in soil salinity (measured in soil suspension) for treatments of *C. ciliaris*, *C. pierceii* and *C. gayana*. Soil depth: 75, 150 cm. Irrigation treatments: 1=100%ET, 2=50%ET (Frequency 1), 3=50%ET (Frequency 2). Salinity: 2,500 ppm/5 dS/m, 7,000 ppm/10 dS/m, 10,500 ppm/15 dS/m, March 2003.
Figure 28b. Seasonal variation in soil salinity (measured in soil suspension) for treatments of C. ciliaris, C. plicata, and C. guayan. Soil depth: 75, 150 cm. Irrigation treatments: 1=100%ET; 2=50%ET (Frequency 1), 3=50%ET (Frequency 2), Salinity: 2, 500 ppm/5 dS/m, 7, 000 ppm/10 dS/m, 10, 500 ppm/15 dS/m, July 2003.

Figure 28c. Seasonal variation in soil salinity (measured in soil suspension) for treatments of C. ciliaris, C. plicata, and C. guayan. Soil depth: 75, 150 cm. Irrigation treatments: 1=100%ET, 2=50%ET (Frequency 1), 3=50%ET (Frequency 2), Salinity: 2, 500 ppm/5 dS/m, 7, 000 ppm/10 dS/m, 10, 500 ppm/15 dS/m, December 2003.
Water use and salt balance of halophytic species (PMS12)

Duration: Ongoing

Resources: ICBA

Background

The quality and quantity of irrigation water not only affects the growth of plant species, but also affects the accumulation of salts in the soil profile. Although leaching can minimize the accumulation of salts to some extent, in many instances irrigation water is scarce and cannot be spared for leaching. In addition, where water tables are shallow, disposal of excess water must be considered.

This project aims to improve water-use efficiency by determining not only the water requirement of the test species and the leaching requirement in the soil, but also by providing information on salt movement.

Movement of water and salts is being studied under controlled conditions to provide long-term data on salt movement and to simulate the processes under given field conditions.

Objectives

1. To develop productivity management techniques for promising halophyte forage species. Salt-tolerant plant genotypes will be tested in lysimeters to determine management methods to optimize productivity.

2. To optimize productivity of promising halophytic species by studying the effects of water quality/quantity, harvest period and frequency, and determining the nutritional characteristics of the species.

3. To develop management practices for optimizing productivity in re-use of saline drainage water.

Achievements 2003

(i) The plant height of Haloxylon salicornicum was measured from January to December 2003 to determine growth at a range of salinity and irrigation volume levels. Results showed that plant growth was less at salinities over 30 dS/m at ET\textsubscript{0} x 1.0, however, no significant changes in plant growth were observed at ET\textsubscript{0} x 1.5 (Figure 29).

![Figure 29: Height of Haloxylon salicornicum as affected by different salinity treatments and level of water application](image)

Soil salinity was also recorded to monitor the extent of salt movement at 30 cm and 60 cm. Soil salinity was higher at ET\textsubscript{0} x 1.0 at salinity > 30 dS/m (Figure 30) and correlated with decreased growth.

Data for irrigation and drainage volumes were collected daily for the salt-water balance equation after one year of plant growth.

![Figure 30: Effect of saline irrigation water supplied at two levels on soil salinity and pH at soil depths of 30 cm and 60 cm](image)
The 3-step lysimeter showing the experimental setup.

<table>
<thead>
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Grass
Tree/shrub
Halophyte
Drained water

Figure 31. Layout of the 3-step lysimeter showing the setup for different plant species. The numbers in boxes indicate the salinity (dS/m) of the irrigation water used at each level for different sets of plants.
Lysimeter experiment to measure salt movements in Haloxylon salicornicum under controlled conditions.

(ii) Three-step lysimeters were prepared for further simulation studies on re-use of drainage water for increasingly salt-tolerant plants:

(a) efficient water utilization;
(b) minimum drainage water disposal; and
(c) maximizing productivity for increasingly salt tolerant plants and halophytes.

Five sets of plant species, including grasses, shrubs and trees, are being tested in increasingly saline drainage water in a 3-step lysimeter system (Figure 31).

Preliminary observations for November and December 2003 for brine water collected at the third level indicates that only 15-25% water is drained off; the rest is transpired, evaporated from the soil surface or remains in the soil. The trees and shrubs use most of the water and leave little to be drained in such systems.

Heights measured for the tree and shrub species showed differences related to the nature of the species, rather than to any salinity treatment (Figure 32).

Figure 32. Height of tree species (grown at the second level) and Atriplex species (grown at the third level) at two-week intervals.

**Plans 2004**

(i) Using the same method, other halophyte and salt-tolerant species will be tested for field simulation studies.

(ii) The 3-step lysimeter model will provide information for reusing drainage water in a sustainable manner and the results will be tested under field conditions.
Increasing biodiversity of mangrove species in the United Arab Emirates: Introduction and adaptation of non-native species (PMS14)

**Duration:** 2002-2004

**Collaborators:** Environmental Research and Wildlife Development Agency (ERWDA), United Arab Emirates

**Resources:** ICBA, ERWDA

### Background

Mangroves are important in the Arabian Gulf for their amenity value and as breeding grounds for shrimp and fish, but they can also be used as fodder. Coastal mangroves in the United Arab Emirates are dominated by *Avicennia marina*. Introduction of other mangrove ecotypes, both of this and other species, will increase the biodiversity of mangroves in the UAE and contribute to establishing productive stands. However, before introduction of non-native species or ecotypes, potential introductions must be screened at the pilot level to determine their suitability for the region.

This project assessed survival, salt tolerance, growth rates, productivity and other eco-physiological characters of the non-native species *Ceriops tagal*, *Rhizophora mucronata* and *Rhizophora stylosa* obtained from Pakistan and Japan with a view to introducing the species to the United Arab Emirates. Based on the results, the successful species/ecotypes were introduced to the coastal zone of Abu Dhabi Emirate island.

### Objective

The objective of the project is to screen and select environmentally and biologically suitable non-native mangrove species for introduction to the UAE.

1. Introduce and adapt non-native mangrove species to the United Arab Emirates.
2. Assess plant responses to environmental conditions and agricultural practices.

### Achievements 2003

The seasonal variation in water requirement was monitored for the test species with reference to salinity levels from 5 dS/m to 50 dS/m. *Rhizophora mucronata* showed greater height as compared to *Ceriops tagal* (Figure 33) whereas in the case of *Rhizophora stylosa* the difference was not significant.

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**Figure 33.** Height of *R. stylosa*, *R. mucronata* and *C. tagal* from 16 December 2002—31 March 2003 under saline irrigation.
The chlorophyll content of the leaves, as an index of its assimilatory efficiency, was measured over a range of salinity levels, and *Rhizophora mucronata* showed a reduction in chlorophyll absorption during summer. This trend was found at all salinity levels (Figure 34).

