ICBA Annual Report 2007 (1427-28H)

# Annual Report 2007

## (1427-28H)

**International Center for Biosaline Agriculture**

## Our Mission

*To demonstrate the value of marginal and saline water resources for the production of economically and environmentally useful plants, and to transfer the results of our research to national research services and communities.*

## Our Mandate

*To develop sustainable water management systems to irrigate food and forage crops and ornamental plants with marginal and saline water, and to encourage the use of suitable plants for socio-economic development.*

# Annual Report 2007
(1427-28H)

International Center for Biosaline Agriculture

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**Cover photograph:** *Field day to local farmers in Al-Khaldiya Research Station, National Center for Agricultural Research and Extension (NCARE), Jordan (Photo: Ghazi Al-Jabri).*

# Contents

## Foreword

The IDB mission lays the foundation on which the Bank's goals, objectives, activities and operations will be built. It emphasizes alleviating poverty, promoting human development, science and technology, and enhancing cooperation amongst member countries and collaboration with development partners.

Agriculture will continue to be the main source of employment and economic growth in many IDB member countries, especially in low-income countries. The need for rapid growth in agriculture cannot be over-emphasized. However, this growth is far from being realized due to numerous constraints, which include low productivity due to backward technology, low levels of skills, and poor natural resource endowments, scarcity of water, environmental degradation and drought, among others.

The Bank's assistance in agriculture is targeted at areas that support the policies and activities of governments. These include irrigation and crop development. A key initiative in this regard is the International Center for Biosaline Agriculture (ICBA). ICBA was established specifically as a center of excellence for research and development in managing the grave salinity problems widespread in many member countries.

The Bank recognizes that science and technology are vital components of human development. The IDB is committed to continuing its support to ICBA and to encouraging member countries to cooperate in this endeavor by allocating funds to support ICBA's research and development efforts.

Finally, I would like to express my appreciation to ICBA's host country, the United Arab Emirates, for the continued support extended to the Center and the Center's programs in managing salinity.

**Dr Ahmad Mohamed Ali**
***President, Islamic Development Bank Group***
***Chairman, Board of Trustees, ICBA***

# MESSAGE

2007 ushered in a period of major changes for ICBA with the appointments of a new Director General, a new Deputy Director General and a new research strategy.

After leading the Center since its inception, Director General Dr Mohammad Al-Attar retired in March. His successor, Dr Shawki Barghouti, a Jordanian national, brought to ICBA a wealth of experience gained over 35 years in agricultural development and management. In September Dr Ahmed Almasoum, an Emirati and Associate Professor at the United Arab Emirates University, was recruited as Deputy Director General.

With the top management team in place, attention then turned to the new research strategy. Commencing in 2008, the new mandate focuses on the use of marginal water such as treated wastewater and oil-produced water containing heavy metals and other pollutants, in addition to ICBA's traditional mandate of using saline water for agricultural production.

The achievements against this new mandate will be reflected in the next annual report. However, the strengthening of partnerships in 2007 with the host country, the United Arab Emirates, especially the Environment Agency - Abu Dhabi (EAD), as well as with organizations such as the Arab Water Council, augur well for the future.

A groundbreaking initiative in partnership with EAD was the selection of ICBA as the host institution of the Arab Water Academy (AWA), which will provide capacity building in the water sector. The Abu-Dhabi-based Academy has received major support from the Arab Water Council, the World Bank, Islamic Development Bank, EAD and other donors.

The year also saw other important acknowledgements of ICBA's reputation with invitations to play a significant part in the Water Master Plan for Abu Dhabi Emirate (another EAD collaboration) and contribute technical expertise to a team in the Shell Nimr Project, a joint venture between Shell and Petroleum Development Oman (PDO).

During 2007 the ICBA team continued to work on existing projects such as the multi-million-dollar, seven country Forage project striving to improve livelihoods for people in marginal lands in West Asia and North Africa, and the Soil Survey for the Emirate of Abu Dhabi in collaboration with EAD.

These projects give some indication of the strength of the partnerships and the kind and scope of projects involving research and capacity building achieved by the ICBA team. None of the achievements outlined in the following Report would be possible without the commitment of all staff and the support of donors. We thank them for their commitment and dedication in realizing the ICBA vision.

**Fawzi AlSultan**
***Chairman, Board of Directors***

**Dr Shawki Barghouti**
***Director General***

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*The ICBA Board of Directors (left to right)*

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*Dr Barghouti*
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*Dr Al-Mulla*

# Summary of Annual Report 2007

## Summary of Annual Report 2007

2007 could best be summed up as a year of change for ICBA with the appointment of a new Director General and a new strategic mandate.

Dr Barghouti

Leadership changes occurred with the retirement in March of the Director General Dr Mohammad Al-Attar, who had led the Center since its inception, and the subsequent appointment of Dr Shawki Barghouti to the position of Director General. A Jordanian national, Dr Barghouti, has spent the last 35 years in agricultural development and management, 20 of them in the Middle East. Prior to his employment by ICBA, he served with the World Bank in Washington DC as Advisor, Agricultural Science and Technology, as well as Manager of the Agriculture and Water Portfolio for South Asia. From 1997 to 1999, Dr Barghouti served as Director General of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in Hyderabad, India and in the 1970s had also been instrumental in establishing the International Center for Agricultural Research in the Dry Areas (ICARDA) .

Dr Almasoum

In September Dr Ahmed Almasoum, a national of the United Arab Emirates and an Associate Professor of horticulture at the United Arab Emirates University, was recruited as Deputy Director General.

After extensive consultation with the agricultural research and development sector, *New Horizons: ICBA's Strategic Plan 2008-2012* was prepared by a small team comprising Dr Shawki Barghouti (prior to his appointment to ICBA), Dr David Seckler, the former Director General of the International Water Research Institute, and Dr Donald Suarez, Director of the US Department of Agriculture's Salinity Laboratory in Riverside, California. Dr Mark Winslow, a Marketing Specialist with ICRISAT, assembled the final document in collaboration with ICBA staff.

The new research mandate focuses on the use of marginal water in addition to ICBA's traditional mandate of using saline water for agricultural production. This includes the use of low-quality water such as treated wastewater and oil-produced water which contains heavy metals and other pollutants. Many projects in progress or commenced in 2007 already exemplify the new program priorities of the revised mandate.

The most significant step towards the revised mandate occurred in late 2007 with the selection of ICBA as the host institution of the Arab Water Academy (AWA). In partnership with the Environment Agency - Abu Dhabi (EAD), the AWA will critically enhance the capacity building of the water sector in the Arab

*In December, ICBA was selected as the host institution of the Arab Water Academy, in partnership with the Environment Agency - Abu Dhabi during the meeting of the Arab Water Council in Dubai* world. The Academy, which will be based in Abu Dhabi, has received significant support from the Arab Water Council, the World Bank, the Islamic Development Bank (IDB), EAD and other donors.

Partnerships are critical to ICBA's ability to fulfill its mandate on a global level. The nature of the collaboration between three new partners in countries ranging from Senegal to the United States was formalized during the year with the signing of 3 Memoranda of Understanding, thus paving the way to exchange knowledge, undertake common projects and/or training opportunities. Projects with these new, or existing, partners may be undertaken at ICBA itself, within the United Arab Emirates, the region or in the international sphere.

*Re-affirming partnerships with NARS in Senegal*

*The Plant Genetic Program assembles the germplasm of species with proven or potential salinity tolerance*

From the site in Dubai, ICBA is able to provide a source of genetic diversity to scientists working on problems of salinity in agricultural production systems throughout the world. It fulfils this worldwide role through its Plant Genetic Program, in which ICBA acquires and conserves plant genetic resources by assembling germplasm of species with proven or potential salinity tolerance. Since crop diversification is important for sustainable agricultural productivity, ICBA has also been investigating potential 'new' crops adapted to the local environment.

As part of its Production and Management Systems Program, ICBA has also been collaborating with the International Center for Agricultural Research in the Dry Areas (ICARDA) and other centers of the Consultative Group on International Agricultural Research (CGIAR) in testing major crops to identify top salt-tolerant performers. Other local ICBA projects undertaken in collaboration with the United Arab Emirates University and national agricultural research systems (NARS), also contribute to the body of research with long-term field studies on sustainable and economically feasible forage production systems, using non-conventional salt-tolerant grasses and highly saline water. Such information has been scanty at the global level and virtually absent in the Middle Eastern region.

Although research is undertaken at the local level, the results can be applied elsewhere, for example, the project *Development of salinity-tolerant sorghum and pearl millet varieties for saline lands* undertaken in collaboration with the International Crops Institute for the Semi-Arid Tropics (ICRISAT), and the National Agricultural Research Systems (NARS) of several countries in West Asia and North Africa (WANA), is aimed at the improvement of agricultural productivity in salt-affected arid and semi-arid environments of the Near East and South Asia through the development of salt-tolerant pearl millet and sorghum genotypes with high grain and forage yield.

*Developing salt-tolerant pearl millet genotypes to improve agricultural productivity*

Exemplifying ICBA's new mandate is the project *Propagation and development of* Distichlis spicata *var. Yensen-4a (NyPa forage) under arid environment*, which uses seawater. Although seawater is by far the largest source of marginal water, its use in any type of plant production system is very limited. ICBA has been working with NyPa International to test the germplasm for its growth and forage potential in the coastal arid and humid conditions of the region, using seawater for irrigation. The quality of forage produced under such conditions and its effects on animals still needs to be ascertained.


*The outcomes of the soil survey will provide information for potential land users in Abu Dhabi Emirate*

The strong partnership with the Environment Agency - Abu Dhabi (EAD) has resulted in ICBA being appointed to prepare a *Water Master Plan for the Abu Dhabi Emirate*. This Plan will detail a clear strategy for managing the water sector and reconcile the water consumption between agricultural, industrial and domestic sectors for the sustainable economic development of the Emirate. World-class experts have already been recruited by ICBA to assist with this project.

Similarly an international Australian firm has been appointed to implement another EAD and ICBA collaboration - the *Soil Survey for the Emirate of Abu Dhabi*, our largest in-country endeavor to date. ICBA's role is to supervise the project activities and to conduct quality assurance that the standards stipulated by the project's terms of reference are met. The Survey will enable understanding of the capabilities and limitations of the Emirate's soil resources: an essential key for sustainable development. Such data is invaluable to potential land users for master planning, soil management and reclamation, environmental impact assessment and monitoring, soil conservation, farming, and combating desertification.

Another partnership, one with the Ministry of Environment and Water, has seen the establishment of a demonstration farm in the Northern Emirates that serves as a useful model for salt-affected farms in the region. By involving local farmers, the farm project enhances their capacity to understand and apply biosaline agriculture principles in producing conventional and non-conventional forage crops.

The use of partnerships within the region, for example, in Oman, has intensified with the approval of several projects: *A proposed study to develop a national strategy to combat salinity within an integrated water strategy in the Sultanate of Oman*, and a collaboration with a private company, Shell International. This latter project evolved when executives from Shell International invited ICBA to join its technical team for planning and implementing the Shell Nimr Project, a joint venture between Shell and Petroleum

*Organizing field days for local farmers, such as the above one in Jordan, is a major aspect of the Forage Project*

Development Oman (PDO). The project, with a proposed life of 20 years, involves the biological cleaning of contaminated water and utilization in biosaline agriculture.

Another Omani project, *Management of salt-affected soils and water for sustainable agriculture*, involves ICBA working with multiple partners including five departments at Sultan Qaboos University (SQU) together with the Ministry of Agriculture and the Ministry of Regional Municipalities, Environment and Water Resources. ICBA's specific role is to provide technical support in determining water management solutions for the management of salt-affected soils and water. Research also focuses on developing a rapid and inexpensive method of monitoring land salinization and the impact of interventions to mitigate salinization, which is a serious threat to Oman's agriculture and economy.

In the international sphere, progress was made on the multi-million-dollar, seven-country Forage Project, which is aimed at the improvement of livelihoods and higher incomes for resource-poor rural men and women in degraded and marginal lands in West Asian and North Africa. Meetings were held for the Steering Committee and the Technical Committee in Amman, Jordan, in March, and a third Annual Work Plan was developed and approved. The Project is now operational in all seven countries. Capacity building activities included several field days and farmers' days in various countries and in August a working group meeting was held in Syria.

*Demosnstrating biosaline agriculture to local farmers in Bangladesh*

In collaboration with the Bangladesh Agricultural Research Institute (BARI), a project demonstrating biosaline agriculture in salt-affected areas of Bangladesh, is aimed at cultivating salt-affected lands: an agricultural necessity in a developing country with a population of over 140 million.

*ICBA helps in improving agricultural productivity in Central Asia*

Another important project, the 3-year study of salt-tolerant plants and halophytes in Central Asia, conducted in collaboration with the International Water Management Institute (IWMI) and the International Center for Agricultural Research in the Dry Areas (ICARDA) and funded by the Asian Development Bank, is being implemented in Uzbekistan, Kazakhstan and Turkmenistan with ICBA taking the lead. The project aims to introduce innovative and integrated methods of land, water and plants to improve the agricultural sector outputs that have been degraded due to irrigation mismanagement.

*ICBA organized a specialized seminar in Senegal*

ICBA continued in 2007 to play a critical role in capacity building in the West Africa and Sub-Saharan Africa region. In May, ICBA's delegation to the Annual Governors Meeting of the IDB in Dakar, Senegal, hosted a seminar on *biosaline agriculture with special reference to sub-Saharan Africa*. The ties forged at this meeting led directly to an important workshop in October in Dubai, where agricultural research directors from six West African research systems (Burkina Faso, Gambia, Mali, Mauritania, Niger and Senegal) formulated a project on S*mall-scale irrigation: development of a regional research project in West Africa* in a workshop funded by the IDB. The final project proposal will be completed during a special workshop for all stakeholders.

Also in October a training workshop was organized for agricultural officers from nine sub-Saharan African countries: Angola, Botswana, Kenya, Lesotho, Mozambique, Senegal, Sierra Leone, Tanzania and Zimbabwe. This workshop, *Biosaline agriculture technologies for arid and semi-arid regions with reference to Africa*, was funded by the Arab Bank for Economic Development in Africa (BADEA).

*Participants from nine sub-Saharan African countries participated in a training workshop at ICBA*

Networking is a critical aspect of successful partnership establishment and delivery of project outcomes. Consequently for three days In November, ICBA conducted the *First Expert Consultation on Advances in Assessment and Monitoring of Salinization for Managing Salt-affected Habitats* at ICBA headquarters. The Expert Consultation of the Food and Agriculture Organisation's Global Network on Salinization Prevention and Productive Use of Salt-affected Habitats (SPUSH), along with the Inter-Islamic Network on Biosaline Agriculture (INBA), was a joint scientific cooperation among experts in various fields. Countries represented included China, Egypt, India, Iran, Jordan, Hungary, Kenya, Mexico, Morocco, the Netherlands, Oman, Pakistan, Romania, South Africa, Spain, Tajikistan, Tanzania, Thailand, the USA and Uzbekistan.

This overview outlines just some of the projects and events undertaken by ICBA in 2007. With the new management team and new strategic framework charting the direction for the next four years in place, and a strong ethos of working in partnership with organizations and individuals, the ICBA team will continue to deliver quality outcomes in the traditional area of biosaline agriculture and the new area of marginal water.

*Experts from different least-developed and developed countries met at ICBA to discuss the world's salinity problems*

# Technical Programs

**Plant Genetic Resources**

**Production and Management Systems**

**Communications, Networking and Information Management**

**Training, Workshops and Extension**

# Plant Genetic Resources Program

## Acquisition and conservation of plant genetic resources (GR01)

**DURATION:** Ongoing
**COLLABORATORS:** National and international genebanks
**RESOURCES:** Core

### SIGNIFICANCE OF THE PROJECT

The productive use of saline lands requires genetic resources of salt tolerant plant species. ICBA has been assembling germplasm of species with proven or potential salinity tolerance to provide a source of genetic diversity to scientists working on problems of salinity in agricultural production systems. To ensure long-term viability and continued availability to the users, the assembled germplasm is conserved in the genebank under controlled environmental conditions and monitored for quality and quantity at regular intervals. Genebank management involves a series of complex and inter-related activities. Hence, storage of the associated information in a systematic manner, using appropriate documentation and information management systems, is important to improve operational efficiency.

### OBJECTIVES

- Assemble germplasm of proven or potentially salt-tolerant species.
- Securely conserve and manage the germplasm for continued availability to users.
- Develop an information management system to improve operational efficiency of the genebank.

*This dying mangrove forest underscores the need for protecting habitats and diversity*

## ACHIEVEMENTS IN 2007

### *Germplasm acquisition*

A total of 287 germplasm accessions of 13 species were assembled from various sources (Table 1). With the new additions, the total number of accessions conserved in the genebank increased to 9,210, representing 54 genera and 218 species originating from 133 countries (Appendix 1).

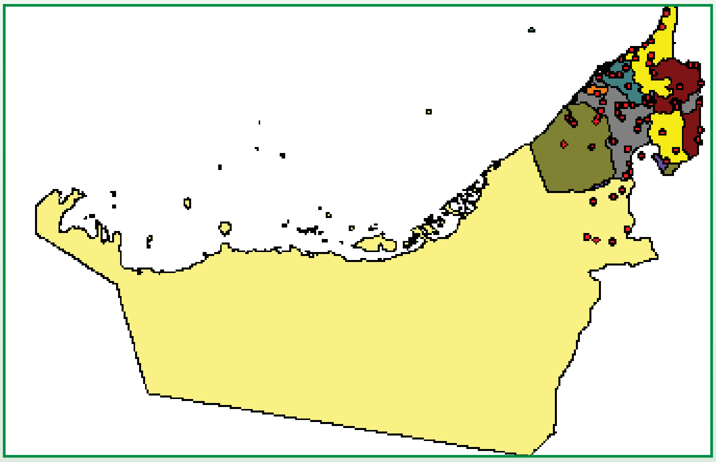


*Figure 1: Germplasm collecting locations in the UAE*

### *Germplasm collection*

In the UAE, drought, salinity and heat are characteristics of the environment and desertification and ecosystem imbalances are rapidly progressing due to unsustainable agricultural practices. Habitats are coming under increasing threat due to rapid urbanization and expansion of human settlements, in addition to overgrazing. Systematic attempts in the past to collect and conserve the genetic resources of economically important plant species have been few and far between. In view of the imminent threat of genetic erosion, ICBA's Genetic Resources Program has prepared a plan to collect and conserve species of economic importance.

***287 accessions of 13 species acquired***

To coincide with the fruiting time of the targeted species, collecting has been proposed in three phases over 2007 and 2008. The first phase of collecting was completed during June and July 2007. Six expeditions were launched in the northern regions of the UAE and a total of 97 samples, representing 24

***97 germplasm samples of 24 species collected from the northern UAE***

**Table 1: Germplasm accessions acquired in 2007**

| Genus/species | Common name | No. | Source |
|---|---|---|---|
| *Brassica juncea* | Mustard | 100 | The Australian Temperate Field Crops Collection, Horsham, Victoria, Australia |
| *Lycopersicon esculentum* | Tomato | 89 | Northeast Regional Plant Introduction Station, Plant Genetic Resources Unit, Geneva, New York, USA |
| *Lycopersicon hybrid* | | 6 | United States Department of Agriculture - Agricultural Research Service (USDA-ARS), Northeast Regional Plant Introduction Station, Plant Genetic Resources Unit, Geneva, New York, USA |
| *Lycopersicon pimpinellifolium* | Currant tomato | 5 | USDA-ARS, Northeast Regional Plant Introduction Station, Plant Genetic Resources Unit, Geneva, New York, USA |
| *Sesbania sesban* | Sesban | 60 | International Livestock Research Institute (ILRI), Addis Ababa, Ethiopia |
| *Sesbania bispinosa* | Prickly sesban, Dhaincha | 9 | ILRI, Ethiopia |
| *Sesbania rostrata* | | 7 | ILRI, Ethiopia |
| *Elymus elongatus* | Tall wheatgrass | 1 | ILRI, Ethiopia |
| *Panicum turgidum* | Desert grass | 2 | ILRI, Ethiopia |
| *Leymus angustus* | Wild rye | 1 | ILRI, Ethiopia |
| *Leptochloa fusca* | Kallar grass | 1 | ILRI, Ethiopia |
| *Salicornia bigelovii* | Glasswort | 3 | National Arid Land Plant Genetic Resources Unit, Parlier, California, USA |
| *Portulaca oleracea* | Purslane | 3 | Ornamental Plant Germplasm Center, Ohio State University, Columbus, Ohio, USA |
| **Total** | | **287** | |

*Collecting* Acacia tortilis *from Hajar mountains in the UAE*

*....... and variation in seed characteristics*

Senna italica. *The powdered leaves and seeds are used as a laxative*

**Table 2: Species collected in the UAE**

| Species | No. of samples collected |
|---|---|
| *Acacia tortilis* | 31 |
| *Avicennia marina* | 1 |
| *Cenchrus ciliaris* | 11 |
| *Citrullus colocynthis* | 2 |
| *Desmostachya bipinnata* | 1 |
| *Indigofera intricata* | 1 |
| *Lasiurus scindicus* | 1 |
| *Leucaena leucocephala* | 1 |
| *Moringa oelifera* | 1 |
| *Panicum antidotale* | 3 |
| *Panicum turgidum* | 1 |
| *Parkinsonia aculeata* | 1 |
| *Pennisetum divisum* | 5 |
| *Phragmites australis* | 2 |
| *Pithecellobium dulce* | 2 |
| *Prosopis cineraria* | 23 |
| *Prosopis juliflora* | 1 |
| *Rhynchosia schimperi* | 1 |
| *Salvodora persica* | 1 |
| *Senna italica* | 3 |
| *Sporobolus spicatus* | 1 |
| *Stipagrostis plumosa* | 1 |
| *Synapis arvensis* | 1 |
| *Vitex nigundo* | 1 |
| **Total** | **97** |

taxa were collected (Table 2). The areas covered by collecting are presented in Figure 1. The timing of the mission was appropriate to collect seeds of the species like *Acacia tortilis* and *Prosopis cineraria* which flower during spring. However, for several annual forage species, it was late as the seeds were already shed and the plants dried up. In perennial forage grasses, where seeds were not available, rhizomes were collected and plants were established at ICBA farm. Follow-up missions will be undertaken at an appropriate time during 2008 to collect the annual species and also to cover the remaining areas of the UAE, especially in the south.

## *Documentation and information management*

The Genebank Documentation and Information Management System was fully developed and deployed for use. The system was developed in Visual Basic™ with MS access™ as the backend. It has three main modules - passport, characterization and inventory. Each facilitates data entry, editing, querying and analysis based on aggregate functions (Figure 2). The system provides for importing data from external sources and backing up the databases.

***Genebank Information Management System deployed***

Citrullus colocynthis - *A relative of watermelon. Fruits are widely used medicinally*


***Figure 2: Screenshots of the Genebank Documentation and Information Management System***

## Proposed activities for 2008

Germplasm of high value crops such as vegetables and medicinal plants and of species with potential for bioenergy production, bioremediation and landscaping will be acquired to study their performance with marginal water irrigation. Collecting germplasm of economically important plants will continue and a botanical garden will be established at ICBA to promote awareness of conservation and uses of native plants.

Acacia tortilis - *the highly nutritive leaves and pods are important sources of browse for wild and domesticated animals*

Desmostachya bipinnata, *a salt-tolerant grass growing along the coast near Ras al-Khaima*

## Regeneration and dissemination of salt-tolerant germplasm (GR02)

**DURATION:** Ongoing
**RESOURCES:** Core

### SIGNIFICANCE OF THE PROJECT

Genetic diversity contained in the germplasm collections assembled at ICBA provides the basis for improving economic yields of saline irrigated agricultural systems. However, continued access to salt-tolerant germplasm by researchers and other users requires that adequate seed stocks be maintained. Most often, the seed samples obtained from donors come in small quantities, necessitating regeneration. Similarly, regeneration becomes necessary when seed viability of individual accessions declines beyond acceptable limits or the seed quantities fall to critical levels due to distribution to users. Germplasm regeneration is the most critical operation, requiring suitable conditions for growth to maximize seed yields and appropriate pollination control measures like bagging and isolation to minimize loss of genetic integrity, especially if the species is cross-pollinating.

***Sunflower, cowpea and quinoa showed excellent adaptation, holding promise for crop diversification in the region***

### OBJECTIVES

- Regenerate germplasm accessions, ensuring maximum seed output and high quality with minimal loss of genetic integrity.
- Disseminate salt-tolerant germplasm to agricultural researchers and other users.

### ACHIEVEMENTS IN 2007

***Seed multiplication***

A total of 720 germplasm accessions were sown for seed multiplication during 2006/2007 cropping season (Table 3). Quinoa and asparagus seeds were sown in jiffy packs and one month old seedlings were transferred into the field. Fresh water irrigation and standard agronomic practices were used to optimize seed yields. Sunflower and canola inflorescences were bagged to prevent out-crossing and seeds harvested from individual plants within each accession were bulked after harvest and threshing.

***629 germplasm accessions of 14 different crops multiplied***

*Asparagus in vegetative growth*

*Seed multiplication of safflower*

**Table 3: Crops and number of accessions regenerated**

| Crop | No. of accessions sown | No. of accessions harvested | Maximum recorded yield in g $m^{-2}$ (Accession no.) | Remarks |
|---|---|---|---|---|
| Sunflower | 100 | 99 | 143 (PI 256334) | |
| Canola | 100 | 56 | 125 (PI 432392) | Many biennial types |
| Cowpea | 24 | 24 | 382 (TVu 9716) | |
| Guar | 99 | 70 | 66 (PI 263876) | |
| Quinoa | 121 | 73 | 296 (Ames 13742) | |
| Fodder beet | 20 | 1 | 108 (IDBB 6151) | Many biennial types |
| Hyacinth bean | 12 | 12 | 289 (PI 388012) | |
| Pigeonpea | 137 | 126 | 121 (ICP 13577) | |
| Safflower | 52 | 52 | 414 (PI 237544) | |
| Barnyard millet | 45 | 4 | 64 (Ames 12684) | |
| Asparagus | 10 | * | * | * In flowering |
| **Total** | **720** | **517** | | |

Among the new crops grown, sunflower, quinoa and cowpea showed excellent adaptation. Yields in many accessions were comparable to those from traditional growing areas. Many accessions of canola and fodder beet failed to bloom, probably because they are biennials. In pigeonpea and asparagus, flowering has been erratic in some accessions probably because of late planting. Barnyard millet performed rather poorly and appeared to be highly sensitive to nutrient deficiencies. Only 4 of the 45 accessions produced small amounts of seed in this crop.

In addition to the above listed material, 43 sorghum, 29 pearl millet and 40 buffel grass accessions that showed salt tolerance in previous trials were multiplied using standard agronomic practices. To prevent out-crossing and to maintain genetic integrity of pearl millet accessions, cluster bagging was adopted in which 3-4 spikes from adjacent plants were enclosed in a common pollination bag soon after their exertion. To facilitate

*Seed multiplication of mustard*

**Table 4: Crops and number of accessions sown for seed multiplication, October/November 2007**

| Crop | No. of accessions |
|---|---|
| Tomato (*Lycopersicon spp.*) | 106 |
| Mustard (*Brassica juncea*) | 100 |
| Sesbania (*Sesbania spp.*) | 76 |
| Canola (*Brassica napus*) | 25 |
| Barley (*Hordeum vulgare*) | 23 |
| Pigeon pea (*Cajanus cajan*) | 20 |
| Guar (*Cyamopsis tetragonoloba*) | 20 |
| Quinoa (*Chenopodium quinoa*) | 20 |
| Sunflower (*Helianthus annuus*) | 28 |
| Cowpea (*Vigna unguiculata*) | 20 |
| Sorghum (*Sorghum bicolor*) | 20 |
| Chickpea (*Cicer arietinum*) | 18 |
| Pearl millet (*Pennisetum glaucum*) | 12 |
| Hyacinth bean (*Lablab purpureus*) | 12 |
| Mung bean (*Vigna radiata*) | 11 |
| Lentil (*Lens esculenta*) | 10 |
| Jojoba (*Simmondsia chinensis*) | 9 |
| Clover (*Trifolium spp.*) | 7 |
| Alfalfa (*Medicago sativa*) | 5 |
| Fodder beet (*Beta vulgaris*) | 5 |
| Saltbush (*Atriplex spp.*) | 3 |
| Glasswort (*Salicornia bigelovii*) | 3 |
| Purselane (*Portulaca oleracea*) | 3 |
| Desert grass (*Panicum turgidum*) | 2 |
| Kallar grass (*Leptochloa fusca*) | 1 |
| Tall wheatgrass (*Elymus elongates*) | 1 |
| Altai Wildrye (*Elymus elongates*) | 1 |
| **Total** | **561** |

cluster bagging, the planting method was slightly modified by sowing seeds in four holes dibbled around the dripper.

A total of 561 accessions of 27 genera were sown for seed multiplication during October-November 2007 (Table 4). The material included the high-yielding accessions of various crops selected from the previous grow-out and the salt-tolerant germplasm identified from screenings (*in vitro*, hydroponics and field). Germination and initial growth was good in most species. *Salicornia* and *Simmondsia* failed to germinate and further tests showed that seeds were unviable. In tomato, the seeds were sown in jiffy packs in the greenhouse and 1-month-old seedlings were transferred into the field. Although establishment was good, most of the plants showed symptoms of virus infection after 2-3 weeks of growth, and these were destroyed.

### *Seed dissemination*

A total of 530 seed samples were distributed during the year (Table 5). The total included 104 samples distributed to partners outside ICBA and 426 samples distributed to the Production and Management Systems Program for field trials.

## Proposed activities for 2008

Seed of some 500 promising germplasm accessions of various salt-tolerant crops will be multiplied for field trials at ICBA and distribution to partners. It is proposed to establish tissue culture facilities for mass propagation of economically important species native to the UAE.

***Table 5: Seed samples distributed from ICBA genebank in 2007***

| *Outside ICBA* | | |
|---|---|---|
| **Country** | **Crop** | **Total** |
| Bangladesh | Barley, pigeonpea, cowpea, sorghum | 4 |
| Uzbekistan | Sorghum, pearl millet, safflower, fodderbeet | 20 |
| Senegal | Sorghum, pearl millet, hyacinth bean, pigeonpea, barley, cowpea, sunflower | 65 |
| UAE | Sunflower, quinoa, pigeon pea | 15 |
| | **Total** | **104** |
| *Inside ICBA* | | |
| **Laboratory** | **Crop** | |
| Agronomy | Canola, buffel grass, cowpea, guar, quinoa, safflower, sesbania, sunflower | 413 |
| Halophyte | *Acacia tortilis* | 13 |
| | **Total** | **426** |

***530 seed samples of 13 species disseminated***

*Chenopodium quinoa (quinoa) seed is highly nutritive and has excellent potential for saline agriculture*

*Seed multiplication in hyacinth bean*

*Cowpea accessions in vegetative growth stage*

# Germplasm characterization and preliminary evaluation for salinity tolerance (GR05)

**Duration:** Ongoing
**Resources:** Core

## Significance of the project

*Data recorded on three observation nurseries received from ICARDA*

Morpho-agronomic characterization and preliminary evaluation for salt tolerance are prerequisites for discriminating among accessions and identifying promising germplasm for further utilization. The process is conducted according to standard international descriptors, and is usually undertaken when the accessions are first grown in the field for seed multiplication. Preliminary evaluation for different levels of salt tolerance is conducted in the laboratory using *in vitro* screening or in the greenhouse using hydroponics. ICBA has also been collaborating with the International Center for Agricultural Research in the Dry Areas (ICARDA) and other centers of the Consultative Group on International Agricultural Research (CGIAR) in conducting yield trials and observation nurseries of major crops to identify top-performing lines with tolerance for abiotic stresses. Since crop diversification is important for sustainable agricultural productivity, ICBA has also been looking into the identification and introduction of 'new' crops adapted to the local environment.

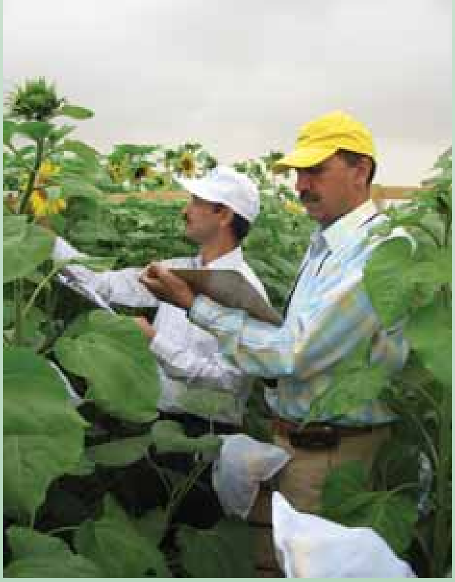
## Objectives

- Use morpho-agronomic characterization to discriminate among accessions.
- Undertake preliminary evaluation to identify accessions tolerant to different levels of salinity.
- Identify new crops with adaptation to local conditions.
- Contribute to global research to improve productivity of marginal lands.

