Integrated Water Resource System

Marginal Quality Water Resources

Capacity Building and Knowledge-sharing

Annual Report Highlights 2008 (1428-29H)

International Center for Biosaline Agriculture

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.

Mandate

ICBA will help water-scarce countries improve the productivity, social equity and environmental sustainability of water use through an integrated water resource system approach, with special emphasis on the effective use of marginal quality water.

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(1428-29H)

International Center for Biosaline Agriculture

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Foreword

The regions where most of the Islamic Development Bank (IDB) member countries – the Middle East, Africa, and the West and Central Asia – are the most water-scarce areas on earth. Renewable water resources are nearly fully exploited, and non-renewable water resources, for example, ancient groundwater aquifers, are being rapidly depleted.

The rural poor suffer the most from water scarcity, because they lack political will and/or economic influence, or the financial resources to buy water services. When water supply, sanitation or irrigation services fail to reach them, their livelihoods and health are seriously compromised. However, it is not just the rural poor who suffer. The quality of life of most inhabitants in these regions is affected by the extent of the lack of water resources.

The IDB represents a major lifeline for many people, but especially the rural poor, in its member countries. The Bank's mission sums up its efforts to help people by alleviating poverty, promoting human development, science and technology, as well as encouraging its member countries to collaborate with each other and development partners.

One of the ways in which the Bank achieves its goals in science and technology transfer is through the work undertaken by organizations such as the International Center for Biosaline Agriculture (ICBA). The Bank has guided and supported the Center's mandate from its initial focus on applied research and technology development in saline irrigated agriculture, to the broader mandate commencing in 2008. This broader mandate is targeted at improving agricultural production within an integrated water resource system approach.

The significant achievements that the Center has made in the current year, the first of its new mandate and Strategic Plan, have clearly marked a new direction in addressing the widespread problems of water-scarcity. This in turn assists poverty alleviation.

The Bank has continued its support to ICBA and also encouraged member countries to collaborate in this highly effective partnership by allocating funds to support ICBA's research and development efforts.

A critical partner in contributing to the success of the Center's achievements is the host country, the United Arab Emirates. Without their ongoing support the considerable achievements of the Center in mitigating water-scarcity would not be possible.

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

MESSAGE

This year has been an exciting one for the International Center for Biosaline Agriculture (ICBA) as 2008 marked the first year of a new mandate charting a new direction. In formulating the new Strategic Plan to realize the mandate, it became clear that the new mandate brought with it many new opportunities to contribute to addressing the challenges of water scarcity.

The initial strategic plan had focused the Center on applied research and technology development in saline irrigated agriculture. After extensive consultation with our donors, partners and the scientific community, the Center has implemented in 2008 its new mandate:

> *ICBA will help water-scarce countries improve the productivity, social equity and environmental sustainability of water use through an integrated water resource system approach, with special emphasis on the effective use of marginal quality water.*

To achieve this broader mandate with its emphasis on improving agricultural production within an integrated water resource system approach, the Center has planned strategies focusing on three broad areas:

- Integrated Water Resource System
- Marginal Quality Water Resources
- Capacity Building and Knowledge-sharing.

The Center has used the knowledge and expertise gained from its past achievements to implement a considerable range of projects around the world, within the United Arab Emirates, and at its headquarters and research station in Dubai. Significant opportunities for capacity building and knowledge-sharing in the water sector will be possible with the establishment of the Arab Water Academy (AWA) under the patronage of His Highness Sheikh Hamdan bin Zayed Al-Nayhan, Deputy Prime Minister of the UAE and Chairman of the Environment Agency-Abu Dhabi (EAD). The AWA was established by the Arab Water Council and is co-hosted by both EAD and ICBA.

The high level of achievement in 2008 has only been possible due to the dedicated staff and the generous support and funding from the Islamic Development Bank, and other major donors, especially IFAD, AFESD, OFID, Ministry of Environment and Water (UAE), and the Environment Agency-Abu Dhabi. We would also like to thank our collaborators, the many project partners, who have contributed unstintingly to the successful implementation of projects.

Fawzi AlSultan
Chairman, Board of Directors

Dr Shawki Barghouti
Director General

Board of Trustees

The Islamic Development Bank (IDB) Board of Executive Directors is also the ICBA Board of Trustees (BoT).

The Chairman of the BoT is Dr Ahmad Mohamed Ali, President, IDB. The other 15 members of the BoT are all IDB Executive Directors, each with a specific geographic responsibility.

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The Board of Directors is a ten-member committee appointed by the Islamic Development Bank and the Center's host country, the United Arab Emirates. The Chair of the Committee is Mr Fawzi AlSultan. The Board of Directors is responsible to the Board of Trustees, which is chaired by the IDB President, Dr Ahmad Mohamed Ali.

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RESEARCH PROGRAMS

INTEGRATED WATER RESOURCE SYSTEM PROGRAM

MARGINAL QUALITY WATER RESOURCES PROGRAM

CAPACITY BUILDING AND KNOWLEDGE-SHARING PROGRAM

Research Programs

The year 2008 represented a milestone in the evolution of the research program with the commencement of the new *Strategic Plan 2008-2012*. The process involved extensive consultation with stakeholders including representatives from key donors, research and development partners and scientific researchers. It had begun in early 2006, when three international consultants were recruited to draft a *Vision and Strategy Document*. The team comprising Dr Shawki Barghouti, who in 2007 became ICBA's Director General; Dr David Seckler, the former Director General of the International Water Management Institute; and Dr Donald Suarez, Director of the US Department of Agriculture's Salinity Laboratory in Riverside, California, worked closely with ICBA management and scientists in preparing the draft document. This document underpinned the major *Strategic Planning Meeting* which occurred in early 2007 and had brought together key policymakers from all over the world. The outcomes of this extensive consultation and consideration resulted in the expanded research mandate outlined in the Strategic Plan 2008-2012 which was approved by ICBA's Board of Directors and the Board of Trustees. The research mandate is:

> *ICBA will help water-scarce countries improve the productivity, social equity and environmental sustainabililty of water use through an integrated water resource system approach, with special emphasis on the effective use of marginal quality water.*

The comprehensive ways in which ICBA are fulfilling this mandate are exemplified in the three programs of Integrated Water Resource Systems, Marginal Quality Water Resources, and Capacity Building and Knowledge-sharing outlined in the following pages. Projects in the first program are being implemented within the host country. The second program has been subdivided into three levels of operations: within the region, within the United Arab Emirates, and at ICBA's headquarters and research station in Dubai.

1. Integrated Water Resource System Program

As outlined in the *ICBA Strategic Plan 2008-2012*, the *Integrated Water Resource Systems* (IWRS) approach examines the system flows, balances, impacts, tradeoff, trends and dynamics in different water resources. IWRS considers all the different uses of a unit of water as it flows from river to farm and from city to sea. Furthermore, IWRS values water resources from multiple perspectives: the cost of extraction versus the value of crops, and the reconciliation of human and societal needs with environmental concerns.

The IWRS Program includes five priorities: assessment of trends in water resources, water allocation optimization, improvement of system/off-farm water use efficiency, environmental protection, sustainability and policy, and the sharing of water resources information and knowledge. Most projects undertaken by the ICBA research team satisfy single priorities; however, some major projects will meet multiple priorities.

Water Master Plan for Abu Dhabi Emirate

One major project in the IWRS Program is the *Abu Dhabi Water Master Plan* which focused on the priority of water allocation optimization. Conducted over the past year, the project was commissioned by the Environment Agency-Abu Dhabi (EAD) to identify and reconcile the different water usage needs of the agricultural, industrial and domestic sectors that currently compete for the available water supply. The Plan, which has been prepared by international and regional professionals guided by ICBA experts, comprises a strategic environmental assessment of the role of water in the Emirate, identification of strategies to resolve demand and supply aspects, and the ways to strengthen the structure and organization of the water sector in the Abu Dhabi Emirate. The main findings of the study were presented for discussion to a stakeholders' meeting in September with the report subsequently prepared.

Irrigation planning and management for United Arab Emirates

The need for another IWRS project, also undertaken in the United Arab Emirates (UAE), has arisen as current irrigation practices in the country are based on extensive water use. This practice, which

provides considerable socio-economic support to farmers, has been encouraged by large government subsidies. However, its development over the last 20 years has been largely unplanned and has not considered the suitability and availability of soil and water resources.

In the UAE, the main consumer of water is the agriculture sector (68%), followed by the domestic (23%) and industrial (9%) sectors. Groundwater, which has been used extensively for agriculture, has long been over-exploited, resulting in diminishing well yields and increasing water salinity. These constraints, exacerbated by increasing soil salinity, have resulted in rendering many areas incapable of supporting cultivation of anything other than a few salt-tolerant crops such as Rhodes grass and dates. Moreover, groundwater is being polluted by nitrates from the excessive use of chemical fertilizers in agricultural farming. In many aquifers, nitrate levels exceed drinking water health guidelines.

To resolve these challenges, the ICBA research team will assess existing irrigation water use in different agro-climatic zones within the UAE. They will recommend to decision makers and planners strategies for sustainable irrigation development by using marginal water such as reclaimed municipal wastewater, salt-tolerant crops (particularly those with a local advantage) and modern irrigation methods.

The new projects with the MOEW aim to improve irrigation practices and reduce salinity in the UAE

In 2008, locations at Dibba, Digdaga, Dhaid, Al Ain and Liwa, which represent three bioclimatic zones of the UAE, with 3 replications, have been selected. Field investigations in these fifteen sites are underway to collect information on crops, soils, water, irrigation technologies and potential efficiencies. The agro-meteorological data from nearby stations has been collected to compute reference evapotranspiration (ET_o).

2. Marginal Quality Water Resources Program

Driven by increasing demand and concomitant diminishing supply of water resources, the region and elsewhere in the world, are focusing on finding solutions. The second ICBA program, the Marginal Quality Water Resources (MQ) Program, revolves around a major solution: the use of marginal quality water. A resource formerly scorned, marginal quality water, which includes municipal and industrial wastewater as well as saline water, is seen as a key strategy to deal with the severe freshwater shortage. As research finds sustainable new uses for it, marginal quality water is transformed into a valuable resource.

To fully exploit multiple aspects of marginal quality water resources, ICBA has determined the following six MQ priorities: 1) assessment of marginal quality water resources quantity and quality; 2) on-farm integrated resource management of marginal quality waters; 3) the use of marginal quality water sources for production of specialty products; 4) methods and techniques for improving marginal quality water and its by-products for agriculture; 5) socio-economic aspects of marginal quality water; and 6) the environmental impact assessment.