Data on irrigation and drainage (volume and salinity), and soil salinity are being used to model the salt-water balance for the test species. Soil salinity and pH were measured for all three species at two soil depths. *R. stylosa* showed maximum salt accumulation at higher salinity levels ECw 40 and 50 dS/m (Figure 35).

Lysimeter data were collected for one growing season. Subsequently the plants were transplanted on the shore of Ras Ghanda Island in May 2003 to test their survival under the water regime, tidal wave action and effects of hot/cold wind. The initial results on survival show that *R. mucronata* and *R. stylosa* are performing better as compared to *C. tagai*. Observations related to survival, growth and multiplication will be continued in 2004.

**Plans 2004**

The three species transplanted on Ras Ghanda Island will be monitored for growth and productivity.
Figure 35. Soil salinity and pH in lysimeters with three mangrove species. Measurements were taken at soil depths of 30 cm and 60 cm.
Production of halophytes in Iran (PMS 22)

Duration: 2003-2005
Collaborator: National Salinity Research Council (NSRC)
Resources: ICBA, NSRC

Background
A collaborative project was initiated with the National Salinity Research Center at Yazd in Iran in January 2003. Previous studies in Iran through IAEA Project INT/5/144 demonstrated that some shrub and tree halophytes established successfully and that production of some halophytes for forage was feasible. Further studies are required to determine agronomic techniques for optimal production of these species as animal fodder.

Objectives
The main objectives of the project are:

1. Evaluation of nutrient requirements of some halophytic forages under irrigation with saline water.
2. Comparison of different irrigation systems for the production of halophytic forages, and their effect on soil salinity.

Achievements 2003

Experiment 1. Effects of nitrogen and phosphorus application rates on the growth and quality of some halophytic forages

This experiment is being carried out in pots at NSRC headquarters in Iran. The objectives include: (i) evaluation of the response of halophytic forages to nitrogen fertilization; (ii) evaluation of the response to phosphorus; (iii) evaluation of the effects of fertilizer on the quality of halophytic forages. Three treatments of N and P are applied at 0, 25 and 50 kg/ha. The experimental design is a CRD with three replications. All pots are being irrigated with ground water having a salinity of ~14 dS/m.

Germinated seedlings of four Atriplex species (A. nummularia, A. lentiformis, A. halimus and A. canescens) and Kochia indica were transplanted in 50 L pots in early April and the fertilizer treatments were initiated during late April 2003. Data on plant height and volume were recorded from June onwards. Plants will be harvested in reference to different stages of growth and treatments.

Evaluation of the effects of application of nitrogen and phosphorus at 0, 25
and 50 kg/ha on Atriplex species in 50 L pots irrigated at ~14 dS/m (above and below)

Experiment 2. Comparison of irrigation regimes for the production of halophytic forages

This experiment is being carried out in the Chah Alzal area in a CRBD design with three replications. The main treatment includes three irrigation methods (bubbler, drip and furrow irrigation) with five plant species (Atriplex nummularia, A. lentiformis, A. halimus, A. canescens and Kochia indica). Soil samples were collected and analyzed for initial salinity measurements. Seedlings were planted in the field during mid April 2003, with various irrigation treatments. The same set of data as described earlier for the pot experiment will be collected for this experiment. Plants will be harvested to assess biomass productivity at appropriate growth stages.
Plans 2004

Both trials will assess the medium-term (three years) response of test species to different factors, for example salinity of water and irrigation method, under field and pot conditions. Plants will be harvested three to four times in 2004 to evaluate their potential as forage crops in Iran and re-growth after successive harvests. The data on the response of halophytes to N and P fertilizers from the pot studies will be further applied in field experiments. Forage quality will also be assessed.

Hands-on training and seminars for researchers and end users of the project will be held during 2004.

Field days will also be organized by NSRC in collaboration with local R&D agencies. Farmers will be invited to inspect the experiments followed by open discussions.
Horticultural crop production

Investigation of elite date palm and olive varieties for salt tolerance (PMS06)

**Duration:** 2001-2006

**Collaborator:** Ministry of Agriculture and Fisheries (MAF), United Arab Emirates

**Resources:** ICBA, MAF (UAE)

**Background**

The cultivation of date palms is widespread throughout all regions of the United Arab Emirates. Many traditional date palm plantations are severely threatened by increasing water salinity caused by seawater intrusion, aridity and over pumping, particularly in the coastal areas of Ras Al Khaimah and eastern UAE. Date palms are negatively affected by the deterioration in water quality which not only affects the yield but also the quality of the fruit.

Few studies have examined the long-term effects of salinity on date palm growth and productivity from establishment to maturity. This long-term experiment, planned to run for five to six years, will provide valuable information on the salt tolerance of elite UAE date palm varieties.

In collaboration with the MAF, ten of the most preferred UAE date palm varieties - Khaleej, Faradh, Barhi, Lulu, Djibri, Naghal, Khassab, Khanizi, Shabale and Abu Maan - were selected for investigation. The ten varieties were planted in 2001 in a replicated field experiment at three salinity levels, with five replications of each variety, totaling 150 trees. In November 2002, eight varieties from Saudi Arabia were planted in the same field under the same salinity treatments, along with four varieties of olive. The group of 18 elite date palm varieties will provide a sound data base for the evaluation of salinity impact on date production in the region.

**Objectives**

1. Evaluate salinity tolerance among elite date palm varieties in the Arabian Peninsula.
2. Assess the long-term impact of salinity on date palm growth and productivity.
3. Assess the effects of different salinity levels on date palm fruit quality.

**Achievements 2003**

The three salinity levels (5, 10 and 15 dS/m) were applied in late 2002 and fine tuned in 2003. The growth and development of each individual plant was monitored by recording basic traits such as height, trunk diameter, number of leaves and phenology. As the ten varieties have dissimilar characteristics, the relative growth will be used to compare development of the different varieties at the three salinity levels. Four measurements were completed on the ten varieties. The additional 8 varieties are still in the establishment phase. Salinity treatments started in October 2003.

**Plans 2004**

Monitoring of plant growth and soil salinity will continue during 2004 to establish a long-term data base for date palm growth in saline conditions. Tissue analysis for various traits will also be undertaken in 2004.

Evaluation of salt-tolerance in elite varieties of date palm from the United Arab Emirates and Saudi Arabia.
Expanding date palm cultivation under saline conditions in Jordan (PMS 23)

Duration: 2003-2006

Collaborator: National Center for Agricultural Research and Technology Transfer (NCARTT)

Resources: ICBA, NCARTT

Background

Approximately 11,400 hectares in the main irrigated areas of the Jordan Valley are saline. This represents around 15% of the available irrigated land. Date palm is a high value crop that is in demand in Jordan and is known to be salt tolerant. The project will test 18 varieties of date palm at two locations in the Jordan Valley. At the same time, the optimum agronomic practices for establishing date gardens on saline soils will be investigated. The trials established will serve as demonstrations for farmers, extension staff and researchers. The outcomes of the project will be recommendations of date palm varieties with adaptation to saline soil areas of the Jordan Valley and appropriate irrigation management systems.