## Achievements in 2007

### *Morpho-agronomic characterization*

Morpho-agronomic characterization was undertaken for 100 sunflower, 40 canola and 23 cowpea accessions using standard crop descriptors. Characterization of canola was conducted for 20 traits, while that of sunflower was based on 35 traits and that of cowpea on 10 traits. The observations were based on five randomly selected plants within each accession. Significant variation was observed in both vegetative and reproductive characteristics in all crops (Tables 6-8).



*Morpho-agronomic characterization of sunflower germplasm*

### *Evaluation*

#### *Observation nurseries*

Three observation nurseries received from ICARDA were planted using irrigation with fresh water and standard agronomic practices to optimize seed yield:

- Barley Low Rainfall Areas (Mild Winter) nursery (100 entries)
- Chickpea Elite Nursery (72 entries)
- Lentil Drought Tolerance Nursery 56 entries)

Data were recorded for days to flowering, days to maturity, height, susceptibility to diseases and grain yield. Plot yields (3m length) in barley ranged from 140 to 1388 g, in chickpea from 51 to 311 g and in lentil from 5 to 322 g. Seeds harvested from promising lines were stored in the genebank for further evaluation under saline conditions. The five top-performing genotypes in the three nurseries are listed in Table 9.

### *Crop diversification*

Pigeonpea is a leguminous shrub cultivated in the tropics and subtropics for a wide range of uses, including food, animal feed and fuel. ICBA acquired the minicore germplasm collection (a limited set of accessions chosen to represent most of the genetic diversity held in the global collection), a total of 137 accessions, from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India, to evaluate the potential for local adaptation. Each accession was grown in two 3-m length rows and irrigated with drip system using fresh water of about 3 dS $m^{-1}$. Compost was incorporated into soil before planting. During crop growth, a single dose of urea one month after planting and three

***Table 6: Range of variation in sunflower germplasm***

| Trait | Min | Max | Mean ± SD |
|---|---|---|---|
| Plant height (m) | 0.5 | 3.2 | 1.9 ± 0.51 |
| Days to flower | 56.0 | 140.0 | 83.2 ± 18.11 |
| Disc diameter (cm) | 8.1 | 15.7 | 11.4 ± 1.54 |
| No. of seeds/head | 179.6 | 2033.0 | 495.6 ± 269.35 |
| Filled seeds (%) | 1.3 | 96.4 | 41.9 ± 25.83 |
| Seed length (mm) | 7.6 | 16.1 | 11.0 ± 1.40 |
| Seed width (mm) | 4.1 | 10.0 | 6.2 ± 1.15 |
| Seed thickness (mm) | 2.5 | 6.2 | 3.9 ± 0.70 |
| 100 seed weight (g) | 3.0 | 13.7 | 7.0 ± 2.15 |
| Seed yield (g $m^{-2}$) | 0.7 | 143.4 | 47.3 ± 27.09 |

***Table 7: Range of variation in canola germplasm***

| Trait | Min | Max | Mean ± SD |
|---|---|---|---|
| Leaf length (cm) | 11.5 | 18.1 | 14.6 ± 1.64 |
| Leaf width (cm) | 6.0 | 13.6 | 10.9 ± 1.52 |
| Plant height (cm) | 111.6 | 195.6 | 149.3 ± 15.79 |
| Days to flower | 59.0 | 157.0 | 115.6 ± 26.90 |
| Silique length (cm) | 2.5 | 7.8 | 5.9 ± 1.17 |
| Silique width (mm) | 2.7 | 5.2 | 4.3 ± 0.60 |
| No. of seeds | 3.2 | 29.6 | 18.4 ± 6.54 |
| 1000 seed weight (g) | 1.8 | 4.2 | 3.1 ± 0. 51 |
| Seed yield (g $m^{-2}$) | 0.4 | 124.7 | 32.9 ± 31.80 |

***Table 8: Range of variation in cowpea germplasm***

| Trait | Min | Max | Mean ± SD |
|---|---|---|---|
| Leaf length (cm) | 4.4 | 8.0 | 6.5 ± 0.88 |
| Leaf width (cm) | 3.7 | 7.2 | 5.4 ± 0.89 |
| Days to flower | 75 | 100 | 89.1 ± 5.66 |
| Pod length (cm) | 12.6 | 16.9 | 15.0 ± 1.29 |
| Pod width (mm) | 6.1 | 8.2 | 7.6 ± 0.56 |
| No. of seeds | 7.2 | 13.6 | 11.2 ± 1.57 |
| 100 seed weight (g) | 9.4 | 18.5 | 13.3 ± 2.61 |
| Seed yield (g $m^{-2}$) | 36.0 | 382.8 | 214.4 ± 84.26 |

*Chickpea observation nursery*

*Lentil observation nursery*

*Pigeonpea adaptation trial*

*Profuse pod bearing in a vegetable type pigeonpea accession*

***Table 9: Top five genotypes selected for yield in observation nurseries***

| Crop | Genotype |
|---|---|
| Barley | IBON-LRA-M2, M3, M28, M29, M69 |
| Chickpea | ICARDA 3125, 3128, 3135, 3207, 3211 |
| Lentil | 20104, 20205, 20227, 20228, 20229 |

***Table 10: Pigeonpea germplasm accessions selected for high seed (dry) yield, green seed (vegetable type) and forage potential***

| |
|---|
| **Seed yield** |
| ICP 772, ICP 3576, ICP 6123, ICP 6128, ICP 6370, ICP 6668, ICP 6739, ICP 6859, ICP 6971, ICP 7221, ICP 7426, ICP 8255, ICP 8921, ICP 10397, ICP 11690, ICP 12298, ICP 13575, ICP 14229, ICP 14 368, ICP 14973 |
| **Vegetable type** |
| ICP 4903, ICP 6668, ICP 6739, ICP 7260, ICP 8921, ICP 8949, ICP 10094, ICP 13270, ICP 13359, ICP 13579, ICP 13633, ICP 14094, ICP 14116, ICP 14120, ICP 15185 |
| **Forage yield** |
| ICP 4167, ICP 4307, ICP 4903, ICP 6845, ICP 7221, ICP 10559, ICP 10654, ICP 11320, ICP 11425, ICP 13579, ICP 13633, ICP 14545, ICP 14569, ICP 14701, 14722, ICP 14801 |

***Table 11: Sunflower and pigeonpea germplasm accessions identified for salinity tolerance in* in vitro *screening***

| |
|---|
| **Sunflower** |
| Ames 18926, PI 167387, PI 170388, PI 170391, PI 181994, PI 184049, PI 243077, PI 251466, P1 252054, PI 343795, PI 426200, PI 426755, PI 432515, PI 433377, PI 490282, PI 536623, PI 536624, PI 536625, PI 536628, PI 599769, PI 600684 |
| **Pigeonpea** |
| ICP 7, ICP 3049, ICP 4167, ICP 6992, ICP 8602, ICP 8700, ICP 8793, ICP 8863, ICP 9045, ICP 11690 |

split doses of NPK (20:20:20) were applied by banding alongside the rows. As a prophylactic treatment, micronutrient solution was applied as foliar spray twice during crop growth. Vegetative growth during the first 2-3 months was slow because of low winter temperatures, but growth became luxuriant with the increase in day temperatures. Also, because of late planting, flowering was irregular and some accessions quickly shifted into a vegetative growth phase after an initial flush.

There was considerable variation among the accessions for morphological traits such as leaf shape, flowering pattern and flower and seed color. While the days to initial flowering varied between 86 and 149, the mean plant height recorded 10 months after sowing was between 84 and 343 cm and the mean canopy width between 37 and 139 cm. After 10 months of growth, mean fresh biomass among the accessions varied between 0.14 to 3.15 kg per plant, while mean dry biomass varied between 0.03 and 0.99 kg per plant. Elite germplasm accessions for high seed yield or with potential as vegetable and forage are listed in Table 10. Based on performance, pigeonpea appears to hold great promise for crop diversification in the region and the multiple use as food, feed and fuel, making it a truly high-value crop.

***Promising material with moderate levels of salinity tolerance identified in canola, sunflower and cowpea***

### In vitro *screening*

An *in vitro* laboratory screening method using water agar (0.8-1.0%) substrate was established to evaluate for salinity tolerance in crops. This method, especially useful for crops with medium-to-large sized seeds, facilitates fast and efficient evaluation of the effect of salinity on germination and seedling vigor. The agar substrate has an advantage over the standard paper substrate because it provides a constant supply of moisture for the entire duration of the test, thus facilitating uniform germination. Also, because agar is translucent, root growth can be easily monitored. Another advantage is that agar can remain moist for several weeks, obviating regular wetting of the substrate. This advantage helps minimize the accumulation of salts on the substrate that tend to occur when paper is used.

In vitro *screening for salinity tolerance*

***An efficient* in vitro *screening method with water agar substrate established to evaluate the effect of salinity on germination and seedling vigor***

Using *in vitro* screening, 133 pigeonpea and 100 sunflower accessions were assessed at three salinity levels (0, 10 and 20 dS $m^{-1}$). In pigeonpea, none of the accessions germinated at 20 dS $m^{-1}$. At 10 dS $m^{-1}$, even though germination was unaffected, root and shoot lengths were greatly reduced in many accessions. However, sunflower was found to be more tolerant of salinity than pigeonpea. In fact, several sunflower accessions germinated and produced normal seedlings even at 20 dS $m^{-1}$.

Based on mean shoot length, the top 20 accessions at 10 dS $m^{-1}$ and 20 dS $m^{-1}$ in sunflower, as well as the top 10 accessions at 10 dS $m^{-1}$ in pigeonpea are listed in Table 11.

### *Hydroponics screening*

Thirty-five accessions of canola were screened at four salinity levels (0, 5, 10, 15 dS $m^{-1}$) and 19 accessions of cowpea at three salinity levels (0, 10 and 20 dS $m^{-1}$) using the hydroponics method. Seedlings were established with fresh water and salinity treatments were initiated on 2-week-old plants, beginning with 5 dS $m^{-1}$ and increasing gradually to the maximum salinity over a period of 3-4 weeks. Five plants were used to study the effect of salinity in each treatment. The plants were harvested and observations on shoot and root lengths and total dry weight were recorded about 8 weeks after the initiation of the highest salinity treatment. In addition to canola and cowpea, a set of 18

*Screening pigeonpea germplasm for salinity tolerance*

*Screening cowpea germplasm for salinity tolerance*

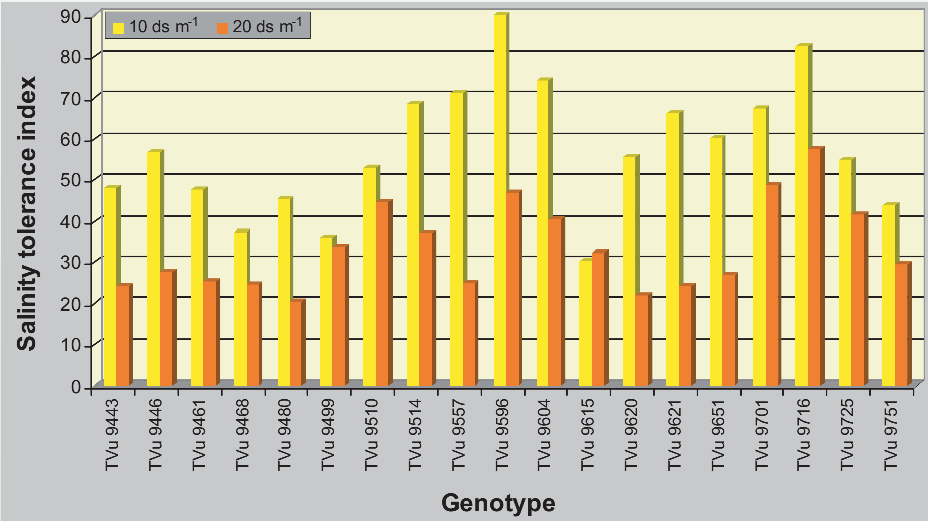



*Figure 3: Salinity tolerance in cowpea germplasm*

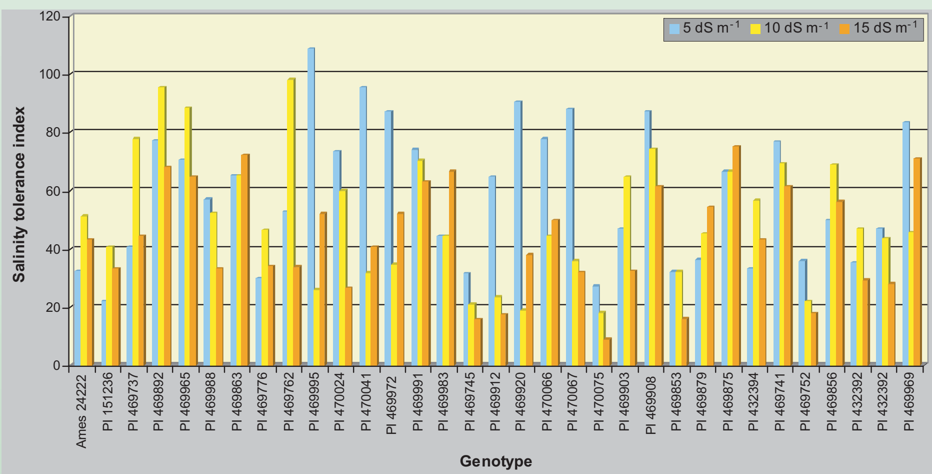



*Figure 4: Salinity tolerance in canola germplasm*

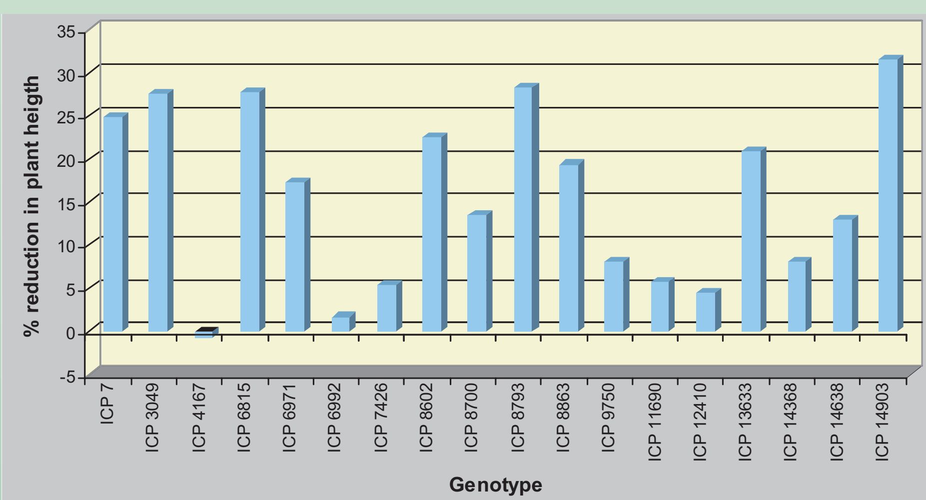



*Figure 5: Reduction in shoot length as percentage of control in pigeonpea germplasm accessions grown at low salinity (5 dS $m^{-1}$)*

pigeonpea accessions selected for tolerance through *in vitro* screening was also evaluated for tolerance at four salinity levels (0, 5, 10 and 15 dS $m^{-1}$).

In cowpea, salt stress significantly affected shoot length, root length and dry weight of seedlings. Significant differences in response to increasing levels of salinity were observed among genotypes. In canola, the response of different genotypes to increasing levels of salinity was found to be erratic. In fact, plant growth and dry mass were greater at higher levels of salinity compared with lower levels in many accessions. Similar observations were made on canola in previous studies (see also *ICBA Annual Report 2005*), the reasons for which are not clear. In both the crops, the salt tolerance index (STI) was calculated as the mean dry weight of an accession in salinity stressed environments compared to mean dry weight obtained in non-stressed environments. (STI = [DW at $S_x$ / DW at $S_1$] x 100, where DW = dry weight, $S_1$ = control and $S_x$ = salinity treatment) (Figures 3-5).

Compared with canola and cowpea, pigeonpea appeared less tolerant of salt stress. Higher levels of salinity (10 and 15 dS $m^{-1}$) resulted in chlorosis and seedling mortality in all genotypes. Although survival was not affected, plant growth was significantly reduced in several genotypes (Figure 5) even at the lower salinity (5 dS $m^{-1}$). However, the reduction in plant height compared with the control was marginal in ICP 4167, ICP 6992 and ICP 12410, indicating the relative tolerance of these accessions.

## Proposed activities for 2008

Morpho-agronomic characterization will be conducted on *Sesbania*, mustard and tomato germplasm accessions using standard descriptors. The newly acquired germplasm will be screened for salinity tolerance and bioremediation potential using *in vitro* and hydroponic screening methods.

*Barley Low Rainfall Areas Nursery from ICARDA grown at ICBA*

# Production and Management Systems Program

## Sustainable Land and Water Use

## Field and Forage Crop Production

## Halophyte Production

## Horticultural Crop Production

# Sustainable Land and Water Use

## Demonstration of biosaline agriculture in salt-affected areas of Bangladesh (PMS09)

**Duration:** 2003-07

**Collaboration:** Bangladesh Agricultural Research Institute (BARI)

**Resources:** BARI, Core

### Significance of the project

Bangladesh is a developing country with a population of 140 million that continues to grow at an alarming rate. To meet the food demands of the increasing population, salt-affected lands, estimated at 0.88 million hectares, must be brought under cultivation.

The average annual precipitation of Bangladesh is estimated at 3,000mm. Most of this precipitation occurs during the monsoon, starting in June. During the driest months of March and April, salinity problems are acute along the coastal belt. Lands are traditionally left fallow because crop production is inhibited by seawater intrusion as a result of the near-sea-level topography.

Cash crops such as tomato, chili and watermelon can be grown with proper management of soil and water. One such technology is the use of raised beds irrigated with drip irrigation. This combination permits proper leaching of salts from the root zone. If mulching is added to the raised beds, the upward flux of salt can be reduced in the root zone.

***Tomato, watermelon and chili are promising cash crops in saline coastal areas of Bangladesh***

### Objectives

The overall objective of the project is to use soil and water management techniques in the coastal saline zone to mitigate salinity. Specific objectives:

- Grow crops using drip irrigation on raised beds and compare yield and salinity results against common agricultural practices.
- Convert yield data into economic returns and evaluate overall economics.
- Demonstrate the results to farmers and NGOs during field days.

***Drip irrigation along with raised bed and mulching can save irrigation water and decrease salt accumulation in the root zone***

### Achievements in 2007

Field experiments were conducted to evaluate the performance of tomato, chili and watermelon under various irrigation management techniques in farmers' fields in coastal saline soils during the dry season. Planting on flat beds, without irrigation and mulch, represented the farmers' practice (ie, control treatment). Rain-harvested water (EC varied from 0.32 to 0.47 dS $m^{-1}$) was used in irrigation.

Drip irrigation in raised bed with mulch treatment produced 69 t $ha^{-1}$ tomato,

*Mature tomato in the experimental field*

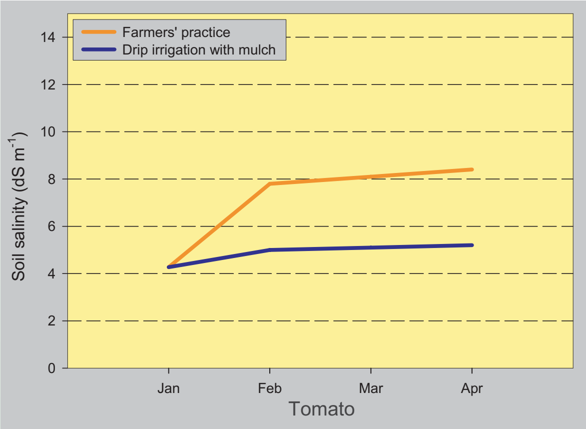



*Figure 6: Soil salinity status comparing farmers' practice vs recommended technique for tomato*

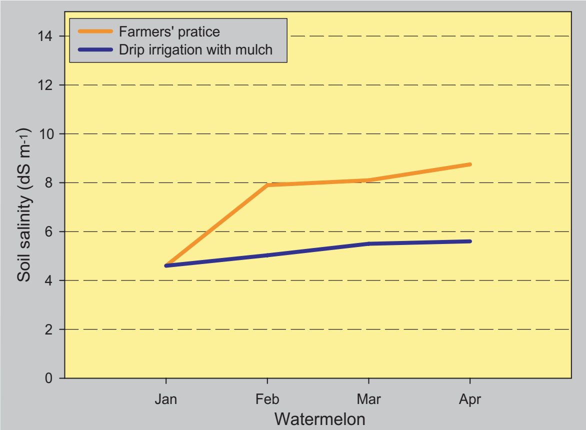



*Figure 7: Soil salinity status comparing farmers' practice vs recommended technique for watermelon*

quadruple the yield of the control treatment. The benefit cost ratio (BCR) was 3.42 for the drip irrigation treatment, while that of the control treatment was only 1.72. In the case of watermelon, the yield was 34 t $ha^{-1}$ in a raised bed with drip irrigation, but only 15 t $ha^{-1}$ for the control plot (Figure 2). BCR for the recommended practice was 2.02 and that for the control 1.47. Chili cultivation also showed a positive result (ie, yield of 3 t $ha^{-1}$ and BCR of 2.91) in manual pump irrigation.

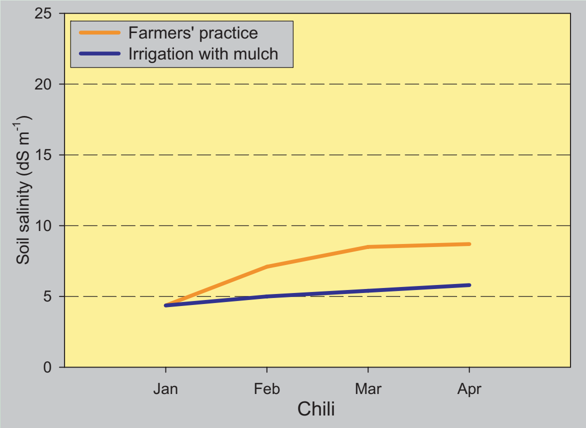



*Figure 8: Soil salinity status comparing farmers' practice vs recommended technique for chili*

Drip irrigation practices saved irrigation water about 20 and 23 percent for tomato and watermelon plots respectively in comparison with manual pump irrigation. For chili plots, manual pump irrigation saved irrigation water more than 5 percent from the traditional pot irrigation practice. Drip irrigation with mulch was able to reduce about 38 and 36 percent of soil salinity at 0-30 cm depth in comparison with farmer's practice during April (i.e. the driest month of the growing season) for tomato and watermelon plots respectively (Figures 6 & 7). In case of chili, manual pump with mulch decreased soil salinity approximately 33 percent against the farmers practice (Figure 8).

A Field Day was held on 23 March 2007 to demonstrate the research results. About 120 farmers participated in the Field Day along with government and non-government (NGO) officials. The officials of both government departments and NGOs expressed their satisfaction over the technology tested. Farmers showed a keen interest in applying the demonstrated technologies.

*Farmers at the field day*

## Biosaline agriculture development program at the NPC Site, Al-Laith, Saudi Arabia (PMS33)

**DURATION:** 2004-08
**COLLABORATION:** National Prawn Company (NPC)
**RESOURCES:** NPC

### SIGNIFICANCE OF THE PROJECT

National Prawn Company (NPC), the largest company in the Gulf Cooperation Council (GCC) region, is located on the Red Sea coast at Al-Laith, about 450 km from Jeddah in the Kingdom of Saudi Arabia. Annual shrimp production is close to 10,000 tons. Seawater is pumped into the shrimp ponds and the return water is discharged into a drainage canal that directs it back to the sea. This water, which contains a significant load of nutrients and organic matter resulting from the production and rearing activities, has good potential for use in agricultural production and coastal rehabilitation. The presence of a natural lagoon is ideal for rehabilitating *Avicennia marina*, a local mangrove species, along the inner shores. This area, which extends to about 40 km, can be used as a hatchery for fish and shrimps.

***Demonstrated potential of return seawater in agricultural production and coastal rehabilitation***

***Provided 7,500 seedlings of shrubs & trees and mother stock of 76,000 seedlings of salt-tolerant grass species***

### OBJECTIVES

- Utilize return seawater for the production of halophytes for forage, environmental beautification, biomass energy and organic fertilizers.
- Expand the mangrove plantation along the barrier island and alongside the return water canal.
- Investigate halophyte groundcover for erosion control of dikes.

***Trained NPC staff in propagation of salt-tolerant plant species***

Salvadora persica *and* Conocarpus *spp. make good windbreaks*

## ACHIEVEMENTS IN 2007

ICBA has fulfilled its commitments by providing 7,500 seedlings of shrubs and trees, mother stock of about 76,000 seedlings of salt-tolerant grass species, and commissioning the irrigation system in the pilot project area. ICBA also trained NPC staff to propagate the plant species in a shade house. *Conocarpus* and *Salvadora* spp. were planted as windbreaks to enable further establishment of plant species in the area.

NPC staff also germinated a large number of mangrove seeds collected from the coastal plantations. These were acclimatized under various salinity conditions and kept in the shallow water of the lagoon at 57 dS $m^{-1}$ salinity level. These will be later used for transplantation in the extended lagoon areas.

*Excellent growth of salt-tolerant grass at NPC field station*

## PROPOSED ACTIVITIES FOR 2008

Three major activities including planting mangroves, extending windbreaks in the demonstration plot, and propagating seedlings and screening them at different salinity levels are proposed.

NPC will acquire satellite imageries of the lagoon area to identify the gaps where mangrove species should be planted. It is envisaged that about ~10,000 seedlings will be propagated and transplanted annually, completing the work in 5-6 years. ICBA proposed to increase wind break plants for protecting the 4 ha demonstration area before transplantation of grasses and shrubs in the desert area. NPC staff will continue propagating seedlings as suggested by ICBA scientists. During this period, screening facilities will also be built in a new shade house, where seedlings of plant species provided to NPC will be tested at salinity levels of 11, 22, 33 and 44 dS $m^{-1}$.

Sporobolus virginicus *stabilizing sand dunes*

*ICBA scientists during the field evaluation*

## Soil Survey for the Emirate of Abu Dhabi (PMS36)

**Duration:** 2005-09
**Collaboration:** Environment Agency-Abu Dhabi (EAD)
**Contractor:** GRM International, Australia
**Resources:** EAD, Core

### Significance of the project

The soil survey for the Emirate of Abu Dhabi is a joint project between the EAD and ICBA implemented through an Australian contractor, GRM International. The project commenced in April 2005 and will conclude in October 2009. ICBA hosts GRM International at its expanded office in Abu Dhabi. ICBA's role is to manage and supervise the project activities and to conduct quality assurance that the standards stipulated by the project's terms of reference are met.

Understanding the capabilities and limitations of a nation's soil resources is essential for sustainable development. The data made available through the soil survey is of immense value to potential land users for master planning, soil management and reclamation, environmental monitoring, environmental impact assessment, soil conservation, farming, managing land resources and combating desertification.

### Objectives

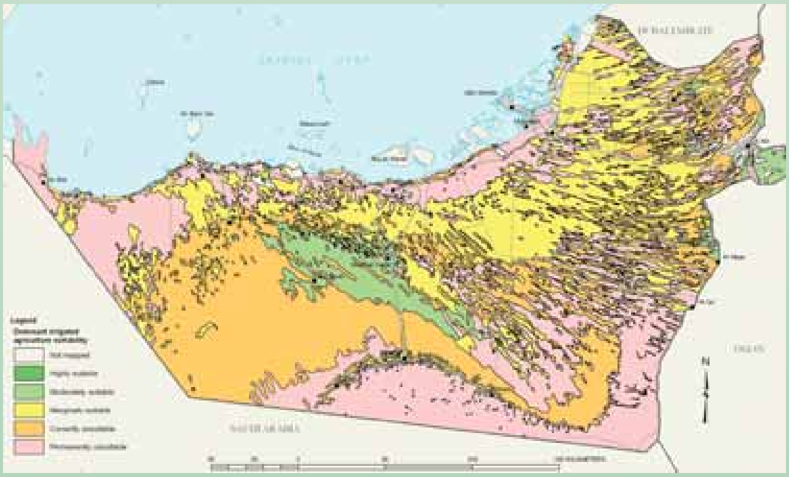
- Conduct an extensive survey of Abu Dhabi Emirate at 1:100,000 scale.
- Conduct a survey of 400,000 ha for irrigated agricultural expansion on 1:25,000 scale.
- Publish soil, current land use, irrigated agriculture suitability, land degradation, soil salinity, vegetation, and other thematic maps at various scales.
- Develop a soil database management system within a geographic information system (GIS) environment.
- Analyze soils for important characteristics and establish a soil archive.
- Build capacity of UAE nationals.

***Soil survey officially launched and extensive survey field work completed***

### Achievements in 2007

#### *Field survey*

After a comprehensive literature review, analysis of satellite-acquired data and a preliminary field survey, a basic profile of Abu Dhabi's soils and landscape was obtained and a workplan agreed for duration of the project. A preliminary statistical assessment of extensive survey results was also conducted.



*Irrigated suitability map of Abu Dhabi Emirate soils*

### *Irrigation suitability map*

Over 100 preliminary soil map units were delineated and the component soils established and described. Preparation for Phase II (intensive survey) was initiated by developing criteria for suitability for irrigated agriculture and an area of suitability was calculated for each class (Table 12). The approach follows the land suitability classification concepts developed by the Food and Agriculture Organization of the United Nations (FAO) in its Framework for Land Evaluation (1976). This was used as a guideline to match Abu Dhabi soils and their properties. An initial area of 50,000 ha was identified and the survey commenced. The rest of the 350,000 ha will be identified for intensive survey in early 2008. Development of criteria for other thematic maps was jointly initiated by EAD, GRM and ICBA.

***Table 12: Irrigated suitability area***

| Suitability class | Definition | Area (ha) |
|---|---|---|
| S1 | Highly suitable land with no significant limitations to the specified use | 2,416 |
| S2 | Moderately suitable land with moderate limitations to the specified use | 309,265 |
| S3 | Marginally suitable land with severe limitations to the specified use | 1,550,349 |
| N1 | Currently unsuitable land with severe limitations that cannot be corrected with existing knowledge and technology at currently acceptable costs | 1,752,854 |
| N2 | Permanently unsuitable land with severe limitations that cannot be corrected | 2,108,211 |
| **Total** | | **5,723,095** |

***Criteria for thematic maps established***

### *Laboratory soil characterization*

Laboratory analysis provided quantitative and qualitative data for specific soil properties. Soil samples were collected from shovel/auger observations as well as from typical soil profiles. As of December 2007, over 300 soil samples had been analyzed for complete characterization and over 400 for partial analysis. Samples of fine clay, carbonate clay, clay and whole soil mineralogy, both x-ray fluorescence (XRF) and thin sections, were submitted to the UAE University for specific analysis. A batch of soil samples was analyzed at the laboratories of the United States Department of Agriculture (USDA) and the University of Western Australia for quality assurance. The EAD/ICBA team also conducted soil analysis at ICBA Headquarters in Dubai. Over 400 soil samples were added to the soil sample archive. The results will be submitted in early 2008.

***Soil, vegetation, thematic and irrigated suitability map prepared***

***Initial selection of 50,000 ha for phase II completed***

### *Abu Dhabi Soil Information System (ADSIS)*

ADSIS is a web-enabled environmental data portal offering an additional gateway to the soil survey database. ADSIS is comprised of five components:

- Geodatabase
- Soil Information System Application, including administration of the user, application module/component and data
- Field Operation System
- Soil Information System Internet Serving Application
- Soil Information System training package

The development plan of ADSIS relies on standard software development methodologies and procedures, with modifications to accommodate the nature of ADSIS requirements analysis, project development history and the development environment. Rational Unified Process (RUP) will be used in a form adapted using Rapid Application Development (RAD).

*A unique anhydrite rich soil mapped in the Abu Dhabi coastline*

The RUP lifecycle organizes the tasks into phases and iterations.

*Initial work on Soil Database Management System commenced*

The activities during 2007 are:

- 17 January: Soil Survey project officially launched.
- 26 February, 9 July, 18 September, 12 December: Technical Committee Meetings.
- 20-24 May: EAD/ICBA jointly organized training for 12 UAE nationals on *Laboratory Techniques in Soils* at ICBA Headquarters, Dubai.
- 28 June: Steering Committee Meeting at EAD Headquarters, Abu Dhabi.
- 26 July: Workshop on Abu Dhabi Soil Information System (when the extensive survey field work had been completed and the intensive survey field work had commenced).
- 29 October: Soil Stakeholders Meeting, chaired by HE Majid Al Mansouri and attended by ICBA management, project staff and stakeholders, Millennium Hotel, Abu Dhabi.
- 50,000 ha identified for intensive survey.