ICBA has a pivotal part to play in the water sector by contributing to marginal quality water science and policy through its efforts in conducting research and development, discovering more effective ways to manage marginal quality water, and devising monitoring protocols and usage guidelines. The ICBA research team are collaborating in projects in three levels of operations: in over fifteen countries within the region, within the host country, and at its headquarters and station in Dubai.

Within the Region

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

Four of the Marginal Quality Water Resources priorities (MQ1, 2, 3 and 5) are being achieved in a major project involving seven countries (Jordan, Pakistan, Palestine, Oman, Syria, Tunisia and the United Arab Emirates). Started in late 2004 as a combined effort among ICBA, the International Fund for Agricultural Development (IFAD), the Arab Fund for Economic and Social Development (AFESD), the OPEC Fund for International Development (OFID), and the national agricultural research system (NARS) of participating countries. The desired outcome 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.

The project outcomes will be achieved through the introduction of salt-tolerant forages and management practices in the involved regions, and increasing feed availability for livestock by the sustainable use of under-utilized marginal quality irrigation water resources. These outcomes contribute to four Millennium Development Goals: 1) eradicating extreme poverty and hunger, 2) promoting gender equality and empowering women, 3) ensuring environment sustainability, and 4) developing a global partnership for development. A key determinant of the sustainability of the project outcome will be the emphasis on the capacity development of the collaborators; namely, the national agricultural research systems located in the seven countries.

Project Highlights

Much has been achieved in the last four years with the concerted efforts of all participants throughout all of the project stages: the initial planning; the introduction of new plant materials to the wide geographical region covered by the project; the establishment of demonstration and evaluation sites; the application of different soil, irrigation and crop management practices; the introduction of packages to the farmers; the development of methods for efficient on-farm production and utilization methods of salt-tolerant forages; and the scaling-up and capacity building of participants.

In 2008, each country identified the summer and winter forage crops most suited to their local environments. ICBA supplied seeds of high yielding, promising genotypes, thus enabling the establishment of seven demonstration sites. Training courses and field days were conducted to inform as many people as possible about the non-traditional forage production systems under marginal and poor growth conditions.

The success of the project is attested by the following:

- Considerable interest in the project has been generated in all project-member countries. Several countries included the outputs and activities in their national agenda and increased efforts to meet the demands of large numbers of farmers who expressed their interest in implementing the project outcomes on their farms.
- The expansion of project activities beyond the initial seven collaborating countries. Through bilateral and multilateral funded projects and their own resources, the project activities are being applied now in more than 15 countries in the Central Asia and WANA regions.

Pilot fields at NARS stations in Jordan (top), Syria (middle) and Oman (bottom)

- Demonstration farms of plant production and soil, and irrigation management under irrigation with marginal quality water have been established in each country.
- The representation of at least 10-15 farmers in each country in the project application and demonstration.
- The identification of ICBA-supplied integrated packages of annual and perennial forages, as well as management processes, that are suitable for each country's specific environmental conditions.
- Each country identified a high demand for seeds to address the gap in seed production as the top priority for the final year of the project.
- The scaling-up and application to more farms, the development of an efficient seed supply system, and additional extension is required to realize the full potential of the project.
- The formation of specialized working groups in various disciplines projects' implementation in the targeted countries in WANA region (soil and irrigation, forage production and utilization and socio-economics aspects related to the use of marginal waters).
- A strong emphasis on the practical aspects of forage production and utilization techniques that can be applied by the small scale resource poor farmers.
- Capacity building is a major focus of the project. Hundreds of technical staff and farmers, as well as project management staff, researchers and extension workers, benefited from the project activities which included group and individual training courses, field and farmers' days, and workshops.

Working in Jordan

Approximately 15% (11,400 ha) of the main irrigated areas of the Jordan Valley is saline, a fact affecting the livelihood of farmers.

An ICBA project team is researching important date palm varieties – a known salt-tolerant plant that is high value and in demand in Jordan – in two locations in the Jordan Valley. These trials will serve as demonstrations for farmers, extension workers and researchers. By investigating optimal agronomic practices for establishing date gardens on saline soils, ICBA will be able to help farmers identify the date palm varieties most adaptable to marginal quality water and poor soil of the Jordan Valley.

In 2008, fifteen date palm varieties were successfully established at the research sites of Al-Karamah and Ghor Safi in the Jordan Valley.

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

The Bangladesh Agricultural Research Institute (BARI), in collaboration with ICBA, conducted a four-year applied research and demonstration project in the Noakhali district using horticultural cash crops, such as tomato, chili, watermelon, cucumber and sunflower, and micro-irrigation techniques along with cultivation management practices.

Farmer's field in Bangladesh

Traditionally the land remains fallow in dry saline conditions during the winter months. However, the project used harvested rainwater as irrigation water to reduce soil salinity from 10-11 dS m^{-1} to 4.5-5.5 dS m^{-1}. Field experiments were conducted in 2008 to evaluate the performance of tomato and fodder crops such as cowpeas and barley under different irrigation management techniques in the coastal saline soils of Bangladesh during the dry season. Cultivation of the trialed crops was also found to be highly profitable demonstrating that such technology holds much promise for alleviating poverty and improving the livelihoods of poor rural farmers. A field day was also organized for local farmers.

The outcomes from this project are two-fold: the research findings will shape the design of a marginal water resource management project proposal by June 2009; and technologies will be demonstrated on a larger scale in selected saline areas with the production of horticultural and fodder crops. Possible sources of irrigation will include harvested rainwater and saline groundwater and/or river water.

Biosaline agroforestry: Remediation of saline wastelands through production of renewable energy, biomaterials and fodder in South Asia

Growing trees on saline wastelands provides the rare opportunity to produce timber, biomaterials and biomass for energy on land that is of little economic value for food production. Thus, one of the major drawbacks of the current production of biomass for energy – the competition with food production – is avoided. With growing populations, rising living standards and increasing pressures on fossil-fuel supplies worldwide, the demand for other resources is growing, providing new opportunities for the salinized marginal lands that can be found in many arid, semi-arid and even sub-humid areas in South-Asia and elsewhere.

Data collection from harvested trees for case study in Bangladesh

The BIOSAFOR (biosaline agroforestry) research is investigating the productive potential of biosaline agroforestry systems in such areas by the selection of trees, in order to optimize management and develop economically feasible value chains.

The project is unique as it integrates different disciplines based on case studies, experimental trials and modeling studies being undertaken by various research institutes, both in developed and developing countries. This is the first time that the knowledge from the different disciplines in agricultural research from plant breeding via GIS and policy making are combined in a research project on biosaline agriculture. The resultant database will be used to identify potential marginal areas locally and globally that could be used for biomass-for-energy.

During the year, ICBA led and coordinated two work packages to benefit Bangladesh, India, Pakistan and Spain by the evaluation of new salt-tolerant tree germplasms and provision of case studies of existing tree plantations on saline wastelands.

During 2008, the project partners have achieved a series of evaluation of salt-tolerant tree germplasms from Australia and partner countries, by using the ICBA-prepared evaluation guidelines or protocol to undertake the following steps:

- Measuring growth and biomass productivities over time to prepare the salinity response curves for the new tree species and accessions.
- Using shoot and total dry biomass data to establish the response curve against the soil salinity.
- Using piece-wise and sigmoidal regression equations to compute the threshold salinity levels and slopes from the curves.

In addition, different sites were selected for the case studies and soil and water analyses were completed for most of the sites. The harvest of selected trees for biomass estimations and analyses for wood properties has occurred and the results of the laboratory analysis for paper and pulp quality will be known in early 2009. To share research findings, ICBA organized a three-day regional workshop covering the project activities at ICBA for delegates from Bangladesh, India, Pakistan and the Netherlands.

Working in Bangladesh, Egypt and Iran

With funds provided by the CGIAR Challenge Program on Food and Water, ICBA collaborated with the Phillipines-based International Rice Research Institute (and the International Water Management Institute as coordinator) to conduct research to select fast growing, salt-tolerant crops that could grow during the short fallow period between successive rice crops in countries such as Bangladesh, Egypt and Iran.

This research partnership will result in identifying livestock fodder to grow during the fallow period, thus supplementing farm income.

In 2008, many genotypes of different crops (such as fodderbeet and canola) were evaluated by ICBA and several other partners in WANA for salt tolerance and yield potential. Based on the length of their life cycle, crops with higher yield in short duration can be selected for distribution among the farmers.

Combating resource degradation in Central Asia and the Caucasus

The long-term prosperity of another region, the Central Asia and the Caucasus (CAC) countries, will be assisted by two projects currently being implemented by ICBA. Due to past irrigation and drainage mismanagement, severe land degradation has resulted in the consequent deterioration of cash crops such as cotton. Serious efforts are needed not only to reclaim the land, but to have alternate crop production systems sustainable with the current land and water situation. Agricultural production has been severely affected in Central Asian countries such as Uzbekistan, Kazakhstan and Turkmenistan due to improper drainage systems, which have resulted in either very dry, or waterlogged, conditions. The latter has brought the soluble salts, both from land and water, to the upper soil surface, affecting the growth and crop productivity.

Scientist conducting millet trials

In the first project, the International Water Management Institute (IWMI) and the International Center for Agricultural Research in the Dry Areas (ICARDA), have partnered with ICBA to enable communities in the Aral Sea Basin to combat land and water resource degradation through the creation of 'Bright spots'. This collaborative research has introduced innovative and integrated methods of land, water and plants, to improve the agricultural production systems in Uzbekistan, Kazakhstan and Turkmenistan by introducing better genetic material and management strategies.

In the second project in the Central Asia and the Caucasus, ICBA and the Tajikistan Academy of Agricultural Sciences (TAAS) are collaborating to introduce agricultural technologies and on-farm management systems to improve degraded abandoned farms in Tajikistan. The management systems include both water management options and use of salt-tolerant conventional and non-conventional trees and crops for lowering the water table, and thus improving productivity and income from these wastelands.

Biofiltration of contaminated water from the oil industry in Oman

The oil industry produces a huge volume of contaminated water. In fact, it is roughly estimated that for each barrel of oil, six barrels of water containing a heavy load of hydrocarbons and heavy metals are pumped. This water is re-injected back into deep aquifers for disposal and to maintain the deep hydrological structures. However, continuous injection of this contaminated water leads to environmental problems. Also, many areas in the region are already impacted as this water flows from one region to another, thus contaminating the quality of all water supplies. Such pollution can cause health problems. Furthermore, high energy costs met by fossil fuels that represent a major burden for the oil industry and the environment are incurred in the disposal of the contaminated water.

