1999 - 2009
Celebrating 10 years of achievements

Integrated Water Resource System

Marginal Quality Water Resources

Capacity Building and Knowledge-sharing

Annual Report 2009
(1429-30H)
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.

Annual Report 2009
(1429-30H)

International Center for Biosaline Agriculture

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Contents

Foreword

The Islamic Development Bank Group (the IDB Group) is a multilateral development institution whose aim is to foster economic development and social progress of its member countries as well as Muslim communities in non-member countries.To achieve this aim, the IDB Group works in close collaboration with many partners.

One such partner, the International Center for Biosaline Agriculture, is particularly important as the IDB Group took the lead in establishing the Center in 1999. A team of dedicated staff from the IDB Group worked assiduously to build world-class modern research facilities in Dubai in the United Arab Emirates and to recruit international scientists to conduct research on improving the well-being of poor farmers cultivating crops under marginal conditions.

Over the last ten years, the IDB Group has guided and supported the Center at every step of its journey starting with its initial focus on applied research and technology development in saline irrigated agriculture. Since 1999, the Center has evolved strategically to a broader mandate of improving agricultural production within an integrated water resource system approach; a critical milestone of this journey was the formulation of the Strategic Plan 2008-2012.

The significant achievements in 2009 highlighted in this Report have clearly consolidated the Center's new direction in contributing solutions to addressing the widespread challenges of water-scarcity aggravated by climate change facing agriculture in the IDB member countries.

The IDB Group has not only continued its support of ICBA over this ten year journey, but 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, whose ongoing support facilitates the considerable achievements of the Center in mitigating water-scarcity.

As the present agreement with the United Arab Emirates is coming to an end by December 31, 2009, IDB is looking forward to continue its partnership with the UAE to ensure that ICBA continues to serve IDB member countries and others. We hope to conclude the extension of the present agreement in the foreseeable future.

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

MESSAGE

Apart from the many achievements in applied research and capacity building, the year under review, 2009, has been a significant year for the Center for two major reasons: the celebration of ten years in existence, and continued negotiations for a new funding model to commence from 2010.

The patron of the anniversary, H.E. Dr Rashed Ahmed Bin Fahad, the United Arab Emirates Minister of Environment and Water, and H.E. Dr Ahmad Mohamed Ali, President of the Islamic Development Bank Group, attended the ten year birthday celebrations held on 25 and 26 March, along with representatives of regional and international donors, research organizations, the private sector, and diplomatic missions in the United Arab Emirates, as well as ICBA staff.

ICBA also took the opportunity to acknowledge the vital roles of donors, who ensure the financial viability of the Center. Of these, the IDB Group, International Fund for Agricultural Development (IFAD), the Arab Fund for Economic and Social Development (AFESD), the Organization of the Petroleum Exporting Countries (OPEC), Environment Agency – Abu Dhabi (EAD), the UAE Ministry of Environment and Water (MOEW) and the Ministry of Agriculture, Oman, to name just a few, were recognized. The endeavors of long-term ICBA staff were also lauded.

To build on the successes of the last ten years, plans already in place for 2010 include the implementation of projects approved for the ICBA Strategic Plan 2008-12. The Strategic Plan implemented a new mandate and a refocusing of ICBA's research programs into three critical areas: Integrated Water Resource System management, Marginal Quality Water Resources and Capacity Building and Knowledge-sharing.

2010 will also see the continuation of ongoing contractual projects as well as in-house core projects. This includes a number of large-scale external projects in both the private and public sectors resulting in significant project workload and commitment of ICBA staff as they enthusiastically continue or complete projects under the old mandate and embrace different project areas to realize the new mandate.

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 Group. The other 15 members of the BoT are all IDB Executive Directors, each with a specific geographic responsibility.

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Dr Ahmad Mohamed Ali
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Board of Executive Directors
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Doha, Qatar
Country represented: Qatar

1. Hon Abdul Aziz Abdulla Al Zaabi replaced the Hon Jamal Nasser Rashid Lootah in June 2009.

Board of Directors

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 2009 has been a significant year for the International Center for Biosaline Agriculture (ICBA) for two major reasons: it celebrated ten years in existence, and conducted negotiations for a new funding model with the United Arab Emirates Government and the Islamic Development Bank (IDB) to be implemented from 2010.

Reaching the first ten years represents a milestone in the life of any institution; this is especially true for ICBA as the initial period for funding was for a ten year period – 1999-2009.

The establishment of the Center was based on a strategic decision in the early 1990s to build a research and development institution focusing on the problems of salinity and using saline water for irrigated agriculture.

The Islamic Development Bank under the visionary leadership of its President, HE Dr Ahmed Mohamed Ali, took the lead in establishing the Center to build world-class modern research facilities and to recruit international scientists to conduct research on improving the well-being of poor farmers cultivating crops under marginal conditions. A team of dedicated staff from the Islamic Development Bank and the Government of the United Arab Emirates worked assiduously to establish the Center in Dubai.

Over the last ten years, the Center has evolved strategically from the initial focus on applied research and technology development in saline irrigated agriculture, to the broader mandate of improving agricultural production within an integrated water resource system approach.

Significant support from donors and fellow researchers and partners in national programs has encouraged this evolution in the Center's research agenda. The Center has received generous support from the Government of the United Arab Emirates, the Arab Fund for Economic and Social Development, the OPEC Fund for International Development, the International Fund for Agricultural Development and the Municipality of Dubai to support the Center's activities.

The patron of the anniversary, HE Dr Rashed Ahmed Bin Fahad, the United Arab Emirates Minister of Environment and Water, and HE Dr Ahmad Mohamed Ali, President of the Islamic Development Bank Group, attended the ten-year celebrations held on 25 and 26 March, along with representatives of regional and international donors, research organizations, the private sector, and diplomatic missions in the United Arab Emirates, as well as ICBA staff.

The celebrations comprised an opening ceremony, a series of scientific seminars and a tour of the research station. It is always gratifying on such occasions to acknowledge those who have contributed to

Dignitaries at the 10-year anniversary celebration

the many successes of the Center since its inception. On this occasion ICBA honored HE Dr Rashed Ahmad Bin Fahad, the UAE Minister of Environment and Water, HE Saeed Bin Mohammad Al Raqabani, the UAE former Minister of Agriculture and Fisheries, HE Dr Ahmad Mohamed Ali, President of the Islamic Development Group, HE Majid Al Mansouri, Secretary General of the Environment Agency-Abu Dhabi, and the Ministry of Agriculture in Oman, for their active contribution to the Center's strategic direction and operations. ICBA also took the opportunity to acknowledge the vital roles of donors, who ensure the financial viability of the Center, and long-term ICBA staff. Three booklets: *The United Arab Emirates and ICBA: Partnership in Action*, *ICBA Around the World* and *Research at ICBA Agricultural Station* were published to mark the occasion.

As part of its steps in implementing the new mandate in the 2008-2012 Strategic Plan, ICBA refocused its research programs into three critical areas: *Integrated Water Resource System Management, Marginal Quality Water Resources* and *Capacity Building and Knowledge-sharing* to benefit the Islamic Development Bank Group member countries.

The Integrated Water Resource System Management 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 sharing of water resources information and knowledge.

The Marginal Quality Water Resources Program comprises the following six priorities: assessment of marginal quality water resources quantity and quality; on-farm integrated resource management of marginal quality waters; the use of marginal quality water sources for production of specialty products; methods/techniques for improving marginal quality water and its by-products for agriculture; socio-economic aspects of marginal quality water; and environmental impact assessment.

Underpinning the success of ICBA's research is a strong partnership with donors, the private sector and national research and development programs.

1. Integrated Water Resource System Program

Increasingly ICBA is collaborating with decision-makers at the regional, national level or local level to formulate policy documents and provide technical scientific expertise.

Within the Region

NASA's MENA-LDAS

At the regional level, a promising project which started towards the end of 2009 is a partnership with NASA using their land data assimilation system for the Middle East North African region (MENA-LDAS) to develop regional water flow modeling. A land data assimilation system is a numerical modeling scheme which integrates observations from various sources within land surface models, using data assimilation and other techniques. The observations are then used to produce optimal maps of land surface states (e.g. soil moisture, surface temperature) and fluxes (e.g. evapotranspiration, runoff) for weather and climate forecast model initialization, water resources monitoring, and other applications.