*ICBA/EAD jointly completed 5 days soil training to UAE nationals*

## Proposed activities for 2008

ICBA will continue to host GRM at its Abu Dhabi office and to supervise and manage project activities. The EAD and ICBA will work closely with GRM to provide technical support and to conduct quality assurance on the survey results. The major focus will be on the completion of the extensive survey report during the first quarter and to conduct an intensive survey of 400,000 ha area at a scale of 1:25,000 for the expansion of irrigated agriculture. During intensive survey 32,653 shovel/auger observations to a depth of 2m will be accomplished on a grid basis (350m x 350m). Field work for this exercise commenced in late 2007.

***Extensive survey:*** The final report as well as special reports on deep drilling, statistical assessment, and water infiltration/permeability measurements will be prepared.

***Intensive survey:*** Three quarterly progress reports and various special reports will be prepared. Many soil samples collected during the survey will be analyzed. UAE nationals will receive on-the-job-training on all components of the project.

*A session of the project Steering Committee chaired by HE Majid Al Mansouri*

## Evaluation of the First AFG treated salt water for crop and forage production at ICBA research station (PMS41)

**Duration:** 2007-09

**Collaboration:** The First AFG, USA

**Resources:** The First AFG

### Significance of the project

*New research initiative with private sector*

First AFG, a USA-based private company, claims that their salt water treatment processing unit can neutralize saline water that can be safely used for crop production without any negative effects. The company had requested ICBA to evaluate its treatment unit, and consequently ICBA signed an MOU with the company on 30 September to conduct field experiments to evaluate treated water at the ICBA experimental station.

### Objectives

The overall goal is to evaluate the treated water on field and forage crop production in comparison to the effects of untreated water. The specific objectives are:

- Assess the suitability of treated water for growing field and forage crops.
- Evaluate the soil quality changes due to application of treated water over time.

### Achievements in 2007

*Research findings will determine the suitability of the treated water for growing crops under saline conditions*

A laboratory experiment was conducted to study the effect of treated water (TW) from the First AFG salt water treatment unit. Two crops, barley (a salt-tolerant crop) and lentil (a salt-sensitive crop) were used for the study. Untreated groundwater (GW), with salinity of 20 dS $m^{-1}$, collected before passing through the unit; and freshwater (FW) with salinity of 3 dS $m^{-1}$, served as controls. In each treatment, 30 seeds were sown in three replicates each of 10 in 9-cm diameter Petri dishes on water agar (0.8%) substrate. The seeds were incubated at 23-25°C and observations on germination, root length and shoot length were recorded after 7 days. The data were analyzed using a statistical software, Genstat 5.

Differences were observed between the two crops in their response to treatment with different types of water. In barley, germination was not significantly different among the three treatments. However, shoot and root lengths were greatest with fresh water, followed by treated water and groundwater treatments. In lentil, germination was higher with FW than with TW and GW treatments. Like barley, shoot and root lengths were significantly reduced in TW and GW treatments compared to the FW (Table 13).

First AFG salinity water treatment unit on location at ICBA

| ***Table 13: Effect of salinity on germination and seedling growth*** | | | | |
|---|---|---|---|---|
| **Parameter** | **Type of water** | | | |
| | **FW** | **TW** | **GW** | **LSD (5%)** |
| ***Barley*** | | | | |
| Germination (%) | 90.00 | 87.00 | 83.00 | 22.10 |
| Shoot length (cm) | 10.50 | 6.20 | 3.90 | 1.57 |
| Root length (cm) | 7.30 | 6.10 | 3.20 | 0.49 |
| ***Lentil*** | | | | |
| Germination (%) | 70.00 | 43.00 | 40.00 | 37.70 |
| Shoot length (cm) | 3.24 | 2.25 | 0.93 | 0.66 |
| Root length (cm) | 4.83 | 2.34 | 1.18 | 0.79 |

*__FW__: Fresh water, __TW__: Treated water, __GW__: Untreated groundwater*


*Evaluation of different types of water on germination, shoot length and root length of barley and lentil seeds using Petri dishes*

## Proposed activities for 2008

Field experiments will be conducted at ICBA Research Station for evaluating the treated water in both winter 2007 and summer 2008 seasons. Both salt-sensitive crops and salt-tolerant forages will be selected for this study. Irrigation water will be applied to crops/forages through drip irrigation. Thorough scientific investigations will be undertaken for monitoring soil and water salinity levels, crops establishment, growth and productivity.

## Water Master Plan for Abu Dhabi Emirate (PMS42)

**Duration:** 2007-09
**Collaboration:** Environment Agency-Abu Dhabi (EAD)
**Resources:** EAD

### Significance of the project

The Emirate of Abu Dhabi needs about 3.2 billion cubic meters of water annually. Saline groundwater is the main source (about 80%) of available water. Fresh water availability does not exceed 1%. The remaining water demand (19%) is met from desalinated and treated wastewater. The challenges facing the water sector such as increases in population, industry and agriculture in Abu Dhabi, water supply and demand for all stakeholders need to be carefully assessed and analyzed through an integrated approach for sustainable development. The strategy to deal with the challenges will be elaborated in the Water Master Plan.

***ICBA will develop the Water Master Plan through an integrated strategy that will benefit agricultural, industrial and domestic sectors***

### Objectives

The overall objective is to develop a clear strategy for managing the water sector and to balance consumption between agricultural, industrial and domestic sectors for sustainable economic development of the emirate. The specific objectives are:

- Develop clear goals and strategies to promote institutional performance in the water sector.
- Develop policies, rules and standards.
- Develop plans for capacity building, public awareness and upgradings of information system services.
- Develop a work plan for targeted projects and their costs.

### Proposed activities for 2008

A team of relevant experts will prepare the draft strategy document in 2008. A discussion workshop with local authorities in Abu Dhabi is planned for finalizing the strategy document. The duration of the project is 9 months. During this time, the work will be focused on four components:

***All relevant water sector stakeholders will be consulted in finalizing the Plan***

- Collection of data.
- Development of a framework for technical (water resources), policy/regulations/standards and institutional aspects.
- Development of a capacity building program based on needs assessment to implement the strategies.
- Promotion of the strategic goal and outputs to staff and stakeholders.

## Marginal water resources assessment and use for growing horticultural crops and fodders in the coastal saline areas of Bangladesh (PMS43)

**Duration:** 2007-08

**Collaboration:** Bangladesh Agricultural Research Institute (BARI)

**Resources:** BARI, Core

### Significance of the project

BARI, in collaboration with ICBA, conducted a 4-year (2003-07) applied research and demonstration project (PMS09) in Noakhali district for growing horticultural cash crops (tomato, chili, watermelon, cucumber and sunflower) using micro-irrigation techniques along with cultivation management practices. Harvested rainwater was used for irrigation. Traditionally, the land remains fallow with dry saline conditions. The technological interventions considerably reduced soil salinity. Cultivation of the above crops was also found to be highly profitable. Such technology holds much promise for alleviating poverty and improving the livelihoods of poor rural farmers.

***An integrated marginal water resources management project proposal for the entire costal belt of Bangladesh will be developed***

These technologies now need further testing in other coastal zones of Bangladesh. In addition to food crops, demand for fodder crops in saline areas is significant. Thus, both cash crops and fodder will be used in future demonstrations at the selected sites. Possible demonstration sites are Patuakhali and Khulna. Such information will be useful in sustainable land use planning for the effective utilization of saline soils and waters.

***All relevant stakeholders in marginal water resources will be consulted through a national workshop***

### Objectives

- Develop necessary information for designing a marginal water resources management project proposal.
- Assess marginal water resources along the coastal saline belt of Bangladesh.
- Use the demonstration results to prepare the proposal.
- Demonstrate the technologies generated from the earlier ICBA-BARI project (2003-07) in selected saline areas for the production of horticultural crops and evaluate these technologies for scaling up. Possible sources of irrigation will include harvested rainwater, well water and tidal river water.

### Proposed activities for 2008

The demonstration and pre-planning initiatives began during winter 2007 and will be completed by April 2008. The reports from these initiatives will be submitted to ICBA by September 2008. The full project proposal for future demonstrations will be prepared by April 2009.

## Management of salt-affected soils and water for sustainable agriculture (PMS 49)

**Duration:** 2006-09

**Collaboration:** Sultan Qabous University (SQU), Oman

**Resources:** SQU, Core

### Significance of the project

Soil salinity is a serious threat to Oman's agriculture and economy. Because of the coarse texture of the soils in the Al-Batinah region, drainage is unimpeded and the build-up of salts can be reduced with proper management. Appropriate solutions that are environmentally sustainable need to be identified and promoted. Moreover, land and water resources of marginal quality need to be utilized. This project focuses on three approaches that could have a compensatory economic return to the farmer:

- Soil reclamation.
- Biosaline agriculture.
- Integration of fish culture and crop production.

Research also focuses on developing a rapid and inexpensive method of monitoring land salinization and the impact of interventions to mitigate salinization. In addition, the socio-economic benefits and cost of reclaiming saline soils need to be well understood before government funds are invested in mitigation of salinization. The project is jointly implemented by five departments at SQU together with the Ministry of Agriculture, the Ministry of Regional Municipalities, Environment and Water Resources, and ICBA. The project is being undertaken in salt-affected farms at the Ministry of Agricultural Research Station in Rumais and in private farms along the Al-Batinah coastal strip.

### Objectives

- Assess the intensity and extent of salinity using remotely sensed satellite images, ground truthing and preparation of temporal and spatial variation maps of soil salinity using GIS.
- Determine agronomic solutions (mulching, tillage, sowing methods, etc.) and nutritional aspects, including microbial nitrogen mineralization in saline conditions.
- Determine engineering and water management solutions (irrigation, sub-irrigation, leaching, leveling, etc.) to reduce water loss and salinization.
- Determine biological solutions by identifying salt-tolerant crops and fruit trees for various salt-affected regions of Oman. This includes introduction of halophytes.
- Assess the effects of feeding salt-tolerant forage crops to sheep.
- Integrate fish culture in the marginal lands in Oman.
- Determine socio-economic costs and benefits of salinity management practices in Oman.

## Achievements in 2007

***Experimental sites selected and assessed***

ICBA's role was to provide technical support and to jointly implement the project activities with SQU to achieve the objectives. ICBA joined the project team in all technical tasks in general, but specifically provided technical support in determining engineering and water management solutions for the management of salt-affected soils and water.

Harvesting of sorghum was completed during the first week of October. Soil and plant data were collected. An experimental design for barley was prepared and an irrigation system completed. Regular project meetings were held to monitor project progress and to formulate plans for future experiments.

***Annual project workshop held***

The first annual workshop was held on 2-3 November at Rumais Experimental Station. During the workshop the project team visited the field and discussed best practice methods to collect soil samples for salinity monitoring from experimental plots watered through drip irrigation .

## Proposed activities for 2008

Additional samples will be studied before and after harvesting. For alfalfa experiments, land will be prepared and soil samples will be collected from the subplots. A sprinkler system will be used for irrigation.

Experiments will be conducted in a 60m x 40m plot for two seasons. Response to salinity level and both organic and inorganic fertilizer are the main focuses in the tomato experiment. The nitrogen dynamics in the plots will be monitored on a regular basis and tomato quality will be investigated. Experimental observations will be recorded on a regular basis, analyzed and reported. ICBA will continue providing technical support to the team throughout the project duration.


*Workshop participants*

# Field and Forage Crop Production

## Optimizing management practices for maximum production of two salt-tolerant grasses: *Sporobolus virginicus* and *Distichlis spicata* (PMS03)

**Duration:** 2002-08

**Collaboration:** UAEU, NARS of several countries in WANA

**Resources:** International Fund for Agricultural Research (IFAD), Arab Fund for Economic and Social Development (AFESD), Core

### Significance of the project

Information on the long-term field studies on sustainable and economically feasible forage production systems, using non-conventional salt-tolerant grasses and highly saline water, have been scanty at the global level and virtually absent in the Middle Eastern region. Two highly salt-tolerant grass species *Sporobolus virginicus* and *Distichlis spicata* are used to study such forage production systems. These species were selected based on previous evaluation of their salinity tolerance, nutritional value and suitability for mechanical harvesting and handling for economical, large-scale production. Each species was planted at ICBA's research farm in Dubai on a 0.6 ha field for research and demonstration. Three treatments - salinity (10, 20, 30 dS $m^{-1}$), irrigation level ($ET_0$, 1.5 ET and 2 ET) and fertilizer rate (0, 50, 100 and 150 NPK units/ha) - were applied using split-split plot technique in randomized complete blocks with three replications.

***Information on sustainable and economically feasible forage production systems using salt-tolerant grasses and highly saline water is lacking in the Middle East***

***Two highly salt-tolerant grass species*** **Sporobolus virginicus** ***and*** **Distichlis spicata** ***were selected for long-term field studies***

### Objectives

- Determine yield potential of the two grasses when irrigated with highly saline water, and the threshold salinity level at which the productivity remains economical.
- Determine the optimal irrigation level for maximum production of the two grasses, and the level that minimizes salt build-up in the root zone.
- Determine an appropriate fertilizer regime for maximum production.
- Assess the nutritional value of the two species in response to the different salinity, irrigation and fertilizer levels.
- Determine the effect of the grass forage on the animal health when fed alone or in combination with other fodders.

***The effect of the grass forage on animal health when fed alone or in combination with other fodders was evaluated***

***The nutritional value of the two species was assessed in response to the different salinity, irrigation and fertilizer levels***

### Achievements in 2007

Three harvests of both grasses were completed. The cutting program was adjusted on actual field growth to avoid low yields at certain times of the year. The results of dry matter production at field level and over different treatment levels are described.

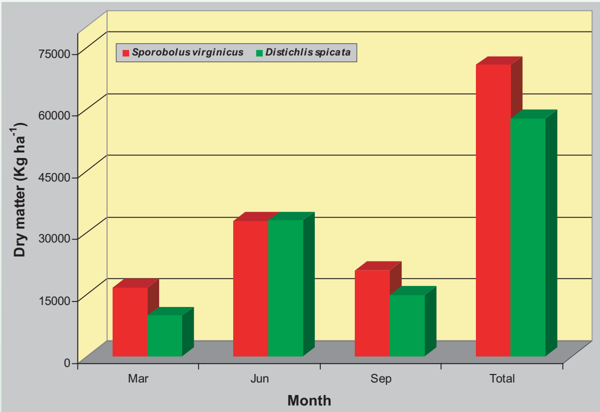



*Figure 9: Total field dry matter production of three harvests of* Sporobolus virginicus *and* Distichlis spicata *over all treatments*

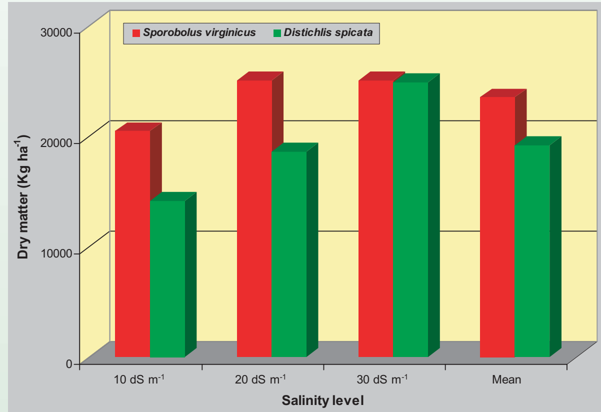



*Figure 10: Total field dry matter production (three harvests) of* Sporobolus virginicus *and* Distichlis spicata *at three salinity levels*

### *A. Large-scale field yield*

Total annual field dry matter yield reached 70.1 t ha$^{-1}$ in *S. virginicus* and 57.8 t ha$^{-1}$ in *D. spicata* (Figure 9). Total field dry matter production of *Sporobolus virginicus* ranged from16.8 to 33.0 t ha$^{-1}$ at each harvest (over all treatments) and 20.5 to 25.1 t ha$^{-1}$ at each salinity level. Total field dry matter production of *Distichlis spicata* ranged from 9.9 to 33.0 t ha$^{-1}$ at each harvest and 14.2 to 25.0 t ha$^{-1}$ at each salinity level (Figure 10). Both species showed significant dependence of dry matter production over the season, with yield highest in summer (June) harvest. *S. virginicus* produced the highest dry matter at medium salinity, although the difference between medium and high salinity was insignificant. Dry matter yield of *D. spicata* was highest at high salinity, approximately 80% higher than yield at low salinity.

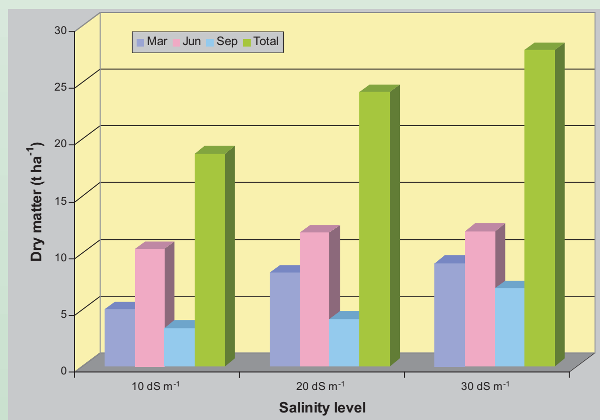



*Figure 11: Dry matter production of* Sporobolus virginicus *of three harvests at three salinity levels*

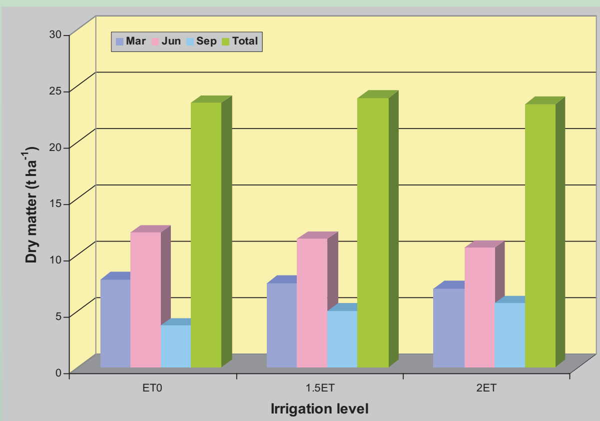



*Figure 12: Dry matter production of* Sporobolus virginicus *of three harvests at three irrigation levels*

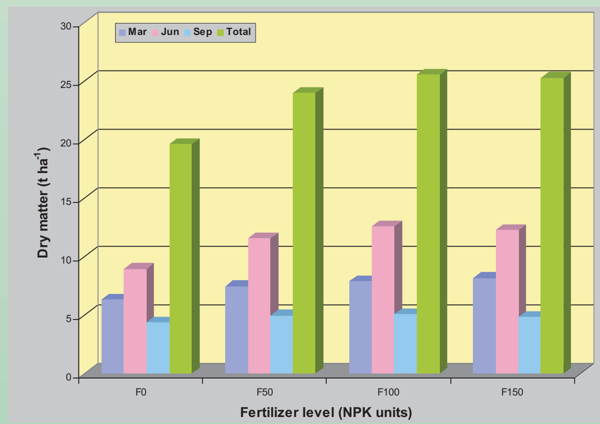



*Figure 13: Dry matter production of* Sporobolus virginicus *of three harvests at four fertility levels*

## *B. Dry matter production under different levels of salinity, irrigation and fertility*

### *1.* Sporobolus virginicus

Results of dry matter production of three harvests of *Sporobolus virginicus* are presented in Figures 11-13.

The results indicated that dry matter production linearly increased with increasing salinity levels, and maximum yield (27.9 t $ha^{-1}$) was achieved at the highest salinity level (30 dS $m^{-1}$). Increased application of irrigation water resulted in reduced dry matter yield, and maximum yield (25.5 t $ha^{-1}$) was obtained with the minimum amount of irrigation water. However, dry matter yield was generally higher when fertilizer level was increased. Maximum dry matter yield was obtained when 100 units of NPK/ha were applied. Dry matter yield did not increase significantly above 100 units NPK/ha; rather, it declined slightly at highest fertility level (150 units NPK/ha).

### *2.* Distichlis spicata

Results of dry matter production of Distichlis spicata are shown in Figures 14-16.

The effect of salinity, irrigation and fertilizer treatments on the dry matter production of *Distichlis spicata* showed a similar trend as for *S. virginicus*. Dry matter yield consistently increased with increase in salinity level of the irrigation water. Maximum dry matter yield (27.6 t $ha^{-1}$) was achieved at the highest salinity level that shows the high salt tolerance of this grass for biomass production. Increasing the amount of irrigation water slightly increased biomass yield with the highest yield (23.6 t $ha^{-1}$) obtained at medium irrigation level (1.5 ET). Increased fertilizer level led to a linear increase in yield, but maximum yield (24.5 t $ha^{-1}$) was produced at 100 units of NPK. Yield started declining when the fertilizer rate was increased to 150 units of NPK.

Results of research on both grasses *Sporobolus virginicus* and *Distichlis spicata* so far indicate that these species can be successfully utilized for fodder production using highly saline irrigation water and that the quality of the forage is almost equivalent to that of green barley or Rhodes grass when managed appropriately.

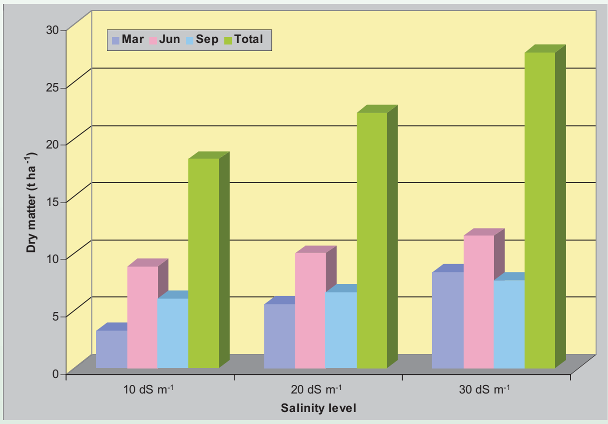



*Figure 14: Dry matter production of three harvests of* Distichlis spicata *at three salinity levels*

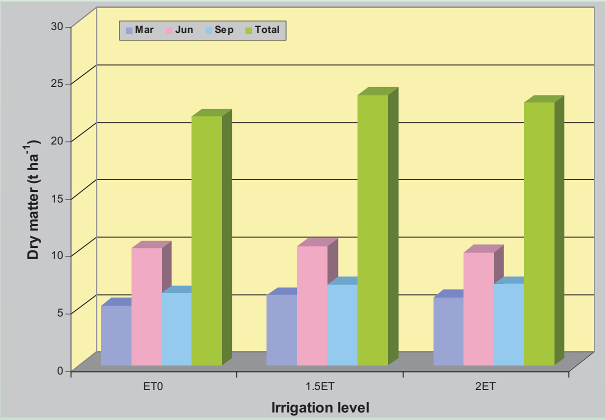



*Figure 15: Dry matter production of three harvests of Distichlis spicata at three irrigation levels*

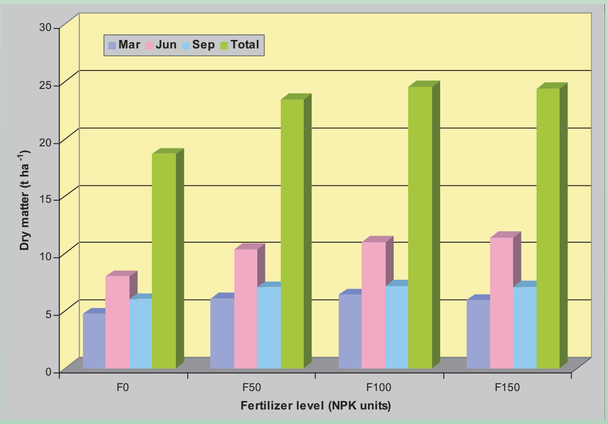



*Figure 16: Dry matter production of three harvests of* Distichlis spicata *at four fertility levels*

Major findings of the study were widely presented and publicized at local, regional and international levels through media, special articles, symposia and workshops.

## Proposed activities for 2008

The experiments will continue in 2008 and field production of both the species will be monitored. Extensive soil salinity data both from automated salinity monitoring system as well as laboratory analysis will be completed. In addition, chemical and nutritional analysis will be performed on samples collected from both species over several cuts with Near Infrared Spectrophotometer (NIRS) in the agronomy laboratory of ICBA. In addition, intact underground plant samples will be collected to investigate the effect of salinity on root growth and health. Moreover, ceramic cups will be installed in both fields in selected treatment plots to collect drainage water samples. These samples will be tested in the Soil and Water Laboratory of ICBA for mineral composition and nutrient leaching.

It is expected that at the completion of the project, the cumulative effect of the application of different treatments will be clear. Solid conclusions may be drawn on the effects of salinity, fertilizer and irrigation, as well as on dry matter production and optimum management practices leading to maximum and sustainable yield. Improved management strategies to further increase the yield ceilings will be identified and the two grasses will be supplied to farmers throughout the WANA region.

*High yield of* Sporobolus virginicus *at ICBA*

# Optimizing management practices for maximum production of three *Atriplex* species under high salinity levels (PMS04)

**Duration:** 2002-08

**Collaboration:** UAEU, NARS of several countries in WANA

**Resources:** International Fund for Agricultural Research (IFAD), Arab Fund for Economic and Social Development (AFESD), Core

## Significance of the project

*Atriplex* is a highly salt-tolerant crop, valued as a high-protein animal feed. However, animals do not thrive if fed solely on *Atriplex* because it contains high concentrations of mineral salts. This problem may be easily overcome by mixing salt-tolerant grasses with it to provide a balanced diet. The project focus on the assessment of long-term, sustainable forage production systems based on salt-tolerant forage shrubs.

***The highly salt-tolerant crop* Atriplex *is a valuable high protein animal feed***

## Objectives

- Determine yield potential when *Atriplex* is grown under high salinity levels, and the level at which the productivity remains economical.
- Determine optimum irrigation level for maximum production and minimum salt accumulation in the root zone.
- Determine optimum planting density for maximum production under all salinity levels.
- Determine appropriate fertilizer regimes for maximum production.
- Assess nutritional value in response to the different salinity, irrigation and fertilizer levels.

**Atriplex *contains high concentrations of mineral salts. To offset this problem and provide a balanced diet, salt-tolerant grasses can be mixed with it***

## Achievements in 2007

*A. lentiformis* produced higher green matter than *A. nummularia* or *A. halimus*. Yield was increased by increasing planting density. At 20 dS $m^{-1}$, the fresh yield of *A. lentiformis* reached nearly 24.1 t $ha^{-1}$, *A. nummularia* 17.9 t $ha^{-1}$ and *A. halimus* 13.9 t $ha^{-1}$. Maximum yield of 53 t $ha^{-1}$ was obtained at minimum irrigation application. *A. nummularia* produced maximum yield at medium irrigation level. Results of biomass production of *Atriplex* species are presented in Figures 17-19.

Atriplex *tolerates high salinity*

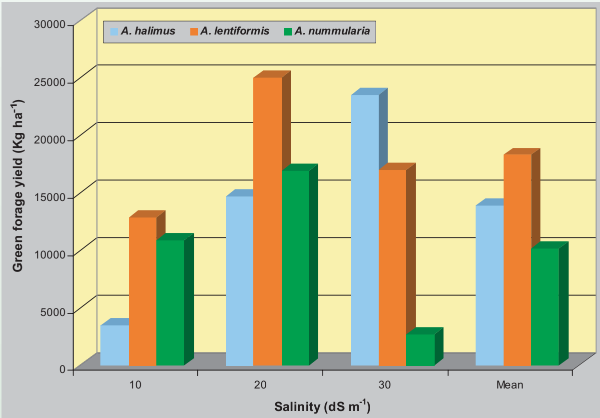



*Figure 17: Biomass production of three* Atriplex *spp. at three salinity levels*

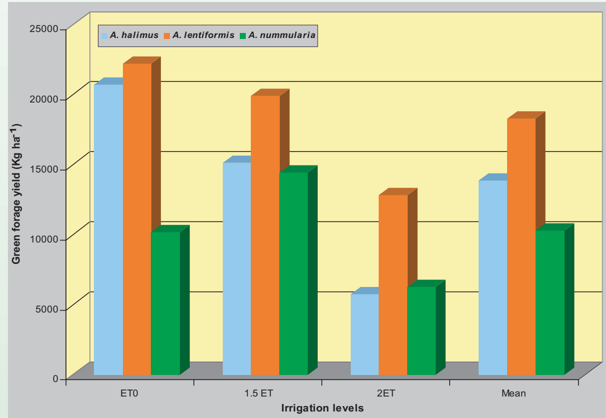



*Figure 18: Biomass production of three* Atriplex *spp. at three Irrigation levels*

## Proposed activities for 2008

Many *A. nummularia* and *A. halimus* plants are showing high mortality rates. In 2008, these species will be propagated at the ICBA shadehouse by vegetative/sexual means to produce large numbers of plants. The seedlings will be transplanted later in the field to replace the dead plants. Treatments will be rearranged and observations recorded on treatment effects and management practices. Nutritional data will be used to develop NIRS calibrations for future analysis at ICBA. Assessment of optimal management practices will be determined at the end of the experiment to make recommendations for *Atriplex* growth under saline conditions.

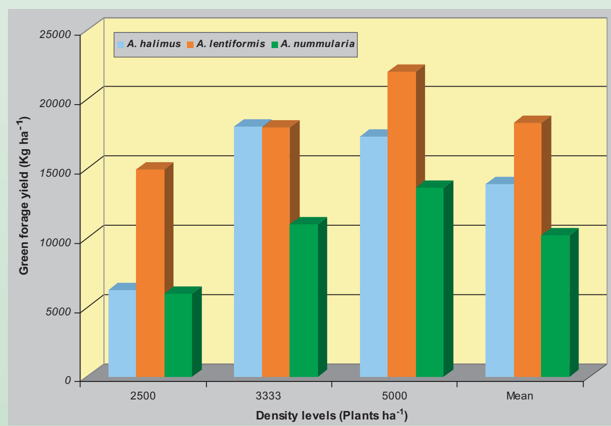



*Figure 19: Biomass production of three* Atriplex *spp. at three planting densities*

Atriplex *species at ICBA*

## Application of biosaline agriculture in a demonstration farm in the Northern Emirates of the UAE (PMS05)

**DURATION:** 2003-08
**COLLABORATION:** MOEW
**RESOURCES:** AFESD, Core

### SIGNIFICANCE OF THE PROJECT

Irrigated agriculture in the UAE has increased dramatically over the last 30 years. Yet few farmers are trained in special skills and techniques. This project demonstrates biosaline agriculture techniques to farmers to show how sustainable and profitable plant production is possible on farms affected by moderate to high levels of salinity.

***A demonstration farm has been planted with salt tolerant species to serve as a model for salt-affected farms in the region***

### OBJECTIVES

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

### ACHIEVEMENTS IN 2007

A demonstration farm for biosaline agriculture was established in the emirate of R'as al-Khaimah in 2004 in collaboration with MOEW. The selected farm was abandoned due to high salinity damage. Irrigation water salinity, which was 20 dS $m^{-1}$ in 2005, exceeded 25 dS $m^{-1}$ in 2006. Due to the high salinity that year, the farm was completely devoted to highly salt-tolerant plants and halophytes. The area previously allocated for conventional crops like barley, millet and sorghum were replaced with halophytes. Expansion in planting of

*Installing irrigation system at the Dibba fram*

*.... and buffelgrass grows under saline conditions*

salt-tolerant grasses and shrubs such as *Sporobolus*, *Distichlis* and *Atriplex* to cover all the of farm is ongoing. *Cenchrus ciliaris* (buffelgrass) and fodder beet were among the few non-halophytic species able to sustain acceptable yield levels at the high salinity level in the farm. Seeds of canola, fodder beet, barley, pearl millet and sorghum were supplied by ICBA for planting at Dibba Farm during winter and summer seasons.

A field day to local farmers was organized in Dibba on 15 August. Farmers were introduced to the new species under saline conditions.

*Introducing pearl millet to local farmers*

### PROPOSED ACTIVITIES FOR 2008

Planting of highly salt-tolerant species will continue during 2008. Accessions and species that prove to be more productive under high salinity level will be used more widely. Soil salinity will be monitored closely as it has been during 2006 and 2007. Management practices will be refined to achieve the objective of maintaining soil salinity at an acceptable level below the irrigation water salinity. Field days for farmers and technical staff will be organized to introduce plant production packages suitable for highly salt-affected farms in the region. Other farms with lower salinity levels will be selected to introduce salt-tolerant conventional crop production systems.