Objective

This project, in collaboration with the National Center for Agricultural Research and Technology Transfer (NCARTT), will explore the potential to expand the area of date palm cultivated in Jordan.

Achievements 2003

The project proposal was developed in the early part of the year by ICBA and NCARTT and the project was implemented from the beginning of September 2003.

Plans 2004

Planting of the date palms will start in late 2003 or early 2004.
Communication, Networking and Information Management Program

The overall objective of the Communication, Networking and Information Management Program is to promote the exchange of information and experience among those involved in biosaline agriculture research and development in the region and throughout the world.
Needs addressed

Many research organizations around the world have conducted and are conducting research in fields related to biosaline agriculture. However, these efforts are generally undertaken in isolation of each other. Many working in this field, especially in the developing world, are unaware of who else is working on similar research areas and what is already known. This leads to uncoordinated activities, fragmented efforts, and waste of scarce resources.

From its initial conception, ICBA was intended to act as a focal point for these efforts, gathering information on what has already been done and what is already known in the field, and bringing this knowledge and information to bear on the problems facing farmers in the developing world. Also, building on this knowledge, ICBA aims to develop networks among those involved in research on biosaline agriculture to focus and align efforts to address common problems occurring across regions and countries.

Objectives

1. Establish formal (Memoranda of Understanding or similar agreements) or informal (project based or individual contacts) collaborations for accessing technology.
2. Develop joint programs/projects for the delivery of biosalinity technology.
3. Prepare and distribute newsletters and articles on biosalinity and establish a managed e-network with individuals and agencies with a common interest in biosalinity.

Communication, networking and managing information activity: Memoranda of Understanding

Duration: Ongoing

Activities 2003

In 2003, ICBA signed five Memoranda of Understanding (Table 3). ICBA is building links and relationships with these organizations to develop collaborative projects for the delivery of biosalinity technology.

Plans 2004

ICBA will continue its efforts to forge linkages with institutions involved in research and development on salinity. Special emphasis will be placed on Middle Eastern countries, North Africa and Central Asia.

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<th>Organization</th>
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<td>Egypt</td>
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<tr>
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<td>5 October 2003</td>
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Communication, networking and managing information activity: Collaboration

Duration: Ongoing

Collaborators: International programs, national research systems

Activities 2003

ICBA focuses on two broad categories of collaboration: with international programs, which primarily involve the acquisition of technology; and with countries which stand to benefit from the technology. Collaboration with the latter is generally through joint projects (Table 4).

In 2003, ICBA also strengthened collaboration with the United Arab Emirates research system (Table 5).

ICBA was also contracted to undertake projects for private enterprise and host country government agencies (Table 6).

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<td>Evaluation of irrigation practices and fertilizer requirements for optimizing productivity of three indigenous grass species</td>
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<td>Investigation of elite date palm and olive varieties for salt-tolerance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PMS07 BARI</td>
<td>Demonstration of biosaline agriculture in salt-affected areas in Bangladesh</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PMS13 IAEA, MAF (UAE)</td>
<td>Sustainable utilization of saline groundwater and wastelands for plant production</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PMS14 ERWDA</td>
<td>Increasing biodiversity of mangrove species in the UAE: Introduction and adaptation of new species</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PMS15 ICRISAT</td>
<td>Development of salt-tolerant sorghum and pearl millet varieties for saline lands. Next phase of PMS02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PMS16 UAEU</td>
<td>Development of sustainable salt-tolerant forages for sheep and goat production, Component of PMS03, PMS04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PMS17 IACARDA</td>
<td>Evaluation of salinity tolerance and yield in 280 barley varieties and accessions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PMS18 ICRISAT</td>
<td>Screening for salt-tolerance among selected pigeonpea and groundnut varieties under controlled conditions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PMS19 IACARDA</td>
<td>Screening for salt-tolerance among large collections of buffelgrass, safflower, fodder beet and lublab</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PMS21 PARC</td>
<td>Use of low quality water for productive use of desert and salt-affected areas in Pakistan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PMS22 NSRC</td>
<td>Production of halophytes in Iran</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PMS23 NCARRT</td>
<td>Expanding date palm cultivation under saline conditions in Jordan</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 5 Joint research in United Arab Emirates</th>
<th>Organization</th>
<th>Joint program/project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ministry of Agriculture and Fisheries, United Arab Emirates</td>
<td>MAF scientist seconded to ICBA to improve and strengthen collaboration with MAF and other governmental and international organizations in the United Arab Emirates</td>
<td></td>
</tr>
<tr>
<td>Ministry of Agriculture and Fisheries, United Arab Emirates</td>
<td>Joint project on Conchirus ciliatus</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 6 Contract projects 2003</th>
<th>Project code</th>
<th>Contract</th>
<th>Project title</th>
</tr>
</thead>
<tbody>
<tr>
<td>GR03 BEHAR</td>
<td>Development and submission of germplasm description of unique Salicornia species produced by BEHAR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PMS07 PDO</td>
<td>Demonstration of biosaline agriculture at Nmri, Sultanate of Oman</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PMS08 SPC, Abu Dhabi</td>
<td>Managing salinity and water logging in coastal agricultural areas in Abu Dhabi. Next phase.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Communication, networking and managing information activity:
Information management

**Duration:** Ongoing

**Activities 2003**

In 2003, the ICBA library continued to establish the collection and to provide information services for Center staff, collaborators and members of its networks.

During the year, a start was made on cataloguing the library collection to internationally recognized standards and around 500 acquisitions were catalogued.

Library staff also continued compiling data on salt-tolerant plants, shrubs and groundcover, confirming taxonomic names using the International Taxonomic Information System or the International Plant Names Index, and locating illustrations and descriptions on the Internet and in ICBA library materials. Information was compiled on 110 species making a total of 378 of the 500 identified.

**Plans 2004**

Work will continue on cataloguing the collection, making the catalogue accessible on-line, compiling information on the 500 salt-tolerant plants identified to date, and developing a database.

---

Communication, networking and managing information activity:
Publications, events and media

**Duration:** Ongoing

**Activities 2003**

**Publications**

ICBA publications (Appendix 3) serve a broad range of audiences. Key among these are donors and potential donors, policy makers, scientific collaborators, extension agents, potential end-users of research results, peer group scientists and the general public. ICBA publications target these key groups.

**Media coverage**

As a result of press releases, publications and interviews with ICBA management and scientists ICBA activities were widely covered in the UAE and regional media, promoting awareness of the Center’s role and activities.