Water flow modeling throughout the region will be undertaken using the latest technology from NASA with the establishment of a hub at ICBA. In a workshop held from 25th to 27th October in Abu Dhabi for remote sensing specialists from 12 different country centers, NASA experts outlined the possibilities of remote sensing for water management and how the MENA-LDAS system would help in the region. The MENA-LDAS hub based at ICBA would inform decision-makers and researchers throughout the Middle East and North Africa by: developing data sets in water and food security at the country and regional level; raising awareness of the possibilities offered by remote sensing application in general and Water Cycle Monitoring modeling in particular; engaging remote sensing water specialists from the region in a long-term knowledge exchange program; and building and supporting a network among remote sensing water specialists to ensure high-levels of support and skills transfer.

National Strategy to Combat Salinity and Develop Protection of Water Resources from Pollution and Salinity in the Sultanate of Oman

Increasing the knowledge about the extent and kind of water resources in Oman will be an outcome of the research endeavors in Oman to develop a national strategy to combat salinity. Traditionally the agricultural sector in Oman has been very productive in contributing to partial food security and self-sufficiency. However, factors such as the expansion of agriculture in the 1990s (especially the perennial forages); shortages of rainfall; and the deterioration of water quality in particular due to water pollution; and salinisation of soil and groundwater and intrusion by sea water (up to 20km) have resulted in a dramatic deterioration and depletion of natural resources. This major decline in productivity has impacted the livelihood of farmers dependent on agriculture in the region to the extent that many have abandoned their farms.

Participants in first workshop to develop Oman National Salinity Strategy

Consequently the Omani Ministry of Agriculture and the International Center for Biosaline Agriculture (ICBA) signed a joint agreement in 2009 to develop a national strategic plan by 2011 to combat salinity and protect water resources from pollution and salinity and to develop a national action plan that would ensure the sustainable development of the agricultural systems and support the livelihood of farmers in the targeted areas in Oman.

Subsequently the Omani Ministry of Agriculture, represented by the Directorate General of Agriculture and Livestock Research, and ICBA organized the first workshop in which national and international experts and representatives from the various Omani stakeholders and partners defined the project parameters and methodologies. They also formed the Strategy Management Committees (the Steering Committee with higher level representatives from the various partner ministries/agencies in Oman and from ICBA, and the Technical Committee which includes higher level technical representatives from the various partner ministries/agencies), as well as the Working Groups to address the five key themes (Physical Resources and Modelling; Biological/Agricultural; Economics and Planning; Capacity Building and Extension; and the Information Database).

Feasibility of Managed Aquifer Recharge (MAR) using excess treated wastewater in Oman

Another project in Oman revolves around supplementing the water supply which is seasonal. During periods of water surpluses, water is stored in an aquifer which is an excellent storage means as there is no evaporation loss and negligible pollution. The water can be withdrawn from the aquifer when a deficit occurs. Aquifers are an appropriate means of storing water as storage of the water below ground means that there are no evaporation losses; the water is usually protected from pollution; minimal land area is used; and there is no environmental damage. On the other hand, MAR has some disadvantages: namely, in most cases, only a part of the recharged water is recovered in the short run.

ICBA's role in this partnership with the Sultan Qaboos University (SQU) to conduct a socio-economic and technical feasibility of MAR schemes in Oman especially in the Muscat areas was to provide technical support and jointly with SQU to achieve project outcomes, in particular aspects related to irrigation and groundwater modeling.

In 2009 ICBA managed a comprehensive review of the use of MAR with treated wastewater; a practice common in several countries, including the USA (where the legal requirements in California are highly relevant to the Omani context), Belgium, Morocco, Singapore and Australia as part of their overall water resources management. Currently groundwater recharge in Oman is practiced using recharge dams only.

Within the United Arab Emirates

Recycled Water Strategic Plan for Abu Dhabi Emirate

One such example at the national level is the Recycled Water Strategic Plan for Abu Dhabi Emirate. Recognizing that recycled water has the potential to reduce stress on fresh water as it can be used in the field and in protected agriculture, the Environment Agency-Abu Dhabi commissioned ICBA to formulate a strategy on the use of recycled water to address the lack of renewable resources in the Emirate of Abu Dhabi. As the average rainfall is less than 100 mm year, surface water is not a reliable water resource, leaving fossil groundwater (which is facing rapid depletion) and sea water as the primary water resources in the Emirate. Depending on its treatment process, recycled water can be reused for different purposes as a dependable water resource for sustainable economic development.

With clear strategic polices, recycled water could be a reliable water source for: agriculture on a long-term basis that could enhance food security in the Emirate; the landscaping and forest sectors where current reuse practice needs to be increased; as well as commercial floriculture; and the industrial sector for such purposes as processing, washing, and cooling in facilities that manufacture products.

In 2009 eleven experts in wastewater treatment and technologies worked closely with ICBA scientists in a multi-disciplinary approach to develop strategies to resolve the challenges faced in the utilization of this important water resource. The draft report, supported by the seven annexes, has been submitted to the client.

Legal and regulatory framework of Abu Dhabi Emirate water law

Water policy reforms such as a clearer determination of institutional roles, responsibilities and accountability are critical to ensure the sustainable management of water resources.

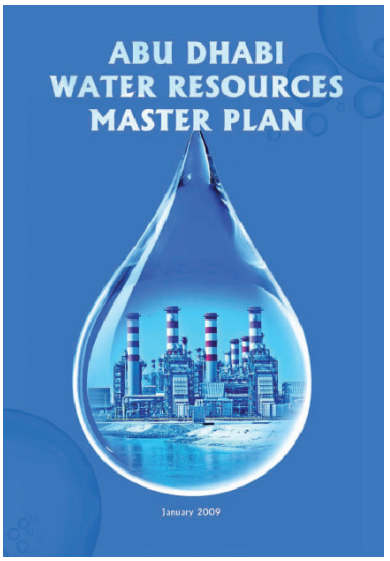
The *Abu Dhabi Water Master Plan 2009* identified that currently there is limited progress in regard to accountability compared with the advanced achievements in the development of water resources and to a lesser extent progress in institutional capacity. Identification and clarification of the roles between different institutions, particularly the roles of the federal and local institutions, and consequent legislative amendment, will assist in eliminating overlap and omissions of institutional responsibilities.

In 2009 ICBA was commissioned to review the existing legal and regulatory framework of Abu Dhabi Emirate water law.

Water Master Plan for Abu Dhabi Emirate

This was the first comprehensive assessment of both natural and non-conventional water in Abu Dhabi Emirate. It involved working very closely with many key stakeholders from the water production and distribution industries through to those responsible for protecting the environment and the strategic water reserve in particular. The research involved developing new data sets on aspects of water such as the environmental and economic costs which are crucial to support decision-makers. Understanding the environmental implications was a key component of the study as the Abu Dhabi government is one of the foremost leaders in green thinking in the world.

The final draft report was delivered in January 2009 to the Environment Agency-Abu Dhabi. This was followed up with a stakeholder workshop where further consultation took place and comments and views were obtained. This feedback was incorporated in a hardcopy report produced by June 2009 for widespread distribution in the Emirate and beyond. Since then various initiatives have come from this work and it is noted that at many water conferences and discussions the *Water Master Plan for Abu Dhabi Emirate* is used as the primary source of up-to-date information and thinking about the resources in Gulf.



Cover of Master Plan published as a monograph

Irrigation planning and management for the United Arab Emirates

The agriculture sector in the United Arab Emirates (UAE) is the main consumer of water (60%), followed by the domestic and industrial (27%) sectors with the remaining 13% being wasted or lost. Groundwater, which has been used extensively for agriculture, has long been overexploited, resulting in falling 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.

The current irrigation practices in the country are based on extensive water use rather than water demand management. This practice, which provides considerable socio-economic support to citizens, has been encouraged by large government subsidies. Its development over the last 20 years has been largely unplanned and has not taken into consideration the suitability of soil and water resources. This study calls for sustainable agricultural development by using (i) marginal water such as saline groundwater and reclaimed municipal wastewater; (ii) salt-tolerant crops (particularly those with a local advantage); and (iii) water saving measures via irrigation water management and application techniques.

The proposed study will assess existing irrigation water use and recommend to decision makers and planners strategies for sustainable irrigation development in different agro-climatic zones of the UAE.