A biofiltration (phytoremediation) approach was tried by ICBA at Nimr in Oman using Phragmites (reeds) to break the oil in water and absorb the heavy metals into the rooting system. The potential exists to use the cleaned water for many purposes such as growing trees for wood, pharmaceutical products, and/or carbon sequestration.

Working in Egypt

Dry regions such as Egypt suffer from a forage shortage due to environmental factors.

In recent times, the Egyptian government settled the Bedouins in the Sinai Peninsula by encouraging agriculture projects. However, Sinai agriculture depends mainly on ground water irrigation and limited rainfall – both deteriorated resources from overuse – and in the coastal and sub-coastal areas, from seawater intrusion. Consequently agricultural production has declined and some farms abandoned.

Both ICBA and its partner, the Egypt-based Desert Research Centre, are working together to share their extensive experience and crop production packages to adapt biosaline production systems in the salt-affected regions to enhance the livelihood of the Bedouin farmers.

In 2008, both summer and winter forage species were evaluated. Conventional forage production systems suitable for medium to high salinity levels (up to 15 dS m^{-1}) and non-conventional highly salt-tolerant forage production systems suitable for extremely high salinity levels (up to 25 dS m^{-1}) were identified. These production packages were transferred to the farmers for large scale evaluation and adoption.

Management of salt-affected soils and water for sustainable agriculture in Oman

One of the major threats in irrigated agriculture to crops is the development of soil salinity, which can occur when applying irrigation water of marginal quality without using proper leaching fraction to flush salts below the root zone. If proper management practices are not adopted, soil salinity levels are reached where the crop yield is significantly affected, or even, under extreme saline conditions, fails completely.

Realizing the threat of soil salinity to Oman's agriculture and economy, the Sultan Qaboos University (SQU), in collaboration with local Omani organizations (Ministry of Agriculture, Ministry of Regional Municipalities, Environment and Water Resources) and ICBA, initiated a project on the management of salt-affected soils in farms at the Agricultural Research Station of the Ministry of Agriculture in Rumais and in private farms along the Al-Batinah coastal strip.

Working in Saudi Arabia

At the National Prawn Company (NPC) located at the Red Sea coast about 450 km from Jeddah in the Kingdom of Saudi Arabia, sea water is used to produce shrimps in ponds, and then discharged into the sea.

Containing nutrients and organic matter, this water could be used to rehabilitate the inner shores of the natural lagoon area with the local mangrove (*Avicennia marina*), thus enabling the hatching of fish and shrimps, and improving the environment by safely disposing of highly mineralized water.

In 2008, ICBA provided 76,000 different mother plants of many salt-tolerant plants. Initially *Conocarpus* and *Salvadora* were planted as wind breaks followed by the planting of grasses in the sand dune areas. The mangrove seedlings were also hardened gradually in the shadehouse area and when fully acclimatized at 40 ppt seawater were transferred to concrete tanks (7m x 6m, height 30 cm) containing seawater to a height of 25 cm. After 5 months growth in the shade house, 10,000 mangrove seedlings were transferred to the lagoon for planting.

Within the Host Country

Plant genetic resources for marginal environments

Genetic diversity is critical to cope with the challenges to agricultural productivity from climate change and environmental degradation. ICBA, since its establishment, has been assembling the germplasm of plant species with proven or potential salinity tolerance to provide a source of genetic diversity to mitigate problems of salinity in agricultural production systems. In line with ICBA's new strategy to expand its work to include other marginal quality waters such as wastewater, the project, while continuing its focus on salinity, has started to acquire and conserve germplasm of high value species like vegetable, medicinal and ornamental plants to develop suitable production and management systems through applied research.

In the host country, overgrazing, desertification and urbanization resulting from rapid increase in human settlements is contributing to progressive loss of native species. Many of these species have great potential for economic exploitation, and because of their natural adaptation to the local environment, they are more appropriate for use in environmental greening, landscaping and habitat restoration programs than the exotic and introduced species. Therefore, ICBA researchers are undertaking expeditions to establish *ex situ* collections of the native plant species for their sustainable conservation and use.

ICBA acquires new crops to diversify its germplasm collection

Continued access to germplasm with adaptation to marginal environments for research and other users requires that adequate seed stocks are maintained. Most often, the seed samples obtained from the donors come in small quantities, therefore necessitating regeneration. Several of the economically important native plants are poor and unreliable seed producers or rely on vegetative means of reproduction. Availability of propagation material of these species in quantities sufficient for large-scale use often becomes a limitation. Therefore, development of suitable seed production and plant propagation techniques which are important to support any extension and developmental activities have also been key activities of the project.

Germplasm acquisition

A total of 205 germplasm accessions of four species namely sorghum, egg-lant, pepper and okra were assembled from various sources. With the new additions, the total number of accessions conserved in the genebank increased to 9,415 - representing 221 species from 134 countries. Additionally, 23 samples of several potentially salt-tolerant ornamental species were acquired to study their adaption and suitability for landscaping.

Figure 1: Germplasm collecting sites

Eight germplasm collecting missions were launched in the UAE and a total of 130 samples, representing 58 economically important taxa were collected, including some rare species like *Atriplex leucoclada*, *Desmostachya bipinnata*, *Alhagi graecorum*, *Indigofera arabica*, *I. oblongifolia* and *Moringa peregrina*. The areas covered and the collecting sites are shown in Figure 1.

A set of 63 samples of medicinal plants received from the Abu Dhabi Municipality was tested for germination and processed for conservation as a security backup.

Seed multiplication

A total of 426 accessions of 16 species, which included the newly acquired germplasm of mustard and *Sesbania* and the elite material of several other crops selected earlier for tolerance to salinity and/or high yield potential, was multiplied. All the crops were grown as winter crops and sown in mid-October or early November in 2007. Cowpea and guar were also grown as summer crops by sowing in late February 2008. Low salinity water irrigation (EC_w 2-3 dS m^{-1}) and standard agronomic practices were used to optimize seed yields. Mustard and sunflower accessions were covered in agryl cages to prevent cross pollination by insects. Seed yields were generally good, except in pigeonpea, mung bean and winter-grown guar. In guar, however, the yields from the summer grow-out were high, exceeding 150 g m^{-2} in several accessions.

Seed dissemination

A total of 534 seed samples of 14 species were distributed during the year. The total included 64 samples distributed to partners in the UAE and Oman, and 470 samples distributed to the Agronomy and Halophyte laboratories of ICBA for field trials.

Morpho-agronomic characterization

Morpho-agronomic characterization was undertaken of 100 mustard, 75 *Sesbania*, 20 quinoa, 40 buffel grass and 103 pigeonpea accessions. The number of traits studied was: 21 in mustard, 20 in buffel grass, 17 in *Sesbania*, 15 in quinoa, and 3 in pigeonpea, and included both vegetative and reproductive characteristics. Significant variation was observed in many of the traits in all crops.

Germplasm collecting in Hajar Mountain

Crop diversification

Among the new crops grown with low-salinity water (EC_w 2-3 dS m^{-1}), mustard, *Sesbania*, guar and asparagus showed excellent adaption and high yield potential.

Optimum planting time for new crops

Cowpea (23 accessions) and guar (45 accessions) were sown in spring (late February 2008) to assess the yield potential as summer crops, in comparison with the winter grow-out, sown in October/November 2007. In cowpea, vegetative growth was observed to be more or less similar,

but seed yields were marginally lower (except Tvu 9716 which produced 318 g m^{-2}) compared to the winter planting. In guar, on the other hand, when grown as a winter crop, vegetative growth was poor and the seed yields were very low, ranging between 9 and 44 g m^{-2}, with an average of 23 g m^{-2}. In the summer grow-out, growth was profuse and the seed yields were very high, ranging from 17 to 279 g m^{-2}, with an average of 122 g m^{-2}. The results indicate that while guar is suitable for cultivation only as a summer crop, cowpea can be grown both as a winter and summer crop.

Ornamental species for saline landscaping

Seeds of Northern Sea Oats (*Chasmanthium latifolium*), Beach Evening Primrose (*Camissonia cheiranthifolia* ssp. suffruticosa) and a salt-tolerant mixture of 12 species of wildflowers were sown to evaluate the performance at three levels of salinity (5, 10 and 15 dS m^{-1}). Among the 12 species of wildflowers, Sweet Alyssum (*Lobularia maritima*), Blanket Flower (*Gaillardia aristata*) and African Daisy (*Dimorphotheca aurantiaca*) germinated at all salinities. Other species in the salt-tolerant mixture failed to germinate in any of the three treatments. Beach Evening Primrose germinated and established well at all salinities. In sea oats, germination was intrinsically poor (4% under laboratory conditions) and no seedlings emerged under the field conditions.

Working with the UAE Ministry of Environment and Water

The UAE has seen an enormous increase in irrigated agriculture over the past 30 years; however, many farmers are still untrained in the specialized skills and techniques in agriculture production.

In collaboration with the UAE Ministry of Environment and Water, ICBA researchers selected a farm which had been previously abandoned due to high salinity damage and replaced conventional crops like barley, millet and sorghum with halophytes such as *Sporobolus*, *Distichlis* and *Atriplex*. *Cenchrus ciliaris* (buffel grass) and fodderbeet were among the few non-halophyte species that were able to sustain acceptable yield levels at high salinity level.

The model farm is used to demonstrate biosaline agriculture techniques to farmers to show how sustainable and profitable plant production on salt-affected farms can be achieved.

In vitro *screening for salinity tolerance*

Using the *in vitro* method with water agar substrate, 100 mustard, 76 *Sesbania* and 12 hyacinth bean accessions were screened for salinity tolerance at 10 dS m^{-1}. The substrate was prepared by dissolving agar powder in NaCl solutions. Agar dissolved in distilled water served as the control. The solutions were heated to dissolve the agar completely, allowed to cool partly and then poured into Petri dishes. Agar solution becomes a stiff jelly after cooling onto which seeds were placed to test for germination. Two replications each of 10 seeds were used and the percentage germination and radicle lengths were measured after 7 days of incubation at 25°C.