***Local farmers and technicians are involved in the project evaluation***

*Introducing salt-tolerant plants to local farmers during the field day*

# Development of salinity-tolerant sorghum and pearl millet varieties for saline lands (PMS15)

**Duration:** 2003-08

**Collaboration:** The International Crops Institute for the Semi-Arid Tropics (ICRISAT), NARS of several countries in WANA

**Resources:** IFAD, OFID, AFESD, Core

## Significance of the project

*Pearl millet and sorghum genotypes with improved salinity tolerance selected*

*Nutritional values of selected genotypes under various saline conditions evaluated*

Salinity in soils and irrigation water is a major threat to crop production, especially in arid and semi-arid regions. It is estimated that more than 50% of the irrigated lands in these regions are affected to some degree by salinization and that millions of hectares of agricultural land have been abandoned because of salinity. Global efforts are under way to alleviate increasing salinization, and integrated methods that sustain crop production under such stressed conditions are being evaluated. Several engineering and agronomic options have been used to manage salt-affected lands. The development of salt-tolerant crop varieties is a cost-effective option in the management of salt-affected lands.

The present project is aimed at the improvement of agricultural productivity in salt-affected arid and semi-arid environments of the Near East and South Asia through the development of salt-tolerant pearl millet and sorghum genotypes with high grain and forage yield.

## Objectives

- Select pearl millet and sorghum genotypes with improved salinity tolerance suitable for either forage or dual-purpose forage and grain production.
- Identify molecular markers for quantitative trait loci (QTLs) that affect salt tolerance.
- Evaluate nutritional values of selected genotypes under various saline conditions.
- Optimize productivity of pearl millet and sorghum in salt-affected environments in the Near East.
- Transfer technologies and crop production packages to national programs and farmers.

## Achievements in 2007

Pearl millet genotypes, germplasm accessions and hybrids, were supplied by ICRISAT for the assessment of salinity tolerance potential. In addition, ICRISAT supplied 55 sub-populations of ICMV 155 Bristled.

ICRISAT supplied selected sorghum genotypes in bulk quantities for evaluation at ICBA as well as for distribution to partners in the NARS.

*Sorghum trials at ICBA*

*Technologies and crop production packages to national programs and farmers in the Near East and South Asia to be transferred*

The experiment results showed wide genetic variation among the genotypes. High-yielding genotypes that produce stable yields across salinity levels will be selected for seed multiplication and distribution to farmers.

The outputs of these experiments were presented at local, regional and international levels. A final report of Phase 1 of the OFID-funded portion of the project was submitted in July. A proposal for Phase 2 (2008-10) subsequently submitted to OFID passed the first stage of approval and is expected to be approved for funding in December 2008. The results will be reported in the international journals.

## Proposed activities for 2008

Once the Phase 2 proposal is approved for funding by OFID, the project activities will expand to six Middle Eastern countries. The project will target a large number of farmers and will include an extensive capacity building component for both NARS staff and farmers, particularly in the fields of production, animal feeding and on-farm seed production.

Promising genotypes will be selected based on performance in the present evaluation trials. The seeds of selected genotypes will be multiplied and distributed to countries in the WANA region for further evaluation under a broad range of environmental conditions. Data will be presented to ICRISAT to formulate future breeding and varietal improvement strategies. ICRISAT will supply newly developed germplasm along with core collections for screening and evaluation. Plant samples will be prepared and sent to reputed laboratories for mineral and nutritional analysis. The data will also be used to calibrate the nutritional analysis at ICBA.

*Pearl millet trials at ICBA*

## Evaluation of salinity tolerance and yield in barley varieties and accessions (PMS17)

**Duration:** 2005-08

**Collaboration:** International Center for Agricultural Research in the Dry Areas (ICARDA), NARS of several countries in WANA

**Resources:** IFAD, AFESD, Core

### Significance of the project

Barley (*Hordeum vulgare*), the fourth most important cereal in the world, is one of the most salt-tolerant crops. Highly tolerant genetic lines and cultivars need to be identified under the particular sets of environments where they are grown. Improvement in the productivity of barley in saline areas is the main objective of the present research. In collaboration with ICARDA, ICBA targets the improvement of salinity tolerance in barley. Large numbers of barley genotypes and accessions are obtained from various origins for evaluation and screening for salinity tolerance under both pot and field conditions.

***ICBA collaborates with ICARDA to improve salinity tolerance of barley***

***Salt-tolerant genotypes for large-scale field evaluation selected***

### Objectives

- Evaluate salinity tolerance among selected groups of barley genotypes and landraces from various sources.
- Select salt-tolerant genotypes for large-scale field evaluation in the UAE and other countries within the WANA region.
- Provide sufficient seed of improved genotypes to the regional NARS for field evaluation.
- Provide pertinent information to the collaborating institutions for use in future breeding programs.

***Seed of improved genotypes provided to regional NARS***

### Achievements in 2007

Two experiments were conducted in 2007. In the first, 70 genotypes were supplied by ICARDA as checks for evaluation and evaluated under field conditions at three salinity levels (5, 10 and 15 dS $m^{-1}$). In the second, selected genotypes/lines were screened in pots at four salinity levels (5, 10, 15, and 20 dS $m^{-1}$). These genotypes belong to five barley nurseries (IBON-CAC, IBCB-W, IBCB-S, IBON-LRA-M, and IBON-MRA) that were also supplied by ICARDA. These nurseries had previously been screened in pots (in 2006) at 10 dS $m^{-1}$. The objective was to select the most promising genotypes for further testing and evaluation. Samples were harvested, threshed, cleaned and packed for further use.

*Pots of barley in ICBA trials*

Maximum yield was obtained at the lowest salinity level (5 dS m$^{-1}$), while the lowest yield was obtained at the highest salinity level (15 dS m$^{-1}$). Total biomass production decreased by 13.2% at the medium salinity level and by 28.3% at the high salinity level. Dry matter yield varied from 4.5 to 12.9 t ha$^{-1}$ among the genotypes (Figure 20). Salinity had a more profound effect on seed production and seed yield was reduced by 19% at medium salinity and by 38% at high salinity. Seed production varied from 0.3 to 5.6 t ha$^{-1}$ (Figure 21). The effects of medium and high salinity were similar as both the salinity levels were non-significant.

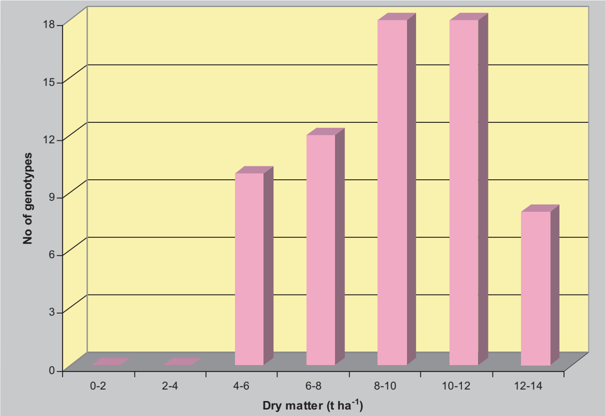



*Figure 20: Range of dry matter yield of barley genotypes at three salinity levels*

## Proposed activities for 2008

Superior genotypes will be selected from the field as well as from pot experiments for the next screening cycle. Seeds from all experiments will be collected and processed for planting. Genotypes from the nurseries will be selected and evaluated under field conditions, and seeds will be produced in sufficient quantities for distribution among NARS partners in the WANA region for national evaluation trials. Plant and seed samples will be sent to reputable laboratories for mineral and nutritional analysis. The data will be used to develop calibration equations for Near-Infrared Spectrophotometer (NIRS) analysis at ICBA. Results of these experiments will be disseminated through various means and published in international journals.

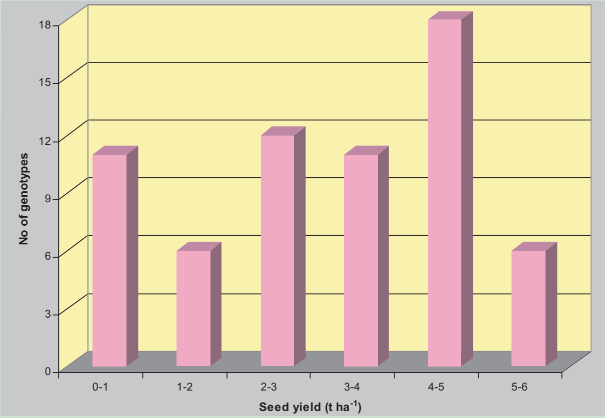



*Figure 21: Range of seed yield of barley genotypes at three salinity levels*

*Barley field trials at ICBA*

## Evaluation of salinity tolerance and fodder yield of fodder beet and fodder rape/brassica varieties (PMS18)

**Duration:** 2006-08

**Collaboration:** NARS of several countries in WANA

**Resources:** IFAD, AFESD, Core

### Significance of the project

*Fodder beet and rape/brassica are important winter forage crops*

Fodder beet and rape/brassica species are widely grown as winter forage crops. They have several advantages, including fast growth, easy seed production, growth at low temperature and considerable frost-tolerance. They are recommended as alternatives for winter fodder crops. Brassicas are high in dry matter digestibility at 85-95%, which contrasts well with alfalfa at 70%, and increases the availability of certain minerals and protein.

### Objectives

- Evaluate salinity tolerance among selected varieties of fodder beet and brassica/rape.
- Distribute sufficient amounts of seed of these varieties to the regional NARS for multi-location field evaluation.
- Provide information to collaborating institutes about salinity tolerance among fodder beet and brassica/rape varieties.

### Achievements in 2007

Seeds of 15 fodder beet and 7 brassica varieties were imported from different international seed companies. Seeds were grown under field conditions for salinity tolerance potential. Standard agronomic practices were followed throughout the production. Three levels of irrigation water salinity (5, 10 and 15 dS $m^{-1}$) were applied with drip irrigation system.

Yield declined linearly at medium (10 dS $m^{-1}$) and high (15 dS $m^{-1}$) salinity levels. Green fodder yields decreased up to 19.1% at medium salinity levels and up to 43.6% at high salinity levels. Dry matter yield decreased by 15.2% at medium salinity and by 47.3% at high salinity. Variety 98D produced the highest green fodder yield; the lowest was that of Hyola 405 (Figure 22). Hyola 61 produced the lowest dry matter (Figure 23). The other varieties showed intermediate yield response.


Fodder beet species grown at ICBA

Maximum fodder production – both above-ground and below-ground yield – was achieved at low salinity (5 dS $m^{-1}$). Generally, salinity caused a linear yield decline. The lowest dry matter yield of stem and tubers was obtained at the highest salinity level (15 dS $m^{-1}$). Above-ground biomass (stem dry weight) yield decreased by 16.2% at medium salinity and by 30.8% at high salinity. Above-ground fresh forage yield varied from 26.2 to 40.6 t $ha^{-1}$ and fresh tuber yield ranged from 74.1 to 95.2 t $ha^{-1}$. Turbo produced

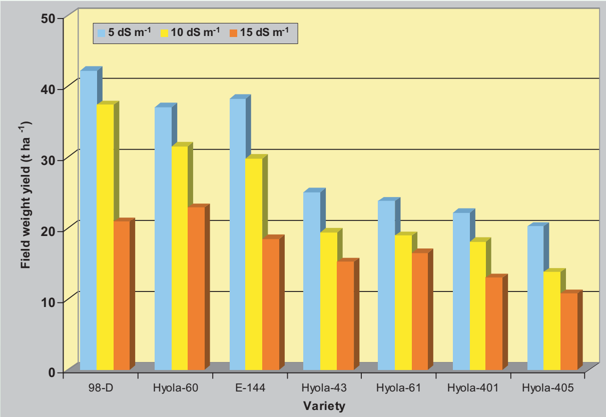



*Figure 22: Green fodder yield of brassica varieties at three salinity levels*

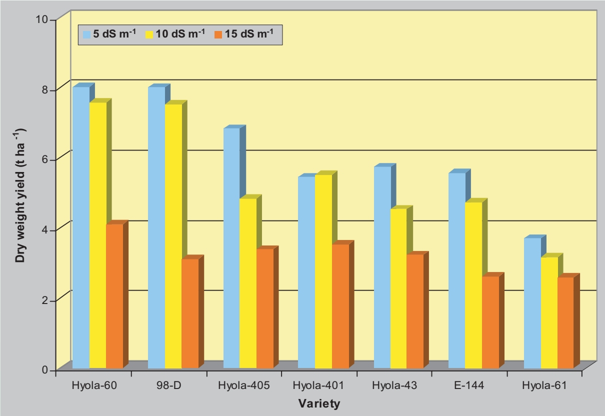



*Figure 23: Dry matter yield of brassica varieties at three salinity levels*

the highest green forage (40.6 t ha$^{-1}$) and Kyros produced the highest tuber yield (95.2 t ha$^{-1}$). Above-ground dry matter yield varied from 2.8 to 4.3 t ha$^{-1}$ and tuber dry matter yield from 6.7 to 10.9 t ha$^{-1}$. Turbo produced the highest above-ground green forage (40.6 t ha$^{-1}$) as well as above-ground dry matter (4.3 t ha$^{-1}$) and Kyros produced the highest tuber yield (95.2 t ha$^{-1}$). The highest tuber dry matter was produced by Blizzard (10.9 t ha$^{-1}$). Results of forage production of fodder beet varieties are demonstrated in Figures 24-27.

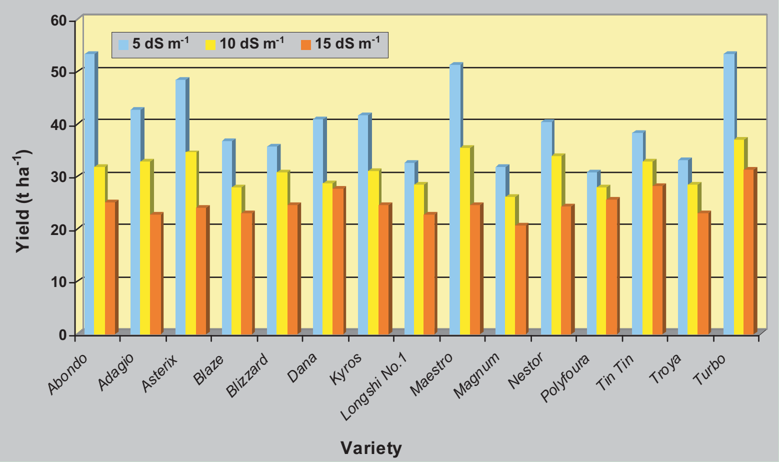



*Figure 24: Above-ground green forage production of fodder beet varieties at three salinity levels*

## Proposed activities for 2008

More than 100 accessions of canola, a brassica variety, were screened with ICBA's hydroponics system. Promising accessions will be selected and evaluated under field conditions at three salinity levels. Highly tolerant genotypes will be selected from field performance and grown for seed multiplication for distribution to partners. Data will be collected from other locations that will lead to wider conclusions regarding the salinity tolerance of both species. Recommendations will then be made on the use of selected varieties under particular sets of environmental conditions.

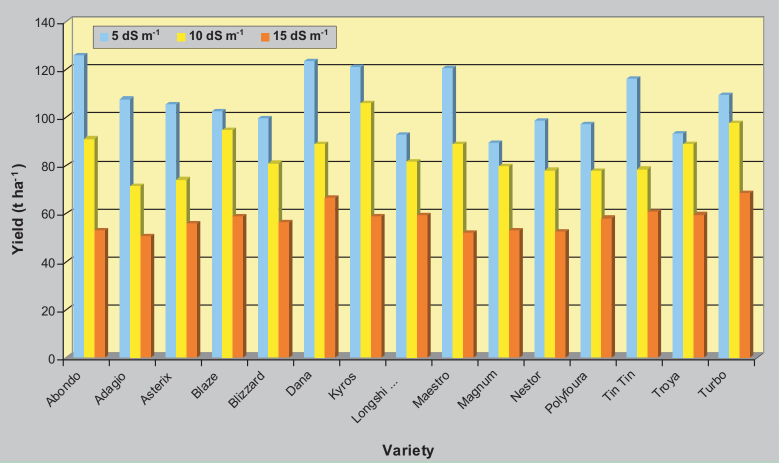



*Figure 25: Below-ground fresh tuber yield of fodder beet varieties at three salinity levels*

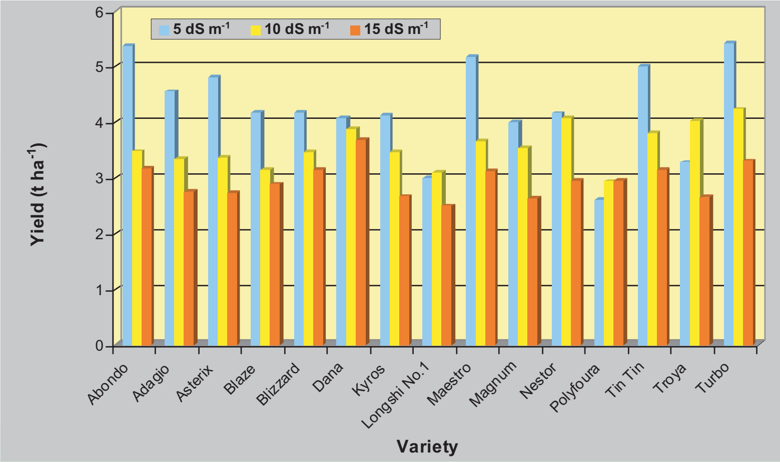



*Figure 26: Above-ground dry matter production of fodder beet varieties at three salinity levels*

***Information about the salinity tolerance of fodder beet and rape/brassica will be provided to collaborating institutions***

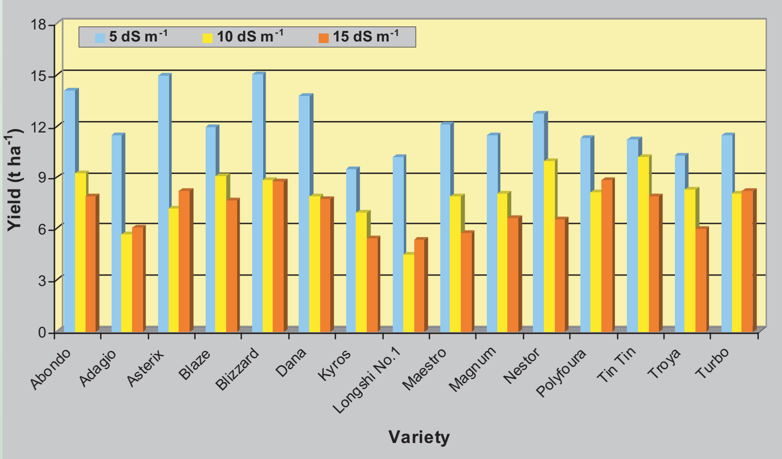



*Figure 27: Below-ground dry matter production of fodder beet varieties at three salinity levels*

***Seeds from both crops were grown under field conditions for salinity tolerance potential at ICBA and regional NARS***

*Brassica trials at ICBA*

# Screening for salinity tolerance among large collections of buffel grass (*Cenchrus ciliaris*) (PMS19)

**Duration:** 2005-08

**Collaboration:** NARS of several countries in WANA

**Resources:** IFAD, AFESD, Core

## Significance of the project

Continuous inclusion of new forage species is extremely important for expanding the existing plant pallet and sustaining the utilization of agro-ecosystems. It is especially important in arid and semi-arid regions where harsh environmental conditions limit the growth of many crop species. Because salinity is one of the major abiotic stresses in these regions, the evaluation and screening of new germplasm for salinity is essential for selecting high-yielding crop species that can be successfully grown under arid environments.

***Maximum biomass production produced at low salinity levels, with Grif-1639 producing the highest biomass (77.5 t ha$^{-1}$)***

***Dry matter production varied from 13.1 to 77.5 t ha$^{-1}$***

## Objectives

- Assess *Cenchrus ciliaris* accessions, including local landraces, for salt tolerance.
- Evaluate the selected accessions for forage yield and quality under field conditions.
- Multiply and distribute seeds among the NARS in the WANA region.
- Optimize production and management technology for *Cenchrus ciliaris* production in the UAE and similar countries.
- Collect baseline data and transfer technology to partner countries.

***Manual, semi-automatic and fully mechanized cutting methods tested for comparison, with semi-automatic cutting with an electric cutter proving the most appropriate***

*Buffelgrass trials at ICBA*

## Achievements in 2007

This experiment was initiated in 2006 when 40 accessions, selected from the previous screening, were planted in the field for evaluation. Irrigation was applied using three salinity levels (8, 16 and 24 dS $m^{-1}$) with drip irrigation. Three cuts have been completed so far. Manual, semi-automatic and fully mechanized cutting methods were tested for comparison. Semi-automatic cutting with an electric saw/cutter was shown to be the most appropriate for cutting this species. Mechanized cutting was stopped because it damaged the irrigation system as well as the plants. Dry matter production over the cuts varied from 13.1 to 77.5 t $ha^{-1}$. Biomass yield was higher in the May harvest than the June harvest (Figure 28). Maximum biomass production was produced at low salinity levels. Accession Grif 1639 produced the highest biomass, 77.5 t $ha^{-1}$ (Figure 29).

## Proposed activities for 2008

The experiment will be monitored throughout the project duration. Data on field management and agronomic practices for forage production will be collected. The cutting schedule will be optimized and adjusted to make recommendations at the end of the project. Data from other countries will also be collected to draw more generalized conclusions. Plant samples will be subjected to laboratory analysis to determine the biochemical characteristics and nutritional parameters of *Cenchrus* forage.

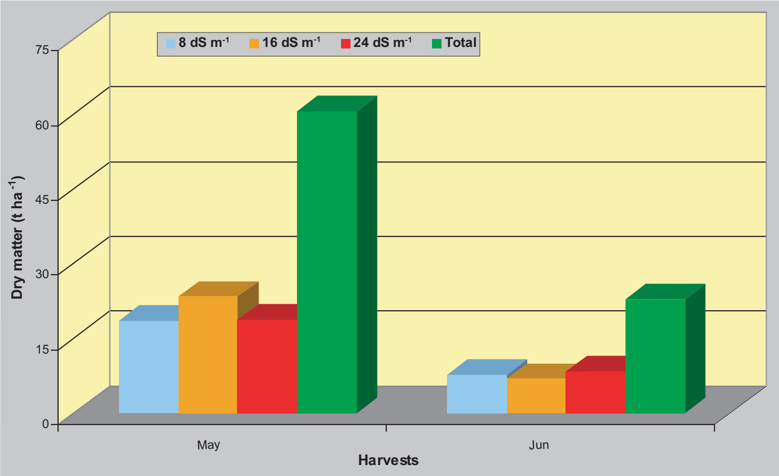



*Figure 28: Dry matter yield of two harvests of* Cenchrus ciliaris *accessions*

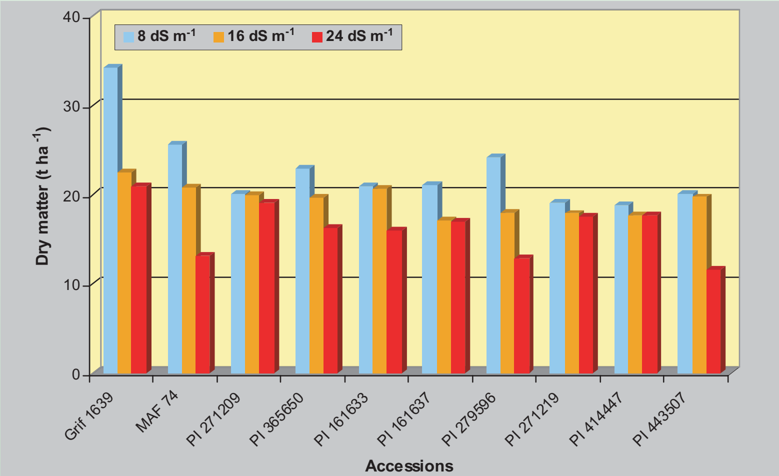



*Figure 29: Dry matter production of ten high yielding* Cenchrus ciliaris *accessions at three salinity levels*

*Buffelgrass accessions after harvest*

## Saving freshwater resources with salt-tolerant forage production in marginal areas of the West Asia and North Africa region – an opportunity to raise the incomes of the rural poor (PMS27)

**Duration:** 2005-08
**Collaboration:** NARS of Jordan, Oman, Pakistan, Palestine, Syria, Tunisia and the UAE
**Resources:** IFAD, AFESD, OFID, 7 NARS, Core

### Significance of the project

The project was approved and financially supported in late 2004 by the International Fund for Agricultural Development (IFAD) for a grant of USD 1,350,000 and was co-financed by the Arab Fund for Economic and Social Development (AFESD), which provided a grant of USD 1,000,000 for all components of the project except those related to Pakistan. The UAE component is not supported by the IFAD grant.

The OPEC Fund for International Development (OFID) supported the component relating to sorghum and pearl millet in UAE and Oman (see PMS15), the component that leveraged the full project, and the aspects of training.

### Objectives

The goal of the project is improved livelihoods and higher incomes for resource-poor rural men and women in degraded and marginal lands in West Asia and North Africa.

This project will prepare under-developed and developing countries to develop animal production systems that improve livelihoods and thus contribute to four Millennium Development Goals (MDGs):

*Project contributes directly to four Millennium Development Goals*

**MDG 1:** Eradicating extreme poverty and hunger
**MDG 3:** Promoting gender equality and empowering women
**MDG 7:** Ensuring environmental sustainability
**MDG 8:** Developing a global partnership for development

This overall goal will be met by focusing on three objectives:

- Increase feed availability for livestock through sustainable use of underutilized saline water resources.
- Integrate the use of saline water into an overall strategy of sustainable semi-arid and arid farm system management.
- Develop capacity of NARS.

### Achievements in 2007

#### *I. Project management*

The third meeting of the project Steering and Technical Committees was convened in Amman, Jordan, in March. A midterm review of project progress and achievements was held simultaneously. The meetings had four main outputs:

*Three quarters of the project is completed*

1. Evaluation was undertaken by each country of its success in implementing the workplan and objectives during the first two years of the project. The main activities and achievements during the second year were presented and summarized. During the meetings, progress made by ICBA and member countries in implementation of second year workplan was reviewed. Generally, all countries made satisfactory progress in implementing the main objectives of the first year.
2. Workplans and budget for the third year were undertaken.
3. Specialized working groups in three areas relevant to project implementation were formed. The groups' objectives were to:
   - Establish specialized working groups in various disciplines related to salinity and water issues in the targeted countries.
   - Provide in-depth capacity building to specialized technical staff from the participating countries in relevant areas.
   - Assign responsibility for such individuals to follow on project monitoring in their area of specialty and to be responsible for generating the required output.
   - Facilitate the exchange of knowledge, information, results and publications among the members of each group.
4. Agreement was reached on the training and support required from ICBA.

### *II. Project implementation*

The full project became operational in all seven countries. Funds were released to each of the national programs by ICBA in accordance with the Cooperation Agreements to execute the workplans. Difficulties were encountered in money transfer to Palestine and Syria due to currency restrictions. In the case of Syria, transfer of funds had to be effected through a transfer bureau instead of a bank.

*Steering Committee meeting*

Implementation plans for 2007 for the seven countries and ICBA were finalized during the Technical and Steering Committee meetings in Amman in March. The implementation plan included details of activities to be undertaken by each country during 2007 and early 2008.

The detailed activities in year two according to outputs are given below.

*Technical Committee meeting*

***Output 1.*** *Productive salt-tolerant forage grasses, legumes and shrubs identified and distributed to national programs in the Near East and North Africa for irrigated cultivation under saline conditions.*

#### *Activity 1.1 Identify forage grass, legume and shrub species*

All countries - Update the species list selected for summer and winter farming systems and identify appropriate genotypes based on national and ICBA trials.

- Create a database of salt-tolerant genetic material for the project and its availability.

***Activity 1.2 Evaluate salinity tolerance and characterize for other traits***

All countries - Complete the development of field salinity screening facilities started in 2005/06.
- Evaluate salinity tolerance of selected species.

***Activity 1.3 Multiply and propagate salt-tolerant genotypes***

Jordan - Multiply and distribute the high-yielding summer and winter varieties to farmers' fields.

Oman - Increase the number of the farmers participating in the project.

Pakistan - Multiply forage (NIAB).

Palestine - Multiply seed and propagate new species such as alfalfa, *Atriplex* and grasses received from ICBA in plots established at NARC.

Syria - Multiply and propagate salt-tolerant genotypes.

Tunisia - Produce seed and seedlings for farmers.
- Analyze the effects of some salt-tolerant forages on animal health, performance and reproduction.

UAE - Multiply plants favored by farmers such as Ce*nchrus ciliaris*, *Panicum turgidium*, and *Lasirus sindicus*.

***Activity 1.4 Distribute salt-tolerant forage germplasm for demonstration plots in participating countries***

All countries - Identify, propagate and distribute plant species and accessions for testing.

***Activity 1.5 Select promising forage species for participating countries/farms***

All countries - Select promising salt-tolerant forage species.

***Activity 1.6 Create database of forage species, their salinity tolerances and productivity under saline conditions***

All countries - Analyze the results of species/accessions performance under the various salinity levels evaluated, including forage quality.

*Members of Steering and Technical Committees, ICBA staff and local farmers during the field day in Jordan*

***Output 2.*** *Soil salinity management packages incorporating irrigation systems and low-cost drainage options for sustainable biosaline forage production developed in collaboration with national programs in the Near East and North Africa*

***Activity 2.1 Assess saline water resources for marginal lands in participating countries***

All countries - Compile and summarize information on quantity and quality of groundwater resources in the target areas and more widely in the country, to build on available information.

***Activity 2.2 Select target sites for research and demonstration plots***

Jordan - Identify suitable farmers' fields in the project target area.
- Establish irrigation systems in farmers' fields (if required).
- Establish initial demonstration plots.

Oman - Establish irrigation systems for additional farmers.

Pakistan - Develop an 8-ha demonstration site at Kaslian of the Agency for Barani Area Development (ABAD).

Syria - Create a model of irrigation water and drainage requirements based on crop and soil information by ICBA/GCSAR scientists.

Tunisia - Establish a new site where irrigation water sources with different salinity levels are available to screen plants for performance.

UAE - Select a new demonstration farm in the Dhaid area and select new farmers for technology transfer.

***Activity 2.3 Model irrigation water and drainage requirements based on crop and soil information***

All countries - Collect soil, water, climate and crop production data on all demonstration sites for use in crop modeling.

***Activity 2.4 Verify model parameters through field tests, including monitoring of soil salinity levels***

All countries - Verify the parameters at ICBA headquarters and at NARS stations with capacity.

*Select promising forage species in Oman*

***Output 3.*** *Optimized systems for economic and environmentally sustainable production of forages using saline water resources developed and transferred to national programs*

***Activity 3.1 Establish pilot trials to test crop and irrigation/drainage systems***

Jordan - Establish farmers' field plots of alfalfa, barley, pearl millet and sorghum in Azraq area.

*Evaluate production yield in Pakistan*

Oman - Continue demonstration of summer and winter crops in farmers' fields.

Pak-ABAD - Demonstrate salt-tolerant forages, millet, barley, sorghum, cowpea, alfalfa, fodder beet and oats at Kaslian.

Pak-NIAB - Undertake pilot trials on crops and irrigation systems.

Palestine - Demonstrate salt-tolerant forages (pearl millet, sorghum, fodder beat and barley).

- Introduce germplasm of forage species such as pearl millet, sorghum, fodder beat and barley.

Syria - Establish pilot trials to test crop and irrigation/drainage systems by ICBA/GCSAR scientists.

Tunisia - Establish plot trials to test germplasm supplied by ICBA for salt tolerance.

UAE - Select new demonstration sites with the cooperation of the extension services.

***Activity 3.2 Conduct economic and environmental analysis of trial results***

All countries - Collect and analyze baseline socio-economic data for impact assessment.

- Conduct initial economic analysis of trial results.

***Activity 3.3 Demonstrate economically viable and environmentally sustainable packages on farmers' fields***

All countries - The activity will start in selected and prepared private farms.

***Output 4.*** *Capacity development of research and development staff of countries in all aspects of biosaline agriculture*

***Activity 4.1 Conduct project workshop, at the project level, to develop detailed activity plans and to allocate responsibilities among participants, and at the country level to review progress***

All countries - At the project level, conduct fourth coordination workshop in Damascus, Syria in February 2008.

Jordan - Participate to the mentioned activities.

Oman - Prepare detailed activity plans and allocate responsibilities among participants.

Pak-NIAB - Conduct a training workshop

Palestine - Conduct local training and a field day.

Syria - Conduct training courses, field days and review workshops.

Tunisia - Conduct two in-country workshops. The first will develop detailed activity

*Propagate salt-tolerant forages at farmers' fields in Syria*

*Assessing soil salinity at farmers' field in the UAE*

*Seed procurement and distribution ongoing*

plans for 2008 and allocate responsibilities among participants. The second will aim to review progress activities.

UAE - Conduct one workshop in June 2008.

***Activity 4.2 Implement training courses in various aspects of crop and irrigation management for biosaline agriculture***

All countries - Convene working group workshops in Syria, Tunisia and Jordan to benefit 2-3 participants from 7 countries (IFAD and AFESD).