In 2009, data collection occurred from sites at Dibba, Digdaga, Dhaid, Al Ain and Liwa. These locations covered agro-climatic zones (i.e. sub-humid, arid and hyper-arid) and the regions of the UAE (i.e. Western, Central, Northern and Eastern).

Developing irrigation techniques to irrigate farms

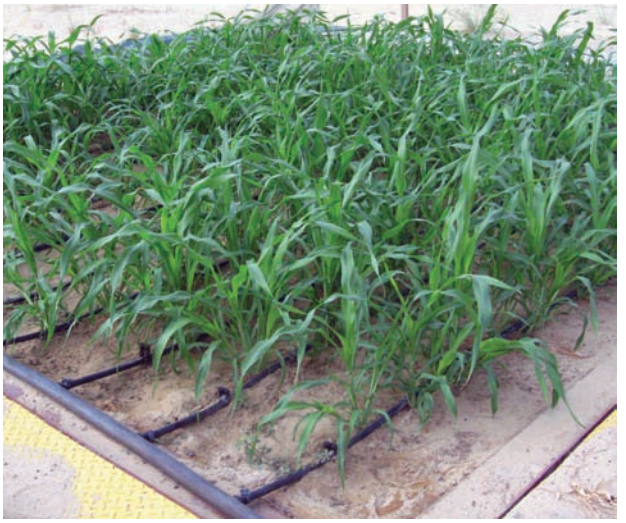
At the ICBA Research Station

Determination of crop water requirements using weighing lysimeter

Improved irrigation planning and irrigation scheduling require precise assessment of all components of the water balance equation - weighing lysimeters are the best available technology to ensure this precision for research.

ICBA installed a weighing lysimeter (Emery Winslow Weighing System) at its research farm in 2005 near the automated weather station, equipped with a Campbell Scientific MetData1 measurement and control system, to provide the necessary agro-meteorological data to compute effective rainfall, and reference evapotranspiration values.

ICBA researchers are using these facilities to ensure the integrity of their comprehensive research program into crop water use of different crops/forages and development of crop coefficient values. In 2009 pearl millet is the crop being researched as part of this program.



Pearl millet crop in the lysimeter

2. Marginal Quality Water Resources Program

Within the region

Saving freshwater resources with salt-tolerant forage production in marginal areas of the West Asia and North Africa region

The importance of saving freshwater resources by using salt-tolerant crops has long been recognized. However, the work that ICBA has done over the last ten years has contributed greatly to the body of scientific knowledge. An important outcome of the application of this knowledge is the impact on livelihoods of the rural poor. One such example concluding in 2009 is the project *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* (Forage Project).

ICBA, in partnership with NARS of seven countries in WANA (Jordan, Oman, Pakistan, Palestine, Syria, Tunisia and UAE), initiated the project's activities in 2004/05. IFAD supported ICBA to carry out an initial study on the Assessment of Saline Water Resources in selected countries in WANA (Jordan, Oman and Syria, Libya, Egypt and Tunisia). IFAD, AFESD, OFID, IDB/ICBA and NARS contributed to the project, which became fully operational in 2005.

The project was designed by ICBA, in partnership with NARS, to improve livelihood systems and incomes for the resource-poor rural men and woman farmers in marginal areas, through increasing feed availability for livestock, using saline water in sustainable semi-arid and arid farm system management and building the capacity of national agricultural research systems, as well as extensive capacity building at the project and country levels.

The innovative characteristics of the project consisted of introducing and testing various-salt-tolerant forage species and applying specific cropping/utilization technical packages, including water, soil and crop management options suitable for the marginal resources found in the three types of environments: groundwater based systems, salinized river based systems, and systems based on agriculture drainage water. Another critical success factor was the high partcipatory approach, which included NARS at all levels (management, technical and outreach staff in the stations) and farmers in the evaluation, selection and scaling to the farms implemented.

The project finished this year with the establishment of national demonstration sites in each country; the screening and evaluation of a large number of forage species/accessions; soil and management and monitoring under saline conditions; optimized production systems transferred to national programs; the screening and evaluation of several thousands of summer and winter annual forages and perennial grass and shrub forages for year round on-farm production; the identification of annual and perennial salt-tolerant forages suitable for each partner country; and seed multiplication of key species for scaling up and adoption of limited number of farmers.

Steering and Technical Committees meeting at ICBA

Capacity building and knowledge sharing at the project level and the country level was critical to the success of the project; this was achieved through workshops, field and farmers days, in-country courses, and publications such as brochures on the potential roles of the different crops/genotypes introduced through the management aspects of the introduced crops. More than 120 farmers participated in the project from partner countries and several countries adopted

the strategic approaches to the use of marginal water and supported several in-house projects. Scientists and technicians from the region were also trained during the project duration.

The final assessment of the project, carried out by IFAD and ICBA, highlighted some key project findings:

1. The barriers to diversification of the farming system and scaling out in salt-affected areas were mainly due to: the lack of supportive policies; unavailability of, or inaccessibility to, the proper seed source of genotypes better adapted to salt stress; irrigation with marginal quality water; and limited extension and capacity building opportunities.

   The project approaches and activities were effective in lowering these barriers. More, however, needs to be done: to improve on-farm training in skills relating to the production and utilization of forages under salinity/marginal conditions; to expand the activities into more farms in the targeted region; to extend capacity building; to increase seed production of the targeted varieties/genotypes; and to strengthen extension services and farmers' awareness.
2. The participatory approach with full partnership, budget sharing, mutual agreement on milestones and interventions, proved to be important in motivating NARS scientists and staff to share full implementation responsibility with ICBA.
3. The implementation of the project demonstrated great flexibility with continuous monitoring and modification, which was tremendously helpful to better achieve project outcomes.
4. The project outcomes and the farmers' demands for the adoption of the introduced forage-livestock package, as well as the impact of climate change on marginal environments, call for the scaling up and out of the project and a second phase.

Enhanced crop-livestock productivity in WANA saline lands

Enhanced crop-livestock productivity in marginal quality was the desired outcome for another major collaborative endeavor in the WANA region between ICBA, ICRISAT and the NARS of five countries (Egypt, Jordan, Oman, Syria and Yemen) to identify farmer-acceptable, high-yielding, salinity-tolerant varieties of sorghum and pearl millet suitable for each target environment. The consortium received financial support from OFID and other international donors to expand the benefits of this project to the WANA region.

Pearl millet and sorghum, moderately salt-tolerant crops, are important for the subsistence of people and livestock in Asia and Africa. Many genotypes including germplasm accessions, breeding lines, hybrids and commercial cultivars have been tested in different countries. Pearl millet and sorghum were studied both in single- and multi-cut systems at different salinity levels and were found to be highly suitable and widely accepted by the farmers.

During 2009, the project agreement and detailed implementation plan were developed for each NARS partner. The achievements for the year were the development of seed production sites; the evaluation of new genetic materials provided by ICBA and ICRISAT to NARS; the selection of 2-3 most suitable genotypes from each crop for large scale multiplication; on-farm demonstration and capacity building of NARS and farmers in cultivar development; seed production; and crop management and utilization.

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

Improved management of salt-affected soils and water for sustainable agriculture was the desired outcome in a research partnership with the Sultan Qaboos University in Oman. The three-year project, which concluded in 2009, was jointly implemented by a number of organizations in salt-affected farms at the Ministry of Agriculture Research Station in Rumais and in private farms in Oman.

The extent and intensity of salinity was assessed by using remotely sensed satellite images, ground truthing and the preparation of GIS (geographic information system) maps. Solutions ranging from agronomic (for example sowing methods), nutritional aspects (including microbial nitrogen mineralization in saline conditions), engineering and water management solutions (for example irrigation), and biological solutions by identifying salt-tolerant crops and fruit trees for various salt-affected regions in Oman. The effects of feeding salt-tolerant forage crops to sheep were also assessed. The project findings will be published as a monograph.

Salinity in Central and Southern Iraq: better understanding of salinisation processes leading to improved management practices and increased productivity

Iraq's agricultural sector represents a vital component of Iraq's economy as it is the largest employer (25 per cent of the labor force) and the second largest industry after oil (in terms of its contribution to GDP). The salinity challenge has long been identified as a major threat to agriculture and past policies aimed to improve irrigation and drainage practices. Iraq's extensive irrigation infrastructure has fallen into disrepair and soil salinity has spread across much of the irrigated areas of central and southern Iraq; the challenge is compounded by the increasing levels of salinity of the irrigation water from both the Euphrates and Tigris Rivers due to changed water regimes.