Mustard was found to be more tolerant to salinity than *Sesbania* and hyacinth bean. In mustard, several accessions germinated and produced normal seedlings at 10 dS m^{-1}. In *Sesbania* and hyacinth bean, germination was severely affected and only a small proportion of the accessions were found to be less sensitive to salinity.

Safe disposal of brine from the reverse osmosis desalination plants of agricultural farms in the United Arab Emirates

The lack of freshwater resources is a serious constraint to agricultural development in the UAE. In inland areas as well as the coastal zone, saline groundwater is available for use as feed water if proper brine concentrate management or disposal practices can be adopted. In fact, many reverse osmosis (RO) plants are used on agricultural farms for desalinating saline groundwater to produce date palm or cash crops in greenhouses or supply drinking water to animals and poultry. The RO product water usually contains low bacteria and nematodes, which help to control plant diseases. However, the main disadvantage of such technology is the lack of safe disposal practices that leads to groundwater pollution.

There are many options available for farmers to dispose of the RO product, for example:

- Discharge into the sea (which may pollute marine eco-systems and requires a pipeline, especially for inland farms).

- Land applications (may be appropriate for low concentrate) and spraying on golf courses or roads.
- Deep well injection (depending on the aquifer, preferably for highly saline aquifers).
- Evaporation ponds for drying and disposal in landfills or commercial uses.
- Controlled thermal evaporation (may be appropriate, but is energy-intensive).
- Growing highly salt-tolerant forages or fish farming if brine quality permits.

During the year, five locations (Dibba, Digdaga, Dhaid, Al Ain and Liwa), representing three bioclimatic zones of the UAE, were selected. Three RO units were chosen in each location. The study was advanced with the completion of a survey gathering technical and operational conditions of the RO units, and the commencement of monitoring of chemical composition of brine and disposal practices in all sites.

Soil survey for Abu Dhabi Emirate

A major project being conducted in Abu Dhabi will contribute greatly to the long-term prosperity of the Emirate. The soil survey, which is a collaboration between the Environment Agency - Abu Dhabi (EAD) and ICBA, commenced in April 2005 with implementation through an Australian contractor, GRM International.

Due to finish in October 2009, Phase 1 (an extensive soil survey of Abu Dhabi Emirate at scale 1:100,000) reached a major milestone in 2008 with the completion of the field work, draft report and soil and thematic maps. Currently underway is Phase 2, which is an intensive soil survey of 400,000 ha at scale 1:25,000 having the highest potential for irrigated agriculture.

The soil survey reports contain much basic information on Emirate soils. The Abu Dhabi Soil Information System (ADSIS) will facilitate the use of this data as a basis for making decisions about the management and reclamation of soils for agriculture purposes, in planning land uses for urban and suburban areas, and in determining the needs for other uses, such as forestry, range management, wildlife, and recreation, thus impacting on long-term resource planning and development throughout the Emirate.

Soil and Thematic Maps

In 2008, all extensive soil survey maps have been completed at different scales and published as drafts in A0, A1 & A3 sizes by ICBA, EAD and GRM International.

Laboratory characterization of soil samples and soil samples archive

To date, a total of 400 soil samples completely (more than 65 parameters per sample) and 900 soil samples partially (3-4 parameters per sample) have been analyzed for physical, chemical, engineering, fertility, mineralogical and soil water aspects. The results will provide comprehensive soil analysis for thematic maps on the suitability and resources of materials. All samples are stored in the Soil Sampling Archive.

Soil salinity map of upper 50 cm soil layer in the Abu Dhabi Emirate

Phase 2 Intensive survey areas

Phase 2

Field Survey Work

The ICBA/EAD team together with GRM International selected four areas for the intensive survey (phase 2 - intensive soil survey of 400,000 ha area having potential for irrigated agriculture at scale 1:25,000). Routine field work in Madinat Zayed, Gayyathi and Sila has been completed with the description of 111 typical profiles. The work is progressing in Abu Dhabi and Eastern Regions.

Soil Samples Archive

The Soil Samples Archive will be a significant repository of soil samples stored for long term accessibility. To date, more than 1500 soil samples have been archived and the information (GPS, sample ID, soil map sheet number, soil name, depth of sample and date of collection) has been entered into the soil database.

Soil Information System

The Abu Dhabi Soil Information System (ADSIS) provides operational tools enabling the soil survey teams to conduct the survey. It also enables users to store, retrieve, and view soil property and characteristics data and generate maps, thus facilitating additional data interpretation to assist with land use planning.

Significant progress has been made in developing ADSIS, which now contains all of the Phase 1 soil data (22,800 sites) and most of the Phase 2 data.

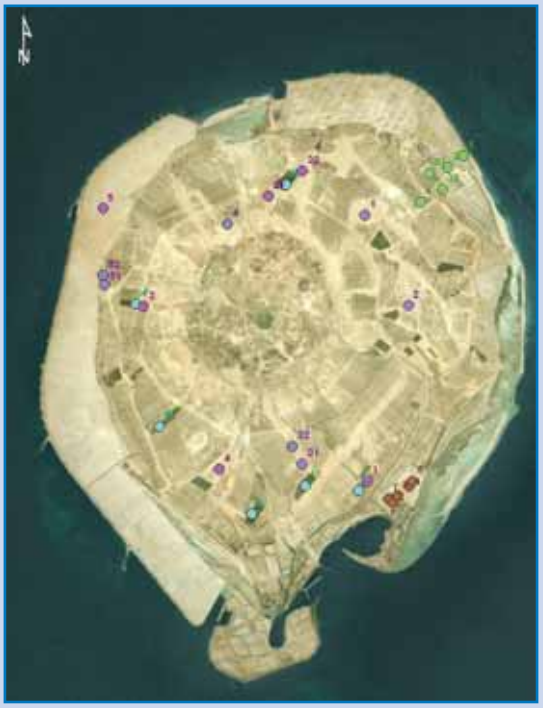
Project reports

The draft Phase 1 report and all soil and thematic maps have been completed and reviewed by the ICBA/EAD Project Technical Support Team. The report is being reviewed by GRM International with completion due in January 2009. Other ancillary reports (deep drilling, infiltration, permeability, and statistical assessment) have been finalized.

The Project Technical Committee chaired by Prof Dr Faisal Taha (ICBA Director Technical Programs) has approved two GRM Progress Reports (Phase 2 Intensive Survey).

Eco-environmental development of Sir Bani Yas Island, Abu Dhabi

Sir Bani Yas Island (SBYI) is about eight km off the coast of the western region of Abu Dhabi. The island was originally home to Arabia's largest wildlife reserve. Spanning over 87 square kilometers, the reserve was established by the late ruler and founder of the United Arab Emirates, Sheikh Zayed Bin Sultan Al Nahyan. Thanks to two decades of intensive conservation work and ecological investment, it is now home to thousands of large free-roaming animals, including antelopes and gazelles and over 2.5 million trees and plants. The herd of Oryx on the island is the largest in the world. A bird sanctuary as well as a wildlife reserve, SBYI showcases nature through activities such as adventure safaris, bird watching, mountain biking and hiking.



Sir Bani Yas Island showing demonstration farm (bright green), golf course (brown), woodland extension (purple), proposed pastures (pink), and existing pastures (turquoise)

Recognizing ICBA's expertise in managing the marginal water quality environment, the Tourist Development and Investment Company Abu Dhabi (TDIC) engaged ICBA for two projects.

For the first project, ICBA and TDIC senior staff visited the site to assess the land, water and climatic conditions and extent of salinity variation, and identified:

1. Demonstration areas for introduction and evaluation of salt-tolerant trees, shrubs and grasses under different salinity levels and irrigation methods.
2. An area suitable for development of a desert-type, less intensive landscaping system near the golf course, using salt-tolerant plants.

The purpose of the second project was to conduct a reconnaissance study and soil analysis of the Island, and

advise TDIC of the most appropriate ways to manage the soil resources to support multiple purposes such as pastures, forestry, and wildlife.

This project involved detailed soil sampling and analyses for the final improvement of existing pastures and woodland production as well as its assessment of suitability for proposed new sites. Indicators, such as morphological, physical, chemical, and fertility, were determined to evaluate the impact of present site management by analyzing ninety soil samples at the ICBA Central Analytical Lab. The research findings of the soil study revealed great differences in soil properties within short distances. A more comprehensive soil study is essential to determine the nature of soil resources and how these could be best utilized.

Evaluation and introduction of innovative technologies and practices for improvement of landscaping in Abu Dhabi Emirate

The landscaping sector has expanded rapidly in Abu Dhabi due to cultural reasons and the desire to improve the quality of life in the Emirate. However, many of these landscaping projects have been at the expense of the scarce fresh water resources that are needed for other important water sectors, such as domestic or industrial. With the increase in water demand in coming years, the current landscaping activities need to be re-evaluated along with the available water resources. Alternatively, marginal water could be used to sustain these projects.

The two broad aspects that need to be considered include the evaluation of the current landscaping areas in Abu Dhabi (mainly from the perspective of water use); and the improvement of existing plantation methods, plant species, irrigation methods and use of alternative water resources, without affecting the aesthetic value of the green areas. Another consideration would be to look into the possibilities of developing and sustaining these landscaping projects that are water-use efficient and/or can be managed through marginal water resources (including treated waste water, brackish/saline ground water and sea water). Furthermore, the project should also identify new and improvised irrigation systems that are sustainable, cost effective and water-use efficient for new landscaping projects. The identification of native and naturalized plant species for landscaping will help in the introduction of species that are well adapted to the dry conditions of Abu Dhabi.

Establishment of pilot scale forage halophyte production system for Arabian Oryx and Sand Gazelle in the Umm al Zammoul Protected Area in Abu Dhabi Emirate

The purpose of this proposal is to present a well structured program to establish a halophyte production system using very high-salinity water in the Umm al Zammoul Protected Area for feeding the re-introduced Arabian Oryx and Gazelles. Located in the south east corner of the eastern region of the Emirate of Abu Dhabi, Umm al Zammoul is one of few remaining areas where undisturbed gravel plains, sand dunes and inland sabkhas still prevail. It is envisaged that initially a total of 20 ha will be used for establishment of halophyte production system in the sabkha areas and those that have high salinity ground water.

In 2008, ICBA and EAD senior staff visited the site to assess the land, water and climatic conditions of the area. Possible areas were selected for project consideration. Based on soil and water data generated and the presence of native halophytes, a proposal was submitted to the Environment Agency - Abu Dhabi (EAD). However, the proposal was later postponed by EAD until fresh water facilities are available for the animals to be introduced into the region.