- Facilitate and support the participation of selected NARS technical staff in specialized training courses conducted by ICRISAT and ICARDA.

Pak-ABAD - Conduct in-country specialized courses and working group meetings.

Pak-NIAB - Conduct farmers' days and community meetings.

Syria - Arrange apprenticeships and on-the-job training for national staff at participating institutions.

UAE - Conduct training courses, field days and review workshops.

***Activity 4.3 Organize apprenticeships and on-the-job training for national staff at participating institutions***

All countries - Conduct group or individual hands-on training for participants from all or part of the seven countries at ICBA.

- Implement selected exchange visits between technical staff of participating institutions for familiarization with partner institutions and technologies in other countries (exact exchanges to take place to be decided in the Second Planning Meeting)

***Activity 4.4 Conduct mid-term review workshop***

All countries - Conducted in March 2007.

***Activity 4.5 Hold final workshop to document and disseminate project results and findings***

All countries - No activities will be held in Year 3.

**Output 5.** *Coordinated management and implementation of the project*

***Activity 5.1 Develop and implement coordinated participatory work plans in consultation with NARS and poor farming communities***

All countries - Finalize workplan for Year 3 with inputs from NARS and ICBA staff (developed by Technical Committee, approved by Steering Committee).

*Evaluation fields in Palestine*

***Activity 5.2 Revise work plans, if required***

All countries - If needed, during the visits of ICBA staff to participating countries.

***Activity 5.3 Produce annual progress reports and final project report and disseminate in Arabic, French and English***

All countries - Provide annual technical progress reports and financial statements of each country to ICBA for collation and submission to donors.

*Utilization of salt-tolerant forages wrokshop in Tunisia*

## *III. Capacity building*

### *A. Workshops*

***1. Midterm Review and evaluation workshop***

A 2-day mid-term review meeting and workshop took place in Amman, Jordan, during March 2007. Technical coordinators and one key researcher from each of the seven countries participated in the workshop. Two presentations related to each country's achievements were given. One focused on crop production, demonstration sites and the farmers involved. The second focused on in-country training activities/capacity building, irrigation and soil monitoring/assessment and other relevant information. IFAD representative participated in the workshop. Feedback, comments and recommendations for future activities were provided by ICBA and donor representatives.

***2. Working group meetings in 2007 (Objectives and outputs of these workshops are provided in the workshop document of each)***

***NARS partners and donors are satisfied with the progress and success of the project***

- *Production and utilization of salt-tolerant forage crops* (production and management of crops and animal feeding). Tunisia, 10-15 December.
- *Management and modeling of irrigation and soil salinity*. Syria, 5-10 August.
- *Socio-economic aspects of adoption of production and utilization of salt-tolerant forages in the targeted countries*. Jordan, January 2008. This will include both a workshop and training activities.

### *B. Individual training*

***Table 14: Individual training courses for NARS***

| Country | Course title (Courses conducted by ICARDA) |
|---|---|
| Jordan | - Advanced experimental design, 10-14 June |
| Oman | - Seed health, 17-28 June |
| Pakistan (ABAD) | - Advanced experimental design, 10-14 June |
| Pakistan (NIAB) | - Seed bank, 6-10 May |
| Palestine | - Seed bank, 6-10 May<br>- Advanced experimental design, 10-14 June |
| Syria | - Advanced experimental design, 17-28 June |
| Tunisia | - Seed bank, 6-10 May |
| UAE | - Seed bank, 6-10 May |

*C. In-country training, workshops and field days*

**Table 15: In-country training, workshops and field days**

| Country | In-country training courses | Workshops | Others |
|---|---|---|---|
| Jordan | - Biosaline agriculture<br>- Seed multiplication and conservation<br>- Scientific reporting | - Regional workshop on socio-economics | - Farmers' and field days |
| Oman | - Seed production | - | - Farmers' and field days |
| Pakistan (ABAD) | - Soil and water management<br>- Production systems of new salt-tolerant crops | - | - Farmers' and field days |
| Pakistan (NIAB) | - In-country workshop on crop, soil and water management under field conditions | - | - Farmers' and field days |
| Palestine | - Seed production and propagation<br>- Forage breeding | - | - Farmers' and field days |
| Syria | - Crop and irrigation and soil management | - Workshop on project activities | - Farmers' and field days |
| Tunisia | - Genebank management | - Two in-country workshops | - Farmers' and field days |
| UAE | - Salinity monitoring system and Irrigation management | - | - Farmers' and field days |

*D. Follow-up field visits to NARS by ICBA staff*

ICBA's scientists and technicians visited the participating countries for follow up and meetings with local project teams to explain in depth the objectives of the project, implementation plans and expected achievements from the country's project team during 2006/07. Also ICBA staff participated in the field days in Jordan. ICBA staff also provided technical backstopping and consultations on specific issues as requested by NARS.

*E. Seed procurement and distribution to NARS*

ICBA staff strived to provide NARS with seeds supply to carry out planned field activities. Each country was supplied with 132 accessions of 11 species. In addition, several countries received additional quantities of certain species as available. ICBA procured fodder beet, forage brassica and rape and sent them directly through commercial companies in Australia and Europe to all countries. ICBA also reached agreement with ICRISAT to produce pearl millet and sorghum seeds in quantities sufficient to meet the demands for summer planting. Seeds were dispatched to all countries by mid 2007.

## PROPOSED ACTIVITIES FOR 2008

The fourth coordination meeting will be held in Damascus, Syria, in early 2008. A new workplan will be developed during the meeting for the remaining 18 months. Training and capacity building will be discussed and planned for the next two years. IFAD grant for the project ended in December 2007. A no-cost extension of IFAD funding until June 2009 was requested. The AFESD-funded component is effective until end of 2008.

*Analyzing salt-tolerant forages on animals in Tunisia*

## Development of technologies to harness the productivity potential of salt-affected areas of the Indo-Gangetic, Mekong, and Nile River basins (PMS34)

**Duration:** 2004-08

**Collaboration:** International Rice Research Institute (IRRI); BARI; Rice Research and Training Center, Egypt; Rice Research Institute of Iran

**Resources:** CGIAR Challenge Program on Food and Water (through IRRI)

### Significance of the project

*Project is an important collaboration with two CGIAR centers*

IRRI developed the research proposal for this project with significant contributions from ICBA and IWMI, and submitted it to the CGIAR Challenge Program on Food and Water. The project was approved for funding and detailed work plans were developed.

*Involvement of ICBA in rice production is key to solving salinity problems in various rice-producing countries*

Rice-based systems are increasingly under pressure from soil salinization caused by several management and environmental factors. The project aims to identify suitable crop species/genotypes that can be productive under the high salinity conditions of the off-season period. Such salt-tolerant crops could fill the gap between two rice cropping cycles or as rotational crops. Candidate species include pearl millet, sorghum, barley, fodder beet and brassica/rape.

### Objectives

- Identify salt-tolerant cultivars that fit into rice-based cropping systems for salt-affected areas of Bangladesh, Egypt and Iran.
- Provide promising crops and varieties with salt tolerance to be validated in target areas.

### Achievements in 2007

The potential of several salt-tolerant field and forage crops to fill the gap between two rice cropping cycles or as rotational crops have been evaluated over the past 3 years. These crops include pearl millet, sorghum, fodder beet, brassica, barley and safflower. Achievements and progress made in each crop are presented for each crop throughout this report. In Egypt, the Desert Research Centre (DRC) collaborated with ICBA to evaluate these crops. Recently, ICBA supplied both Egypt's Rice Research and Training Center and the Rice Research Institute in Iran with sufficient seed for evaluation in farmers' fields.

### Proposed activities for 2008

ICBA acquired 17 varieties of fodder beet and 14 of brassica/rape for evaluation at ICBA and other participating countries. Salinity tolerance and yield potential of nurseries of forage and field crop species will be evaluated under field conditions as potential off-season crops for the Nile Delta of Egypt and the Caspian Sea coast of Iran. Selected varieties or lines under

## Introduction of salt-tolerant forage production systems to salt-affected lands in the Sinai Peninsula in Egypt: a pilot demonstration project (PMS37)

**DURATION:** 2006-09
**COLLABORATION:** Desert Research Center (DRC), Egypt
**RESOURCES:** Special funding from IDB

### SIGNIFICANCE OF THE PROJECT

*Project is a key collaboration with the Arab world's largest country*

Dry regions generally suffer from a chronic shortage of forage production due to several environmental and management factors. This problem is acute in Egypt where agriculture is largely limited to the Nile Valley and rainfall is insufficient to support a sustainable rangeland system. In recent decades, government efforts led to the settlement of Bedouins on the Sinai Peninsula and other desert areas through the support of agricultural projects. However, agriculture in the Sinai depends mainly on groundwater irrigation and the limited rainfall. Such water resources have recently deteriorated due to overuse and seawater intrusion. Consequently, agricultural production has deteriorated and some farms abandoned. To sustain and bring back production to acceptable economic levels and support the livelihoods of the Bedouin, production systems must be adjusted and evolved to fit the changing environments. Introduction of biosaline agriculture production systems is an effective way to overcome the increasing salinity levels. Both ICBA and DRC have extensive experience with crop production packages that fit salt-affected lands. The need is urgent to transfer and adapt such production systems.

*Sustaining livestock feed is critical for enhancing livelihoods of Bedouins*

### OBJECTIVES

The overall objective is to enhance forage production in the Sinai Peninsula through the use of saline water resources and marginal lands to improve the Bedouins' livelihoods. The specific objectives of the project are fivefold:

- Introduce conventional forage production systems suitable for salinity ranges up to 15 dS $m^{-1}$.
- Introduce non-conventional, highly salt-tolerant forage production systems suitable for salinity ranges up to 25 dS $m^{-1}$.
- Develop proper utilization strategies for the available natural resources (saline soils and water and natural vegetation).
- Provide livestock with a sustainable source of nutritional feed all year round at an economical cost.
- Build capacity of DRC staff and farmers in the region.

Pearl millet farms in Sinai

*Project locations*

- ***DRC South Sinai Research Station***. Three wells are available at the station, which has between 0.5 and 1.0 ha available for the demonstration plot. Salinity of groundwater generally ranges between 4.3 and 11.4 dS $m^{-1}$. However, soil salinity can be much higher. The targeted salinity will be obtained by mixing groundwater of different salinities.
- ***Farms in the region***. Salinity of groundwater and soil varies considerably among the farms in the region. Salinity of the targeted farms ranges from 5 to 14.3 dS $m^{-1}$.
- ***A coastal plot near the research station managed by DRC***. A large 10-ha plot is available, 0.5-1.0 ha of which will be ultimately developed for highly salt-tolerant species. Groundwater salinity is very high (>21 dS $m^{-1}$).

*Sorghum production fields in Sinai*

***Project enhances capacity building of Egyptian farmers and technicians***

## Achievements in 2007

Several crops including the following, were introduced to the region:

- ***Winter annual species***. Barley, fodder beet, safflower, forage brassica and forage legumes, in addition to species available with the national program.
- ***Summer annual species***. Pearl millet and other millets, sorghum, Sudan grass, Napier grass and forage legumes.
- ***Perennial forage species***. Alfalfa, buffel grass, *Panicum* spp. and other species available with the national programs.

Highlights of the 2007 results are presented in Tables 16-18.

Results demonstrated that the varieties and accessions provided by ICBA were adapted to the environment in South Sinai, and the best-performing genotypes achieved economic yields under the salinity levels encountered in farmers' fields. Also, in most cases, drip irrigation improved crop yields in comparison with traditional furrow irrigation.

## Proposed activities for 2008

In 2008 the focus will be on scaling-up to a minimum of eight farms in the region and on developing production and management practices suitable for the salinity levels affecting the farming systems. On-farm forage utilization techniques suitable for poor farmers will be also demonstrated.

*DRC and ICBA technical staff with South Sinai Agriculture Department officials visiting coastal salt-affected farms*

**Table 16: Effect of irrigation water salinity levels and irrigation system on fodder beet yield during 2006-07**

| Parameter | Salinity (dS m-1) | | Irrigation system | |
|---|---|---|---|---|
| | 4.30 | 11.40 | Gated pipe | Drip |
| 1. Total fresh weight of leaves / plant (g) | 88.00 | 48.42 | 35.17 | 52.75 |
| 2. Total fresh weight of root / plant (g) | 683.30 | 410.00 | 271.00 | 409.80 |
| 3. Total fresh weight of leaves / $m^2$ (kg) | 10.56 | 5.81 | 4.22 | 6.33 |
| 4. Total fresh weight of root / $m^2$ (kg) | 31.50 | 16.40 | 13.50 | 20.10 |
| 5. Total dry weight of leaves / plant (g) | 34.00 | 20.40 | 18.70 | 23.00 |
| 6. Total dry weight of root / plant (g) | 205.20 | 123.00 | 81.40 | 123.00 |
| 7. Total dry weight of leaves / $m^2$ (kg) | 3.18 | 1.78 | 1.27 | 1.90 |
| 8. Total dry weight of root / $m^2$ (kg) | 2.07 | 1.24 | 0.52 | 1.55 |

**Table 17: Effect of irrigation water salinity and systems on barley yield and its components at Ras Sudr in winter 2006-07**

| Parameter | Salinity (dS m-1) | | Irrigation system | |
|---|---|---|---|---|
| | 4.30 | 11.40 | Gated Pipe | Drip |
| 1. Plant height (cm) | 97.00 | 89.40 | 70.80 | 93.00 |
| 2. No. of tillers / plant | 3.40 | 1.70 | 2.10 | 2.90 |
| 3. No. of spikes / plant | 3.00 | 1.10 | 1.80 | 2.30 |
| 4. No. of grains / spike | 19.40 | 15.30 | 17.00 | 17.00 |
| 5. Spike length (cm) | 11.30 | 8.00 | 7.90 | 10.70 |
| 6. Grain yield / plant | 7.47 | 2.74 | 4.48 | 5.73 |
| 7. 1000-grain weight (g) | 37.40 | 29.80 | 30.90 | 35.60 |
| 8. Grain yield / $m^2$ (g) | 449.00 | 270.00 | 250.80 | 418.00 |
| 9. Straw yield / $m^2$ (g) | 1010.70 | 615.00 | 760.00 | 1000.00 |
| 10. Biological yield / $m^2$ (g) | 1420.70 | 889.80 | 1000.40 | 1387.00 |
| 11. No. of spikes / $m^2$ | 275.00 | 204.00 | 188.00 | 250.00 |

**Table 18: Effect of irrigation water salinity level and systems on sorghum and pearl millet character on harvesting date in two summer seasons (2006 and 2007) under Ras Sudr conditions**

| Parameter | 2006 | | | | 2007 | | | |
|---|---|---|---|---|---|---|---|---|
| | Salinity (dS m-1) | | Irrigation system | | Salinity (dS m-1) | | Irrigation system | |
| | 4.3 | 11.4 | Gated | Drip | 4.3 | 11.4 | Gated | Drip |
| **Sorghum** | | | | | | | | |
| 1. Plant height (cm) | 150.10 | 121.40 | 131.50 | 144.80 | 144.10 | 118.70 | 125.10 | 149.10 |
| 2. Leaf fresh weight (g) | 94.10 | 64.80 | 70.10 | 88.30 | 90.10 | 60.30 | 65.00 | 74.00 |
| 3. Leaf area ($cm^2$) | 26.09 | 21.51 | 24.00 | 27.00 | 25.11 | 20.11 | 21.50 | 24.80 |
| 4. Stem fresh weight (g) | 151.00 | 123.10 | 124.00 | 140.30 | 150.10 | 124.00 | 130.50 | 150.70 |
| 5. Leaf dry weight (g) | 33.40 | 21.10 | 26.40 | 31.00 | 31.00 | 20.70 | 25.40 | 27.90 |
| 6. Stem dry weight (g) | 98.40 | 79.90 | 80.80 | 91.00 | 97.50 | 80.60 | 84.50 | 98.00 |
| 7. Straw yield / plant (g) | 233.40 | 191.40 | 195.40 | 219.40 | 226.10 | 184.40 | 190.10 | 215.70 |
| 8. Biological yield / $m^2$ (kg) | 270.50 | 207.40 | 211.10 | 250.10 | 267.00 | 200.1 | 198.40 | 257.10 |
| **Pearl millet** | | | | | | | | |
| 1. Plant height (cm) | 170.10 | 141.40 | 151.50 | 164.80 | 164.10 | 138.70 | 145.10 | 169.10 |
| 2. Leaf fresh weight (g) | 114.10 | 84.80 | 90.10 | 108.30 | 110.10 | 80.30 | 85.00 | 94.00 |
| 3. Leaf area ($cm^2$) | 46.09 | 41.51 | 44.00 | 47.00 | 45.11 | 40.11 | 41.50 | 44.80 |
| 4. Stem fresh weight (g) | 171.00 | 143.10 | 144.00 | 160.30 | 170.10 | 144.00 | 150.00 | 170.70 |
| 5. Leaf dry weight (g) | 54.40 | 41.10 | 46.40 | 51.00 | 51.00 | 40.70 | 45.40 | 47.90 |
| 6. Stem dry weight (g) | 118.40 | 99.90 | 100.80 | 111.00 | 117.50 | 100.60 | 104.50 | 118.00 |
| 7. Straw yield / plant (g) | 253.40 | 211.40 | 215.40 | 239.40 | 246.10 | 204.40 | 110.10 | 235.70 |
| 8. Biological yield / $m^2$ (kg) | 290.50 | 227.40 | 231.10 | 270.10 | 287.00 | 220.10 | 218.10 | 277.10 |

# Evaluation of salinity tolerance and yield of alfalfa varieties under arid and semi-arid conditions (PMS44)

**Duration:** 2006-08

**Collaboration:** NARS of several countries in WANA

**Resources:** IFAD, AFESD, Core

## Significance of the project

*Selected alfalfa genotypes for forage yield and quality under saline conditions evaluated*

Development of salt tolerance in crops depends ultimately on availability of genetic variation with respect to tolerance, and exploitation of available genetic variation by screening and selection of those plants with superior performance when exposed to such stress. Previously, ICBA evaluated a large number of alfalfa genotypes, but limited seed production restricted the expansion of such materials to NARS in the region. Therefore, evaluation and selection from existing varieties was adopted as an alternative. The main focus of this study is to determine the variation between cultivars at different salinity levels, and effect of salinity on forage yield and quality of alfalfa.

## Objectives

- Assess alfalfa genotypes/accessions for salt tolerance.
- Evaluate selected accessions for forage yield and quality under saline conditions.
- Select promising genotypes and distribute seed to NARS.
- Optimize production and management technology for alfalfa production.
- Collect baseline data and transfer technology to partner countries.

*Alfalfa trials at ICBA*

## Achievements in 2007

This experiment was initiated in 2006 when eight genotypes were selected and procured for field evaluation. Irrigation was applied using three salinity levels with drip irrigation. Three cuts were completed. As shown in Figure 30, the dry matter yield of the alfalfa variety from Pakistan produced the highest biomass (15 t $ha^{-1}$) and mean dry matter production varied between 7.1 to 15 t $ha^{-1}$. Results indicate that biomass yield was higher in the May cutting than in the July cutting (Figure 31).

***Seed distributed to NARS***

***Project results will be shared with partner countries***

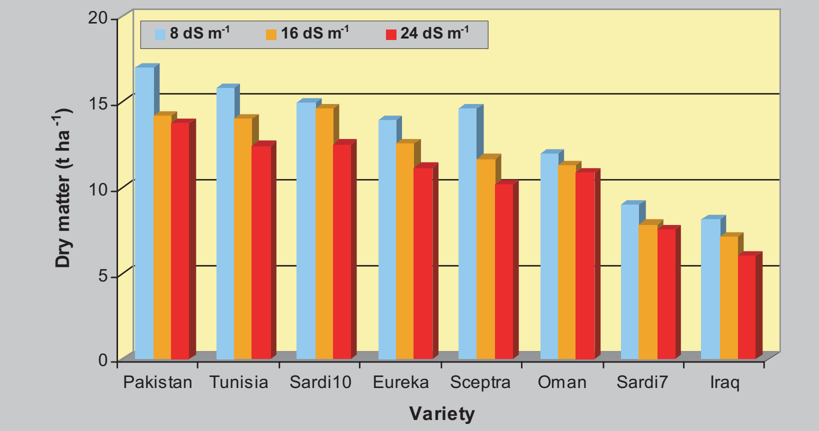



*Figure 30: Dry matter production of alfalfa varieties at three salinity levels*

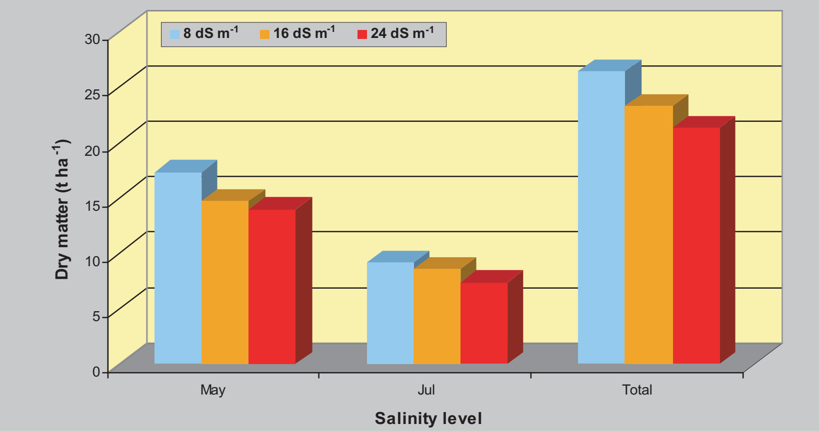



*Figure 31: Dry matter production of alfalfa varieties for two harvests at three salinity levels*

## Proposed activities for 2008

The experiment will be continued and monitored throughout the project duration. Data on field management and agronomic practices for forage production will be collected. The cutting schedule will be optimized and adjusted for maximum production. Plant samples will be subjected to laboratory analysis for mineral and nutritional content.

## Evaluation of salt-tolerance and yield potential of safflower accessions (PMS45)

**Duration:** 2005-08

**Collaboration:** NARS of several countries in WANA

**Resources:** Core

### Significance of the project

Safflower (*Carthamus tinctorius* L.) is an annual, broadleaf oilseed crop. There are two types of safflower varieties. One produces oil that is high in mono-unsaturated fatty acids (oleic acid), and the other produces high concentrations of polyunsaturated fatty acids (linoleic acid). Both types are very low in saturated fatty acids compared to other vegetable oils. Although at present only linoleic safflower is grown commercially, varieties with high oleic acid content may soon be grown more widely. Safflower is an important cash crop and can provide cash income to farmers while increasing flexibility in dryland crop rotations. Safflower was originally grown for its flowers, which can be used to make red and yellow dyes for clothing and food preparation. It also supplies oil, meal, birdseed and residue from oil processing for the food and industrial product markets. The crop is now primarily grown for its oil.

Relative salt tolerance has been reported in safflower. If salt-tolerant genotypes/lines can be identified and grown in salt-affected lands, this would help to manage such areas.

*Safflower is an important annual crop which can provide cash income to farmers while increasing flexibility in dryland crop rotation*

*Salinity tolerance and yield potential of selected accessions of safflower evaluated*

*Seed from high-yielding, salt-tolerant accessions will be distributed to the national programs for multi-location field trials*

*Information about the salinity tolerance accessions provided to project partners*

### Objectives

- Evaluate salinity tolerance and yield potential of selected accessions of safflower.
- Select high-yielding, salt-tolerant accessions and distribute seed to the national programs for multi-location field trials.
- Provide information to the collaborating institutes about the salinity tolerance among accessions.

*Variation in safflower species grown at ICBA*

## Achievements in 2007

Around 600 accessions were screened in the beginning of this project and promising accessions were selected for further selection. The 273 selected accessions were screened in pots during 2003. Based on their performance during the past screening trials and selection cycles, 60 accessions were selected for field evaluation in 2007. These were grown under three salinity levels. Data were collected for biomass production as dry weight and number of heads. Average number of heads produced by each plant varied from 1.2 heads by accession PI 251267 to a maximum of 16 heads by accession PI 248836. Biomass yield (dry matter) varied from 2.6 t $ha^{-1}$ for accession PI 568792 to 4.6 t $ha^{-1}$ for accession PI 251267. These measurements indicate a wide range of genetic variability for heads but a relatively low variability for biomass production. Results of biomass and number of heads of safflower accessions are presented in Figures 32 and 33.

## Proposed activities for 2008

Data will be completed after the harvesting and cleaning operations are finished. Results will be presented in the next report as well as in international journals. Seed of selected accessions will be multiplied and distributed to partners for evaluation under their local environmental conditions. Seed samples will be analyzed for chemical composition and oil percentage.

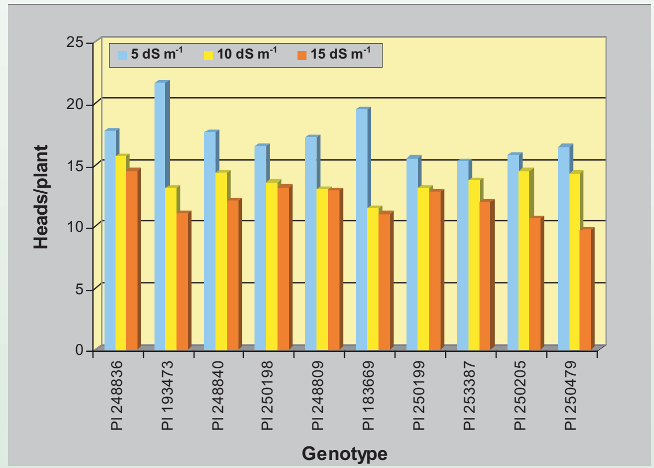



*Figure 32: Number of heads of top ten safflower accessions at three salinity levels*

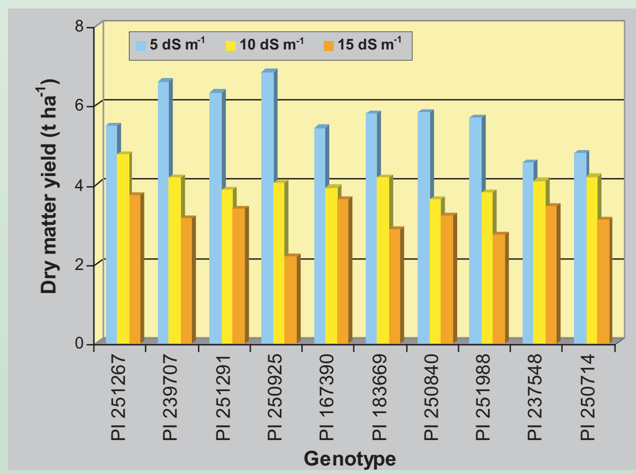
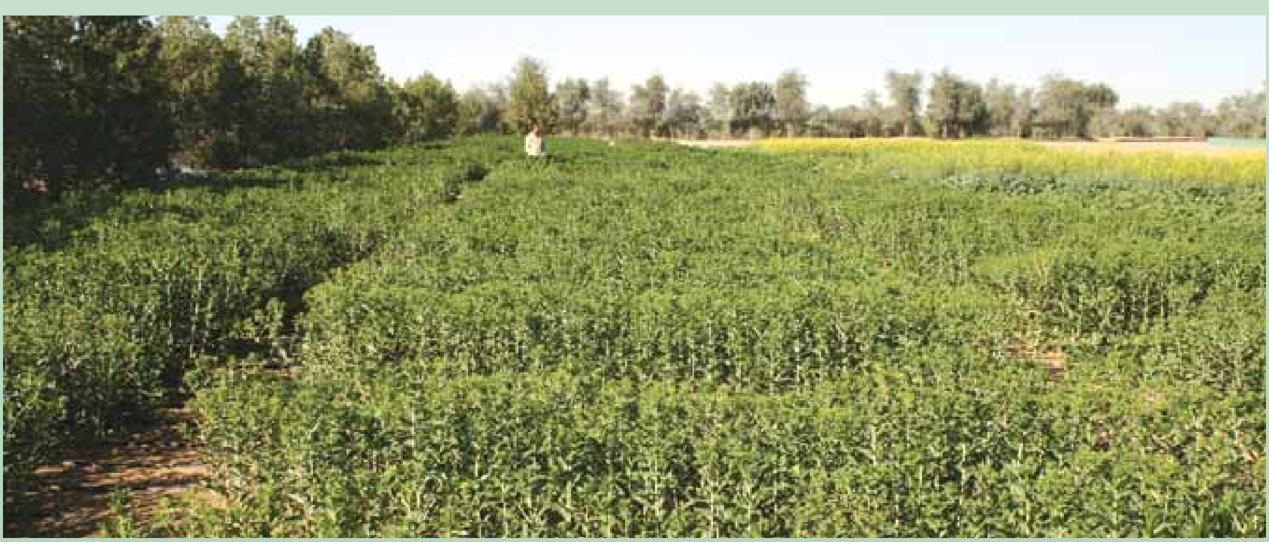



*Figure 33: Dry matter production of ten high-yielding safflower accessions at three salinity levels*



*Safflower trials at ICBA*

## Screening and selection of *Triticale* genotypes for salinity tolerance and dry matter production (PMS46)

**Duration:** 2006-09

**Collaboration:** NARS of several countries in WANA

**Resources:** IFAD, AFESD, Core

### Significance of the project

*Triticale* (*Triticale hexaploide* Lart.) is a hybrid between wheat and rye. It is self-pollinating (similar to wheat) and not cross-pollinating (like rye). Most agronomically desirable *triticales* have resulted from several cycles of improvement. *Triticale* has potential use as a feed and forage crop, as the protein content of *Triticale* lines is higher than that of wheat. As *Triticale* varieties are improved, they may compete with oats and barley as a home-grown feed crop. Feeding equal parts of *Triticale* and barley highly improves the weight gain and efficiency over a straight *Triticale* ration. It is an important feed for cattle, swine and poultry and can be used as an alternative for maize and soybean. Forage yield and quality of *Triticale* is comparable to barley and oats. Recently, farmers started growing peas with spring *Triticale* for silage. Information on yield potential and performance of *Triticale* is scanty. This project was initiated at ICBA to screen and identify high-yielding grain and forage lines of *Triticale* that can be used under saline environments.

***Triticale has a wide range of genetic variability for biomass and seed production***

***Genotypes grouped into three categories: forage types, seed types and dual-purpose***

Triticale *trials at ICBA*

## OBJECTIVES

- Screen for salinity tolerance among *Triticale* accessions under pot culture.
- Select salt-tolerant accessions/lines for field evaluation.
- Distribute seed of selected accessions to the national programs for selection under broad range of environmental conditions.
- Evaluate seed and forage production potential of *Triticale* accessions.
- Develop standard production packages for this crop.

***Dry matter production of more than 800 genotypes varied from 11 to 204 g/plant***

## ACHIEVEMENTS IN 2007

A large number of *Triticale* accessions/lines was procured by ICBA and screened in pots at the beginning of the project. The best-performing genotypes were selected for further evaluation. Promising genotypes were identified and selected for further evaluation and selection. In 2007, 836 genotypes were selected and grown in pot culture covered with fishnet for protection from bird damage. Samples were harvested and processed for threshing and cleaning. Visual observations indicated wide genetic variation among the genotypes for grain and forage production.

***Seed yield varied from 0.43 to 33.2 g/plant***

***Project results will be used to develop standard production packages for NARS***

## PROPOSED ACTIVITIES FOR 2008

Data will be completed and the results will be presented in the next annual report. The best suitable genotypes will be further selected for next selection cycle under field conditions at ICBA. Seed will also be distributed to other countries for evaluation. It is very important to evaluate under a diversified set of climatic conditions because some lines do not perform well due to unsuitable environmental conditions for their growth in the UAE. Genotypes performing poorly here may perform better under different conditions at other locations.

Triticale *trials in pots shaded by fishnet*

## Screening of *Sesbania*, cowpea, guar and sunflower accessions for salinity tolerance and yield (PMS47)

**Duration:** 2006-09
**Collaboration:** NARS of several countries in WANA
**Resources:** IFAD, AFESD, Core

### Significance of the project

*The multiple species under study are particularly important in dry areas*

*Sesbania* spp. are important annual and perennial agricultural crops. They are well adapted to a wide range of climatic conditions. The species are outstanding in their ability to tolerate waterlogging and are ideally suited to seasonally waterlogged environments. They are grown for food, forage and fuel. They are an important source of nutritious fodder. One of the major advantages of perennial *Sesbania* spp. over other forage trees and shrubs is their rapid early growth rate. However, more research is required to determine appropriate management systems to maximize yields of edible material. More studies on the effects of direct grazing in extensive feeding systems are also warranted to determine the effects of grazing on plant longevity. Studies are also needed to determine the effect of salinity on growth performance and yield of *Sesbania* spp. under various agro-ecological production systems.