The proposed intervention by the Australian Center for International Agricultural Research (ACIAR) will complement other aid work in Iraq by providing research-based approaches to improve irrigation water management and the production of suitable crops in bio-saline environments. A collaboration between ICBA, ICARDA, IWMI and national partners from Iraq, the anticipated outcome from this phase is identification of the broad research questions. Ultimately a research foundation could be established to address these questions with funding from ACIAR and other potential donors.

The proposal is about using saline soils and addressing the symptoms of salinized irrigation areas. The project will look at the problems on three different scales (i) regional; (ii) irrigation district; and (iii) on-farm, and address these through (i) assessment, (ii) mitigation, and (iii) adaptation strategies. Different partner agencies were identified to lead the different scales. ICBA was nominated to lead the work on on-farm management related to demonstration work on improved crop varieties suitable for salt-affected areas in Iraq; and development of methodologies to improve irrigation water management for salinity control.

In addition, ICBA will provide a supporting role to ICARDA and IWMI on a 'irrigation district scale' related to (i) evaluations of current crop/agronomic systems; and (ii) water management for salinity control.

The outcomes of the scoping workshop held in June 2009 at ICARDA headquarters in Aleppo, Syria, shaped the basis for the full project proposal that was submitted to ACIAR through ICARDA. It is anticipated that project activities will start from 2010.

An Iraqi delegation also visited ICBA to discuss further the collaboration on this and other research projects on 'biosaline agriculture' and water management studies.

Introduction of agriculture technologies for improvement of degraded abandoned farms in Tajikistan

On-farm management of land, water and plant resources would provide a key strategy for using marginal lands in Tajikistan, which represent up to 40% of the land resources. In addition, lack of proper drainage systems has resulted in waterlogging problems in many areas, significantly affecting agricultural production.

This collaborative project targets the establishment of suitable production systems using native tree and shrubs on marginal land, use of introduced winter/summer conventional and non-conventional crops (multi-purpose trees and shrubs). These measures will benefit small, remote, rural communities and through bio-drainage, agro-forestry and growing forage crops can bring the abandoned farms back to production.

Salt-affected wastelands with a high rising water table were selected in the Khudjand province in north Tajikistan. Trials were designed for the on-farm use of drainage mineralized water to cultivate salt tolerant plant species that could provide economic returns to the farmers.

During 2009, the final year of the project, experiments were continued on the potential forage accessions of sorghum, pearl millet and alfalfa under different management treatments.

Results showed that by adopting early-maturing varieties under high plant density, pearl millet could be made into a valuable feed, and stover and forage crop could also easily fit into an intercropping production system early spring-summer with low canopy crops, like soybean and other legumes. By providing a dense cover to the salt-affected lands, they can also contribute to the soil improvement and moisture holding.

A separate trial for seed multiplication of top-yielding alfalfa was also established. Growing salt-tolerant, high-yielding legumes in combination with cereals, alternated by strips of naturalized halophytes, such as

Atriplex undulata, *A. nitens* and *Kochia scoparia*, was found to have great potential for producing highly nutritional fodder (both fresh and dry as hay).

Experiments on the utilization of drainage mineralized water on the establishment of wild multi-purpose wild and fruit trees were initiated at the Yangiobod farm (north Tajikistan). In early February 2009 tree/shrub plantations were deeply planted into the water table. Limited irrigation with low quality water was required during the initial stage of the seedlings' growth before extracting the available drainage ground water.

Biosaline agroforestry: remediation of saline wastelands through production of renewable energy, biomaterials and fodder

Along with water and food, another major commodity affected by scarcity is energy. With increasing population and pressure on resources, alternate resources of energy are becoming more critical. '*Bioenergy*' is one form that can supplement the energy requirements from unused resources of degraded land and marginal water.

The BIOSAFOR research project is an investigation into the productive potential of biosaline agroforesty systems in degraded lands ranging from the selection of trees to an optimized management and the development of economically feasible value chains.

The project integrates different disciplines based on case studies, experimental trials and modeling studies being undertaken at different research institutes in Bangladesh, India, Pakistan, Spain, UAE, Germany and the Netherlands. The completed database will be used to identify potential marginal areas locally and globally that could be used for biomass-for-energy projects.

The project has seven different work packages (WP) from experimental trials to case studies, leading to global characterization of saline/sodic wastelands. ICBA leads WP1 and WP2 and has a significant role in other WP's. In addition, it acts as Regional Coordinator for activities in Bangladesh, India and Pakistan.

During 2009, sixty new salt-tolerant germplasms obtained from CSIRO Australia and other sources were screened. The plants were grown under variable salinity for a year and different growth and biomass characteristics were measured. ICBA prepared the Protocol document to assess the baseline for evaluation.

For WP2, extensive studies on tree biomass and its components were carried out on *Eucalyptus camaldulensis, Prosopis juliflora* and *Tamarix articulata* in two different locations in India and Pakistan. The sites represented the typical salinity/sodicity situation of marginal lands.

ICBA assisted in saline land characterization in partner countries that would lead to identification of marginal/waste lands where bioenergy trees can be grown with minimum management and cost. In addition, ICBA participated in different coordinating activities given its role as the Regional Coordinating Unit for South East Asia and also supplied technical and fiscal reports.

The Director Technical Program and the Regional Coordinator/Project Manager also attended the annual meeting held in Stuttgart, Germany in May 2009.

Marginal water resources assessment and use for growing horticulture 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. Small-scale micro-irrigation techniques along with cultivation management practices were evaluated.

Traditionally the land remains fallow in dry saline conditions during the winter months. As cultivation of the crops trialed during 2003-2007 using harvested rainwater was profitable, such technology is promising for improving the livelihood of poor rural farmers.

These research findings will underpin the design of a marginal water resource management project proposal for further technology testing on a larger scale in other coastal zones for the production of horticultural and fodder crops using harvested rainwater, saline groundwater and/or river water.

In 2009 the main activity was to collect data on (i) crop production systems; (ii) soil and water salinities; (iii) groundwater status and quality; (iv) surface water status and quality; and (v) irrigation technologies, as the basis for the project proposal.

Within the United Arab Emirates

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 United Arab Emirates. In inland areas as well as the coastal zone, saline groundwater is available for use in agriculture although it is not suitable for growing cash crops. To overcome this problem, many small-scale reverse osmosis (RO) plants are used for desalinating saline groundwater to produce date palm or cash crops in greenhouses or supply drinking water to animals and poultry. The use of such technologies requires proper brine concentrate management or disposal practices; otherwise disposal practices can lead to groundwater pollution. Thus, a thorough review/analysis is needed to identify suitable environmentally friendly brine disposal options or alternatives ranging from sea discharge; deep well injection; evaporation ponds for drying and disposal in landfills or commercial uses; controlled thermal evaporation: and growing highly salt-tolerant forages or fish farming if brine quality permits.

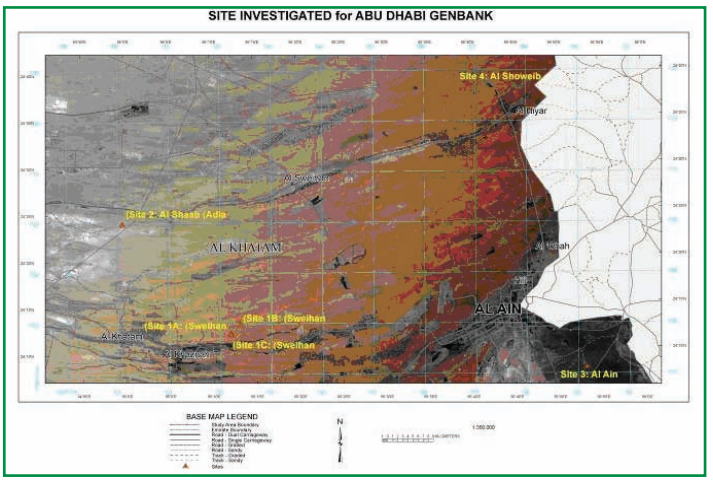
As part of meeting the strategic objectives of MOEW, the study will evaluate the existing RO induced brine disposal practices in the United Arab Emirates and formulate guidelines for optimal uses of RO units for irrigation.

In 2009, the main objective was to collect the data from the selected 15 project sites; all of which had RO desalination plants for supplying low-saline irrigation water for crop-growing.