At the ICBA Research Station

The International Center for Biosaline Agriculture (ICBA) is located twenty three kilometers from Dubai in the United Arab Emirates. Thanks to the host country, ICBA has available a total area of 100 hectares; however, 65 ha of mainly 2-5 meter high sandy hummocks have been left undeveloped for the protection and rehabilitation of natural ecosystems common in the area.

Fully developed for research with field salinity controls available up to the plot level, the remaining 35 ha are divided into 14 blocks, 2.5 ha each. The extent of land and availability research facilities enables ICBA to undertake research at its headquarters in a climate similar to many of its project collaborators.

Enhancing crop-livestock productivity in regions affected by marginal water quality using conventional and non-conventional forages

Marginal quality water and poor soil conditions in arid and semi-arid regions pose a real challenge to irrigated agriculture. It is estimated that more than 50 per cent of the irrigated lands in these areas are affected to some degree from salinization and that millions of hectares of agricultural land have been abandoned because of salinity hazards. Reclamation, drainage, and improved irrigation practices might reduce the severity and spread of salinization in some regions, but costs of these practices are generally prohibitive. Agricultural scientists are focusing resources to develop sustainable, integrated methods that can effectively be utilized for crop production in salt-hit lands.

Non-conventional salt-tolerant crop species

Sporobolus virginicus* and *Distichlis spicata

Sporobolus virginicus and *Distichlis spicata* were selected for research due to their proven salinity tolerance, nutritional value, and suitability for mechanical harvesting - aspects important for economical, large-scale production. These species have been used to investigate the potential use of poor quality saline water in the forage production system and to assess the effect of its long-term use on soil and ground water qualities.

Three harvests of both *Sporobolus virginicus* and *Distichlis spicata* have been completed in 2008. Total field dry matter production of *Sporobolus virginicus* ranged between 17.8 to 32.5 t ha^{-1} at each harvest (over all treatments) and 21.5 to 26.5 t ha^{-1} at different salinity levels. Total field dry matter production of *Distichlis spicata* ranged between 12.9 to 33.6 t ha^{-1} at each harvest and 16.5 to 25.1 t ha^{-1} at different salinity levels. Total annual field dry matter yield reached 72.8 t ha^{-1} in *S. virginicus* and 61.9 t ha^{-1} in *D. spicata*. Both the species showed significant dependence of dry matter production over the season, with the yield being highest in summer (June) harvests. *S. virginicus* produced highest dry matter at medium salinity level, although the difference between medium and high salinity levels was not significant. The dry matter yield of *D. spicata* was highest at high salinity level than at low salinity level.

Mechanical harvest and baling of non-conventional grasses field

Results so far indicate that these grasses can successfully be utilized for sustainable fodder production systems and environment protection using poor quality saline water for irrigation.

Atriplex

Atriplex is valued as a high-protein animal feed as it is one of the most salt-tolerant crops able to withstand harsh growing conditions like marginal quality irrigation water and poor quality soils. However, it contains high concentration of mineral salts, so it must be fed as a mixture with other grass and/or shrubs to provide a balanced ration. The research will assess the fodder quality in response to saline irrigation and fertilizer treatments, and determine its effect on the animal health when fed alone or in combination with other fodders.

The 2008 research results showed that *A. lentiformis* produced the highest fodder compared with *A. nummularia* and *A. halimus*. The yield was increased with an increase in planting density, green fodder yield of *A. lentiformis* reached nearly 25.9 t ha^{-1}, *A. nummularia* 16.2 t ha^{-1} and *A. halimus* 14.7 t ha^{-1}. Maximum yield of 52 t ha^{-1} was obtained at minimum irrigation application (ET_0). *A. nummularia* produced maximum yield at medium irrigation level ($ET_{1.5}$).

Atriplex is an excellent choice for fodder production using marginal quality saline water in problem soils where the grower has limitations for crop selection.

Conventional salt-tolerant crop species

Pearl millet and sorghum

Both pearl millet and sorghum are among moderately salt-tolerant crops. Both crops are important for the subsistence of people and livestock of Asia and Africa regions.

All the field grown plants were irrigated with low, medium and high salinity water (5,10 15 dS m^{-1}). Two genotypes were used to test the effect of multiple harvesting and plant density on fodder production under three salinity levels. Plant densities treatments were standard (16 plants m^{-2}), medium (20 plants m^{-2}) and high (27 plants m^{-2}).

Dry matter production of pearl millet genotypes varied between 9.5 t ha^{-1} and 25.8 t ha^{-1}. Dry matter production of sorghum genotypes varied between 9.9 t ha^{-1} and 22.3 t ha^{-1}. Genotypes of both pearl millet and sorghum maintained acceptable yields across higher salinity levels.

Dry matter yield at low and medium planting density levels (16, 20, 27 plants m^2) was not significantly different. However, yield at high density was significantly higher than low and medium densities. Yield of sorghum variety ICSV93046 was similar across all planting densities. These findings indicate that both pearl millet and sorghum genotypes have the potential to sustain competition among plants and produce higher forage yields at higher density levels.

Barley

Barley (*Hordeum vulgare*) is one of the most salt-tolerant and fourth most important cereal crops in the world due to its multi-purpose use for both human consumption and animal feed. ICBA, in collaboration with ICARDA, is working on the improvement of salt tolerance among barley germplasm.

Sixty-four barley genotypes including 3 commercial checks were evaluated under field conditions at three salinity levels (EC 5, 10 and 15 dS m^{-1}). Most of the genotypes maintained high yields over higher salinity levels. Dry matter yield varied between 8.1 to 1.3 t ha^{-1}. Only one commercial check could outyield the genotypes. Genotype CHK-55 had a similar yield as the top yielding commercial variety.

Triticale

Triticale (*Triticale hexaploide* Lart.) is a hybrid of wheat and rye. Most *Triticales* that are agronomically desirable and breed true have resulted from several cycles of improvement. *Triticale* is an important feed and forage crop for cattle, swine and poultry and can be used as an alternate for corn and soybean. The forage yield and quality of *Triticale* is comparable to barley and oat. Recently, farmers are growing peas with spring *triticale* for silage. However, comprehensive information on yield potential and performance of *Triticale* is scanty.

In 2008, out of 836 accessions, 150 accessions were selected for screening at three salinity levels in the pots. Data were collected for dry matter, plant height, number of tillers, head length and seed yield. Dry matter yield varied between 13.9 to 32.4 g per plant and grain yield varied between 0.2 to 9.9 g per plant. One accession did not produce seeds possibly due to the unsuitable environmental conditions of the UAE.

Alfalfa

Eight genotypes were selected for field evaluation. Dry matter production varied between 6.9 and 17.2 t ha^{-1}. The variety from Pakistan produced the highest average dry matter (17.2 t ha^{-1}) over all salinity levels.

Some of the genotypes showed high yield potential under high salinity levels, with genotypes showing wide genetic variability for growth and yield from sensitive to tolerant levels. The yield was higher in spring cuttings than summer cuts.

Fodder beet and brassicas

Fodder beet and rape/brassica are important winter forage crops with multiple advantages including fast growth, easy seed production and growth at low temperature. Both crops show considerable salt and frost tolerance and therefore are recommended as alternatives for winter fodder crops. Brassicas are high in protein and dry matter digestibility at 85 to 95%, which contrasts well with alfalfa at 70%, and increase the availability of certain minerals.

Brassica genotypes showed wide range of genetic variability for all the measured variables. Green forage yield of the genotypes varied between 15.4 t ha^{-1} and 83.9 t ha^{-1}. Ames 24222 produced the highest green forage over all the salinity levels with dry matter production from 4.8 t ha^{-1} to 13.7 t ha^{-1}.

Accessions showed better results compared with the commercial hybrids in term of green forage as well as dry matter production. Only two commercial hybrids (E144 and 98D) of Chinese origin were among the ten high yielding genotypes.

Buffel grass

Cenchrus ciliaris (Buffel grass) is an important forage grass native to the Arabian Peninsula. It is moderately salt-tolerant and can be grown under poor soil and water conditions.

The present field study was started in 2006. Forty accessions were selected from previous pot screening of more than 950 accessions at ICBA and planted under field conditions for long term evaluation. Salinity of irrigation water was maintained at three levels (8, 16 and 24 dS m^{-1}). Three cuts have been completed so far in 2008. Mean dry matter production varied between 25.8 to 4.4 t ha^{-1}. Grif-1639 produced the highest dry matter.

***Sesbania*, cowpea, guar, quinoa and sunflower**

The seeds of a large number of *Sesbania* (65), guar (45), quinoa (40) and sunflower (98) accessions from the Plant Genetic Resources Section of ICBA were screened for the selection of best performing genotypes. *Sesbania*, guar, quinoa and sunflower were planted in pots at three (5, 10 and 15 dS m^{-1}) salinity levels.

Salinity affected the growth of all the crops, however, many genotypes showed high yield across the salinity levels used. There was wide genetic variability among the germplasm tested.

Sesbania

The genus *Sesbania* includes important annual and perennial species, which are grown as nutritious forage for animals and fuel. An additional benefit over other forage trees and shrubs is their rapid early growth rates, and outstanding ability to grow under waterlogged environments. However, more research is required to determine appropriate management technology for maximum production of edible material under poor conditions.

In 2008, ICBA's research showed the average dry matter yield of *Sesbania* genotypes varied widely between 6.1-360 g per plant. Two accessions of species *Sesbania bispinosa* did not survive. *Sesbania sesban* ILRI ID no

15368 produced the highest dry matter 360.3 g per plant. Dry matter yield of ten best performing genotypes varied from 84.5-360.3 g per plant. Dry matter yield varied from 19.3-96.5 g per plant across the salinities.

Guar

Guar (*Cyamopsis tetragonoloba* L. Taub) is a drought-tolerant annual legume grown for multiple uses ranging from products for human consumption, feed for cattle and as a green manure crop. World demand for guar has increased in recent years leading to introduction of the crop in several countries.

Experiments in 2008 indicated that dry matter yield of guar accessions varied between 1.1-31.5 g per plant. Eight accessions could not either germinate or become established and died. Accession 263893 produced the highest dry matter compared with the lowest dry matter yield of 1.1 g per plant for the accession 158125.