Journalist interviewing a participant of an ICBA intensive course
Table 7 Participation in exhibitions 2003

<table>
<thead>
<tr>
<th>Conference</th>
<th>Date</th>
<th>Place</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment and Energy</td>
<td>February</td>
<td>Abu Dhabi, United Arab Emirates</td>
</tr>
<tr>
<td>WETEX 2003</td>
<td>March</td>
<td>Dubai, United Arab Emirates</td>
</tr>
<tr>
<td>Al Ain Flower Show 2003</td>
<td>March</td>
<td>Al Ain, United Arab Emirates</td>
</tr>
<tr>
<td>UNCCD</td>
<td>June</td>
<td>Abu Dhabi, United Arab Emirates</td>
</tr>
<tr>
<td>3rd International Trade and Industrial Fair</td>
<td>September</td>
<td>Almaty, Kazakhstan</td>
</tr>
<tr>
<td>World Bank, International Monetary Fund Exhibition</td>
<td>September</td>
<td>Dubai, United Arab Emirates</td>
</tr>
<tr>
<td>Consultative Group on International Agricultural Research (CGIAR) Annual General Meeting</td>
<td>October</td>
<td>Nairobi, Kenya</td>
</tr>
</tbody>
</table>

Events

ICBA participated with publications, posters, videos and plant samples in events attended by policy makers, scientific collaborators, local, national and regional institutions, government representatives and the general public to increase awareness of the Center, both in its host country the United Arab Emirates, and internationally (Table 7).
Communication, networking and managing information activity:
Networks

Duration: Ongoing

Background
By establishing international networks in biosaline agriculture, ICBA aims to promote collaborative projects between the Center and other agencies involved in biosaline agriculture research and development.

Networks, both human and electronic, support a culture of dialogue between practitioners, stakeholders and other change agents. Networks are also essential to sustain the growth of and linkages between institutions and individuals as well as to encourage learning. Moreover, networks help understanding of the information and communication needs of stakeholders and encourage their involvement.

Activities 2003
Inter-Islamic Network on Biosaline Agriculture (INBA)
ICBA coordinates the Inter-Islamic Network on Biosaline Agriculture, established in 2002, a non-political, non-profit, independent, and autonomous body promoting biosaline agriculture under the auspices of the Organization of the Islamic Conference (OIC) Ministerial Committee on Scientific and Technological Cooperation (COMSTECH).

INBA targets national, regional, and international institutions in developing and developed countries, and aid agencies, in particular those in the Organization of the Islamic Conference (OIC) member states. Network members will include ministries of agriculture and water resources, universities, national, regional and international agricultural research and development agencies, extension services, and end-users, including farmer groups and non-governmental organizations (NGOs).

Activities in 2003 included:

- Summaries of the economic impacts of biosaline research in Islamic Countries and recommendations for future work. Two reports were completed in 2003.
- An INBA brochure and the INBA Statutes were published.
- INBA news was published in the INBA section of ICBA’s newsletter.

INBA organized two regional workshops in 2003:

1. Genome characterization of whitefly-transmitted geminivirus of cotton and development of virus-resistant plants through genetic engineering and conventional breeding, INBA-NIBGE-ICAC-CFC, 28-30 September.

2. Technological advances in seawater desalination and its impact on the coastal environment, in collaboration with Inter-Islamic Network on Oceanography (NOC), 1-3 December.
INBA was represented at the 11th General Meeting of COMSTEC

Participants of the seminar ‘Technological advances in seawater desalination and its impact on the coastal environment’

Participants of the seminar ‘Genome characterization of whitely-transmitted geminivirus of cotton and development of virus-resistant plants through genetic engineering and conventional breeding’

INBA was also represented at the 11th General Meeting of COMSTEC during December 25-27, 2003. Annual report of INBA for 2003 was presented in the meeting.

Global Biosoaline Network

The Global Biosoaline Network is hosted on ICBA’s website. The network is a data bank of professionals involved in biosoaline agriculture. At the end of 2003, the network had 284 registered members from 55 countries. With funds provided by the OPEC Fund the network provided members free access to the comprehensive on-line agricultural research bibliographic databases Agricola, AGRIS and CABCD.

Plans 2004

In 2004 INBA activities will include:

• Preparation of a database of research scientists.
• Preparation of further summaries of the economic impacts of biosoaline research in Islamic Countries and recommendations for future work.
• Seeking funds for bilateral research projects with OIC member countries.
• Strengthening ICBA library facilities and continuing to provide literature access facilities,
• Seeking funds to support participants for training courses,
• Development of an INBA web page on ICBA’s web site.
• Continuing to report INBA activities in the INBA section of ICBA’s newsletter.

The Global Biosoaline Network will continue to provide members with free access to free access to on-line agricultural research bibliographic databases.
Training, Workshops and Extension Program

The Training, Workshops and Extension Program provides specialized courses for scientists and technicians in aspects of biosaline agriculture. The Center also organizes seminars and meetings to exchange information on biosaline agriculture and to identify priority areas that need to be addressed locally, regionally and globally.
Needs addressed

Few people are trained in the special skills and techniques of biosaline agriculture. Capacity development in technical aspects of saline irrigated agriculture is thus a key role for ICBA.

Capacity development is a key to sustainable agricultural production and ICBA has a vigorous program of activities to assist with building specialist skills and knowledge in biosaline agriculture.

ICBA’s capacity building activities fall into five main categories:

- Technical short courses at ICBA
- Technical short courses in other countries
- Technical on-the-job skills enhancement
- Providing facilities and supervision for students pursuing higher degrees by research
- Workshops and seminars

Objectives

1. Arrange or participate in seminars, workshops and conferences
2. Provide on-the-job training through collaborative projects
3. Provide facilities and supervision for graduate students conducting their thesis research
4. Participate in scientific exchanges

The Director General speaking at the session on Non-conventional Water Resources at the Third World Water Forum, Kyoto, Japan, 20 March
Training, workshops and extension: Training

Duration: Ongoing

Resources: OPEC Fund, USAID, ICARDA, IDB, Private Office of H.H President of the UAE, DFID (UK)

Background

Technical training short courses are aimed at a wide range of individuals involved in aspects of biosaline agriculture, for example: technicians and research assistants, engineers from ministries and municipalities, forage farm managers, managers of dairy farms, and soil and land reclamation specialists.

Since the Center’s establishment in 1999, over 200 individuals have attended courses convened by ICBA on aspects of biosaline agriculture (Figure 36).