Abu Dhabi Genebank and Botanical Garden Site Assessment

ICBA's management of the formulation of the Abu Dhabi Genebank and Botanical Garden Strategic and Business Plans in 2008 led to its appointment by the Environment Agency-Abu Dhabi to assess suitable sites for the proposed facility. The facility will focus on the conservation and sustainable use of economically important native plants and revegetation of degraded terrestrial ecosystems in the Emirate of Abu Dhabi.

Chaired by ICBA, the team comprising ICBA and EAD representatives framed a set of criteria including accessibility and soil suitability in order to assess the sites during field visits to collect samples of soil and water for laboratory analyses. Three suitability classes (low, medium and high) were defined to assess the suitability of the four potential sites: Site I is situated in Abu Arta where three subsites (IA, IB and IC) were examined; Site II is located in Al Adlah area; Site III In Al Ain; and Site IV in Al Showeib.



Site location map of four potential sites for Abu Dhabi Genebank and Botanical Garden

Soil Survey of Abu Dhabi Emirate

The soil survey of Abu Dhabi Emirate, a joint project between ICBA, Environment Agency-Abu Dhabi (EAD) and an Australian contracting company, GRM International, was conducted from 2005 to October 2009. During the four years, field work was completed in the entire Emirate (extensive survey) and a 400,000 ha area (intensive survey) comprising four sub-areas (Madinat Zayed; Ghayathi; Al Ain and Al Sila) investigated.

The final reports add significantly to the knowledge and understanding of the natural environment of the Emirate. The soil information collected will serve as a guide for future development by informing strategies to reduce the negative impact of human activities on the natural surroundings and assist in sustainable use.

During 2009 the soil survey (extensive and intensive) results were compiled for the five-volume final report. Loose map sheets, the Abu Dhabi Soil Information System (ADSIS) and a soil sampling archive were also completed.

Soil Survey of Northern Emirates

ICBA and EAD jointly prepared the proposal *Soil Survey of Northern Emirates* for approval and funding by the Abu Dhabi Executive Council (ADEC) to provide digital soil information to aid in broad land use planning and agricultural expansion in the Northern Emirates.

The survey will utilize Geographic Information Systems, satellite image processing and the Abu Dhabi Soil Information System (ADSIS) to produce state-of-the-art soil information. The project will be completed at a scale of 1:50,000 using soil survey standards of the United States Department of Agriculture (modified to fit Northern Emirates conditions) to generate maps: soil, thematic, irrigated agriculture suitability, salinity, and current land use. ADSIS will be used for the storage, processing, retrieval and management of soil-related information.

International Conference on Soil Classification and Reclamation of Degraded Lands in Arid Environments and Launch of Abu Dhabi Soil Survey Report

In order to ensure the widest dissemination of the research findings of the Abu Dhabi Soil Survey, it is planned to hold an international conference in 2010 on "Soil Classification and Reclamation of Degraded Lands in Arid Environment". The conference will also provide the forum for the launch of the Abu Dhabi Soil Survey Report.

In 2009 the scientific committee chaired by ICBA invited the international scientific community through the first announcement and call for abstracts to participate in the conference planned for 17-19 May 2010. The concurrence of the international conference and launch of the Report will provide an excellent opportunity for the international scientific community to share soil management strategies leading to proper land use management, and reclamation of degraded land in arid and semi-arid environments.

At the ICBA Research Station

Improving plant productivity through genetic diversity

Genetic diversity contained in the germplasm assembled at ICBA has over the last ten years continued to form the basis to improve the productivity of salt-affected areas. The initial focus has been on assembling germplasm of salt-tolerant forages and their morpho-agronomic characterization and preliminary evaluation for adaption, yield potential and tolerance to prevailing abiotic stresses such as salinity.

Such research helps in the identification of promising germplasm for further utilization through applied research. In recent times, the program has also started to acquire and conserve germplasm of high value crops such as vegetables and ornamentals to study their adaptation to local conditions and tolerance to marginal environments and disseminate the germplasm to the national programs for research and other uses.

Germplasm acquisition and coservation

In 2009, 43 accessions of vegetable crops were acquired from various sources; with this, the total number of accessions conserved in the genebank has increased to 9,458, representing 224 species from 136 countries.

Seed harvested from 258 accessions of 10 species were dried, cleaned and stored in the genebank for further use. Additionally, seeds collected from 36 accessions of 17 native species and three salt-tolerant ornamentals were also processed and stored in the genebank.

Variation in fruit size, color and shape of pepper

Morpho-agronomic characterization

Morpho-agronomic characterization was undertaken on 95 tomato, 92 pepper and 20 okra germplasm

accessions. In all the crops, significant variation was observed, especially for fruit size, shape and color.

Crop diversification

Asparagus – A high value crop for desert farming

The performance of ten accessions of asparagus (*Asparagus officinalis*) was evaluated during the second year of growth in spring 2009. In many cultivars, spear yields obtained are comparable to the yields reported from the productive environments in the tropics, showing that asparagus has considerable potential for cultivation under the desert conditions of the Arabian Peninsula.

Asparagus spears have high nutritional value

Cowpea and guar – Alternative forage legumes

Research on the performance of 23 accession of cowpea (*Vigna unguiculata*) and 10 accessions of guar (*Cyamopsis tetragonoloba*) show that both cowpea and guar have high potential for adaptation in the UAE and because of their low water requirements; they could be excellent alternatives for the water-thirsty forage species such as alfalfa. Both these crops are salt-tolerant and in addition, they are fast-growing high quality forages and have other economic uses, especially as vegetables.

Potential of native desert grasses for forage production

A study was conducted to evaluate the forage yields of 25 accessions of five desert grasses collected from natural habitats in the UAE. The objective of the study was to identify alternative species for possible replacement of the 'thirsty' exotic species in forage production systems in the UAE. The results demonstrate the potential of these native grasses to replace Rhodes grass in local forage production systems. The results also indicate that significant intra-specific variation exists within these species, which could provide the basis for improving productivity through selection.

New ornamentals for saline landscaping

The growth and performance of a wild flower mixture containing ten exotic herbaceous ornamental species was evaluated by irrigating with saline water at 2, 5, 10 and 15 dS m^{-1}. Differences were observed in germination and establishment of the various species in response to the quality of water used for irrigation. Species that germinated in all treatments included *Lobularia maritima, Dimorphotheca aurantiaca* and *Gaillardia aristata*. While *G. aristata* was the most abundant in the control, *L. maritima* was dominant at the higher salinity (15 dS m^{-1}).

The attractive flowers of Dimorphotheca aurantiaca

Among other ornamental species evaluated for their performance, *Camissonia cheiranthifolia, Matthiola incana, M. bicornis, Portulaca grandiflora, Pennisetum villosum* and *Gazania hybrida* appeared to have good adaptation and therefore potential for possible introduction in the region.

Regeneration and dissemination of plant genetic resources

Continued access to germplasm adapted to marginal environments for research and other uses requires that adequate seed stocks are maintained. Most often, the seed samples obtained from the donors or those collected from natural habitats will be in small quantities, therefore necessitating regeneration. Regeneration also becomes necessary when seed viability of individual accessions declines below acceptable limits or the seed quantities fall to low levels due to distribution to users. Furthermore, several of the economically important native plants are poor and unreliable seed producers and 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 is an important requisite to support any extension and developmental activities.

Seed multiplication

Seeds of 258 accessions of 10 species, including the recently acquired vegetable crops such as tomato, pepper and okra, were multiplied in all species. Sowings were performed in October to make use of the favorable winter temperatures for growth. However, okra was also grown as a summer crop by sowing in late February 2009, as the performance of the winter grow-out was found to be unsatisfactory. In all cases, low salinity water irrigation (EC_w 2-3 dS m^{-1}) was used to maximize growth and productivity. Seed yields were generally good except in the winter-grown okra. However, a good amount of seed was obtained from the summer grow-out of okra.

In addition to the crops described above, reasonable quantities of seed were harvested in three of the 10 ornamental species, namely *Lobularia maritima, Dimorphotheca aurentifolia* and *Gaillardia aristata*, contained in a mixture of wild flowers obtained from the USA. Seed multiplication was also undertaken in 33 accessions of 12 native species collected from the UAE in 2008.

A total of 112 accessions of 6 crops and 5 ornamental species was sown for seed increase during October-November 2009. The material included 20 accessions of eggplant acquired recently from the World Vegetable Center, and elite germplasm of tomato and pepper, identified from the preceding grow-out. Germination and initial growth were good in all species.