Quinoa

Quinoa (*Chenopodium quinoa* Willd.) is an important food and fodder crop with great potential as it is highly nutritious and resistant to drought, frost, and salinity. The protein quality and quantity in quinoa seed is often superior to those of more common cereal grains. It is used to make flour, soup, breakfast cereal, and alcohol. Quinoa leaves are frequently eaten as a leafy vegetable, like spinach. Quinoa grain has lower sodium content and is higher in calcium, phosphorus, magnesium, potassium, iron, copper, manganese, and zinc than wheat, barley or corn.

Research in 2008 showed that dry matter yield varied between 1.5-24.2 g per plant among the accessions across all the salinity levels. Accession Ames 13737 produced the highest dry matter compared with the lowest dry matter of 1.5 g per plant by Ames13750. Grain yield varied from 0.3-12.9 g per plant among all the accessions across all the salinity levels. Ames 13731 produced the highest grain yield (12.9 g per plant), whereas PI478408 produced the lowest grain yield of only 0.3 g per plant. Accession PI510537 did not produce grains.

Sunflower

Sunflower (*Helianthus annuus* L.) is an important oil seed crop after soybean and palms. Sunflower oil is generally considered premium oil 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 feeding. 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. Nutritional quality of sunflower silage is often higher than corn but lower than alfalfa hay.

During the year sunflower accessions showed a very wide range of seed yield among the accessions which varied from 0.1-43.4 g per plant across the salinity levels. Accession PI343807 produced the highest seed yield (43.4 g per plant); whereas accession 599759 produced the lowest seed yield only 0.1 g per plant. Seed index (weight of 100 seeds) was also spread widely among the accessions. Seed index varied between 0.7-11.2 g per 100 seeds. Accession PI 432518 produced the heaviest seeds compared with PI 343801 producing the lightest seeds. Some accessions did not produce seeds.

Growing conventional and non-conventional crops at ICBA Research Station

Investigation of elite date palm varieties for salt tolerance

The date palm shows a wide range of genetic diversity in the Arabian Peninsula. Productivity and sustainability of agro-ecosystem needs continuous inclusion of new germplasm and adjustments in the existing management strategies to meet the ever-changing production priorities. It is therefore extremely important to develop high yielding, tolerant date palm varieties and improve crop management techniques to maintain optimal functioning of the agro-production system and survival of the plants under stress environments. Information on the salt tolerance of date palm is scanty and limited studies have been conducted to evaluate salinity tolerance; hence research is critical to further the knowledge of this important plant in the Middle East.

Given these facts, long-term research to develop high yielding, salt-tolerant date palm varieties and improve crop management techniques for date palm imported from the Kingdom of Saudi Arabia and available locally within the United Arab Emirates has been started at ICBA. The purposes of the research are to evaluate salt tolerance among the elite date palm varieties in the Arabian Peninsula, and assess the impact of long-term use of marginal quality irrigation on soil properties, date palm growth, productivity and fruit quality.

ICBA's research has determined that the extent of growth variance between high and low salinity is up to 30%. However, some of the varieties have the ability to show a consistent and stable growth across the salinity levels applied. Among local varieties, Lulu, Abu-Maan, Barhai, Khisab and Khinizi show the highest salt tolerance and maintained high plant growth and yield at high salinity levels. Among the imported varieties, Sukkari, Maktoumi, Nabtat Saif and Shagri are identified as promising in terms of growth and fruit yield in the United Arab Emirates climate, whereas Ajwa-tul-Madinah, another imported variety, showed medium adaptation to the experimental conditions and showed minimum growth and yield.

ICBA research has shown that date palms show tolerance to medium (10 dS m^{-1}) and high (15 dS m^{-1}) salinity levels in terms of growth and fruit yield, are able to maintain promising growth and yield even after many years of irrigation with poor quality water, and that high quality fruit production is possible using marginal quality water with informed management practices.

Date palm fruiting under saline conditions

Growing plants with seawater: propagation and development of **Distichlis spicata** *var. Yensen-4a (NyPa Forage)*

Coastal areas have little potential for landscaping and other agricultural uses due to the high salinity of seawater and aerial salt spray. However, such areas could potentially grow economical crops or landscaping plants for coastal rehabilitation or seawater agriculture using brackish and saline water for irrigation.

Among the few halophytes, NyPa grass (*Distichlis spicata* var.Yensen 4a), developed by NyPa International and marketed internationally as NyPa Forage, could potentially be grown with sea water.

ICBA evaluated NyPa Forage under a range of salinity conditions, including seawater irrigation, and optimize productivity through management practices. Successful results would indicate opportunities for coastal areas and contribute to the development of models for efficient use of marginal water and identification of viable systems for seawater based agriculture.

In 2008, NyPa grass grown at different salinity (15, 25 and 40 dS m^{-1}) and irrigation treatments (ET_0 x1, ET_0 x1.25 and ET_0 x1.5) demonstrated higher biomass at 25 dS m^{-1}. The results from three harvests showed a maximum biomass of 37 t ha^{-1} at ET_0 x 1.5. Sodium sulphate treatment increased dry biomass at 6 and 12 mM at dS m^{-1}, approximately 39 t ha^{-1}. Soil salinity (EC_e) remained lower than the salinity of irrigation water (EC_{iw}). At higher salinity levels, EC_e increased from winter to peak summer season.

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

A number of wild species native to the region has been tested in other parts of the world and re-introduced into the region as highly drought and/or salt-tolerant lines/accessions. With the increasing pressure on all types of water resources in the UAE, high water consuming plants for forage/fodder and other uses need to be replaced by water-efficient ones.

ICBA has taken the lead in collecting local germplasms from different parts of the country. As part of its collaboration with the Ministry of Environment and Water (MoEW), ICBA is conducting research on two salt-tolerant grasses, the indigenous cultivar of *Lasiurus scindicus* and an introduced African variety of *Cenchrus ciliaris*, to study the responses of the test grass species to different levels of saline irrigation water, and to evaluate the growth, dry matter yield and nutritive value of these species.

Initial results showed better adaptability, growth and biomass of these two species under saline conditions. Different management strategies were introduced to optimize the productivity of these grasses.

The key feature of the trial in 2008 is the biomass productivity of both these grasses harvested at every two months interval. Total dry biomass from the six harvests showed a total productivity of 90.50-94.55 t ha^{-1} for *C. ciliaris* and 62.54-73.02 t ha^{-1} for *L. scindicus*, for the three salinity treatments.

L. scindicus showed a reduction with an increase in salinity, and at 15 dS m^{-1} showed a reduction of 14.3% as compared to 5 dS m^{-1} salinity level. *C. ciliaris* on the other hand showed non-significant differences between all the salinity treatments.

Agroforestry trial using Acacia ampliceps, Sporobolus arabicus *and* Paspalum vaginatum *at different salinity levels*

The agroforestry system is an integrated approach to deal with different crops (or production systems) in a unit to complement each other. In general, a tree species is alternated with crops and/or other shrubs/forbs. These types of system benefit the different components, mainly through better nutrient and water management.

Acacia ampliceps is one of the most successful plant species tried in many partner countries, from Central Asia to North Africa. The plant fixes atmospheric nitrogen, provides forage/fodder for animals, and is also a source for bio-energy. The plant provides a favourable environment conducive for under-storeyed plants.

ICBA initiated a trial using *A. ampliceps* with two other salt-tolerant grass species, *Sporobolus arabicus* and *Paspalum vaginatum*, to evaluate the responses of salinity treatments and fertilizers on growth and productivity of the test plants, and the potential of mixed forage of grasses and trees for the animals.

In comparing the results over the last two years, the difference in percentages between non-fertilizer and fertilizer treatments (at all salinity levels) were minimal for both the grasses. In the case of *S. arabicus*, the increase in dry biomass were 5.42 to 6.29% for 10 to 30 dS m^{-1} salinity levels respectively, for non-fertilized plots

Agroforestry system at ICBA Station

as compared to fertilized treatments. For *P. vaginatum*, the differences were 5.32 to 7.25% for the same salinity range and fertilizer treatments. The data confirms the hypothesis that tree species can fix atmospheric nitrogen even under salinity conditions and leach the nitrogen in the soil, thus enabling other crops to be grown.

For *Acacia ampliceps*, an increase in biomass (both shoot and leaf) was observed after four years of the trial for non-fertilized trees as compared to fertilized plots. Comparative data for 2007 and 2008 shows that overall biomass (harvested at 1.5 m from ground level) increased progressively over time. A sharp reduction in the total biomass at 20 and 30 dS m^{-1} is due to woodier stem rather than tender stem and leaves (that is used as fodder). For the leaf and stem biomass, the differences were relatively lesser both at 20 and 30 dS m^{-1}.

Soil salinity was monitored as a consequence of long-term application of saline water. Results showed that average soil salinity (EC_e) at 0-75 cm soil depth varied from 5.4-9.6 at 10 dS m^{-1} irrigated water salinity; 8.2-10.8 at 20 dS m^{-1}; and 11.1-12.17 at 30 dS m^{-1}. At lower soil depth (75-150 cm), the overall EC_e values were slightly higher than that of 0-75 cm at all salinity and fertilizer treatments, reaching a maximum of EC_e 16.25 dS m^{-1} when irrigated with 30 dS m^{-1}.

Evaluation of the First AFG treated salt water for crop and forage production

First AFG, an USA-based private company, claim that their salt water treatment plant can be safely used for crop production without any negative salt related growth restrictions. ICBA started field experiments to evaluate the effect of treated water effect on crop and forages production in comparison with untreated water from the same water source.

In 2008, field experiments were conducted at ICBA research station for evaluating the treated water during the winter seasons in 2007 and 2008. The soil at the research site is within the range of very slight salinity (EC_e varied from 2.4 to 2.8 dS m^{-1}) at 0-120 cm depth with no sodicity problem. The soil reaction (pHs), however, at 0-120 cm depth is moderately alkaline (i.e. 7.9-8.4).

Three varieties of barley were tested in subplots sized 3.33 x 12 m in winter 2007. The size of each plot for each water treatment was 10 x 12 m, with buffer spacing of 4 m maintained between the plots. The spacing between the rows and plants was 50 and 25 cm respectively. Field experiments included three water treatments (i.e. treated water from day zero, groundwater after establishment with low saline water and low salinity water) with three replications on a complete randomized block design. The electrical conductivity (EC) of feed water to the treatment plant and groundwater was 20 dS m^{-1}, and that of low salinity was approximately 3 dS m^{-1}. The irrigation water was applied by drippers at a rate of 4 L per hour. The total water use was 520 mm for the growing season.