*Seeds and production packages distributed to NARS*

Cowpea [*Vigna unguiculata* (L.) Walp.], an annual legume, originated in Africa. It is widely grown in Africa, Latin America, Southeast Asia and in the southern United States as a grain crop, for animal fodder, or as a vegetable. Because protein in cowpea seed is richer in amino acids than other cereal grains, the crop is valued as a nutritional supplement to cereals and as an extender of animal proteins. Cowpea can be used at all stages of growth as a vegetable crop. In many areas of the world, cowpea is the only available high quality legume hay for livestock feed. Digestibility and yield of certain cultivars have been shown to be comparable to alfalfa. Cowpea may be used as green or dry fodder. It is also used as a green manure crop, a nitrogen-fixing crop, or for erosion control. Although other grain legumes such as soybean and common dry edible bean may out-yield cowpea (for dry seed yield) under many conditions, cowpea is valued as an annual forage crop in many regions.


*Cowpea is a multi-purpose crop grown as a grain crop, for animal fodder, or as a vegetable*

Guar, or clusterbean [*Cyamopsis tetragonoloba* (L.) Taub], is a drought-tolerant annual legume grown for multiple uses. Unlike the seeds of other legumes, guar bean contains significant amounts of galactomannan gum (19-43% of the whole seed). World demand for guar has increased in recent years, leading to crop introduction in several countries. In Asia, guar beans are used as a vegetable for human consumption and the crop is also grown for cattle feed and as a green manure crop. Highly refined guar gum is used as a stiffener in soft ice cream, a stabilizer for cheeses, instant puddings and whipped cream substitutes, and as a meat binder. Guar has excellent soil-building capacity as a green manure crop and can increase the yield of succeeding crops.

Sunflower (*Helianthus annuus* L.) is the third most important oilseed crop after soybean and palm. Sunflower oil is generally considered premium because of its high level of unsaturated fatty acids. Non-dehulled or partly dehulled sunflower meal has been substituted successfully for soybean meal for ruminant animals, as well as for swine and poultry feed. Sunflower oil is used in certain paints, varnishes and plastics. The sunflower seed is used for birdfeed or in human diets as a snack. Varieties used such purposes require slightly different management practices. Sunflower can also be used as a silage crop, as a double crop after early-harvested small grains or vegetables, an emergency crop, or in areas with a season too short to produce mature corn for silage. The nutritional quality of sunflower silage is often higher than that of corn but lower than that of alfalfa hay. Crude protein level of sunflower silage is similar to grass hay and higher than corn silage.

The main focus of these experiments is to screen large collections of genotypes of these crop species to identify and select best-performing and high-yielding genotypes under saline irrigation conditions.

## Objectives

- Screen for salinity tolerance among *Sesbania*, cowpea, guar and sunflower accessions at various salinity levels under pot culture.
- Select salt-tolerant accessions/lines for field evaluation.
- Distribute seed of selected accessions to the national programs for a broad range of environmental conditions.
- Develop standard production packages for these crops.

## Achievements in 2007

Seeds of large number of *Sesbania*, cowpea, guar and sunflower accessions were acquired by the Plant Genetic Resources Laboratory of ICBA for screening under pot and field conditions. Sesbania (67), cowpea (23), guar (65) and sunflower (100) accessions were planted in the pots. *Sesbania* and cowpea were screened at three (5, 10 and 15 dS $m^{-1}$) salinity levels, whereas, sunflower and guar were grown at a single salinity level (10 dS $m^{-1}$). *Sesbania*, guar and cowpea experiments were abandoned because of the unavailability of saline water during the middle of the cropping season. Sunflower seeds did not germinate due to high temperatures at the germination stage.

## Proposed activities for 2008

Seeds have been prepared for planting in the 2008 season under both pot and field conditions.

*Sunflower is the third most important oilseed crop in the world*

# Halophyte production

## Water use and salt balance of halophytic species (PMS12)

**Duration:** Ongoing
**Resources:** Core

### Significance of the project

*Soil salinity can be controlled by high leaching fraction in irrigation water*

*Drainage water re-used for irrigation trees to maximize evapo-transpiration*

*Highly saline water only suitable for halophytes*

Salt and water movements are dynamic processes based on soil properties and climatic conditions. Growth of different types of plant species also influences the movement of salts and water at different stages of growth and periods. In order to study these movements, which could lead to better irrigation and soil management practices, it is desirable to study them under controlled conditions. Lysimeter studies provide controlled measurements of responses to changes in soil profile. They also provide guidelines for irrigation volume and scheduling, as well as the leaching fractions needed to flush the salts from the rhizosphere. Proper disposal of drainage water with high concentrations of salts and other chemicals, such as pesticide residues and nitrates, is a critical factor when using marginal quality water. It is clear that drainage water is a very important resource that can be used effectively in agriculture with or without treatments.

Lysimeter studies undertaken at ICBA provide models for studying the different physical and chemical aspects of using drainage water in agriculture. Since the drainage water is expected to have more minerals and salts, re-use of this water should complement the salt tolerance of the plants used. A serial biological concentration (SBC) approach successfully tried in both the USA and Australia has been adapted. The SBC approach uses drainage water successively more than once to grow different salt-tolerant plant species in successions.


*Tree level of the lysimeter*

### Objectives

- Develop productivity management of promising halophytic species for forage.
- Test plant genotypes exhibiting salt tolerance in lysimeters for productivity management.
- Study the effects of water quality and quantity, harvest period and frequency, and their nutritional aspects for optimizing productivity.
- Simulate studies related to re-use of drainage water for efficient water utilization, minimum drainage disposal and maximization of productivity of salt-tolerant plants and halophytes.

## Achievements in 2007

*Volume of water can be reduced by 85%*

Due to fluctuating evapo-transpiration rates, variation in volume and salinity of drainage water were observed during different months of the year. The average salinity of drainage water after three successive plant species (a grass first, followed by a tree species and a halophytic shrub), showed an increase of 3.0-3.2 times the salinity of the irrigation water (~10 dS $m^{-1}$). The salinity of the drainage water increased threefold and ranged between 30 and 35 dS $m^{-1}$ in the five sets evaluated. Volume of the drainage water was reduced to ~12-15% of the application.

Among the grass species studied, *Distichlis spicata* produced maximum dry biomass and *Leptochloa fusca* the minimum. Among the tree species, *Acacia ampliceps* exhibited the highest growth rate with minimum for *Salvadora persica*. *Conocarpus lancifolius* showed highest evapo-transpiration rates.

## Proposed activities for 2008

Extensive studies will be conducted on nutrient management of drainage water under saline conditions. Data will be collected on the chemical content of the drainage effluents and their interaction with salts for different plant species. Attempts will also be made to study biological methods to clean the drainage waste water and make it safe for use and re-use.

*Lysimeter setup at ICBA*

## Propagation and development of *Distichlis spicata* var. Yensen-4a (NyPa forage) under arid environment (PMS29)

**Duration:** 2004-08

**Collaboration:** NyPa International

**Resources:** NyPa, Core

### Significance of the project

Among sources of marginal water, seawater is by far the largest. Its use in any type of plant production system, however, is very limited. Mangroves and *Salicornia* are examples of plants that have been tested and used commercially in the USA, Europe and other areas. Among the halophytes, NyPa grass (*Distichlis spicata* var.Yensen 4a), developed by NyPa International, has the potential to be cultivated with seawater and become a reliable source of forage/fodder for higher animals. This grass is currently being marketed internationally as NyPa Forage.

*Seawater is the largest source of marginal water*

*Seawater's use to date in any plant production system is very limited*

ICBA has been working with NyPa to test the germplasm for its growth and forage potential in the coastal arid and humid conditions of the region, using seawater for irrigation. This trial, conducted over the past 3 years, has proved that it is technically feasible to produce biomass equivalent to other grass species irrigated with half seawater salinity. This provides an excellent opportunity for regions where seawater is abundant and fresh water scarce. The prospect of converting barren coastal areas into forage production areas is enticing. However, the quality of forage produced under such conditions and its effects on animals needs to be ascertained.

*The halophyte NyPa grass has the potential to be cultivated with seawater*

*ICBA is testing the germplasm for its growth and forage potential using seawater irrigation*

*Growth of NyPa grass at 40 dS $m^{-1}$ salinity level*

## Objectives

- Demonstrate growing NyPa Forage under local conditions using highly saline water.
- Expand NyPa Forage material in agreement with NyPa International and NyPa Arabia.

## Achievements in 2007

A small-scale trial was initiated at ICBA in 2005 with three irrigation treatments ($ET_0$x1, $ET_0$x1.25 and $ET_0$x1.5) and three salinity treatments (15, 25 and 40 dS $m^{-1}$). Shoot air-dried biomass of NyPa Forage grown at 25 dS $m^{-1}$ showed optimum biomass of 23.35 t $ha^{-1}$ at $ET_0$x1.25 (Figure 34).

Application of sodium sulfate as commercial fertilizer increased the dry biomass to 23.28 t $ha^{-1}$ when irrigated with 25 dS $m^{-1}$ irrigation water (Figure 35). Different concentrations (2, 6 and 12 mM) of sodium sulfate treatments (as fertilizers) did not show any significant effect on shoot dry biomass and ranged from 20.0 to 23.5 t $ha^{-1}$. Long-term assessment is being undertaken for introduction of this grass in the region.

Soil salinity measured from saturated extract and EM-38 readings showed levels similar to that of irrigation water salinity, however, $EC_e$ derived from EM-38 after calibration for moisture and temperature showed slightly higher values, since sampling was done on transects in the experimental field.

## Proposed activities for 2008

Over the past 3 years, plants were harvested 3 times annually. The green foliage was high in fiber content. In 2008, attempts will be made to harvest the plants at shorter intervals so that shoots are less fibrous and more suitable as forage/fodder for small ruminants. Plants will also be harvested closer to the ground to replicate naturally grazed lands, enabling evaluation of plant regeneration. Plant samples at different growth periods will also be analyzed for N and other organic compounds to evaluate forage quality.

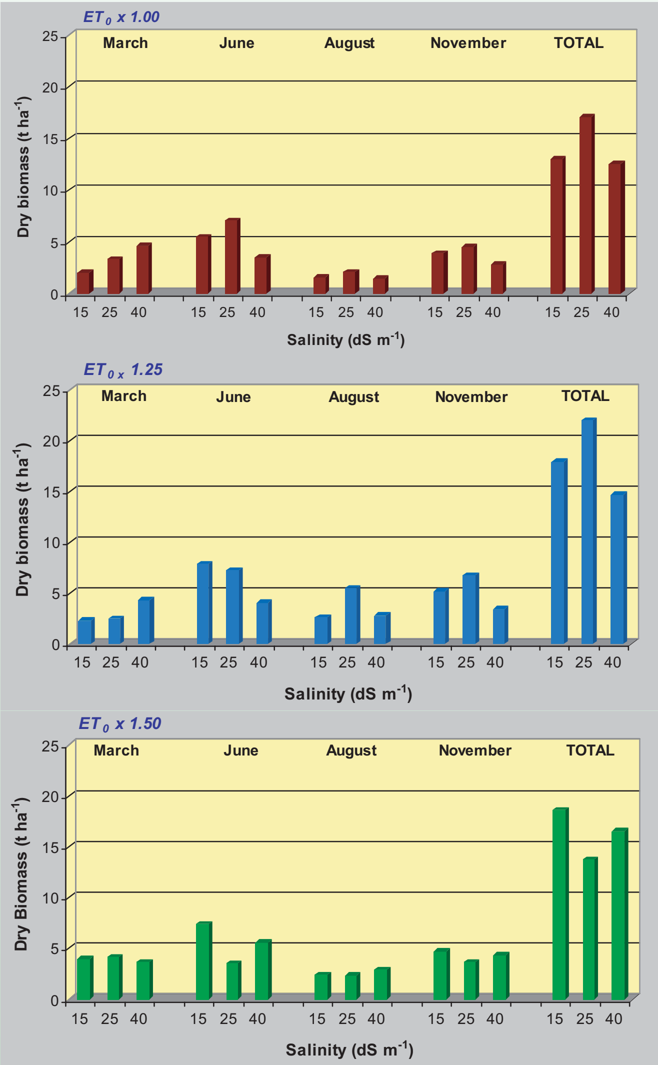



*Figure 34: Dry biomass of NyPa forage at four harvest periods (the last column shows the total dry biomass per year)*

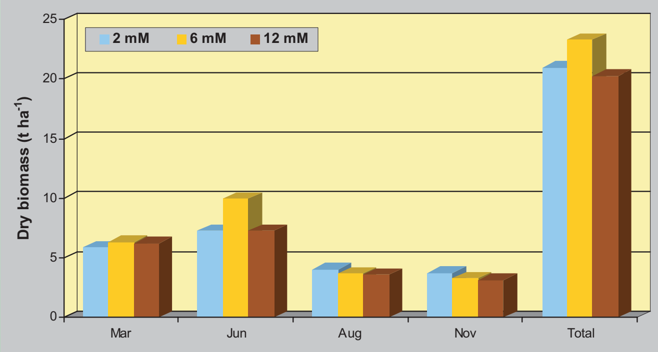



*Figure 35: Dry biomass of NyPa forage at three sodium sulphate treatments (2, 6 and 12 mM). Plants were grown at 25 dS.$m^{-1}$ and $ET_0$x1.25*

## Response of two prominent grasses – indigenous Dhai (*Lasiurus scindicus*) and an introduced African variety of *Cenchrus ciliaris* – to water salinity (PMS30)

**DURATION:** 2004-08
**COLLABORATION:** MOEW
**RESOURCES:** Core

### SIGNIFICANCE OF THE PROJECT

In recent years, ICBA has introduced a number of salt-tolerant germplasm accessions from different agro-climatic zones to the region. However, the success of any new species is based on its adaptability in addition to its salt tolerance. Indigenous plant species can be domesticated more easily and more quickly than introduced germplasm. Previous screening undertaken by MOEW on indigenous cultivars of *Lasiurus scindicus* and an introduced African variety of *Cenchrus ciliaris* showed promising results. The collaborative MOEW-ICBA work is aimed at assessing the productivity potential and quality of the two grass species at various levels of saline irrigation water and water stress.

***African* Cenchrus ciliaris *and* Lasiurus scindicus *showed high growth rate and were harvested seven times in 2007***

***Total dry biomass were 90 t ha$^{-1}$ for* Cenchrus *and 61 t ha$^{-1}$ for* Lasiurus *at 15 dS m$^{-1}$***

***Preliminary results show that nutrient quality improved with quick cuttings with low fiber and ash content***

### OBJECTIVES

- Study the responses of the test grass species at different levels of saline irrigation water.
- Evaluate the growth, dry matter yield and nutritive value of these species.

### ACHIEVEMENTS IN 2007

Preliminary efforts to establish the two grasses showed a slow establishment rate when propagated by seeds. It is relatively easier to establish them vegetatively. Repeated attempts were made to bring new cuttings/seedlings from Dibba Research Station, raise them in the shade house and then transplant them in the field. Once the plants established themselves, salinity treatments of 5, 10 and 15 dS m$^{-1}$ were initiated. The grasses were harvested three times annually. Although *C. ciliaris* showed higher biomass than *L. scindicus*, forage quality was higher in the former species.

### PROPOSED ACTIVITIES FOR 2008

Growth and productivity of the test species will be evaluated in 2008. Nutritional value of these grasses will also be studied at different growth periods during 2008.

Cenchrus ciliaris *(top) and* Lasiurus scindicus *(bottom) grown with 15 dS m$^{-1}$ water at ICBA station*

## Agroforestry trial using *Acacia ampliceps*, *Sporobolus arabicus* and *Paspalum vaginatum* at various salinity levels (PMS31)

**Duration:** 2004-08

**Resources:** Core

### Significance of the project

Increased plant production per unit area and nutrient management are important factors for sustaining agricultural productivity. To be competitive, an agricultural system should be less cost-intensive and more productive. Crops that provide bi-products with commercial value and markets in addition to providing primary products will comprise the future generation production systems. Furthermore, in less productive areas and wastelands, deficiency of minerals, especially nitrogen, is a major limitation. Addition of expensive fertilizers in such wastelands makes the whole system unviable for farmers.

***Acacia ampliceps* fixes atmospheric nitrogen, provides forage/fodder for animals, a bio-energy source and an environment conducive to under-storeyed plants**

Multicropping systems are not limited to crop rotations, but include various crops grown simultaneously in a unit area. Agroforestry is a multicropping system that includes production of tree species along with crops and/or other plants in a unit area that benefit each other through nutrient and water management.

ICBA has successfully introduced *Acacia ampliceps* to many partner countries. This tree species fixes atmospheric nitrogen, provides forage/fodder for animals and comprises a source for bio-energy and an environment conducive to under-storeyed plants. ICBA has introduced *A. ampliceps* in an agroforestry trial with two salt-tolerant grass species, *Sporobolus arabicus* and *Paspalum vaginatum*, to evaluate the responses of salinity treatments, and absence and presence of fertilizers, on growth and productivity of the test plants.

***A. ampliceps* is used in an agroforestry trial with two salt-tolerant grass species, *Sporobolus arabicus* and *Paspalum vaginatum*, to evaluate the responses of salinity and fertilizer treatments on plant growth and productivity**

Acacia ampliceps *alternated with* Paspalum vaginatum *and* Sporobolus arabicus *shows slight reduction in biomass at different salinity levels, even without any fertilizers*

## Objectives

- Test the potential of grass and tree species in an integrated form for increased productivity.
- Evaluate the nitrogen placement after fixation by the legume *Acacia ampliceps*.
- Evaluate the potential of mixed forage of grasses and trees for animals.

## Achievements in 2007

Results over 2 years have shown that the absence of fertilizer on *Sporobolus arabicus* made no significant difference on the dry biomass at any salinity treatment when compared with blocks that were fertilized. *Paspalum vaginatum* and *Sporobolus arabicus* plots showed 21.35% and 25.21% increases in dry biomass in response to fertilizer at 30 dS $m^{-1}$. At lower salinity levels (10 and 20 dS $m^{-1}$), non-significant differences were observed between the two fertilizer treatments. *S. arabicus* produced 31.25 t $ha^{-1}$ of dry biomass with four cuts per year and without addition of any fertilizers for 3 years. *P. vaginatum* produced 23.47 tons. This indicates that nitrogen is fixed by *Acacia ampliceps* and translocated horizontally, but this conclusion needs to be further verified with soil nutrient data over different seasons.

## Proposed activities for 2008

Growth and productivity of the various species will continue to be assessed in 2008 at different salinity levels, with and without fertilizer treatments. Efforts will be made to estimate soil nitrogen content at different salinity levels and fertilizer treatments. Nutritional value of these grasses will be studied at different growth periods of the year. Sensitivity analyses will be undertaken to demonstrate the economics of using agroforestry over time.

Sporobolus arabicus *and* Paspalum viginatum *alternated with* Acacia ampliceps *in an agroforestry trial irrigated with 30 dS $m^{-1}$ salinity of irrigation water*

# Enabling Communities in the Aral Sea Basin to combat land and water resource degradation through the creation of 'bright spots' (PMS35)

**Duration:** 2005-08

**Collaboration:** Kazakhstan, Turkmenistan, Uzbekistan, ICARDA, IWMI

**Resources:** Asian Development Bank (ADB)

## Significance of the project

The Central Asia and Caucasus (CAC) states have seen rapid degradation of their agricultural lands because of irrigation mismanagement. Dramatic reductions in yields of cotton necessitate the introduction of alternative crops to improve the livelihoods of farming families.

***All ICBA accessions and varieties of sorghum, pearl millet and fodder among conventional forage species proved better than local varieties under saline conditions***

ICARDA, IWMI and ICBA have demonstrated that appropriate water management techniques and soil conservation practices can significantly increase agricultural productivity and income generation. The project work aims to introduce innovative and integrated methods of land, water and plants management to improve the agriculture sector.

Diversification of cropping systems under prevailing saline conditions is likely to sustain agricultural production from salt-affected areas and increase farmers' profits. Introduction of new species and varieties of forage crops, including grasses, legumes and shrubs, can reduce waterlogging and contribute to restoration of degraded soil.

## Objectives

The overall goals of the project are to alleviate poverty by improving food security at the household level, and to improve environmental security by developing and promoting strategies that enhance the productivity of farming systems. The main objectives of the crop selection activity are to:

- Develop agronomic practices (plant density, fertilizer application, time of planting, etc) for seedling establishment, crop management and yield.
- Select appropriate plant species to match the environment, in particular the salinity conditions and type of production system for different ecological zones.

***The non-conventional* Atriplex *spp. (particularly* A. undulata*) and* Acacia ampliceps *showed very high growth rate and biomass, and were readily accepted by cattle and other ruminants***

## Achievements in 2007

Project activities related to ICBA were conducted at three experimental stations in Makhtaral (southern Kazakhstan), Dashauz province (Turkmenistan) and three stations in Uzbekistan (in collaboration with Gulistan State University, Plant Research Institute and Karakul Sheep Breeding Institute).

ICBA provided seeds of 50 different species/cultivars/lines of salt-tolerant crops, shrubs and trees. In addition, 300 vegetative cuttings were sent for propagation. These materials were used at different sites. Among conventional forage crops, sorghum, pearl millet, fodder beet, *Atriplex* spp. and *Acacia ampliceps* proved very successful. In addition, local varieties and cultivars were used for comparisons.

Introduced sorghum varieties/improved lines from ICBA germplasm such as Speed Feed, Super Dan, Sugar Graze, Pioneer 858, SP 40516 and SP 39269 had significantly higher growth rates, plant height, fresh and dry biomass, and seed production than locally planted varieties.

***Seed production trials in Turkmenistan successfully increased the population of successful germplasm***

***Kyzylkum region of Uzbekistan provided a natural habitat for domestication of local and exotic halophytes as fodder using artesian saline water***

Among the pearl millet accessions, most promising and highly adaptive to saline soils were ISCMS 7704 (a very fast-growing and early-maturing cultivar with a yield of fresh biomass of 42 t $ha^{-1}$ at plant density of 116 plants/$m^2$). Significant increases in plant height and green biomass were also observed for MC 94 C2, 11612, 6109, Sudan Pop III, Gurenian-4 and HHVDBC Tall varieties. In addition to these annual forage crops, two introduced alfalfa (*Medicago sativa*) varieties, Eureka and Sceptre, outperformed the local variety Khivinskii. The two introduced varieties showed rapid germination, high seed production and excellent regenerative capacity – all desirable attributes for a perennial forage crop.

Seedlings of *Acacia ampliceps* were produced from seeds both by direct sowing in the field and in plastic bags. These seedlings were transplanted into the field at the Akdepe site in Turkmenistan along with poplar (*Populus alba* L.), quince (*Cydonia oblonga*), mulberry (*Morus alba*), thuya (*Thuja occidentalis*) and *Rosa canina*. Growth and survival of these species will be monitored. In addition, among the *Atriplex* species assessed, highest seed germination (about 82%) under field conditions was observed for *A. undulata*. This species showed a rapid growth rate with excellent biomass production. With its large canopy, the species can occupy the inter-row spaces forming a dense halophytic pasture. The green biomass produced in 4 months was 1.6 kg $m^{-2}$ of fresh biomass and was readily eaten by cattle and small ruminants. Lower seed germination (55%) was observed for *A. nummularia* and *A. amnicola*.

In Uzbekistan, studies were conducted in collaboration with Gulistan University. Oil and fodder crops were assessed along with alfalfa. In addition, a study using the aquatic weed *Azolla karoliniana* as a potential organic fertilizer source was assessed using a maize cropping system. Preliminary results on the effects of *Azolla* on maize yield showed positive response to both N fertilizer and *Azolla* treatment. Studies have also been undertaken to investigate methods for the establishment of *Acacia ampliceps,* because the seeds require pre-treatment prior to planting. Gentle mechanical scarification between sheets of sand paper resulted in a 76% seed germination.

In collaboration with the Institute of Plant Industry in Tashkent, seedlings of *Acacia ampliceps*, *A. nummularia*, *A. undulata* and *A. amnicola* were established for further

*Saline groundwater from artesian source (up) used for irrigating new salt-tolerant forage material (down)* distribution to NARS partners. In addition, cuttings produced from 1-year-old seedlings of *Acacia* have been established successfully, suggesting an effective method of producing planting material.

A study was initiated in the Kyzylkum region of Uzbekistan at the experimental station of the Institute of Karakul Sheep Breeding. The focus of this activity is to assess the feasibility of domesticating wild halophytes that could be used as fodder species. The region has a diverse and rich natural halophyte population well adapted to high salinity. Experimental plots were established for *Kochia scoparia*, *Atriplex nitens*, *Agropyron desertorum*, *Atriplex canescens*, *Climacoptera lanata* and *Beta vulgaris*. Growth and productivity of these species are currently being monitored.

ICBA organized a training course during June in Uzbekistan on Production and utilization of salt-tolerant forage crops/halophytes. This course benefited many scientists, young researchers and technicians from the partner countries. The course was organized by ICBA in close collaboration with ICARDA and IWMI and sponsored by the OPEC Fund for International Development (OFID) and the Asian Development Bank (ADB).

## Proposed activities for 2008

The first phase of the project will be completed by the mid of 2008. Results obtained from the 3-year project will be compiled and summarized as a working paper for future strategies in the CAC region. During this period, a proposal for a replacement project will be submitted to the donor agencies to capitalize on the successes of the current work. Introduction of new crops into the region can make a significant impact on the poor farmers of the region. The second phase will mainly focus on:

1. Optimization of various technologies (*Azolla* efficiency, intercropping, crop rotations) and productivity of potential salt-tolerant species for further dissemination under saline environments.
2. Upscaling and development of agronomic practices to optimize plant yield of selected ICBA germplasm (most importantly, sorghum, pearl millet and *Acacia ampliceps*).
3. Establishment of seed production facilities of salt-tolerant plants in partner countries.
4. Human capacity building of staff, extension services and farmers.

*Participants of the training course in Uzbekistan*

*ICBA scientists interact with NARS, extension people and farmers in CAC countries*

## Biosaline agroforestry: Remediation of saline wastelands through the production of renewable energy, biomaterials and fodder (PMS38)

**Duration:** 2007-08
**Collaboration:** OASE/ODE, UU, Bangladesh, India, Pakistan and Spain
**Resources:** European Union (EU)

### Significance of the project

Increasing salinity is a threat to more than agricultural production alone. It contributes to desertification, disrupts socio-economic structures and causes rural migration. Biosaline agroforestry seeks to change the problem of salinity into an opportunity by applying innovative approaches. By selecting salt-tolerant species, using unconventional saline water resources and adopting improved management practices, farmers can enhance their agricultural productivity.

*New tree germplasm evaluated for salinity tolerance and biomass (bio-energy) production*

*Evaluation done in Bangladesh, India, Pakistan, Spain and UAE in different agro-climatological conditions*

Domestic and export markets for woody biomass (energy and biomaterials) are becoming more and more attractive worldwide. Climate change is pushing energy markers in the direction of renewables, mainly in European countries. Industrial developments in Asia (especially China and India) together with increasing living standards and extremely high prices of oil are all contributing to this development. In short, a commodity market for biomass is emerging.

*Case history area surveyed on existing tree plantations on saline sites in partner countries*

The development of agroforestry systems for saline areas is an excellent opportunity to contribute to biomass supply while sustainably reclaiming saline wastelands.

### Objectives

- Contribute to the development of biosaline agroforestry systems for various saline environments (local/regional approach).
- Explore the potential and options for biomass production in saline environments (global approach).

### Achievements in 2007

ICBA and other collaborators submitted a project proposal to the EU for funding. The proposal includes seven work packages (WPs), with ICBA involved directly in two work packages and indirectly in three. Moreover, ICBA leads the activities for WP1 and WP2 as regional coordinator. During 2007, ICBA scientists were involved with OASE/ODE and also with the technical coordinators

*Set-up for screening of tree germplasm in Bangladesh*

**_Data collected and collated for regional projections based on GIS and satellite imagery_**

to discuss the project's structure. The inaugural meeting was held in the Netherlands, where the workplan was discussed with all partners. As a follow-up, ICBA prepared the protocols for WP1 and WP2, and provided partners in Bangladesh, India, Pakistan and Spain with salt-tolerant germplasm of tree species. ICBA also prepared data templates for both the work packages, including methodologies, time frame, and parameters related to soil, water and plant components of the work packages.

As leader of WP1 and WP2, ICBA managed the discussions with partners from BARI, CITA, CSSRI, PARC (UoAF and NIAB also from Pakistan), in addition to OASE and UU. ICBA facilitated the final selection of plant species suitable for different geographical regions and arranged for acquiring and distributing the germplasm. ICBA also prepared the protocols for both WP1 and WP2, providing detailed information on methodology, data collection, storing and analysis. Additionally, ICBA prepared the data templates for both packages and sent them to all partners for storage. The main features included:

- Liaising with partners to prepare a workplan for all partners, including selection of pots, salinity types and levels, monitoring guidelines, etc.
- Preparing a protocol document describing the activities and monitoring guidelines for all partners.
- Procuring and acquiring salt-tolerant germplasm from potential sources and distributing it to partner countries.
- Preparing data templates for both WP1 and WP2.
- Preparing screening trials at ICBA, including irrigation systems.

ICBA actively participated in both the pre-kick-off and the kick-off meetings in the Netherlands to finalize the details of the workplan related to both work packages.

The protocol also identified germplasm suitable for each country, and a final list of 100 species/accessions was identified for testing during the first year. In addition, partners agreed to share the genetic resources native to their countries, and seeds were supplied to all partners.

The UAE, one of the partners undertaking the trial on WP1, established a set-up for testing 15 plant genotypes. The trial consisted of 5 salinity treatments (5-25 dS $m^{-1}$), and 15 plant genotypes with 5 replicates. Sandy loam soil was used and salinity levels maintained by mixing NaCl + $CaCl_2$ salts. Pots were irrigated with saline solution to saturate the soil profile, plus a 20% leaching fraction using drip irrigation. Salinity was maintained by monitoring the EC of the drainage water. Data for soil, water and plant were collected and entered into the database sheet.

*Set-up for screening of tree germplasm in Pakistan*

*Potential for future areas and marginal lands identified for bio-energy production on non-arable lands*

WP2 is related to the selection of existing sites where tree plantations exist on salt-affected (low to high salinity) lands, in order to study the (i) growth responses of plant species; (ii) soil characteristics under which these tree plantations exist; and (iii) groundwater level and salinity fluctuations affecting the tree plantations.

During the project planning phase, Bangladesh, India and Pakistan were requested to provide preliminary information about such plantations. Based on this information, a number of potential sites were identified in each country and discussed during the kick-off meeting. Since many national agencies are involved in such programs within each country, the partners proposed seeking more details before finalizing the site locations. It was agreed that the sites should have the following features:

1. Minimum size of 5 ha.
2. Plantations may have one or more than one tree species.
3. Background information on soil, water and plants of these plantations should be available.

A protocol for selection of plantations, plant categorization, individual trees within each plantation, parameters to be studied, soil and water sampling and analysis were prepared, discussed with partners and provided to all.

Since these WPs were related to other work packages, ICBA, OASE, UU, ACACIA and UHOH worked together to form a matrix for collection of data on climate, soil and water. These matrix tables were discussed during the kick-off meeting, modified based on feedback and sent to all partners for data collection. Partner countries including BARI (Bangladesh), CSSRI and CAZRI (India) and NIAB and PARC (Pakistan), have finalized the sites and have started collecting data.

## Proposed activities for 2008

During 2008, ICBA will be involved in overseeing the project activities in partner countries for WP's 1 and 2. In addition, ICBA will undertake WP1 activities at its headquarters, involving 15 different salt-tolerant species/accessions tested for various salinity treatments. For WP1, ICBA will also be responsible for evaluation of data from partner countries, help in coordination for preparing salinity curves for different germplasm, and submission of reports to coordinators and donors. For WP2, compilation and analyses of data from naturally occurring tree stands under saline environments in partner countries will lead to an understanding of the growth curves of salt-tolerant trees and potential for bio-energy.

*Set-up for screening of tree germplasm in the United Arab Emirates*

## Introduction of biosaline agriculture technologies for improvement of degraded abandoned farms in Tajikistan (PMS39)

**Duration:** 2007-09

**Collaboration:** Tajikistan Academy of Agricultural Sciences (TAAS)

**Resources:** Core

### Significance of the project

*Poor drainage is the main reason for salinity and waterlogging in Tajikistan*

Formerly productive irrigated lands are degrading into marginal lands in Tajikistan because of salinity and waterlogging. Once these constraints have taken hold, the farmers abandon their lands. The main cause of salinization is the rising water table brought about by high irrigation water application and poorly managed drainage systems.

*Cotton production has significantly decreased and farmers have abandoned farms*

Salinity has reduced productivity of cash crops like cotton and vegetables. Without remedial action, it is unlikely that these areas can be reclaimed and cultivated in the near future. Solutions need to be worked out at on-farm level to reduce the groundwater level and grow cash crops and/or forage crops.