Tomatoes - variation in fruit characteristics (top) and Seed extraction (bottom)

Seed dissemination

A total of 563 seed samples of 19 species was distributed, including 300 samples to partners in four countries (including 70 Omani barley accessions) and 263 samples to the Agronomy, Halophytes and Soil Science laboratories in ICBA for various trials.

Research into date palm varieties

Date palm (*Phoenix dactylifera*) is of great socio-economic importance and grown widely for fruit production, ornamental, gardening and landscape purposes in the Arabian Peninsula. The area under date palm cultivation has continuously increased in the Arabian Peninsula during the recent decades; in the United Arab Emirates, for example, the number of date palm trees has reached to almost 41 million. Date palms are often grown under saline conditions; a major impact on plant growth.

Mycorrhizal symbioses could enhance the date palms' survival and growth. The symbiosis confers numerous benefits to host plants including improved plant growth and mineral nutrition, tolerance to diseases and stresses such as drought, temperature and salinity. Date palms, possessing a coarse and limited root system, depend highly on mycorrhizae symbioses for water and nutrient uptake.

Two date palm varieties (Khalas and Khenizi) were tested with two mycorrhizae and two fertility treatments over four salinity levels of irrigated water.

In summary, the research outcomes were: plant establishment and growth was better at low fertility conditions compared to high fertility condition; growth of plants with low fertility and with mycorrhizae inoculation was higher than non-mycorrhized plants under similar fertility conditions; and mycorrhized plants had better growth under high salinity conditions compared to non-

Date palm fruiting under saline conditions

mycorrhized plants. Research findings indicated a clear rationale for using mycorrhizae fungi biotechnology for date palm production systems under marginal conditions.

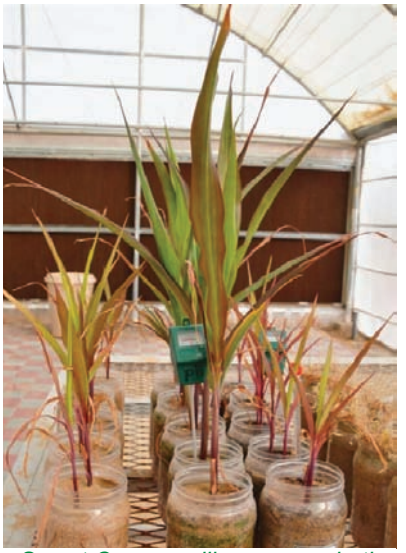
ICBA is also testing the salt-tolerance of elite date palm varieties. Exhibiting a wide range of genetic diversity in the Arabian Peninsula, it is extremely important to develop high yielding, tolerant date palm varieties. The research is designed to improve crop management techniques to maintain optimal functioning and survival of the plants under stress environments. After 7 years of salinity treatments using local and imported date palm varieties, marked effects on the growth and development of 10 UAE and 8 Saudi varieties are evident. Among local varieties, Lulu, Abu-Maan and Khisab showed higher trunk height among other varieties tested over all salinity ranges used. Cultivars Sukkari, Rothan and Shagri showed higher fruit production among the imported varieties tested.

*Soil improvement through the use of Rhizosphere Bacteria, fertilizer and Mycorrhizal fungi to grow Sweet Corn (*Zea mays *var.* rugosa*)*

In March 2009 ICBA with IGZ Germany signed a Memorandum of Understanding for general cooperation; subsequently a Memorandum of Agreement was also signed to jointly start a PhD degree program. Mr Reinhard Seltz was nominated by IGZ to conduct research into the fact that desert sandy soils are infertile due to low clay and organic matter contents and have low water holding capacity.

Under the supervision of the ICBA Salinity Management Scientist, Mr Reinhard's preliminary research made use of a number of inorganic and organic based materials available in the market to improve soil quality through the use of products such as compost, rhizosphere bacteria, mycorrhizal fungi and fertilizers.

A comparison of germination tests revealed a relatively higher germination rate with mixture 1 (sand mixed with 3% organic material, rhizosphere bacteria, fertilizer and mycorrhizal fungus compared with control) and mixture 2 (mix of sand with 3% of compost material from local sources – a common practice in the UAE for farms or landscape areas). The findings are probably due to improved soil properties leading to moisture retention; however, this needs to be validated.



Sweet Corn seedlings grown in the greenhouse on control sand, Mixtures 1 and 2

The same composition of soil mixtures were used in the greenhouse as for germination tests and showed that treatment (Mixture 1) increased the growth of Sweet Corn plants over the growth in other treatments. The increased growth with mixture 1 over other mixtures clearly revealed that the quality of the native desert sandy soils can be improved for agricultural purposes.

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

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. The company had requested ICBA to evaluate its treatment plant and consequently ICBA signed an agreement with the company on 30 September 2007 to conduct field experiments to evaluate the AFG-unit treated water at the ICBA experimental station.

In winter 2008-2009 field experiments were conducted at ICBA for evaluating the treated water. Research findings indicate that treated water is showing relatively better performance over the feed water (i.e. groundwater) especially on plant growth and mortality rate. In the case of seed weight the treated water showed a slightly better result over the groundwater treatment, although the groundwater treatment performed better for both the number of seeds and yield parameters. The treated water, however, did not show a better performance over both mixed and low salinity waters on any tested parameters.

Soil mapping at ICBA

The soil mapping of ICBA research station was undertaken to provide information classified using the USDA Soil Taxonomy and thus enhance the validity of applied research at ICBA transferable to arid and semi-arid Islamic regions covered by ICBA's mandate. The project will be completed in the first quarter of 2010.

QuickBird Remote Sensing Imagery (40 cm resolution) was used to initially prepare a total of 325 potential investigation sites identified at a grid of 50mx50m; and allocated GPS coordinates (longitude-latitude). 150 sites have been investigated and 50 soil samples analyzed; 3 soil types were identified and these will affect potential land-use.

The ICBA landscape is level (existing research plots) and undulating sand dunes. Soil analyses revealed a dominance of fine and very fine sand fractions in the fine earth fraction (<2mm) and the presence of calcium carbonate as a major soil mineral in ICBA soil. The research plots present different salinity classes.

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

Integrating trees and shrubs with the other enterprises on a farm can create additional sources of income and increase the productivity of all enterprises, while protecting soil, water, and wildlife. Agroforestry systems include alley-cropping, silvopasture, windbreaks, riparian buffer strips, and forest farming for non-timber forest products. While they clearly offer economic and ecological advantages, these systems also involve complex interactions, which complicate their management.

An additional benefit of agroforestry system is better nutrient management since absence or loss of nutrients significantly affects the productivity of plants. Under marginalized situations, the success of any type of production system will depend on the cost-benefit ratio and hence a stable biological system that can manage nutrient efficiently adds economic benefits. In general, tree species are grown with other crops and/or other shrubs/forbs. These types of system benefit the different components, mainly through 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 favorable environment conducive for under-storey plants. A trial undertaken at ICBA station for more than four years demonstrates the compatibility between *A. ampliceps* to two salt-tolerant grasses, *Sporobolus arabicus* and *Paspalum vaginatum*, in response to different salinity treatments and fertilizers.

There were no significant differences between the biomass for fertilized and non-fertilized treatments at all the salinity levels for both the grasses.

Integrating trees and shrubs in the Agroforestry system

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

Indigenous plant species are more adaptable to the local environments compared with introduced plant species. 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.

Cenchrus ciliaris *growth under field conditions*

ICBA has taken the lead in collecting local germplasm from different parts of the country. As part of its collaboration with the Ministry of Environment and Water (MOEW), it has initiated a collaborative work on two salt tolerant grasses, the indigenous cultivar of *Lasiurus scindicus* and introduced African variety of *Cenchrus ciliaris*. 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.

ICBA's research indicates that quality is better (less fiber and more protein) with repeated harvest forage; however, the total biomass is reduced due to stress for re-growth of foliage. Soil samples have been collected to correlate the soil moisture and salinity to the overall biomass production.

Screening and selection of Triticale genotypes for salinity tolerance and dry matter production

Triticale (*X Triticosecale*) 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 becoming an important forage and feed crop for cattle, swine and poultry and can be used as an alternate for corn and soybean. Forage yield and quality of triticale is comparable to barley and oat. Recently, farmers have begun growing peas with spring triticale for silage; however, the information on the yield potential and performance of triticale under salinity is scanty. Out of more than 800 genotypes, 40 were advanced to intensive field evaluation under multiple salinity levels.