![Participants in the 'Quality evaluation and utilization of salt-tolerant forages' course inspect test plots at ICBA](image1)

![Participants in the 'Salinization of irrigated lands and reclamation' course at ICBA examining irrigation equipment](image2)

![Participants of the course on 'In situ conservation of plant genetic resources' view propagation of genetic material in the shade house at ICBA](image3)

Activities 2003

In 2003, three training courses were held at ICBA. Funding was provided by the OPEC Fund for Development and ICBA. The training course for Central Asia was supported with funds from the Private Office of H.H. the President of the UAE and Department for International Development (DFID), UK (Table 8).
<table>
<thead>
<tr>
<th>Countries participating</th>
<th>OPEC Fund</th>
<th>IDB/Self financed</th>
<th>OPEC Fund</th>
<th>IDB/Self financed</th>
<th>IDB/ICBA, Private Office HH President UAE, DFID (UK)</th>
<th>IDB/ICBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algeria</td>
<td>1</td>
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<td>Azerbaijan</td>
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<td>Bangladesh</td>
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<td>Burkina Faso</td>
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<td>Egypt</td>
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<td>Indonesia</td>
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<tr>
<td>Kyrgyzstan</td>
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<td>Libya</td>
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<td>Oman</td>
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<td>Sudan</td>
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<td>Tunisia</td>
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<td>United Arab Emirates</td>
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<td>Yemen</td>
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<td>Uzbekistan</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>18</strong></td>
<td><strong>18</strong></td>
<td><strong>21</strong></td>
<td><strong>10</strong></td>
<td><strong>25</strong></td>
<td><strong>13</strong></td>
</tr>
</tbody>
</table>
ICBA also collaborated with the International Center for Agricultural Research in the Dry Areas (ICARDA) to hold a course in Tashkent, Uzbekistan attended by 25 professionals from the government and non-government sectors in Central Asia and the Caucasus (CAC).

![Participants in the course in Tashkent, Uzbekistan](image)

**On-the-job skills development**

Technical on-the-job skills development focuses on "learning by doing" internships or apprenticeships. Individuals become familiar with specific field or laboratory technologies guided by ICBA scientific staff in on-going ICBA research activities.

Three Afghani agriculturalists from the Afghanistan Ministry of Agriculture spent four months at ICBA (Dubai) and at the International Center for Agricultural Research in the Dry Areas (ICARDA, Aleppo, Syria) for hands-on skills development in sustainable irrigated agricultural production on degraded and saline land. USAID provided funds through the Short-Term High Impact Program coordinated by ICARDA. The UAE government provided logistical support.

The agriculturalists developed basic skills in research methodology, and identified and solved problems in irrigated agriculture and multiplying seed for crops. They interacted closely with scientists and technicians in both centers and took part in regular research activities as well as practical applications of crop and water management.

![Three Afghani agriculturalists spent four months at ICBA and ICARDA for on-the-job skills development in technical aspects of biosaline agriculture](image)

![The agriculturalists participating in research activities at ICBA](image)

![Familiarization with laboratory techniques](image)
Training, workshops and extension: Seminars

Duration: Ongoing

Background

As the only international research center dedicated to biosaline agriculture ICBA arranges seminars for interested parties to promote interest in biosaline agriculture locally, regionally and globally.

Activities 2003

Three seminars were convened during the year (Table 9).

The first, ‘Technologies of biosaline agriculture in arid areas’ was held in collaboration with the Abu Dhabi Chamber of Commerce and Industry for the federal government and private sectors.

At the Third World Water Forum, Kyoto, Japan, in March, ICBA co-sponsored the seminar on Non-conventional Water Resources with Algeria, the Islamic Development Bank, and the World Bank.

At the Islamic Development Bank Annual Meeting in Kazakhstan, the IDB, the National Academy of Sciences in Kazakhstan and ICBA co-sponsored a seminar on the prospects for biosaline agriculture both in Kazakhstan and globally.

Plans 2004

In 2004, ICBA will convene further seminars on aspects of biosaline agriculture aimed at a wide range of individuals involved in biosaline agriculture.

Table 9

<table>
<thead>
<tr>
<th>Seminars 2003</th>
<th>Title</th>
<th>Venue</th>
<th>Date</th>
<th>Organized by</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Technologies of biosaline agriculture in arid areas</td>
<td>Abu Dhabi Chamber of Commerce and Industry</td>
<td>January</td>
<td>Abu Dhabi Chamber of Commerce and Industry, ICBA</td>
<td>85 participants from federal, government and private sectors</td>
</tr>
<tr>
<td></td>
<td>Middle East and Mediterranean Regional Day: Session on Non-conventional Water Resources</td>
<td>Third World Water Forum, Kyoto, Japan</td>
<td>March</td>
<td>Algeria, Islamic Development Bank, World Bank, ICBA</td>
<td>Global participants with strong representation of high level officials from the Middle East and Mediterranean</td>
</tr>
<tr>
<td></td>
<td>Prospects for biosaline agriculture globally and in Kazakhstan</td>
<td>IDB Annual Governors Meeting, Almaty, Kazakhstan</td>
<td>August</td>
<td>Islamic Development Bank, National Academy of Sciences of the Republic of Kazakhstan, ICBA</td>
<td>80 academicians, Islamic Development Bank governors</td>
</tr>
</tbody>
</table>
Administration and Finance Division
**Administration and Finance Services**

**Achievements 2003**

The Administration and Finance Services Division effectively carried out its activities and provided support to the Technical Division of the Center. The major highlights follow:

**Board of Directors**

Two new members have joined ICBA’s Board of Directors: Dr. Mohammad H. Roozitalab and Dr. Ismaeil Al-Hosani. Dr. Roozitalab is an Iranian national, currently Deputy Head of Agricultural Research, Education and Extension Organization in Iran. Dr. Al-Hosani is a United Arab Emirates national, from the Agriculture Extension and Marketing and Livestock Department in Abu Dhabi Municipality and Town Planning Department of the United Arab Emirates.

**Safety Manual**

The safety manual, was completed in January 2003 and implemented during the year. The implementation of this safety policy will make ICBA a safer place to work in.

**Capital Assets**

The Administration and Finance Division has tagged the fixed assets of the Center.

**Host Government Relations Office, Abu Dhabi**

The Government Relations Office, opened in Abu Dhabi in July 2002, played an important role in the year 2003 in reaching out to governmental and semi-governmental organizations in Abu Dhabi.

**Staffing**

ICBA bade farewell to Mrs. Hemmat Lashin, the Executive Secretary of the Director General. Miss Aber Elfyass was recruited to replace Mrs. Hemmat Lashin.

ICBA also bade farewell to Ms. Sohila Vadipoor, Library Assistant. The position has not been filled due to resource constraints.

Dr. Abdullah Abboudi joined ICBA on secondment from the Ministry of Agriculture and Fisheries of the UAE. Dr. Abboudi is a UAE national and his main area of study in post-harvest storage and preservation of dates.