Both groundwater and treated water reduced barley growth and yield parameters in comparison with low salinity water. The parameter values for the treated water were lower than those obtained with groundwater. This could be due to the fact that groundwater was applied after initial plant establishment using low salinity water. Analysis of variance (ANOVA), showed highly significant differences between treatments for tiller number and, 100-seed weight and yield (g m^{-2}). The differences between treatments were not significant for plant height, spike length, and number of grains per spike. Differences between varieties and treatments were not statistically significant.

In a recent pot experiment with okra (*Abelmoschus esculentus*) in the ICBA greenhouse, one plant out of six was germinated with treated water and showed stunted growth (on average about 41% less plant height than low salinity treatment) after 5 weeks of seeding. There was no germination of okra seeds with groundwater treatment.

Experiment set up at ICBA

In the winter of 2008, seeds of three varieties of sunflower were planted using three replications in a complete randomized block design. Groundwater with electrical conductivity of EC_w = 20 dS m^{-1} is being used as feed water for the treatment plant. The treatments include (i) treated water, (ii) groundwater (EC_w = 20 dS m^{-1}), (iii) mixed water (EC_w = 10 dS m^{-1}), and (iv) low salinity water (EC_w = 3 dS m^{-1}). Irrigation water is being applied using drip method. The discharge of emitters is 4 L per hour.

The seed germination in the treated, groundwater, mixed water and low salinity water treatments was 72, 63, 94 and 92 percent, respectively. The average plant height, one month after sowing, was 6.7, 7.2, 16.9 and 19.8 cm for the treated, groundwater, mixed water and low salinity water treatments respectively. Final results of this experiment will be reported in 2009.

Research support: Soil mapping of ICBA research station

Throughout the world, national and international research centers conducting agricultural research have usually undertaken detailed soil mapping of their research sites using internationally recognized soil classification systems. It is recognized that the value of the site is impacted by the extent to which the site is representative of the agro-ecological conditions of the surrounding environment. However, once the soil information is documented, these sites gain more creditability as the location for the application of research and the transfer of technology and expertise.

In 2008, ICBA has commenced a detailed soil mapping of the ICBA research station in Dubai, in order to be able to use different soil units for agricultural experimentation and develop different land uses and management strategies. Furthermore, the use at ICBA of the internationally recognized soil classification, the soil report and a geo-referenced soil map will assure the scientific community of, among other things, the merit of ICBA's soil research, capacity building and knowledge-sharing.

Research support: ICBA Central Analytical Laboratory (CAL)

Since the inception of ICBA in 1999, the ICBA Soil and Water Testing Laboratory has provided an essential service analyzing soil and water samples for ICBA and external agencies such as the Environment Agency-Abu Dhabi, GRM International Australia and Tourism Development and Investment Company of Abu Dhabi.

To enhance ICBA's scientific capability to continue to provide these services and meet the additional demands of the expanded mandate, the laboratory facilities have been upgraded. The Soil and Water Testing Laboratory has now been renamed as the Central Analytical Laboratory to reflect this broader role.

ICBA Central Analytical Laboratory

3. Capacity Building and Knowledge-sharing Program

Arab Water Academy

Under the patronage of His Highness Sheikh Hamdan bin Zayed Al-Nahyan, Deputy Prime Minister of the UAE and Chairman of Environment Agency-Abu Dhabi (EAD), the Arab Water Academy (AWA), an institution established by the Arab Water Council (AWC) and co-hosted by both EAD and ICBA, was launched in July 2008.

The AWA's mission is to transform the governance and management of water in the Arab region by encouraging change to happen within organizations through executive leadership education, mentoring and coaching. The focus on 'thinking holistically' about water parallels ICBA's new mandate and emphasis on integrated water resource systems. The AWA will significantly enhance opportunities for capacity building and knowledge-sharing in the water sector when it delivers programs in the coming year.

Training workshop in Libya

ICBA organized a regional training workshop on *Biosaline agriculture technologies for the Arab Region* in Misratah, Libya on January 6-10, 2008. The workshop, the first in a series requested by the League of Arab States, was organized in cooperation with Libya's Environment General Authority (EGA) and the Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD). The workshop was sponsored by the United Nations Environment Programme, the OPEC Fund for International Development and the League of Arab States. The course was attended by 20 participants from Bahrain, Kuwait, Libya, Mauritania, Morocco, Oman, Sudan, Syria and Tunisia.

Workshop on socio-economic aspects of adoption of production and utilization of salt-tolerant forages in selected countries in WANA

The workshop was organized jointly with National Center for Agricultural Research and Extension (NCARE), in Amman, Jordan on May 25-27, 2008. The main objectives of the meeting were to analyze the profitability and socio-economic aspects of the current crop production system in the target region in the seven countries participating in the Regional Forage Project, and to evaluate the alternative salt-tolerant forage system from economic, environmental and social perspectives; and the prediction of the long-term impact. The workgroup developed methodology, indicators and workplans needed for the completion of the socio-economic evaluation related to the introduction of salt-tolerant forage production.

Regional workshop on seed production, crop management and production constraints for selected salt-tolerant forages

The workshop was organized jointly with the General Commission for Scientific Agricultural Research (GCSAR) of Syria from October 19-22, 2008. Representatives from seven countries (Jordan, Oman, Pakistan, Palestine, Syria, Tunisia and UAE) attended the workshops. The main objectives of the

The official launch of the Arab Water Academy in Abu Dhabi

workshop were to: identify forage species suitable for each country; finalize the action plan for in-country seed production; develop strategy for the promotion of in country and on-farm seed production; discuss technical, social and economic constraints on introduction and adoption of salt-tolerant forages in each country; and develop possible solutions and the measured impact potentials of the project.

Annual Governors' Meeting of the Islamic Development Bank

ICBA was invited to present its achievements at the Annual Governors' Meeting of the Islamic Development Bank held at its headquarters in Jeddah, Saudi Arabia in May 31, 2008.

Capacity building for the Iraqi water sector

Under the auspices of the Arab Water Academy, the World Bank Institute and the US Government, ICBA organized an interactive course on *Asset Management with focus on distribution systems and business planning/risk management* for 25 experts and policy makers from the water sector in Iraq. Held in Dubai on March 22-25, 2008, the lectures were given by international experts from the World Bank, the private sector in the United Kingdom and the United States, and ICBA.

Second International Salinity Forum

ICBA participated in the Second International Salinity Forum, which took place on March 30 to April 3 at the Adelaide Convention Centre in South Australia. Professor Dr Faisal Taha and Dr Mahmoud Abdelfattah delivered papers at this meeting of the foremost authorities on salinity from all over the world.

An important outcome from this participation was the International Steering Committee resolution that ICBA be invited to host the next meeting of this prestigious scientific forum on salinity in 2011. Prof Dr Faisal Taha has been nominated as the Convenor.

Field Day for Omani Farmers

As part of the Forage Project which involves seven countries (Jordan, Oman, Pakistan, Palestine, Syria, Tunisia and the UAE) in the region, Omani farmers and representatives of the Ministry of Agriculture in Oman attended a field day at ICBA on April 9, 2008.

Workshop in Bangladesh

The Bangladesh Agricultural Research Institute (BARI), in collaboration with ICBA, organized a one-day workshop on *Best irrigation water management practices for sustainable crop production systems in coastal areas of Bangladesh* in Gazipur, Bangladesh on April 24, 2008. Eighty participants, including scientists, agricultural extension officers, engineers and farmers participated in the discussion covering the research findings of the BARI-ICBA project, the Bangladesh Rice Research Institute, the Bangladesh Institute of Nuclear Agriculture and Shagorika (a non-governmental organization).

Capacity building is an essential component of ICBA's research and development activities

BIOSAFOR Project Workshop

A workshop for the BIOSAFOR (Biosaline Agroforestry) project was held at ICBA from July 20-22, 2008. The project is funded by the European Commission (6th framework program) and is undertaken in seven countries, including United Arab Emirates. The Netherlands, Germany and Spain are the other partners (from Europe), whereas Bangladesh, India and Pakistan represent the DEV (Developed) countries. The Organisation for Agriculture in Saline Environments (OASE) Foundation of the Netherlands has the overall role of 'Project Coordinator'. ICBA serves as the coordinating unit for the DEV country partners and is also a member of the Project Executive Committee, with Dr Shoaib Ismail serving as the 'Regional Coordinator'.

The nine senior scientists from Bangladesh, India, Pakistan and the Netherlands in addition to scientists from ICBA used the forum to discuss the progress of the work, including gaps and constraints, and designed strategies to resolve them. Deliberations were held in detail on the economics of using wastelands, the potential markets for the products, and the technologies to convert biomass into useful products.

ICBA Library and Information management

In 2008, ICBA continued to provide library and information services to its staff, and add to the Image database, which now contains almost 35,000 images relating to ICBA projects and functions. The *Biosalinity News* newsletter and other ICBA publications were distributed to over 1500 people in about 120 countries.

Memoranda of Understanding

Keen to collaborate on projects as well as exchange research information to further its mandate, ICBA signed the following Memoranda of Understanding throughout the year:

- National Water Research Center (NWRC) of the Ministry of Water Resources and Irrigation, Egypt, March 14.
- Djibouti Center for Studies and Research (CERD), Djibouti, March 19.
- Avesthagen Limited, India, on April 1.
- BioMyc Environment GmbH, Germany, on April 23.
- King Abdul Aziz University (KAU) in Saudi Arabia, Jeddah, Saudi Arabia, on June 1.
- Statute of the Arab Water Academy on July 6.
- Arab Water Council to establish Arab Water Academy on July 6.
- Environment Agency-Abu Dhabi to establish Arab Water Academy on July 6.
- Ministry of Environment and Water (MOEW) of the UAE for the project of *Irrigation planning and management* on August 8.
- Ministry of Environment and Water (MOEW) of the UAE for the project *The safe disposal of brine from the reverse osmosis desalination plants of farms in the United Arab Emirates* on August 8.

Bilateral Projects

As tangible proof of its strong commitment to collaboration as a preferred mode of scientific research and development, ICBA has ongoing joint projects in many regions spanning Central Asia and the Caucasus, South Asia, and the Middle East and North Africa.