This project was started at ICBA to screen and identify high yielding grain and forage lines of triticale, selected from more than 1000 accessions over 3 seasoning cycles, that could be used under marginal growth conditions. The technical scope of work for all project tasks was completed.

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

Given declining fresh water availability, the use of marginal water for agricultural crops is of increasing interest. Marginal water provides a solution for all other cropping systems, except the cash crops. In extreme cases, sea water can be used for growing some halophytic crops that have either economic values or for certain kinds of landscaping.

Among the few halophytes, NyPa grass (*Distichlis spicata* var.Yensen 4a), developed by NyPa International, has the potential to be grown with seawater and can be a source of forage/fodder for higher animals. The species has been trialed for over 6 years now as part of an agreement between ICBA and NyPa to test the species in the highly arid climate of the region to research salinity conditions, best management practices and forage quality with seawater irrigation. Successful results will provide opportunities for the region which are near the sea coast and can be converted into production areas.

NyPa grass was grown at different salinity levels (15, 25 and 40 dS m^{-1}) and irrigation treatments (ET_0x1, ET_0x1.25 and ET_0x1.5). No additional treatments or management were added to the trial in 2009. Dry biomass varied between 30-35 t ha^{-1} per year at 40 dS m^{-1}.

Soil salinity also corresponds to the salinity of the irrigation water which confirms that seawater based agriculture is possible with proper management practices and suitable sites.

In 2009 high yielding accessions with promising potential for dry matter and grain production were selected from a previous group of 150 accessions screened under pot culture. Data were collected for dry matter and grain yield.

Evaluation of salinity tolerance and fodder yield of crops: Buffel grass (*Cenchrus ciliaris*), fodder beet and fodder rape/brassica varieties and Barley (*Hordeum vulgare*)

Sustainable functioning of the agro-production systems needs the continuous introduction of new germplasm; especially in arid and semi-arid regions where harsh environmental conditions limit the growth of many crop species. Salinity is one of the major abiotic stresses.

ICBA researchers are conducting a series of projects designed to identify high yielding, tolerant cultivars and germplasm accessions for general cultivation under poor growth conditions like marginal quality irrigation water and saline soils. Seeds will be multiplied and distributed among NARS in the WANA region, crop production technology optimized and information on salt tolerance potential of the genotypes will be exchanged to design future genetics and breeding strategies. The crops under investigation are:

- *Cenchrus ciliaris* (Buffel grass), an important forage grass native to the Arabian Peninsula, is salt-tolerant. During 2009, four harvests were completed. Mean dry matter production varied between 1.5 to 13.8 t ha^{-1}. Grif1639 maintained the highest yield potential for green as well as dry matter production. MAK9 was ranked as the lowest for green fodder as well as dry matter production among all the genotypes.
- Fodder beet and rape/brassica are important winter forage crops with multiple advantages (fast growth, easy seed production, growth at low temperature, considerable salt and frost tolerance, alternative to winter fodder crops). Brassicas, which are high in protein, are high in dry matter digestibility at 85 to 95%, which contrasts well with alfalfa at 70%, and increases the availability of certain minerals.

  20 varieties of fodder beet were obtained from many known suppliers and grown under field conditions at low, medium and high salinity levels at ICBA. The crop was harvested when plants had attained the maximum growth. Stem and leaf yield ranged between 4.8 to 44.5 t ha^{-1}. Yield of fresh tubers varied from 11.6 to 70.8 t ha^{-1}. Monogerm variety Solidar ranked the top in stem/leaf and tuber production. Monogerm varieties showed higher yield in general compared to polygerm varieties.

Variation in tuber color of fodder beet genotypes

- Barley (*Hordeum vulgare*) is one of the most salt-tolerant and fourth most important cereal crop in the world as it is a multi-purpose cereal used for human consumption and animal feed. ICBA is collaborating with ICARDA to work on the improvement of salt tolerance of barley germplasm.

  In 2009, 62 barley genotypes including 4 check varieties were evaluated under field conditions at 5, 10 and 15 dS m^{-1} of salinity levels. Observations so far indicate the presence of wide genetic variability among the germplasm for all growth parameters. Data on vegetative growth stages have been collected while data collection on seed yield and related characteristics is in progress.

Barley growth under field conditions

Optimizing management practices for maximum production of three Atriplex *species under high salinity levels*

Atriplex is valued as a high-protein animal feed. It is one of the most salt-tolerant crops and can withstand harsh growing conditions like marginal quality irrigation water and poor quality soils. However, it contains high concentration of mineral salts. Therefore, it must be fed as a mixture with other grass and/or shrubs to provide a balanced ration. The present project is aimed to study long term, sustainable forage production systems based on salt-tolerant forage shrubs.

Two harvests were completed in the year 2009. *A. lentiformis* proved its hardiness and re-growth potential with the highest survival rate consistently over the 7 years of the project duration (the survival percentage varied between 83.2 and 87.8%).

Highest green biomass was produced at highest planting density by all species. *A. lentiformis* produced the highest green biomass over all treatments. *A. lentiformis* and *A. numularia* performed well at higher salinities and maintained higher yield.

Optimizing management practices for maximum production of two salt-tolerant grasses – Sporobolus virginicus *and* Distichlis spicata

Long-term field studies are important to develop sustainable forage production systems, using non-conventional salt-tolerant crop species and marginal quality water. *Sporobolus virginicus* and *Distichlis spicata* are two highly salt-tolerant grasses. Selected for the present study due to their proven salinity tolerance, nutritional value, and suitability for mechanical harvesting which is important for economical, large-scale production, these species were used to investigate prospective 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.

Both grass species maintained a sustainable production over years over all treatments tested. Results indicated a consistent trend of increased production over increased salinity level. Research findings for forage production during 2009 revealed *Sporobolus virginicus* and *Distichlis spicata* showed a significant dependence of dry matter production over the season, with the yield being highest in summer harvests.

High fodder production of salt-tolerant grasses

Water use and salt balance of halophytic species

Salt and water movements are dynamic processes influenced by soil properties, water resource, climatic conditions and different types of plant species. Understanding of this complex interaction, which could lead to better irrigation and soil management practices, is only possible when research occurs under controlled conditions. Lysimeter studies provide control measurements of these changes in response to changes in soil profile. Furthermore, it provides answers to irrigation volume and scheduling, and leaching fraction needed to flush the salts from the rhizosphere.

Lysimeter studies undertaken at ICBA provide a model to study the different physical and chemical aspects of using drainage water in agriculture. Since the drainage water is expected to have more chemicals such as pesticide residues and salts, re-use of this water has to be complementary with the salt tolerance of plants. A serial biological concentration (SBC) approach tried in USA and Australia successfully has been adapted, where the drainage water is used more than once to grow different salt-tolerant plant species in succession.

3. Capacity Building and Knowledge-sharing Program

ICBA has continued to incorporate into project design wherever possible a significant component of capacity building and knowledge-sharing. To date over 847 individuals from 44 countries have been trained.

None of the research which ICBA undertakes would be possible without the commitment gained from strong partnerships with donors, private sectors and national research and development programs. The major donors are the Islamic Development Bank, International Fund for Agricultural Development (IFAD), the World Bank, USAID, Sultanate of Oman, BADEA (Arab Bank for Economic Development in Africa), the Arab Fund for Economic and Social Development (AFESD), OPEC, European Union and the agencies in the host country: UAE Ministry of Environment and Water and the Environment Agency-Abu Dhabi. ICBA had prepared the proposal for the Arab Water Academy, which is now hosted by EAD and is fully operational.

Workshops

Soil survey and sustainable use of land resources in Abu Dhabi Emirate

The workshop was held at ICBA Headquarters from 1-5 February 2009. As capacity building of the national workforce was a critical element of the project, the project team conducted three intensive week-long training activities over the project duration of 42 months for UAE nationals to enable them to use and update soil information. In the third and final training session, twenty-eight UAE nationals participated along with eminent scientists from Australia, Environment Agency-Abu Dhabi and ICBA in discussing different aspects of soil surveying, land resources use and management. The participants also undertook a field trip to learn how to appreciate the soil and landscape types of Abu Dhabi Emirate.