**Information Technology**

In the year 2003, ICBA has continued to upgrade the computer network and maintain its website. Towards the end of the year 2003, ICBA devised and started implementing a migration plan to enhance and upgrade its network. The implementation plan will be concluded in early 2004.
Resource mobilization

Achievements 2003

Resource mobilization activities generated US$654,400 during 2003. In addition, considerable progress was made towards developing a major four-year multi-country, multi-donor project.

USAID

The United States Agency for International Development (USAID) provided a grant through ICARDA for four-month apprenticeships for three nationals from the Afghan Ministry of Agriculture. Their hands-on skills development took place at ICBA (Dubai) and ICARDA (Aleppo).

The OPEC Fund for International Development

The OPEC Fund for International Development made a three-year grant for conducting research on salt-tolerant sorghum and pearl millet genotypes. The research will be carried out in collaboration with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).

While generally benefiting all regions of the world facing salinity, the outcome of the project specifically targets production of the two crops under saline conditions in six countries: United Arab Emirates, Oman, India, Iran, Yemen and Sudan.

Developing a multi-donor salt-tolerant forage project

Considerable effort was made during the year to develop a major four-year, US$4 million project to grow forage with saline water on marginal land. A workshop was held in June to develop the proposal with direct inputs of the beneficiary countries. The International Fund for Agricultural Development (IFAD) funded a design mission late in the year. ICBA delegations visited Pakistan and Oman in December and planned visits to Jordan and Palestine, Syria and Tunisia early in 2004 to consult with national scientists and institutions to seek their inputs and assistance in developing the proposal.
Arab Fund for Economic and Social Development (AFESD)

A project proposal was submitted to the Arab Fund to co-finance the salt-tolerant forage project in the UAE, Oman, Tunisia, Syria, Jordan and Palestine.

International Fund for Agricultural Development (IFAD)

The International Fund for Agricultural Development (IFAD) provided ICBA with funds for an assessment of saline water resources available for utilization in irrigation in seven countries. The salt-tolerant forage project is targeting areas for biosaline agriculture based on the results of the assessment.

The Private Office of HH the President of UAE

The Private Office of HH the President of UAE provided support towards the first training course for Central Asia held in Tashkent in May 2003. Of the 27 participants, 25 were directly supported with these funds.

Department for International Development (DFID), UK

The Department for International Development (DFID), UK, supported two Tajik participants for the training course in Tashkent.

Petroleum Development Oman (PDO)

In 2002, this private sector firm awarded ICBA a consultancy to implement projects to utilize process saline water that is extracted with oil and is currently unutilized. The project is implementing a new reed bed treatment system and a biosaline agriculture demonstration project.

Sewerage Projects Committee of the Emirate of Abu Dhabi

The Sewerage Projects Committee of the Emirate of Abu Dhabi awarded a consultancy to ICBA to mitigate salinity and water-logging on 55 square kilometers of important farm areas of the Emirate. The consultancy began in June 2003 and was completed in October 2003.

CGIAR Comprehensive Assessment on Global Water Issues

A proposal addressing the availability and potential use of saline/braackish water resources in West Asia and North African countries was funded.

Donor Visits to ICBA

During the year, representatives of several potential donors visited ICBA. They included senior staff of IFAD, IAEA, AFESD, and of the private sector in the Netherlands, France, and Australia. These were in addition to visits by many Ministers of Agriculture from the Islamic world.

Plans 2004

Efforts to diversify core support for the Center will continue.

Several CGIAR challenge programs have included ICBA as a partner. The Challenge Programs will involve participation in fund raising and project development. ICBA envisages increased involvement in such activities during 2004.

At the beginning of 2004 a major proposal targeting at least three Central Asian countries and a proposal to support capacity development activities, communications and networking will be prepared in collaboration with ICARDA and IWMI.

Strategic visits will be made to sensitize donors to ICBA’s research and development activities and ICBA will approach non-conventional donors.
Appendices
## Appendix 1 Summary of genebank holdings (December 2003)

<table>
<thead>
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Total: 141 plants, 237 accessions
Appendix 2 Summary of weather data, ICBA Station, 2003

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Temperature Data for Year 2003

Evapotranspiration

Solar Radiation Data for Year 2003
Appendix 3 Publications, presentations, reports, meetings, seminars

Published by ICBA

Biosalinity News Vol. 4 No. 1 English, French, Arabic. February

Biosalinity News Vol. 4 No. 2 English, French, Arabic. June

Biosalinity News Vol. 4 No. 3 English, French, Arabic. December

INBA Brochure English/Arabic/French

ICBA Statutes English/Arabic/French

ICBA Annual Report 2002 English

ICBA Annual Report 2002 Arabic

ICBA Annual Report 2002 French

Saline Water, the Last Great Frontier: Founding a Center of Excellence in Biosaline Agriculture Brochure for session on Water: From Scarcity to Security at the International Monetary Fund meeting, Dubai, September 2003

Refereed publications


Published papers

Dakheel, AJ. 2003. Date palm and biosaline agriculture in the UAE. In: The Date Palm: From Traditional Resource to Green Wealth. The Emirates Center for Strategic Studies and Research. Pages. 199-211.


Presentations


Al Attar, MH. 2003. Presentation at IDB seminar, December, Kuwait.


Taha, FK. 2003. Prospects for biosaline agriculture and ICBA’s contribution to combating salinity. Presentation at the seminar in conjunction with the IDB Annual Governors meeting, Almaty, Kazakhstan.

ICBA reports


Trip Report/ICBA/01/03. 05-12/05/2003 Kazakhstan & Uzbekistan. MH Al Attar, FK Taha

Trip Report/ICBA/03/03. 07-11/07/2003. Tashkent, Uzbekistan. FAO Regional Workshop on Management and Rehabilitation of Salt Affected Soil and Fertility Declined Soils for Sustainable Agriculture and Food Security. S Ismail


Report/ICBA/10/03, 11th General Meeting of OIC-COMSTECH, Islamabad, Pakistan. S Ismail, MH Al Attar and FK Taha
## Appendix 4 Core staff as of 31 December 2003