ICBA and TAAS prepared a joint project proposal to test biosaline agriculture technologies on abandoned farms. Use of salt-tolerant conventional and non-conventional species and halophytes for bio-drainage, agroforestry and forage crops could bring these abandoned farms back to production.

### Objectives

- Develop management systems for efficient utilization of available marginal resources of land and water.
- Evaluate indigenous salt-tolerant plants and halophytes and domesticate them into production systems through farmer-participatory programs.
- Introduce conventional and non-conventional forage production systems at 10 dS $m^{-1}$ and higher salinity levels.
- Support capacity building of TAAS technical staff and farmers in the region.

### Achievements in 2007

ICBA initiated the work in 2007 in Khudjand province, where lands had been badly affected by the rising water table. Since irrigation water had not been properly drained, experiments were designed to use the drainage water on farm to cultivate salt-tolerant species that could provide economic returns to farmers. Four main areas were identified:

*Non-functional drainage system has resulted in a very shallow water table causing salinity problems*

- Continuous monitoring of ground fluctuation.
- Introducing and monitoring tree species as bio-pumps to drop the water table downwards.
- Monitoring different plant species for growth rate, water use and other characteristics.
- Screening and evaluating germplasm for forage production under field conditions.

*Tree species used as tools for bio-drainage followed by salt-tolerant fodder plants*

During 2007, sites were selected and detailed soil and water analysis completed before the trials were implemented. Germplasm of salt-tolerant fodder species, including sorghum, pearl millet and alfalfa were acquired and sent to Tajikistan. In addition, seeds of tree species were also introduced for bio-drainage. The seeds were grown under local conditions and planted/transplanted in the fields. Since the soil is very poor in nutrients, representative farms were selected for detailed soil analysis.

*On-farm management has to be introduced for introducing new crops with food and feed value*

Among the ICBA varieties tested, alfalfa variety Eureka showed a good response with establishment rate of 300 plants/$m^2$. Local variety Vaksh was found unsuitable for planting in saline soils.

## Proposed activities for 2008

Monitoring of field sites for groundwater depth and salinity will help to select suitable plant species for bio-reclamation. Suitable agronomic and irrigation practices will be tested to increase productivity and manage water in the soil profile. Since these areas were traditionally dominated by cotton, the potential of alternate tree and crop species for wood and forage must be studied carefully before introducing new commodities to the market. Initially screened cultivars that prove successful during the first year will be used the following year under various management options to optimize productivity.

*Drainage water from agricultural farms with low to moderate salt content can be used for on-farm management in Khudjand district*

*Typical abandoned saline farms due to salinity and waterlogging in Khudjand district*

# Horticultural Crop Production

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

**Duration:** 2002-10
**Collaboration:** MOEW
**Resources:** Core

### Significance of the project

Although the genetic diversity of date palm in the Arabian Peninsula is wide, the agro-ecosystem needs continuous inclusion of new germplasm and adjustments in structure and management strategy to meet changing production priorities. It is extremely important to develop high-yielding, stress-tolerant varieties and to improve production management if the survival of the plants under stress environments is to be assured. Information on the tolerance of date palm to salinity is limited and few studies have been conducted to evaluate salinity tolerance. Long-term experiments comprising both local and imported varieties are therefore in progress at ICBA.

### Objectives

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

### Achievements in 2007

Due to fluctuating evapo-transpiration rates, variation in volume and salinity measurements on growth parameters were recorded. These included measurements of plant height, trunk circumference, fruit production, number of leaves and phenology. Soil samples were collected and laboratory analyses conducted. Fruit was harvested at maturity and fruit yield

*Protecting date palm fruits*

calculated. The samples were preserved and sent to UAE University for mineral and nutritional analysis. After 6 years of establishment, effects of increased salinity levels on growth and production became very evident. Both parameters declined drastically with increased salinity levels (up to 15 dS $m^{-1}$). Results of plant height, trunk diameter and fruit yield from Experiment I (local varieties) are presented in Figures 36-38. Results from Experiment II (exotic varieties) are presented in Figures 39-41.

### *Experiment I - Local varieties*

Results indicate that plant height, trunk diameter and fruit yield declined with increases in salinity level of the irrigation water. Plant height varied between 65.1 and 126.9 cm. Variety Lulu obtained the maximum height (126.9 cm) over three salinity levels whereas the height of variety Fard was drastically reduced. Lulu also exhibited the highest growth rate in terms of girth and maximum trunk diameter (316.3 cm). Fruit yield varied between 3.9 and 25.8 kg/plant. Maximum fruit yield was produced by Lulu, followed by Barhi.

### *Experiment II - Varieties from the Arabian Peninsula*

Results indicate that growth and fruit yield of imported varieties was lower than that of local varieties. This may be because of the age of the imported varieties, which are younger than the local varieties. Local varieties were planted almost 1 year earlier than the imported varieties. Plant height varied between 46.2 and 75 cm. Trunk diameter varied between 139.7 and 254.6 cm. Fruit yield varied between 2 and 22 kg/plant. Variety Sukkari attained the maximum plant height (75 cm) and trunk diameter (254.6 cm), and produced the maximum fruit yield (22 kg/plant). Ajwa-Tul-Madinah showed poor performance under similar conditions with respect to all growth and yield parameters.

## Proposed activities for 2008

Data collection will be completed and recorded data analyzed. Leaf and fruit samples will be prepared and sent to reputed laboratories for mineral and nutritional analysis. The results will be published in the progress report as well as in peer-reviewed journals.

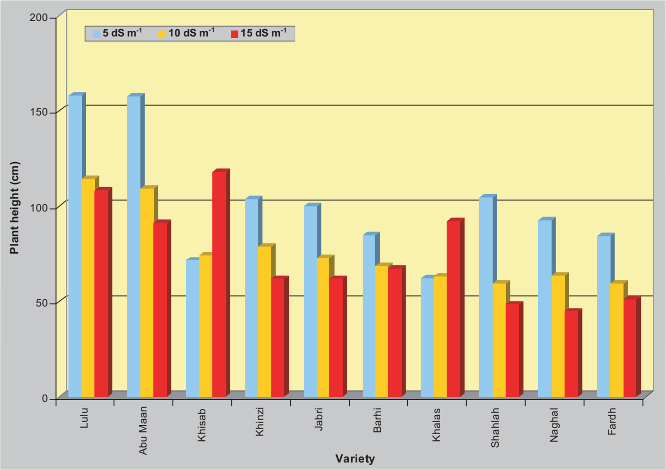



*Figure 36: Plant height of local date palm varieties at three salinity levels*

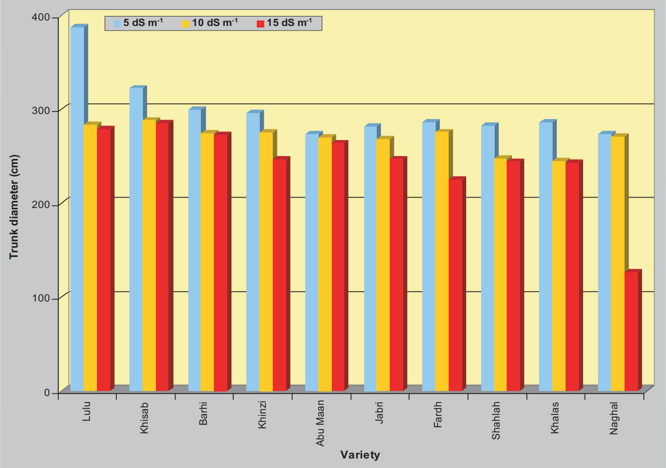



*Figure 37: Trunk diameter of local date palm varieties at three salinity levels*

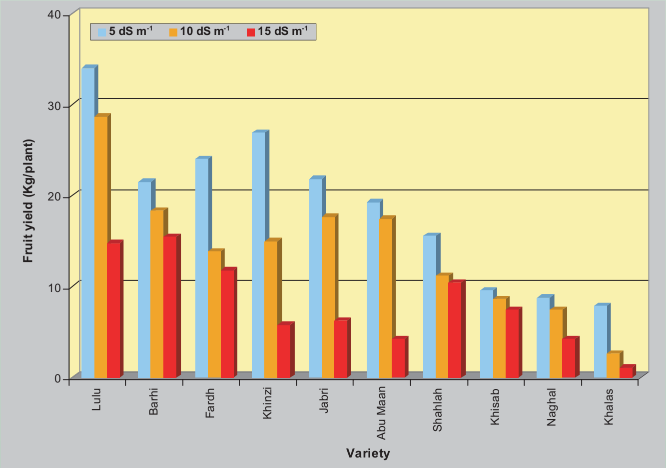



*Figure 38: Fruit yield of local date palm varieties at three salinity levels*

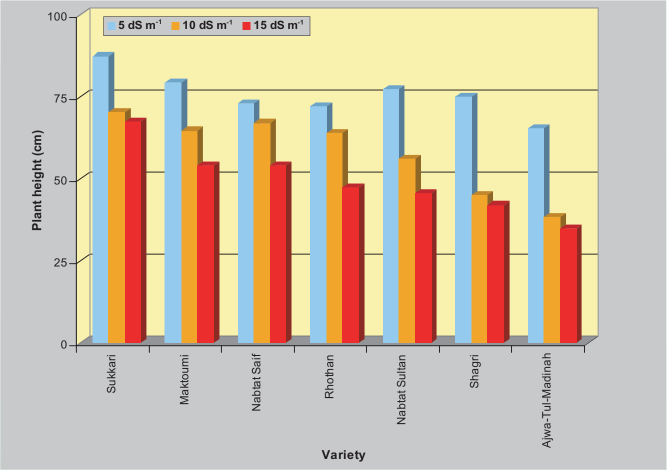



Figure 39: Plant height of imported date palm varieties at three salinity levels

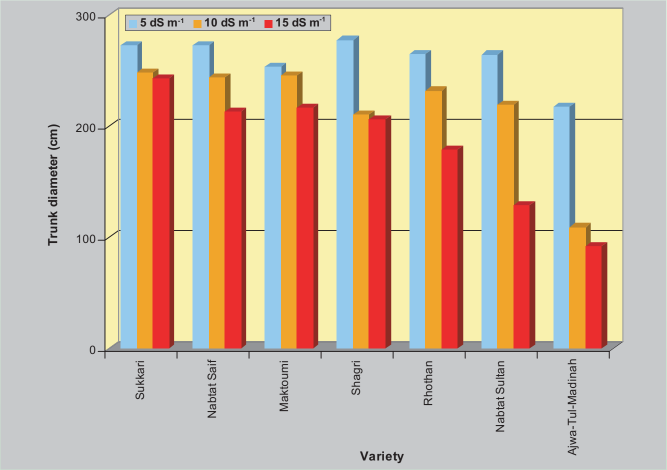



Figure 40: Trnuk diameter of imported date palm varieties at three salinity levels

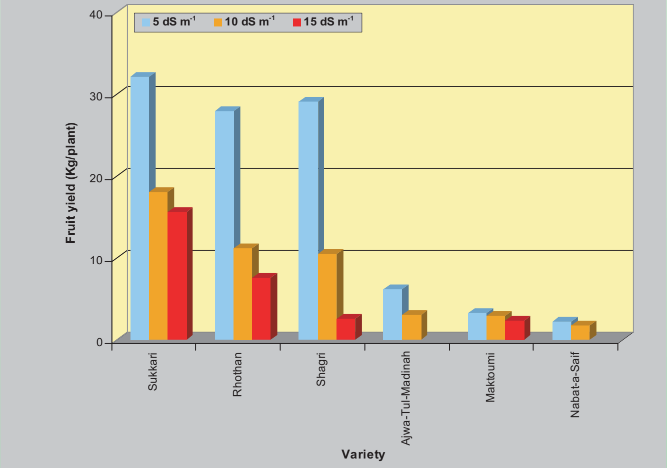


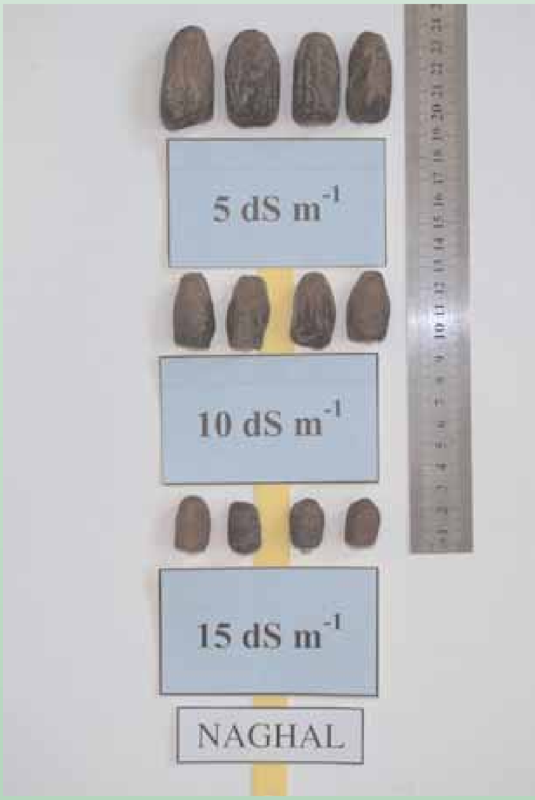

Figure 41: Fruit production of imported date palm varieties at three salinity levels

### Experiment I (local varieties)

- Plant height, trunk diameter and fruit yield declined with increased salinity
- Plant height varied from 65 to 127 cm with Lulu obtaining the maximum plant height, trunk diameter and fruit yield
- Fruit yield varied from 4 to 26 kg/plant

### Experiment II (imported varieties)

- Plant height varied from 46 to 75 cm
- Trunk diameter varied from 140 to 255 cm
- Fruit yield varied from 2 to 22 kg/plant
- Sukkari attained the maximum in each category




The effects of different salinity levels on date palm fruit quality

# Technical Program Services

## Soil and Water Testing Laboratory

Laboratory facilities were upgraded to undertake necessary soil and water analytical tests at ICBA Headquarters to avoid dependence on external laboratories and save financial resources. Focus was on salinity monitoring in various experimental fields and on the nutritional aspects of soil and water quality to help establish various salinity levels in irrigation water through blending. A total of 2,774 soil and 100 water samples were analyzed (Figure 42).

***2,774 soil and 100 water samples were analyzed***

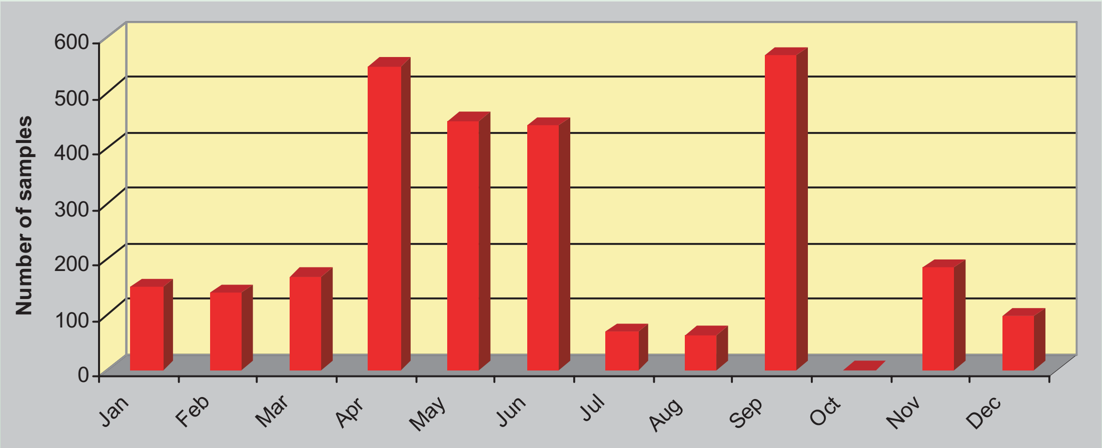



*Figure 42: Number of samples analyzed in 2007*

## Real Time Dynamic Automated Salinity Monitoring System

Salinity monitoring is essential for tracking periodic salinity changes in the root zone. ICBA installed a Real Time Dynamic Automated Salinity Monitoring System in a grass field in 2006. This system made it possible to log *in situ* soil salinity on an hourly basis using salinity sensors connected to a smart interface consisting of an integrated microprocessor that allows autonomous operation of the sensor and direct and dynamic monitoring of EC in dS $m^{-1}$ at 25 $^{o}$C. The system has attracted wide interest by trainees and visiting scientists.

*Visitors to ICBA observing the salinity datalogger*

# Communication, Networking and Information Management Program

# Communication, Networking and Information Management Program

## Objectives

- Establish both formal agreements such as memoranda of understanding and informal collaborations through individual contacts.
- Develop joint programs/projects for the delivery of biosalinity technology.
- Prepare and distribute information about biosalinity and maintain a network of communications with individuals and agencies with an interest in biosalinity.

*ICBA Director General Dr Shawki Barghouti shakes hands with Dr Macoumba Diouf, ISRA's Director General in the presence of Mr Fawzi AlSultan, ICBA Chairman of the BoD (middle) and Prof Faisal Taha Director of Technical Programs(left)*

## Memoranda of Understanding

Three Memoranda of Understanding (MOUs) were signed during 2007. These agreements establish links with a view to exchanging information and developing collaborative relationships for the delivery of technologies.

- Senegalese institute of Agricultural Research (ISRA): 25 May
- First AFG: 30 September
- EAD (Master Water Plan for Abu Dhabi): 28 October

## Partnerships

### Official Launching - Soil Survey for the Emirate of Abu Dhabi

On 17 January, ICBA jointly with EAD launched officially Soil Survey of Abu Dhabi Emirate project at a desert site (Al-Remah). The launching was attended by senior management and key staff from ICBA, EAD, GRM International, Ministry of Environment and Water, UAE University along with press reporters.

*HE Majid Al Mansouri (Secretary General, EAD) and ICBA Director General Dr Mohamad Al-Attar at the launching of the Soil Survey for Abu Dhabi Emirate*

## Bilateral Projects

During 2007, ICBA had ongoing joint projects in Bangladesh, Egypt, Jordan and the UAE (Table 19).

## Networking

### *Global Biosalinity Network (GBN)*

The web-based Global Biosaline Network (GBN) promotes collaboration between individuals involved in research and development on biosaline agriculture.

| Table 19: Joint projects 2007 | | | |
|---|---|---|---|
| **Organization** | **Project** | **Location** | **Duration** |
| **Bangladesh** | | | |
| - Bangladesh Agricultural Research Institute (BARI) | - Demonstration of biosaline agriculture in salt-affected areas in Bangladesh (PMS09) | Bangladesh | 2003-08 |
| **Egypt** | | | |
| - Desert Research Center (DRC) | - Introduction of salt-tolerant forage production systems to salt-affected lands in Sinai Peninsula in Egypt: A pilot demonstration project (PMS37) | Egypt | 2006-09 |
| **Jordan** | | | |
| - National Center for Agricultural Research and Extension (NCARE), Jordan | - Expanding date palm cultivation under saline conditions in Jordan (PMS23) | Jordan | 2003-08 |
| **United Arab Emirates** | | | |
| - Ministry of Environment and Water (MOEW) | - Investigation of elite date palm varieties for salt tolerance (PMS06) | ICBA | 2002-10 |
| - MOEW | - Application of biosaline agriculture in a demonstration farm in the northern Emirates (PMS05) | R'as al-Khaimah | Ongoing |

The ICBA website includes 15-20 pages of information covering the main program areas. In addition, an online registration form for GBN membership is available at **www.biosaline.org/join.cfm**. When a new member joins the network, his/her information is entered into temporary tables and new registrations are checked by designated personnel. The information is then uploaded to the GBN database.

GBN allows individuals to identify others with similar interests and to initiate contact with them. Interest in an interactive internet discussion forum facilitated by ICBA is keen, and the resources required to undertake such an activity are important considerations for 2007.

Because GBN is not facilitated, no statistics for hits and downloads are at present available from the website hosting service. Evaluation of the impact of GBN is therefore unavailable at present, although plans to improve this situation are under study for implementation in 2008.

GBN members (Table 20) are continually reminded that they can request information from the ICBA Librarian by email **library@biosaline.org.ae**.

### *Inter-Islamic Network on Biosaline Agriculture (INBA)*

INBA is a non-political, non-profit, independent, and autonomous body promoting biosaline agriculture under the auspices of the Organization of the Islamic Conference (OIC). OIC established INBA through its Ministerial Committee on Scientific and Technological Cooperation (COMSTECH) in 2002 (1422H).

The aims of INBA are:

- To establish a mechanism for coordinating research on biosaline agriculture among participating countries and organizations.
- To develop a database of scientists, non-governmental organizations (NGOs) and others involved in biosaline agriculture.
- To prepare a directory of scientists working on biosaline agriculture in the Islamic countries.

*Table 20: GBN membership data*

| Country | Members | Country | Members | Country | Members |
|---|---|---|---|---|---|
| Algeria | 5 | Indonesia | 1 | Qatar | 5 |
| Argentina | 2 | Iran | 36 | Russia | 1 |
| Australia | 25 | Iraq | 6 | Saudi Arabia | 15 |
| Austria | 1 | Italy | 3 | Senegal | 2 |
| Azerbaijan | 3 | Japan | 4 | Somalia | 1 |
| Bahrain | 3 | Jordan | 13 | South Africa | 5 |
| Bangladesh | 3 | Korea | 2 | Spain | 4 |
| Belarus | 1 | Kuwait | 6 | Sri Lanka | 2 |
| Belgium | 1 | Lebanon | 1 | Sudan | 15 |
| Bosnia | 1 | Libya | 4 | Sweden | 2 |
| Cameroon | 2 | Luxembourg | 1 | Syria | 9 |
| Canada | 13 | Malaysia | 2 | Tajikistan | 1 |
| Chile | 2 | Malta | 1 | The Netherlands | 8 |
| China | 7 | Mauritania | 1 | Trinidad and Tobago | 1 |
| Djibouti | 1 | Mexico | 1 | Tunisia | 14 |
| Dominican Republic | 1 | Morocco | 4 | Turkey | 4 |
| Egypt | 30 | Nepal | 1 | UAE | 51 |
| Eritrea | 3 | New Zealand | 3 | UK | 12 |
| France | 2 | Nigeria | 4 | USA | 21 |
| Germany | 9 | Oman | 12 | Uzbekistan | 3 |
| Ghana | 1 | Pakistan | 66 | Venezuela | 1 |
| Greece | 1 | Peru | 3 | Yemen | 6 |
| India | 75 | Philippines | 2 | | |
| **Total** | | | | | **552** |

- To train human resources in the field of biosaline agriculture among Muslim Ummah countries.
- To work with other international institutions and donors to strengthen the work on biosaline agriculture among Muslim countries.

INBA targets national, regional, and international institutions in developing and developed countries, and aid agencies, in particular those in OIC-member states. Network members 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 NGOs.


*INBA's web page within the ICBA website*

### *Achievements in 2007*

In collaboration with the FAO's global network on Salinization Prevention and Productive Use of Salt-affected Habitats (SPUSH), INBA organized the *First Expert Consultation on Advances in assessment and monitoring of salinization for managing salt-affected habitats*. The meeting, which took place 26-29 November, attracted participants from all over the world.

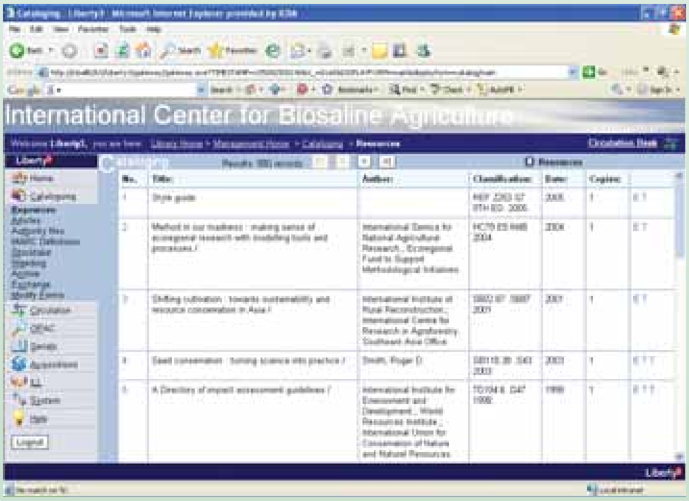
News and other updates on INBA and other Inter-Islamic Network activities are posted at INBA's web page within the ICBA website: **www.biosaline.org**. In addition, INBA news is published in the ICBA newsletter *Biosalinity News*.

### *Plans for 2008*

INBA will continue to work on its database, arrange seminars/workshops and negotiate proposals for bilateral collaborative projects.

## Information Management

Additional information resources have been acquired, and requests for information satisfied, to support the needs of ICBA staff and its partners. Information resources were catalogued, classified and promoted to all staff and ICBA partners.



*Liberty 3 catalogue*

The implementation of the new Liberty3 integrated library management system has been progressing well. More of the ICBA publications have been catalogued onto the new system and thus will be accessible to all via the Internet.

The Forage Database – a data collection tool developed as part of the *Saving freshwater resources with salt-tolerant forage production in marginal areas of West Asia and North Africa (PMS27)* – has been updated with details of more plants.

### *Client database*

A key tool for dissemination of information is a comprehensive and well-maintained stakeholder database. In early 2000, a contact database was developed and made accessible to all staff on the ICBA network. The database is used for targeted distribution of annual reports, newsletters and other ICBA communication activities. In 2003, the database was developed further to include alumni of ICBA capacity development activities, both their contact details and the details of their participation in related activities. This information provides the basic data for developing targeted communication products.

The database also records the details of visitors to the Center. The main issues discussed during these visits are added to the database for subsequent reference.

### *Image database*

The image database, which contains over 30,000 images relating to ICBA projects and activities, catalogued by topic and year, provide a useful resource for reports, publications and presentations.

*Former DG Dr Al-Attar with current DG Dr Barghouti at ICBA stand in the Environment Exhibition in Abu Dhabi*

### *Exhibitions*

- Environment, Abu Dhabi, January
- Federal Environment Authority, Al-Ain, February
- WETEX 2007, Dubai, March
- IDB Annual Governors' Meeting, Senegal, May
- CGIAR Annual Meeting, China, December

### *Publications*

- *ICBA Annual Report* 2006 (English and Arabic)
- *Biosalinity News* Vol 8 No 1 (English and Arabic)
- *Biosalinity News* Vol 8 No 2 (English and Arabic)
- *Biosalinity News* Vol 8 No 3 (English and Arabic)
- *Unique center with a unique mandate* (French)

Biosalinity News

Newsletter of the International Center for Biosaline Agriculture

APRIL 2007

New Director General assumes office

*ICBA's Biosalinity Newsletter*

### *Plans for 2008*

- Acquire information resources to support the needs of ICBA and its client base.
- Catalogue and classify information resources to ensure accessibility to all.
- Provide information as required to meet the specialized needs of ICBA.
- Promote ICBA's library resources.
- Compile library procedures manual.
- Renew access to specialized subject databases and journals.
- Implementation of Integrated Library Management System software.

## Journal articles, papers and book chapters

### *Journal articles and papers*

**Abdelfattah MA** and **Shahid SA**. 2007. A comparative characterization and classification of soils in Abu Dhabi coastal area in relation to arid and semi-arid conditions using USDA and FAO soil classification systems. Arid Land Research and Management 21:245-271.

**Indieka SA**, **Odee DW**, **Muluvi GM**, **Rao NK** and **Machuka J**. 2007. Regeneration of *Melia volkensii* Gürke (Meliaceae) through direct somatic embryogenesis. New Forestry 34: 73-81.

**Japakova UN**, **Orlovskiy N** and **Toderich KN**. Salts impacts on seed germination at early growth stages for some Central Asian halophytes. 2007. Uzbek Journal of Biology, No 2: 18-26 (in Russian).

**Japakova UN**, **Toderich KN** and **Khamraeva D**. 2007. Fruit morphology and anatomy of some species of genus *Salsola* (*Chenopodiaceae*). Uzbek Journal of Biology, No 3: 23-29 (in Russian).

**Omar SAS**, **Bhat NR**, **Shahid SA** and **Assem A**. 2006. Land and vegetation degradation caused by military activities: A case study of the Sabah Al-Ahmad nature reserve of Kuwait. European Journal of Scientific Research, 14(1): 146-158.

**Rao NK** and **Mohammed S**. 2007. Desert agriculture – Quest for new crops. Farming Outlook 6: 22-24.

**Rao NK**, **Sastry DVSSR** and **Reddy VG**. 2007. Seed maturity and longevity in sorghum. Seed Research 35: 117-120.

**Shahid SA**, **Abdelfattah MA** and **Wilson MA**. 2007. A unique anhydrite soil in the coastal sabkha of Abu Dhabi Emirate. Soil Survey Horizons 28(4):75-79.

**Shahid SA** and **Hasbini BA**. 2007. Optimization of modern irrigation for biosaline agriculture. Arabian Gulf Journal of Scientific Research, 25(1/2):59-66.

**Toderich KN**. 2007. Contemporary status of cover vegetation of Aydarkul-Arnasay-Tuzkan lake system and adjoining territories: strategies for rehabilitation and conservation. Proceedings of the International Conference on Environmental protection and sustainable management in Syrdarya River Basin, 30 Jul to 8 Aug 2007. Warsaw University, Warsaw, Poland: 32-39.

**Toderich KN** and **Ismail S**. 2007. Extent of salt-affected land in Central Asia: Biosaline Agriculture and utilization of the salt-affected resources. Proceedings of INBA/SPUSH/FAO Expert Consulting Meeting on Assessment, management and sustainable production under salt-affected environments, 26-29 Nov 2007, Dubai, UAE (in press).

**Toderich KN** and **Ismail S**. 2007. Plant Production on salt-affected soils in Central Asian Region. Annual Report of ICBA-CAC, Tashkent-Dubai: 78p.

**Toderich KN**, **Kuliev T**, **Suleimanov N**, **Ismail S**, **Kushiev H**, **Alimova G**, **Aralova D** and **Sattarov S**. 2007. Improving feed resources in the saline desert areas of Uzbekistan by introducing the strip-alley agropastoral cropping system. Proceedings of the International Conference on Conservation of Biodiversity, Gulistan State University: 34-38.

**Toderich KN**, **Massino IV**, **Ismail S**, **Khujanazarov AM**, **Rabbimov AR**, **Kuliev TA**, **Boboev H**, **Aralova DB** and **Usmanov S**. 2007. An analysis of opportunities and challenges for utilization of agriculture residues and livestock wastes in Uzbekistan. 2nd Regional Expert Consultation on the utilization of agricultural residues with special emphasis on utilization of agricultural residues as biofuel, 29 October to 1 November 2007, Cairo, Egypt.

**Toderich KN**, **Masseno IV**, **Rabimov A** and **Nurmetov D**. 2007. Prospects for introduction and cultivation of non-conventional halophytes and salt-tolerant crops under saline environments of Central Asian countries. ICARDA-Tashkent, 29p.

**Yunusov T** and **Toderich KN**, 2007. Biochemistry and contents of flavonoids in ground biomass of wild desert species of halophytes. Bulletin of National University of Uzbekistan. Tashkent: p: 1-45 (in Russian).

### *Book chapters*

**Shahid SA** and **Abdelfattah MA**. 2007. Soils of Abu Dhabi Emirate. Book Chapter in Terrestrial Environment of Abu Dhabi Emirate published by Environment Agency-Abu Dhabi (in Press).

**Toderich K**, **Black CC**, **Juylova E**, **Kozan O** and **Mukimov T**. 2007. C3/C4 plants in the vegetation of Central Asia, geographical distribution and environmental adaptation in relation to climate. In Lal R, Suleimenov M, Stewart B, Hansen D and Doraiswamy P, eds. Climate changes and terrestrial sequestration in Central Asia". Taylor & Francis/Balkema Publishers: pp. 33-65.

# Training, Workshops and Extension Program

# Training, Workshops and Extension Program

## Objectives

- Provide specialized courses in aspects of managing salinity for scientists and technicians.
- Organize seminars and meetings to exchange information on managing salinity.
- Identify priority areas that need to be addressed locally, regionally and internationally.

## Training Courses and Workshops

### *Vision and Strtegy Workshop*

**Date**: 5-6 February

**Venue**: Dubai, UAE

Participants of the Vision and Strategy Workshop

ICBA organized a Strategic Planning Meeting to discuss the Center's *Vision and Strategy Plan 2008-2010*. The meeting was the culmination of a process begun in early 2006, when three respected scientists were recruited to draft a Vision and Strategy Document. These scientists, each a well-known in agricultural research and development, worked closely with ICBA management and scientists in preparing the draft document.

With the assistance of ICBA staff, the team collated the outcomes of the meeting and the discussion groups to assemble a document entitled *New Horizons: ICBA's Strategic Plan 2008-2012*. This plan explains ICBA's expanded research agenda to include integrated water resources systems and marginal water quality. Importantly, the center's traditional mandate of biosaline agriculture will remain an integral part of the new Strategic Plan.