Networking

To progress collaboration between institutions and individuals involved in research and development on integrated water resource systems and marginal quality water resources including biosaline agriculture, ICBA hosts two networks:

- The Global Biosalinity Network (GBN) for those involved in research and development on biosaline agriculture www.biosaline.org/join.cfm
- The Inter-Islamic Network for Biosaline Agriculture (INBA) was established during the 10th General Assembly Meeting of the Standing Committee on Scientific and Technological Cooperation

(COMSTECH) in Islamabad, Pakistan, in 2002. Since then, the network has provided a forum for mutual collaboration and cooperation among the members of the Organization of Islamic Countries (OIC) in the field of biosaline agriculture.

In 2008, INBA continued its networking with the other Inter-Islamic Networks (IIN's), in particular the Inter-Islamic Network on Water Resources Development and Management (INWRDAM). INBA also participated actively in the 13th General Assembly Meeting of COMSTECH, attended by all OIC Ministers and organized by COMSTECH. The INBA Coordinator also attended an Expert Consultation Meeting for the OIC Water Vision 1441H held in Jordan during October 2008. News and other updates on INBA and other Inter-Islamic network activities are posted to INBA's web page on the ICBA website *www.biosaline.org* and *Biosalinity News*.

Publishing

- *ICBA Annual Report 2007* (English and Arabic)
- *Biosalinity News* Vol 9 No 1 (English and Arabic)
- *Biosalinity News* Vol 9 No 2 (English and Arabic)
- *Biosalinity News* Vol 9 No 3 Special issue: Arab Water Academy (English and Arabic)
- *Project Snapshots* brochure (Arabic)
- *2009 Calendar* (English, Arabic and French).

Media

Media coverage of ICBA was generated by distributing newsletters, annual reports and news releases to a media list, followed up by direct contact. The local Arabic and English press covered ICBA on numerous occasions. ICBA also received requests for articles and features for a variety of regional and international newsletters and magazines.

Publications

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Rao NK and **Shahid M.** 2008. 'Desert farming – Quinoa', *Landscape*. (11):60-63.

Shabbir G and **Dakheel AJ**. 2008. Plants without irrigation and fertilizer! Using Bio-Mycorrhiza is the optimal solution to green the desert. *Landscape.* (12):69-71.

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ADMINISTRATION AND FINANCE

Administration and Finance

Board of Directors

ICBA Board of Directors (BoD) held two meetings in 2008 (June and November) under the chairmanship of Mr Fawzi AlSultan. At the meetings the BoD attended to matters on hand regarding the ICBA Strategy Plan 2008-2012, Resource Mobilization, ongoing projects, new proposals, ICBA future funding and the Audit Report 2007.

Administration

Administration plays a critical role in supporting the scientific endeavor of the Center. An essential component of this support is the administrative work required to ensure that visitors to ICBA maximise their opportunities to meet the scientific team and learn about the Center's work.

A. Partnership and joint research/training

Strengthen the relations between local and international institutions such as:

- International Islamic Trade Finance Corporation (ITFC).
- Abu Dhabi Municipality.
- Government of Djibouti.
- Credit Agricole Bank (Dubai branch).
- German research institutions and universities.
- National Center for Water Research in Egypt.
- Avestagen (India).
- BioMYC (Germany and Dubai office).
- Provision of information and lectures to students from the UAE University.
- McGill University, KSU, Australian universities and institutions.

B. Human Resources

From January to early November 2008, nine new employees joined ICBA:

1.	Dr Rachael A McDonnell	Visiting Scientist
2.	Ms Suzara S Naga	General Accountant
3.	Mr Tarek Ateya Ali	IT Specialist
4.	Mr Surya Gotame	Office Assistant
5.	Mr Yousif Salim Hedar	Research Technician
6.	Mr Kaleem Ul Hassan	Soil Assistant
7.	Mr Abdul Rahiman Kunhi	Driver
8.	Mr Ahmed El-Sayed	Driver-Abu Dhabi Office
9.	Ms Patricia Pluvinage	Administrative Assistant-Technical Programs

During the year 2008, six employees left the Center:

1.	Mr Eric McGaw	Communications Specialist
2.	Mr Ghassan El-Eid	IT & Network Supervisor
3.	Mr Wameed Munther	Farm Technician
4.	Mr Sameen Gul	Driver
5.	Abdul Sather Chedanguil	Driver-Abu Dhabi Office
6.	Ms Patricia Pluvinage	Administrative Assistant-Technical Programs

Due to budgetary constraints, the following posts remained vacant during the year 2008:

1. Hydrogeologist
2. Resource/Water Economist
3. Communications Specialist
4. Donor Relations Specialist
5. IT Specialist
6. Human Resources Officer
7. Purchasing Officer

ICBA intends to fill these positions in the year 2009 and to consider recruiting additional staff with expertise in disciplines that reflect the research thrusts of the Center's new Strategic Plan.

The Human Resources Team from the Islamic Development Bank visited ICBA from 27 to 28 April 2008 to review the salary structure and benefits. Their report was submitted firstly to the IDB President and secondly to the ICBA Chairman Mr Fawzi AlSultan. It was agreed that the recommendations would be supported and ICBA was requested to implement the decision promptly.

ICBA Management is developing currently a Performance Appraisal and Evaluation System for promotion and incentive purposes.

C. Information Technology

In 2008 the following activities were undertaken:

1. Maintenance contracts

The current maintenance contract for Abu Dhabi office, desktop computers, server hardware, network active components and the main printers was renewed.

2. Internet

The internet connection, a 256Kbs leased line connection, was deemed to be sufficient to fulfill the current requirements of ICBA.

3. Antivirus subscriptions renewal

Enterprise antivirus packages, such as McAfee Antivirus, were yearly renewed for upgrades and updates. These upgrades and updates introduce add-on technologies to the existing package to help protect more IT systems from the virus and spam threats that emerge every day. Currently the antivirus subscription only supports updates without upgrades.

4. New computer/laptop/peripheral purchases

As the digital requirements of ICBA staff increases, the demand on the existing systems also increases, rendering the technologies of mainly general level staff obsolete. Consequently some of computers were replaced during the year.

5. IT supplies

IT supplies such as printer toners, printer cartridges, storages (flash and external hard disks), recordable DVD's & CD's are under continuous and heavy demand at ICBA, especially by the technical and communications departments due to the high number and quality of documents required for in-house and overseas trainings as well as normal daily requirements.

D. Finance

The selection of Deloitte and Touche (ME) as the external auditors was approved by the Financial Committee of the Islamic Development Bank (IDB) Executive Directors. Deloitte and Touche (ME) undertook the audit of the 2007 financial statements. The summary of audited financial report and the statement of the audited financial position at the end of the year are:

Statement of audited financial activities for the year ended 31 December 2008 (US$)		
Particulars	**2007**	**2008**
Grants and contributions		
Grants unrestricted	4,083,038	4,285,315
Contributions for training courses and research	937,611	1,116,908
Other income	12,652	4,078
Total grants and contributions	**5,033,301**	**5,406,301**
Programs and other expenses		
Employees' salaries and benefits	(2,814,353)	(3,234,580)
Expenses on training courses and research	(937,611)	(1,116,908)
Travel	(94,429)	(121,026)
Depreciation of property and equipment	(367,007)	(384,410)
Supplies and utilities	(285,617)	(224,873)
Maintenance	(155,635)	(157,101)
Contract services	(125,842)	(88,084)
Strategic planning	(142,242)	0
Board of Directors	(80,002)	(42,129)
Other expenses	(30,563)	(37,190)
Total programs and other expenses	**5,033,301**	**5,406,301**
Excess of revenues over expenses	**0**	**0**

Statement of audited financial position as at the year ended 31 December 2008 (US$)		
Particulars	**2007**	**2008**
Assets		
Current assets		
Cash and cash equivalents	4,083,038	4,164,575
Prepayments and other receivables	475,926	88,381
Total current assets	**3,259,948**	**4,252,956**
Non-current assets		
Property and equipment	6,539,032	6,313,761
Total current and non-current assets	**9,798,980**	**10,566,717**
Liabilities and net assets		
Current liabilities		
Accruals and other payables	801,831	999,026
Non-current liabilities		
Provision for employees' end of service indemnity	88,980	127,581
Total liabilities	**890,811**	**1,126,607**
Net assets		
Unrestricted - unappropriated	6,539,032	6,313,761
Unrestricted - appropriated	1,269,680	1,798,817
Temporarily restricted	1,099,457	1,327,532
Total net assets	**8,908,169**	**9,440,110**

Outreach project budget

During 2008, the Center spent USD1,201,529 on outreach projects which were financed by donors other than IDB.

E. Facilities

- Establishment of a new laboratory (Central Analytical Laboratory) to be used for soil and plant analysis. The laboratory was provided with furniture and up-to-date equipment.
- Introduction of 2 greenhouses to be used for vegetative propagation, seed establishment and acclimatization of plants.
- Connection of waste water in the labor camp to the city waste water network.
- Introduction of row cover technologies for plant growing to protect plants and environmental factors.
- Evaluation of the cooling system to improve the efficiency of the airconditioning system.
- Establishment of additional shade area for ovens to be used for drying plant materials.
- Conversion of an old soil lab to offices in order to provide extra office area.
- Installation of an irrigation system and provision of the water for landscaping area in front of the main building that is to be used as a nursery for halophytic plants.
- Installation of 10 k gallons of treated water.

Acronyms and abbreviations

AFESD	Arab Fund for Economic and Social Development
BARI	Bangladesh Agricultural Research Institute
CGIAR	Consultative Group on International Agricultural Research
DRC	Desert Research Center, Egypt
EAD	Environment Agency - Abu Dhabi
IAEA	International Atomic Energy Agency
ICARDA	International Center for Agricultural Research in the Dry Areas
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDB	Islamic Development Bank
IFAD	International Fund for Agricultural Development
IGZ	Institute of Vegetable and Ornamental Crops (Germany)
IRRI	International Rice Research Institute
IWMI	International Water Management Institute
MOEW	Ministry of Environment and Water (UAE)
NARS	National Agricultural Research System
NCARE	National Center for Agricultural Research and Extension (Jordan)
NPC	National Prawn Company (Saudi Arabia)
OASE/ODE	Organization for Agriculture in Saline Environments / Ocean Desert Enterprises (Netherlands)
OFID	OPEC Fund for International Development
OPEC	Organization of Oil Exporting Countries
PDO	Petroleum Development Oman
SQU	Sultan Qaboos University (Oman)
TAAS	Tajikistan Academy for Agricultural Sciences
TDIC	Tourism Development & Investment Company (Abu Dhabi)
UAEU	University of the United Arab Emirates
WANA	West Asia and North Africa

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.

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.

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.

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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