### Office of the Director General

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<thead>
<tr>
<th>Name</th>
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<tr>
<td>Dr. Mohammad Al-Attar</td>
<td>Kuwait</td>
<td>Chairman of the Board of Directors/Director General</td>
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<tr>
<td>Mr. Ibrahim Bin Taher</td>
<td>UAE</td>
<td>Government Liaison Officer</td>
</tr>
<tr>
<td>Mr. Jugu Abraham</td>
<td>India</td>
<td>Donor Relations Specialist</td>
</tr>
<tr>
<td>Miss Abeer Elyass</td>
<td>Jordan</td>
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<tr>
<td>Mrs. Ayat Abed Rasheed</td>
<td>Palestine</td>
<td>Office Assistant</td>
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<td>Mr. Akhtar Ali</td>
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<td>Dr. Abdullah Dakhel</td>
<td>Syria</td>
<td>Field and Forage Crops Scientist</td>
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<tr>
<td>Dr. John Stenhouse</td>
<td>UK</td>
<td>Plant Genetic Resources Specialist</td>
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<tr>
<td>Dr. Shoab Ismail</td>
<td>Pakistan</td>
<td>Halophyte Agronomist</td>
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<td>Dr. Bassam Hasbini</td>
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<tr>
<td>Dr. Sandra Child</td>
<td>Australia</td>
<td>Communication Specialist</td>
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<tr>
<td>Mrs. Mae Cutler</td>
<td>Canada</td>
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<tr>
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<td>Jordan</td>
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<td>Dr. Mohammad Shahid</td>
<td>Pakistan</td>
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<td>Jordan</td>
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</thead>
<tbody>
<tr>
<td>Mr. Ghassan Sarris</td>
<td>Canada</td>
<td>Administration and Finance Officer</td>
</tr>
<tr>
<td>Mr. Ghassan Al Eid</td>
<td>Lebanon</td>
<td>IT and Computer Supervisor</td>
</tr>
<tr>
<td>Mr. Jamal Telmasani</td>
<td>Saudi Arabia</td>
<td>Facilities Supervisor</td>
</tr>
<tr>
<td>Mrs. Souhad El Zahed</td>
<td>Lebanon</td>
<td>Office Administrator and End User Support</td>
</tr>
<tr>
<td>Mr. Sami Barakey</td>
<td>Palestine</td>
<td>General Accountant</td>
</tr>
<tr>
<td>Mr. Bilal al Salem</td>
<td>Jordan</td>
<td>Administrator/Government Relations</td>
</tr>
</tbody>
</table>
Appendix 5 Funding 2003

<table>
<thead>
<tr>
<th>Donor / Contracting organisation</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDB</td>
<td>3,000,000</td>
<td>3,249,375</td>
<td>1,999,946</td>
<td>2,040,000</td>
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<tr>
<td>Arab Fund (AFESD)</td>
<td>43,874</td>
<td>900,000</td>
<td>20,000</td>
<td></td>
</tr>
<tr>
<td>OPEC Fund</td>
<td>250,000</td>
<td>140,000</td>
<td>130,000</td>
<td></td>
</tr>
<tr>
<td>IAEA</td>
<td>18,612</td>
<td></td>
<td>139</td>
<td></td>
</tr>
<tr>
<td>PDO (Oman)</td>
<td>18,489</td>
<td>31,409</td>
<td>108,000</td>
<td></td>
</tr>
<tr>
<td>Abu Dhabi Municipality</td>
<td></td>
<td>27,734</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BEHAR (KSA)</td>
<td></td>
<td>22,500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IFAD</td>
<td>9,600</td>
<td>28,700</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USAID/ICARDA</td>
<td></td>
<td>78,350</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comstech</td>
<td></td>
<td>4,968</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HH President of UAE</td>
<td></td>
<td></td>
<td>20,000</td>
<td></td>
</tr>
<tr>
<td>DFD (UK)</td>
<td></td>
<td></td>
<td>3,000</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3,250,000</strong></td>
<td><strong>3,334,239</strong></td>
<td><strong>3,127,301</strong></td>
<td><strong>2,403,189</strong></td>
</tr>
</tbody>
</table>

ICBA funding support 2000-2003

![ICBA funding support 2000-2003](chart.png)
### Appendix 6 Audited financial statements

#### Statement of Activities
**Year ended 31 December 2003**

<table>
<thead>
<tr>
<th></th>
<th>2003 USD</th>
<th>2002 USD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Revenues</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grants—unrestricted</td>
<td>2,728,432</td>
<td>2,805,833</td>
</tr>
<tr>
<td>Grants—restricted</td>
<td>18,727</td>
<td>19,013</td>
</tr>
<tr>
<td>Contribution against training</td>
<td>232,988</td>
<td>122,841</td>
</tr>
<tr>
<td>courses and research</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contribution from outreach</td>
<td>236,447</td>
<td>91,866</td>
</tr>
<tr>
<td>projects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other income</td>
<td>24,366</td>
<td>20,560</td>
</tr>
<tr>
<td><strong>Total revenues</strong></td>
<td>3,240,840</td>
<td>3,057,513</td>
</tr>
<tr>
<td><strong>Expenses</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salaries</td>
<td>1,135,806</td>
<td>1,095,419</td>
</tr>
<tr>
<td>Benefits</td>
<td>730,445</td>
<td>698,934</td>
</tr>
<tr>
<td>Supplies</td>
<td>113,973</td>
<td>174,376</td>
</tr>
<tr>
<td>Board expenses</td>
<td>18,987</td>
<td>21,712</td>
</tr>
<tr>
<td>Contract services</td>
<td>113,279</td>
<td>169,836</td>
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<tr>
<td>Travel</td>
<td>103,022</td>
<td>143,529</td>
</tr>
<tr>
<td>Utilities</td>
<td>114,474</td>
<td>103,400</td>
</tr>
<tr>
<td>Maintenance</td>
<td>110,295</td>
<td>102,367</td>
</tr>
<tr>
<td>Depreciation</td>
<td>312,318</td>
<td>323,539</td>
</tr>
<tr>
<td>Water expense for irrigation</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Expenses related to grants</td>
<td>19,727</td>
<td>19,013</td>
</tr>
<tr>
<td>restricted</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expenses against training</td>
<td>232,988</td>
<td>122,841</td>
</tr>
<tr>
<td>courses and research</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expenses related to outreach</td>
<td>236,447</td>
<td>91,866</td>
</tr>
<tr>
<td>projects</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total expenses</strong></td>
<td>3,240,840</td>
<td>3,057,513</td>
</tr>
<tr>
<td><strong>Excess of revenues over</strong></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>expenses</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Statement of Financial Position
**At 31 December 2003**