### *Training workshop on laboratory techniques in soils*

**Date**: 20-24 May

**Venue**: ICBA Headquarters

**Collaborator**: EAD

**Resources**: EAD, Core

Participants of the laboratory techniques workshop

In its efforts to build capacity of UAE nationals in soils, EAD and ICBA organized a 5-day training workshop. The training involved 12 UAE nationals and was aimed at improving their knowledge of laboratory analysis with specific reference to the soils of the UAE. The latest developments and improvements in soil analytical procedures were introduced through lectures, hands-on experience, laboratory sessions and field excursions.

### *Seminar on the Activities of the International Center for Biosaline Agriculture with special reference to Senegal*

**Date**: 26 May

**Venue**: Dakkar, Senegal

**Collaborators**: IDB, Senegalese Agricultural Research Institute (ISRA)

In collaboration with IDB and the Senegalese Agricultural Research Institute (ISRA), ICBA organized a seminar on the A*ctivities of the International Center for Biosaline Agriculture with special reference to Senegal* during the 32nd Governors' Meeting of the Islamic Development Bank in Dakkar, Senegal.

The seminar was attended by the Minister of Agriculture and Food Security, the Minister of Hydrographical Network in Senegal along with officials, scientists and researchers from IDB, ISRA and other local research institution in Senegal.

*ICBA's Seminar in Dakar, Senegal*

### *Training workshop on production and utilization of salt-tolerant forage crops/halophytes*

**Date**: 5-8 June

**Venue**: Samarkand, Uzbekistan

**Collaborators**: ICARDA; IWMI; and NARS of Kazakhstan, Tajikistan and Uzbekistan

**Resources**: ADB, OFID

The workshop, part of the ongoing ADB project (PMS35), was designed to benefit young researchers and farmers working on salt-tolerant and halophytic crop production, utilization, and livestock systems of the CAC region. The workshop was hosted by the Karakul Institute of Sheep Breeding and Desert Ecology (KSBDE), in Samarkand, Uzbekistan.

*Participants of the production and utilization of salt-tolerant forage crops at a farmer's field in Samarkand, Uzbekistan*

### *Workshop on Abu Dhabi Soil Information System (ADSIS) - Setting tools for decision makers*

**Date**: 26 July

**Venue**: ICBA Abu Dhabi Office

**Collaborators**: EAD, GRM International

**Resources**: EAD, GRM, Core

ADSIS is an essential component of the soil survey project, delivered in a GIS environment with functionality that provides users with an easy access to soil data on specific locations. ADSIS provides answers to questions concerning the availability of soil information and soil quality. The workshop's objective was to encourage discussion about the design and functionality of ADSIS.

### *Workshop on small-scale irrigation: Development of a regional research project for West Africa*

**Date**: 21-23 October

**Venue**: Dubai, UAE

**Collaborators**: IDB, Burkina Faso, Gambia, Mali, Mauritania, Niger and Senegal

**Resources**: IDB

Senior research directors from six West African countries met in Dubai to participate in a seminal meeting entitled *Workshop on small-scale irrigation: Development of a regional research project for West Africa*. The workshop was supported by the Islamic Development Bank.

Delegates from the six participating countries – Burkina Faso, Gambia, Mali, Mauritania, Niger and Senegal – discussed both technical and institutional problems involved in developing small-scale irrigation in this emerging region.

*Meeting of the Governors of the Arab Water Council*

### *Workshop on biosaline agriculture technologies for arid and semi-arid regions with reference to Africa*

**Date**: 27 October to 8 November

**Venue**: ICBA Headquarters

**Collaborators**: Governments of nine sub-Saharan African countries

**Resources**: Arab Bank for Economic Development in Africa (BADEA)

Fifteen representatives from nine sub-Saharan African countries (Angola, Botswana, Kenya, Lesotho, Mozambique, Senegal, Sierra Leone, Tanzania and Zimbabwe) participated in hands-on modules in both field and laboratory, and experienced field trips to UAE government research facilities.

*Participants from African countries during a field session at ICBA Headquarters*

### *Soil Survey Project stakeholders workshop*

**Date**: 29 October

**Venue**: Millennium Hotel, ICBA Abu Dhabi Office

**Collaborators**: EAD, GRM

**Resources**: EAD, Core

The workshop was attended by representatives of EAD, ICBA, GRM, MOEW, ADNOC, Abu Dhabi Municipality, the Forestry Department, members of the soil survey technical and steering committees and the media. The workshop provided key stakeholders with the opportunity to review the information developed during the extensive soil survey, and to identify the important issues to take into account when selecting an intensive survey area.

### *Workshop on the management of salt-affected soils and water for sustainable agriculture*

**Date**: 2-3 November

**Venue**: Rumais Experimental Station, Ministry of Agriculture (MA), Oman

**Collaborators**: Sultan Qaboos University (SQU), MA

**Resources**: MAF, SQU, Core

ICBA joined hands with SQU for an implementation of *Management of salt-affected soils and water for sustainable agriculture*. During the workshop, the project team made suggestions for future planning and the ICBA experience in managing salt-affected soils was presented. Soil sample collection from plots irrigated with drip irrigation was demonstrated.

*ICBA scientist interacting with participants of the workshop in an experimental field*

### *Expert consultation on advances in assessment and monitoring of salinization for managing salt-affected habitats*

**Date**: 26-29 November

**Venue**: ICBA Headquarters

**Collaborators**: The FAO's global network on Salinization Prevention and Productive Use of Salt-affected Habitats (SPUSH), INBA

**Resources**: FAO

Experts in various fields came from all over the world to read papers pertaining to the problems of salinity. Strategies were discussed on how best to streamline salinity assessment methodologies and transfer biosaline agriculture technologies to developing countries. The consultation was attended by 30 foreign experts from 27 countries. International organizations participating in the meeting included UNESCO, ICARDA and the OASE Foundation.

*Participants of the expert consultations workshop in the field*

### *Governors' Meeting of the Arab Water Council*

**DATE**: 9-10 December

**VENUE**: Dubai, UAE

**COLLABORATORS**: AWC, MOEW, EAD

At the third meeting of the Arab Water Council (AWC), held in Dubai, the Board of Governors took a major decision by formally selecting ICBA as the hosting institution of the Arab Water Academy in collaboration with the Environment Agency-Abu Dhabi (EAD).

The meeting, hosted jointly by the Ministry of Environment and Water (MOEW) of the UAE and ICBA, was attended by nearly 60 policymakers and stakeholders from the region and beyond. The Arab Water Academy addresses the daunting challenges posed by the deteriorating water supply throughout the Middle East and North Africa region.

*Meeting of the Governors of the Arab Water Council*

# Finance and Administration

# Finance and Administration

## Board of Directors

ICBA's Board of Directors (BoD) met twice during 2007: in May and in November.

## Administrative matters

The Finance and Administration Division made considerable achievements in 2007. These achievements were facilitated by a substantial increase in ICBA's operational budget. Considerable time and effort was spent in carrying out all pending maintenance and renovation work that had been postponed because of earlier budget limitations.

## Government Relations Office, Abu Dhabi

The Government Relations Office (GRO) in Abu Dhabi continued to play an important role in developing and enhancing the Center's relations with the Government and governmental agencies. GRO staff participated in several international conferences and exhibitions. The office continued to accommodate the GRM International staff working on the Soil Survey Project for Abu Dhabi.

## Information technology

The IT section made significant progress during 2007 by providing internet connectivity to all computer terminals in the training building.

## Insurance

ICBA's buildings, property and equipment were continued to be insured

*Mr Fawzi AlSultan chairs the Board of Directors meeting in May* throughout the year under AXA Insurance (Gulf) BSC. ICBA staff life insurance was provided by American Life Company (ALICO) and medical insurance under the group coverage of Goodhealth.

## Staffing

### *Departures*

1. Dr Mohammad Al-Attar, Director General, March
2. Ms Hiba Kamal Abdul Kareem, Administrative Assistant – Abu Dhabi Office, April
3. Ms Lina Al Cherkawi, Receptionist, August
4. Ms Diane Giessen, Administrative Assistant – Technical Programs, December
5. Ms Irene Galang, General Accountant, December

### *New staff*

1. Dr Shawki Barghouti, Director General, March
2. Mr Sahajad Elahi Ansari, General Maintenance Technician, May
3. Mr Sameen Gul, Driver, Director General's Office, May
4. Ms Alice Soliman, Administrative Assistant – Finance and Administration, July
5. Mr Tarek Sakran, Administrative Assistant – Abu Dhabi Office, July
6. Dr Ahmed Almasoum, Deputy Director General, September

### *Vacancies advertised*

1. Hydrologist
2. Receptionist
3. Human Resources Coordinator/Purchaser
4. General Accountant
5. Administrative Assistant-Technical Programs

## Budget and Expense Analysis

### *Audit Report*

The external auditors issued their unqualified audit report on the Center's financial statement for 2007. The audit was approved by the Board of Directors and the Board of Trustees.

### *Total budgeted and projected expense analysis*

- The External Auditors have issued their report on the Center's financial statement for the year 2006 which was approved by the Finance Committee for the IDB Executive Directors.

**Table 21: Core Budget Expenditure 2007 (USD)**

| Item | Approved budget | Actual expenses | Variance |
|---|---|---|---|
| Total salary, benefit and operating expenses | 4,268,250 | 4,090,754 | 177,496 |
| Capital expenditure | 331,750 | 285,952 | 45,798 |
| **Total core** | **4,600,000** | **4,376,706** | **223,294** |

- By the end of the year, the center incurred total expenses of USD 4,376,706 as compared to the approved total budget of USD 4,600,000, resulting in a favorable variance of USD 223,294 (Table 21).

### *Capital expenses*

Capital expenses in 2007 totaled USD 285,952 of a budget amount of USD 331,750. The favorable balance in capital was USD 45,798. The majority of the expenditures were for the enhancement of the center's computer system and server, laboratory equipment, farm machinery and infrastructure.

## Resource Mobilization

Total donor contribution for 2007 was USD 5,946,937.82 (Table 22).

*Table 22: Donor contributions for 2007 (USD)*

| Donor | Contribution (USD) |
|---|---|
| IDB | 4,600,000.00 |
| OPEC - Capacity Building (OFID) | 67,419.00 |
| EAD - Soil Survey Project | 174,456.52 |
| IFAD | 276,500.00 |
| COMSTECH | 7,961.05 |
| INBA Workshop (SPUSH) | 16,000.00 |
| ARAB FUND | 303,026.05 |
| IRRI | 22,500.00 |
| ADB | 24,714.90 |
| European Union (Biosafor) | 54,057.42 |
| FAO | 19,027.07 |
| Sheikh Hamdan Palace | 17,119.57 |
| Shell International | 40,199.73 |
| IDB/Small-scale Irrigation Workshop | 48,000.00 |
| AFG | 15,000.00 |
| BADEA | 124,000.00 |
| EAD-Water Master Plan | 136,956.52 |
| **Total** | **5,946,937.82** |


Center For Biosaline Agriculture
المركز الدولي للزراعة الملحية

# APPENDICES

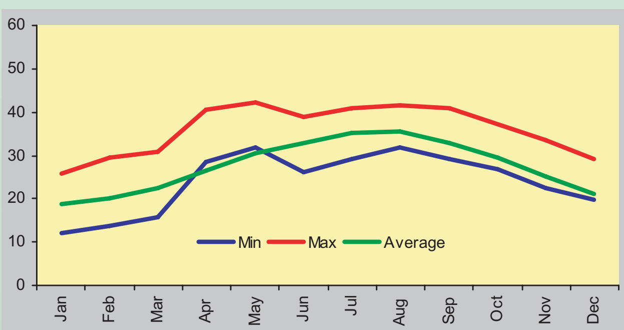
## Appendix 1: Summary of genebank holdings (*as of December 2007*)

| | Genus | Family | No. of accessions | No. of species | Used as |
|---|---|---|---|---|---|
| 1 | *Acacia* | Fabaceae | 1 | 1 | Forage/fuel |
| 2 | *Asparagus* | Liliaceae | 11 | 1 | Food |
| 3 | *Astragalus* | Fabaceae | 68 | 20 | Forage |
| 4 | *Atriplex* | Chenopodiaceae | 39 | 8 | Forage |
| 5 | *Avena* | Poaceae | 1 | 1 | Food/forage |
| 6 | *Beta* | Chenopodiaceae | 108 | 1 | Forage |
| 7 | *Brassica* | Brassicaceae | 200 | 2 | Oilseed/forage |
| 8 | *Cajanus* | Fabaceae | 137 | 1 | Forage/food |
| 9 | *Carthamus* | Asteraceae | 642 | 2 | Oilseed |
| 10 | *Cenchrus* | Poaceae | 713 | 1 | Forage |
| 11 | *Chenopodium* | Chenopodiaceae | 121 | 1 | Forage/food |
| 12 | *Chloris* | Poaceae | 116 | 1 | Forage |
| 13 | *Cicer* | Fabaceae | 10 | 1 | Food |
| 14 | *Coelachyrum* | Poaceae | 1 | 1 | Forage |
| 15 | *Cyamopsis* | Fabaceae | 99 | 1 | Food/forage |
| 16 | *Dichanthium* | Poaceae | 5 | 1 | Forage |
| 17 | *Echinochloa* | Poaceae | 145 | 10 | Forage |
| 18 | *Elymus* | Poaceae | 1 | 1 | Forage |
| 19 | *Haloxylon* | Chenopodiaceae | 1 | 1 | Forage |
| 20 | *Hedysarum* | Fabaceae | 16 | 5 | Forage |
| 21 | *Helianthus* | Asteraceae | 100 | 1 | Oilseed |
| 22 | *Hordeum* | Poaceae | 2088 | 1 | Food/forage |
| 23 | *Hymenocarpos* | Fabaceae | 2 | 1 | Forage |
| 24 | *Lablab* | Fabaceae | 16 | 1 | Forage |
| 25 | *Lasiurus* | Poaceae | 3 | 1 | Forage |
| 26 | *Lathyrus* | Fabaceae | 254 | 3 | Forage |
| 27 | *Leptochloa* | Poaceae | 4 | 2 | Forage |
| 28 | *Leucaena* | Fabaceae | 232 | 1 | Forage |
| 29 | *Lotus* | Fabaceae | 414 | 23 | Forage |
| 30 | *Lupinus* | Fabaceae | 276 | 16 | Forage |
| 31 | *Lycopersicon* | Solanaceae | 100 | 3 | Food |
| 32 | *Lymus* | Poaceae | 1 | 1 | Forage |
| 33 | *Maireana* | Chenopodiaceae | 1 | 1 | Forage |
| 34 | *Medicago* | Fabaceae | 577 | 38 | Forage |
| 35 | *Melilotus* | Fabaceae | 481 | 2 | Forage |
| 36 | *Ochthochloa* | Poaceae | 1 | 1 | Forage |
| 37 | *Panicum* | Poaceae | 20 | 1 | Forage |
| 38 | *Paspalum* | Poaceae | 2 | 1 | Forage |
| 39 | *Pennisetum* | Poaceae | 47 | 2 | Forage/food |
| 40 | *Prosopis* | Fabaceae | 1 | 1 | Forage/fuel |
| 41 | *Rhanterium* | Asteraceae | 2 | 1 | Forage |
| 42 | *Salicornia* | Chenopodiaceae | 3 | 1 | Food |
| 43 | *Scorpiurus* | Fabaceae | 27 | 1 | Forage |
| 44 | *Sesbania* | Fabaceae | 77 | 4 | Forage |
| 45 | *Simmondsia* | Simmondsiaceae | 29 | 1 | Oilseed |
| 46 | *Sorghum* | Poaceae | 319 | 1 | Forage/food |
| 47 | *Sporobolus* | Poaceae | 76 | 17 | Forage |
| 48 | *Stipagrostis* | Poaceae | 5 | 1 | Forage |
| 49 | *Trifolium* | Fabaceae | 225 | 17 | Forage |
| 50 | *Trigonella* | Fabaceae | 23 | 7 | Forage |
| 51 | *x Triticosecale* | Poaceae | 869 | 1 | Forage/food |
| 52 | *Triticum* | Poaceae | 58 | 1 | Forage/food |
| 53 | *Vicia* | Fabaceae | 11 | 1 | Forage |
| 54 | *Vigna* | Fabaceae | 431 | 2 | Forage/food |
| | | **Total** | **9210** | **218** | |

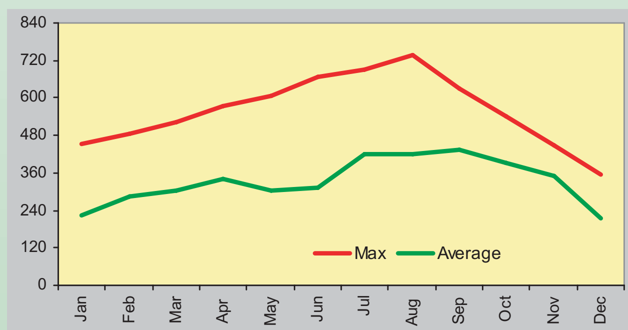
# Appendix 2: Summary of Weather Data, ICBA Station, 2007

| | Temperature (°C) | | | | Relative humidity (%) | | | | Sunshine | Solar radiation (W m-2) | | | | Windspeed (kph) | | | | Rainfall (mm) | | ETo (mm) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Min | Max | Avg | Med | Min | Max | Avg | Med | Hours | Min | Max | Avg | Med | Min | Max | Avg | Med | Total | Total to date | Monthly | Total to date |
| **Jan** | 12.2 | 25.8 | 18.9 | 19.0 | 38.0 | 81.2 | 64.0 | 59.6 | 8.3 | 288.0 | 451.0 | 224.5 | 337.8 | 2.9 | 18.7 | 16.6 | 10.8 | 12.2 | 12.2 | 121.1 | 68.9 |
| **Feb** | 13.8 | 29.5 | 20 | 21.7 | 30.0 | 90.3 | 62.5 | 60.2 | 8.4 | 281.0 | 485.0 | 282.7 | 383.9 | 1.1 | 16.8 | 17.2 | 9.0 | 44.5 | 56.7 | 137.0 | 258.1 |
| **Mar** | 15.7 | 31.0 | 22.5 | 23.4 | 20.0 | 77.4 | 60.5 | 48.7 | 9.2 | 272.0 | 521.0 | 304.2 | 412.6 | 2.5 | 19.1 | 16.9 | 10.8 | 6.7 | 63.4 | 194.7 | 452.8 |
| **Apr** | 28.4 | 40.7 | 26.4 | 34.6 | 15.0 | 54.3 | 54.0 | 34.7 | 9.9 | 286.0 | 572.0 | 340.1 | 456.1 | 6.5 | 26.5 | 19.9 | 16.5 | 9.4 | 72.8 | 147.4 | 600.2 |
| **May** | 32.0 | 42.2 | 30.65 | 37.1 | 20.0 | 61.8 | 50.0 | 40.9 | 11.1 | 321.0 | 607.0 | 304.5 | 455.7 | 4.3 | 23.4 | 21.2 | 13.9 | 0.0 | 72.8 | 172.6 | 772.8 |
| **Jun** | 26.0 | 39.0 | 32.95 | 32.5 | 24.0 | 81.9 | 55.0 | 53.0 | 11.5 | 342.0 | 666.0 | 312.7 | 489.4 | 4.7 | 24.5 | 18.9 | 14.6 | 0.0 | 72.8 | 151.9 | 924.7 |
| **Jul** | 29.0 | 40.9 | 35.1 | 35.0 | 20.0 | 84.5 | 54.0 | 52.3 | 11.5 | 335.0 | 692.0 | 422.1 | 557.1 | 5.5 | 22.9 | 15.0 | 14.2 | 0.0 | 72.8 | 193.8 | 1118.5 |
| **Aug** | 31.8 | 41.6 | 35.5 | 36.7 | 26.0 | 65.1 | 52.5 | 45.6 | 10.6 | 306.0 | 736.0 | 418.2 | 577.1 | 5.5 | 24.7 | 16.0 | 15.1 | 0.0 | 72.8 | 191.8 | 1310.3 |
| **Sep** | 29.0 | 40.8 | 32.95 | 34.9 | 23.0 | 77.7 | 56.0 | 50.4 | 10.3 | 298.0 | 629.0 | 431.8 | 530.4 | 5.1 | 21.8 | 15.0 | 13.5 | 0.0 | 72.8 | 188.6 | 1498.9 |
| **Oct** | 26.7 | 37.2 | 29.35 | 32.0 | 28.0 | 84.6 | 57.5 | 56.3 | 9.2 | 274.0 | 542.0 | 391.1 | 466.6 | 5.5 | 22.8 | 14.0 | 14.2 | 0.0 | 72.8 | 156.3 | 1655.2 |
| **Nov** | 22.5 | 33.4 | 25.05 | 28.0 | 27.0 | 78.8 | 60.0 | 52.9 | 8.6 | 265.0 | 450.0 | 350.2 | 400.1 | 5.8 | 19.8 | 14.0 | 12.8 | 0.0 | 72.8 | 127.7 | 1782.9 |
| **Dec** | 19.9 | 29.0 | 21.05 | 24.5 | 38.0 | 81.7 | 64.0 | 59.9 | 8.0 | 267.0 | 357.0 | 212.9 | 285.0 | 6.1 | 16.7 | 14.0 | 11.4 | 3.5 | 76.3 | 141.2 | 1924.1 |
| **Avg** | **23.9** | **35.9** | **27.5** | **29.9** | **25.8** | **76.6** | **57.5** | **51.2** | **9.7** | **294.6** | **559.0** | **332.9** | **446.0** | **4.6** | **21.5** | **16.6** | **13.1** | | | | |

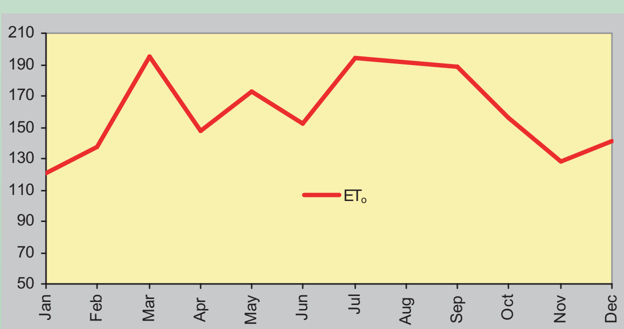
## Temperature (°C)




## Solar Radiation (W m-2)




## Evaporation (mm)




## ICBA weather station

## APPENDIX 3: CORE STAFF (*as of 31 December 2007*)

| | | |
|---|---|---|
| ***Office of the Director General*** | | |
| Dr Shawki M Barghouti | Jordan | Director General |
| Dr Ahmed Almasoum | UAE | Deputy Director General |
| Mr Ibrahim Bin Taher | UAE | Government Liaison Officer |
| Ms Badryh Bochi | Syria | Administrative Assistant |
| Mr Tarek Sakran | Egypt | Administrative Assistant – Abu Dhabi Office |
| Mr Akhtar Ali | India | Public Relations Assistant |
| Mr Sameen Gul | Pakistan | Driver |
| Mr Abdul Sathar Chedanguil | Pakistan | Office Helper – Abu Dhabi Office |
| ***Technical Programs*** | | |
| Prof Dr Faisal Taha | USA | Director |
| Dr Abdullah Dakheel | Syria | Field and Forage Crops Scientist |
| Dr Shoaib Ismail | Pakistan | Halophyte Agronomist |
| Dr Nurul Akhand | Canada | Irrigation Management Scientist |
| Dr NK Rao | India | Plant Genetic Resources Scientist |
| Dr Shabbir Shahid | Pakistan | Salinity Management Scientist |
| Mr Eric McGaw | USA | Communications Specialist |
| Dr Kristina Toderich | Romania | Plant Scientist – Tashkent |
| Ms Carla Mellor | Australia | Library Specialist |
| Dr Mahmoud Ali Abdelfattah | Egypt | Soil Scientist on Secondment |
| Dr Mohammed Shahid | Pakistan | Plant Genetic Laboratory Technician |
| Mr Abdul Qader Abdel Rahman | Iraq | Research Station Technician |
| Mr Wameedh Monther | Iraq | Farm Technician |
| Mr Basel Ahmad Al-Araj | Jordan | Irrigation Technician |
| Mr Ghulam Shabbir | Pakistan | Agronomy Technician |
| Mr Khalil ur-Rehman | Pakistan | Halophyte Laboratory Technician |
| Mr Khurshid Ahmad Mufti | Pakistan | Salinity Technician |
| Mr Ghazi Al Jabri | Syria | Communications Coordinator |
| Ms Loubna Baya | Morocco | Administrative Assistant |
| Mr Bassam Razzak | Pakistan | Field Assistant, Salinity Unit |
| Ms Baedaa Ismail Khalil | Iraq | Communications Assistant |
| Mr Mohammad Shah | Pakistan | Technical Support |
| Mr Balagurusamy Santhanakrishnan | India | Technical Support |
| Mr Saiful Islam Mehrab | Pakistan | Technical Support |
| ***Finance and Administration*** | | |
| Mr Ghassan El-Eid | Lebanon | IT and Network Supervisor |
| Mr Jamal Telmesani | Saudi Arabia | Facilities Supervisor |
| Mr Sahajad Elahi Ansari | India | General Maintenance Technician |
| Ms Irene D Galang | Philippines | General Accountant |
| Ms Alice Soliman | Philippines | Administrative Assistant |
| Mr Bilal Al Salim | Jordan | Administrator/Government Relations |
| Ms Lina Al Cherkawi | Syria | Receptionist |

## Appendix 4: Financial Statements

| Statement of activities (USD, as of 31 Dec 2007) | | | |
|---|---|---|---|
| | | 2006 | 2007 |
| **Revenues** | Grants - unrestricted | 3,459,150 | 4,083,038 |
| | Other income | 769,106 | 7,716 |
| | Total revenues | 4,228,256 | 4,090,754 |
| **Expenses** | Salaries | 1,475,331 | 1,625,609 |
| | Staff benefits | 952,405 | 1,188,744 |
| | Board expenses | 140,878 | 80,002 |
| | Supplies | 67,862 | 156,437 |
| | Contract services | 177,362 | 155,685 |
| | Travel | 127,671 | 94,429 |
| | Utilities | 107,897 | 129,292 |
| | Maintenance | 148,301 | 155,634 |
| | Depreciation | 304,838 | 367,007 |
| | Strategic plan | 700,852 | 142,242 |
| | Other expenses | 24,859 | (4,327) |
| | Total expenses | 4,228,256 | 4,090,754 |
| **Net income** | | - | - |

| Statement of financial position (USD, as of 31 Dec 2007) | | | |
|---|---|---|---|
| | | 2006 | 2007 |
| *Assets* | | | |
| **Current assets** | Bank balances and cash | 2,292,921 | 2,784,607 |
| | Grants receivable | - | - |
| | Accounts receivable - staff | 4,539 | 6,765 |
| | Prepaid housing allowance | 132,916 | 409,620 |
| | Prepaid expenses | 64,163 | 59,541 |
| | Sub-total | 2,494,539 | 3,260,533 |
| **Non-current assets** | Physical plant and equipment | 6,471,080 | 6,539,034 |
| **Total assets** | | **8,965,619** | **9,799,567** |
| *Liabilities and net assets* | | | |
| **Current liabilities** | Accounts payable | 186,731 | 87,916 |
| | Accrued expenses | 97,350 | 66,872 |
| | Research grants payable | 1,445,689 | 647,629 |
| | Sub-total | 1,729,770 | 802,417 |
| **Non-current liabilities** | Employee end-of-service benefits | 52,027 | 88,980 |
| **Total Liabilities** | | **1,781,797** | **891,397** |
| **Net Assets** | Unrestricted-unappropriated | 6,471,080 | 6,539,034 |
| | Unrestricted-appropriated | 22,612 | 1,269,680 |
| | Temporarily restricted (projects) | 690,130 | 1,099,457 |
| | Net income | 7,183,822 | 8,908,170 |
| **Total liabilities and net assets** | | **8,965,619** | **9,799,567** |

## Appendix 5: Acronyms and abbreviations

| | |
|---|---|
| ABAD | Agency for Barani Area Development |
| ADB | Asian Development Bank |
| ADF | acid detergent fiber |
| ADNOC | Abu Dhabi National Oil Company |
| AFESD | Arab Fund for Economic and Social Development |
| BADEA | Arab Bank for Economic Development in Africa |
| BARI | Bangladesh Agricultural Research Institute |
| CAC | Central Asia and the Caucasus |
| CAZRI | Central Arid Zone Research Institute (India) |
| CGIAR | Consultative Group on International Agricultural Research |
| CIMMYT | International Maize and Wheat Improvement Center |
| CITA | Unidad de Suelos y Riegos, Servicio de Investigacion Agroalimentaria |
| COMSTECH | Standing Committee on Scientific and Technological Cooperation (of the Organization of the Islamic Conference) |
| CSSRI | Central Soil Salinity Research Institute, Karnal, India |
| DRC | Desert Research Center (Egypt) |
| EAD | Environment Agency-Abu Dhabi |
| EU | European Union |
| FAO | Food and Agriculture Organization |
| GBN | Global Biosaline Network |
| GCC | Gulf Cooperation Council |
| GCSAR | General Commission for Scientific Agricultural Research (Syria) |
| IAEA | International Atomic Energy Agency |
| ICARDA | International Center for Agricultural Research in the Dry Areas |
| ICBA | International Center for Biosaline Agriculture |
| ICRISAT | International Crops Research Institute for the Semi-Arid Tropics |
| IDB | Islamic Development Bank |
| IFAD | International Fund for Agricultural Development |
| INBA | Inter-Islamic Network on Biosaline Agriculture |
| INRA | Institut National de la Recherche Agronomique (Morocco) |
| INRAN | Institut National de Recherches Agronomiques du Niger |
| IRRI | International Rice Research Institute |
| ISRA | Senegalese Agricultural Research Institute |
| IWMI | International Water Management Institute |
| KSBDE | Karakul Institute of Sheep Breeding and Desert Ecology (Uzbekistan) |
| MARDI | Malaysian Agriculture Research and Development Institute |
| MOEW | Ministry of Environment and Water (UAE) |
| MDG | Millennium Development Goal |
| MoU | Memorandum of understanding |
| NARS | National agricultural research system |
| NCARE | National Center for Agricultural Research and Extension (Jordan) |
| NDF | Neutral detergent fiber |
| NIAB | Nuclear Institute for Agriculture and Biology (Pakistan) |
| NGO | non-government organization |
| NPC | National Prawn Company (Saudi Arabia) |
| NSRC | National Salinity Research Council (Iran) |
| NIRS | near-infared spectrophotometer |
| OFID | OPEC Fund for International Development |
| OIC | Organization of the Islamic Conference |
| OASE/ODE | Organisation for Agriculture in Saline Environments/Ocean Desert Enterprises |
| OPEC | Organization of Petroleum Exporting Countries |
| PARC | Pakistan Agricultural Research Council |
| PFU | Project Facilitation Unit (Uzbekistan) |
| PDO | Petroleum Development Oman |
| QTL | quantitative trait locus |
| SBC | serial biological concentration |
| SPUSH | Salinization Prevention and Productive Use of Salt-Affected Habitats |
| SQU | Sultan Qaboos University, Oman |
| TAAS | Tajikistan Academy of Agricultural Sciences |
| UAE | United Arab Emirates |
| UAEU | United Arab Emirates University |
| UHOH | University of Hohenhein (Germany) |
| UoAF | University of Agriculture, Faisalabad |
| UU | Utrecht University (The Netherlands) |
| WANA | West Asia and North Africa |
| WUE | water use efficiency |

## International Center for Biosaline Agriculture

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## ICBA's major 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.

### 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 (a) financing development projects, with preference given to overall Arab development and to joint Arab projects; (b) encouraging the investment of private and public funds in Arab projects; and (c) providing technical assistance services for Arab economic and social development.

### OPEC Fund for International Development

The OPEC Fund for International Development (OFID) is a multilateral development finance institution established in 1976 by the member countries of the Organization of Petroleum Exporting Countries. OFID aims to promote cooperation between OPEC member countries and other developing countries as an expression of South-South solidarity and in particular to help the poorer, lower-income countries to pursue their social and economic advancement.

### The International Fund for Agricultural Development

The International Fund for Agricultural Development (IFAD) is a specialized international financial institution of the United Nations established in 1977. IFAD's mission is to enable poor rural people to overcome poverty.

### Ministry of Environment and Water, United Arab Emirates

The Ministry of Environment and Water (MOEW) endeavors to provide an optimal environment for the inhabitants of the United Arab Emirates through balanced and sustainable development.

### Environment Agency – Abu Dhabi

The Environment Agency – Abu Dhabi (EAD) is a governmental agency established in 1996 with an overall mission to protect and conserve the environment and promote sustainable development of Abu Dhabi Emirate, the capital of the United Arab Emirates.

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