<table>
<thead>
<tr>
<th></th>
<th>2003 USD</th>
<th>2002 USD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ASSETS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current assets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bank balances and cash</td>
<td>874,230</td>
<td>1,460,135</td>
</tr>
<tr>
<td>Receivable from donors</td>
<td>146,047</td>
<td>-</td>
</tr>
<tr>
<td>Accounts receivable—other</td>
<td>107,635</td>
<td>-</td>
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<tr>
<td>Receivables from staff</td>
<td>995</td>
<td>484</td>
</tr>
<tr>
<td>Prepayments</td>
<td>37,862</td>
<td>5,489</td>
</tr>
<tr>
<td></td>
<td>1,166,629</td>
<td>1,480,108</td>
</tr>
<tr>
<td>Non-current assets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Property, plant and equipment</td>
<td>6,955,864</td>
<td>6,329,698</td>
</tr>
<tr>
<td></td>
<td>6,955,864</td>
<td>6,329,698</td>
</tr>
<tr>
<td><strong>TOTAL ASSETS</strong></td>
<td>8,122,493</td>
<td>7,798,798</td>
</tr>
<tr>
<td><strong>LIABILITIES AND NET ASSETS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current liabilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accounts payable</td>
<td>137,455</td>
<td>60,002</td>
</tr>
<tr>
<td>Accrued expenses and other</td>
<td>134,946</td>
<td>85,678</td>
</tr>
<tr>
<td>payables</td>
<td>271,391</td>
<td>145,680</td>
</tr>
<tr>
<td>Non-current liabilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employees end-of-service</td>
<td>26,910</td>
<td>28,743</td>
</tr>
<tr>
<td>benefits</td>
<td>26,910</td>
<td>28,743</td>
</tr>
<tr>
<td><strong>Net assets</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unrestricted—Unappropriated</td>
<td>6,955,864</td>
<td>6,653,229</td>
</tr>
<tr>
<td>Restricted— Appropriated</td>
<td>460,530</td>
<td>561,976</td>
</tr>
<tr>
<td>Temporarily restricted</td>
<td>397,245</td>
<td>428,159</td>
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<tr>
<td><strong>Total net assets</strong></td>
<td>7,813,642</td>
<td>7,820,555</td>
</tr>
<tr>
<td><strong>TOTAL LIABILITIES AND NET ASSETS</strong></td>
<td>8,122,493</td>
<td>7,798,798</td>
</tr>
</tbody>
</table>
### Appendix 7 Acronyms and abbreviations

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFESD</td>
<td>Arab Fund for Economic and Social Development</td>
</tr>
<tr>
<td>AFDW</td>
<td>Ash-free dry weight</td>
</tr>
<tr>
<td>AFLP</td>
<td>Amplified fragment length polymorphism</td>
</tr>
<tr>
<td>APRP</td>
<td>Arabian Peninsula Research Program</td>
</tr>
<tr>
<td>BARI</td>
<td>Bangladesh Agricultural Research Institute</td>
</tr>
<tr>
<td>BEHAR</td>
<td>Arabian Saline Water Technology Company</td>
</tr>
<tr>
<td>CGIAR</td>
<td>Consultative Group on International Agricultural Research</td>
</tr>
<tr>
<td>CIMMYT</td>
<td>International Maize and Wheat Improvement Center</td>
</tr>
<tr>
<td>COMSTECH</td>
<td>Organization of the Islamic Conference Standing Committee on Scientific and Technological Cooperation</td>
</tr>
<tr>
<td>DFID</td>
<td>Department for International Development, UK</td>
</tr>
<tr>
<td>DRC</td>
<td>Desert Research Council, Egypt</td>
</tr>
<tr>
<td>EC</td>
<td>Electrical Conductivity</td>
</tr>
<tr>
<td>ERWDA</td>
<td>Environmental Research and Wildlife Development Agency</td>
</tr>
<tr>
<td>FAO</td>
<td>Food and Agriculture Organization</td>
</tr>
<tr>
<td>GBN</td>
<td>Global Biosaline Network</td>
</tr>
<tr>
<td>GCC</td>
<td>Gulf Cooperation Council</td>
</tr>
<tr>
<td>IAEA</td>
<td>International Atomic Energy Agency</td>
</tr>
<tr>
<td>ICARDA</td>
<td>International Center for Agricultural Research in the Dry Areas</td>
</tr>
<tr>
<td>ICBA</td>
<td>International Center for Biosaline Agriculture</td>
</tr>
<tr>
<td>ICRISAT</td>
<td>International Crops Research Institute for the Semi-Arid Tropics</td>
</tr>
<tr>
<td>IDB</td>
<td>Islamic Development Bank</td>
</tr>
<tr>
<td>IFAD</td>
<td>International Fund for Agricultural Development</td>
</tr>
<tr>
<td>INBA</td>
<td>Inter-Islamic Network on Biosaline Agriculture</td>
</tr>
<tr>
<td>IWMI</td>
<td>International Water Management Institute</td>
</tr>
<tr>
<td>MAF</td>
<td>Ministry of Agriculture and Fisheries, United Arab Emirates</td>
</tr>
<tr>
<td>MoU</td>
<td>Memorandum of Understanding</td>
</tr>
<tr>
<td>NCARTT</td>
<td>National Center for Agricultural Research and Technology Transfer, Jordan</td>
</tr>
<tr>
<td>NIBGE</td>
<td>National Institute for Biotechnology &amp; Genetic Engineering, Pakistan</td>
</tr>
<tr>
<td>NSRC</td>
<td>National Salinity Research Council, Pakistan</td>
</tr>
<tr>
<td>OPEC</td>
<td>Organization of Petroleum Exporting Countries</td>
</tr>
<tr>
<td>PARC</td>
<td>Pakistan Agricultural Research Council</td>
</tr>
<tr>
<td>PDO</td>
<td>Petroleum Development Oman</td>
</tr>
<tr>
<td>SPC</td>
<td>Sewerage Projects Committee, Abu Dhabi</td>
</tr>
<tr>
<td>UAE</td>
<td>United Arab Emirates</td>
</tr>
<tr>
<td>UAEU</td>
<td>United Arab Emirates University</td>
</tr>
<tr>
<td>USAID</td>
<td>United States Agency for International Development</td>
</tr>
<tr>
<td>WANA</td>
<td>West Asia and North Africa</td>
</tr>
</tbody>
</table>
ICBA’s founding donors

Islamic Development Bank
The Islamic Development Bank (IDB), established in 1975, is an international development finance institution whose purpose is to foster the economic development and social progress of member countries and Muslim communities, individually and jointly, in accordance with the principles of Islamic law (shariah).

Arab Fund for Economic and Social Development
The Arab Fund for Economic and Social Development (AFESD) is an autonomous regional Pan-Arab development finance organization. AFESD assists the economic and social development of Arab countries through, firstly, financing development projects, with preference given to overall Arab development and to joint Arab projects; secondly, encouraging the investment of private and public funds in Arab projects; and, thirdly, providing technical assistance services for Arab economic and social development.

OPEC Fund for International Development
The OPEC Fund for International Development is a multilateral development finance institution established in 1976 by the member countries of the Organization of Petroleum Exporting Countries (OPEC).

The OPEC Fund aims to promote cooperation between OPEC member countries and other developing countries as an expression of South-South solidarity and to help particularly the poorer, low-income countries in pursuit of their social and economic advancement.

Ministry of Agriculture and Fisheries, United Arab Emirates
The Ministry of Agriculture and Fisheries, United Arab Emirates, provides support to farmers, fishermen and animal breeders to increase production and contribute to food security.
International Center for Biosaline Agriculture

P.O. Box 14660, Dubai, United Arab Emirates

Telephone: +971 (4) 336 1100 ● Facsimile: +971 (4) 336 1155

Email: icba@biosaline.org.ae ● Website: www.biosaline.org