Soil survey workshop participants

Marginal quality water utilization in agriculture with special reference to Central Asia

Organized by ICBA and the Minister of Agriculture in Ashgabat, Turkmenistan on 30 May 2009, the well-received seminar was held in conjunction with the annual Governors' Meeting of the Islamic Development Bank Group.

ICBA seminar in Turkmenistan

Strategic environmental goals for MOEW

Over two days (10-11 June 2009) ICBA staff hosted and participated in a workshop with representatives from the UAE Ministry of Environment and Water and the Food and Agriculture Organisation to brainstorm strategic goals, set priorities, consider constraints and opportunities for implementation, and formulate recommendations to the Ministry.

National Strategy to combat salinity and protect water resources from pollution and salinity in the Sultanate of Oman

The Workshop was held in Muscat Oman during 4-7 October 2009. Over the three days of the workshop the Omani Ministry of Agriculture and ICBA fleshed out the details and timelines of the work plan, stakeholder consultation targets and mechanisms, and the roles and responsibilities of the working groups.

Oman workshop

Wastewater re-use strategy for Abu Dhabi Emirate

An Expert Consultation Pre-planning Workshop to kick-off the project was held during the 10-15 October 2009 at ICBA. Nine external wastewater sector experts, two official representatives from the Environment Agency-Abu Dhabi, and ICBA scientists contributed to the workshop. Outcomes from the workshop included key messages to be included in the Plan, an outline of annotated reports and the planning schedule of project activities. To be managed by the International Center for Biosaline Agriculture on behalf of the Environment Agency-Abu Dhabi, the main goal of the three month project will be to develop a comprehensive strategy to capture, recycle or reclaim, and use municipal and industrial wastewaters.

Biosaline agriculture technologies in the arid and semi-arid environments

This regional Training Workshop was organized by ICBA and the Kuwait Institute for Scientific Research from 25 to 29 October 2009. The workshop, which was held in Kuwait, also provided the opportunity for the signing by Dr Al-Mutairi, Director General KISR, and Dr Shawki Barghouti, Director General ICBA, of a Memorandum of Understanding to formalize an already strong existing partnership.

Participants of the training workshop in Kuwait

Integrated Strategic Plan for water conservation

ICBA in collaboration with the Ministry of Environment and Water arranged a kick-off workshop on the Integrated Strategic Plan for Water Conservation in UAE on 12 November 2009 at ICBA. The meeting was attended by thirty-four experts and professionals representing different water related institutions, such as the Federal Electricity and Water Authority, Dubai Electricity and Water Authority, Sharjah Electricity and Water Authority, Abu Dhabi Water and Electricity Authority, and municipalities, universities and private companies. The main outcomes of the workshop included a thorough exploration of the main issues and possible solutions for conserving water resources in UAE. A team of ICBA experts in collaboration with well-known international experts will prepare the study for the benefit of the Ministry of Environment and Water. The main goal of the study is to position the UAE to better manage water policy and strategy, cross-sectoral coordination and regulation.

Design and Management of Irrigation Systems

Sultan Qaboos University (SQU) of Oman organized this workshop during 23-25 March 2009. The SQU invited international resource persons including Dr Nurul Akhand, Irrigation Management Scientist of ICBA, who discussed irrigation management under saline environments.

International Conference on Soil Classification and Reclamation of Degraded Lands in Arid Environments and Launch of the Abu Dhabi Soil Survey Report

The conference will be held from 17 to 19 May 2010 in Abu Dhabi under the patronage of His Highness Sheikh Hamdan bin Zayed Al-Nahyan, the Ruler's Representative in the Western Region Abu Dhabi and Chairman of the Environment Agency-Abu Dhabi. The Abu Dhabi Soil Survey Report will be launched at the Conference, which is co-organized by Environment Agency-Abu Dhabi and ICBA. The deadline for abstract submission was 30 November 2009.

Arab Water Academy

A major focus for ICBA's capacity building activities has been bringing into being the Arab Water Academy. Following the identification of priority areas at the July 2008 workshop, and working closely with doners susch as USAID, the World Bank and EAD, four learning programs were developed. These areas were:

- Water Governance
- Water Diplomacy
- Utility Reform
- Non-conventional water use

The first two programs were delivered in the second half of 2009. Draft learning material for the Utility Reform program was developed in collaboration with the World Bank and an outline schedule was designed for the non-conventional water use study-tour. A fifth program was delivered on 'Remote sensing for Water Management' as part of an ongoing ICBA/USAID project.

Water Governance for Future Leaders: concepts, practices and analysis of water governance (Module 1)

The workshop attracted 24 people in middle management positions operating in ministries, government agencies, the private and public sectors, and academic institutions in the water sector ranging across seven countries in the region. Funded by USAID and the Environment Agency-Abu Dhabi, Module 1 was held from 28 June to 2 July in Abu Dhabi and Module 2 from 15 to 19 November in Abu Dhabi.

Water Diplomacy: Sharing water: Sharing benefits

The course was held from 11 to 13 October 2009 in Abu Dhabi. This senior executive level course was attended by representatives of Ministries of Foreign Affairs and Ministries of Water from 18 different Arab states. The course was a focused consideration of the challenges and possibilities involved with transboundary aquifers and rivers in the Middle East.

Applications of Remote Sensing for Water Management

Funded by USAID and Environment Agency-Abu Dhabi, the course was held from 25 to 27 October 2009 in Abu Dhabi. Data on water resources is scarce in many states, yet images from satellite images can today provide important information on both surface and groundwater flows. This workshop brought together managers from a number of remote sensing centers in the region. The learning was led by NASA scientists from Goddard Space Flight Centre who explained the current and future possibilities in this subject.

ICBA Director General addressing the participants at water governance course

Water Diplomacy course

Conferences

Integration of sustainable agriculture, rural development, and ecosystems in the context of food insecurity, climate change, and the energy crisis

This International conference was held in Agadir from 12-14 November 2009 in Agadir Morocco. Dr Shabbir Shahid, ICBA Salinity Management Scientist, chaired a panel discussion on the sustainable use of land and water resources and at the conclusion of the conference synthesized and presented in the closing session the conference report and recommendations.

Agadir conference

Science and Technology Conference for the OIC institution

The conference took place in Damascus Syria from May 24, 2009. Organized by COMSTECH and the Syrian Ministry of Science and Education, the conference was held concurrently with the 36th Council of Foreign Ministers Conference of OIC Member States. Dr Shoaib Ismail represented ICBA and presented an overview of the potential of marginal/saline water in agriculture for under-developed states of the OIC.

Genomics of Salinity

Dr Nanduri Rao, ICBA Plant Genetic Resources Scientist, was invited to the annual symposium on salinity of the Australian Center for Plant Functional Genomics that was held from 16-18 November 2009 in Adelaide, Australia. Dr Rao joined over 120 other international and national delegates at the 2009 ACPFG Genomic Symposium to discuss his work on the large scale field selection of plants in Dubai.

Water Tech 2009

The International Quality and Productivity Center (IQPC) invited Dr Nurul Akhand, Irrigation Management Scientist, ICBA to give a presentation on “Successful Irrigation Planning and Demand Management” in the conference held on 4-5 May 2009 held in Abu Dhabi.

Library and Information Management

ICBA’s collection of printed and electronic material has been developed in order to make information resources accessible to Center staff, partners and members of the ICBA networks. Nearly 40,000 images relating to ICBA projects and activities are available for Center activities and publications. The Biosalinity Newsletter is distributed to more than 1000 individuals in about 100 countries. The daily media (major local and regional newspapers in English and Arabic) is monitored to maintain awareness of topics related to ICBA mandate.

Memoranda of Understanding

To establish formal organizational links with partners, Memoranda of Understanding (MoU) were signed during 2009 with the following parties:

Oman: His Excellency Khalfan bin Saleh Al Naabi, Deputy Minister of Agriculture, Oman, signed an agreement on 4 January with Dr Shawki Barghouti, ICBA Director General, to manage a project to formulate a national strategy for Oman to combat salinity and protect water resources from pollution and salinity.

Germany: ICBA and IGZ formalized a MoU in February. Consequently Mr Reinhard Seltz was nominated to undertake a PhD at ICBA to test soil conditioners to improve the soil quality of UAE lands.

BITS, Pilani-Dubai: ICBA and the Birla Institute of Technology and Science (BITS), Pilani-Dubai, formalized their relationship by agreeing on specific areas of collaboration.

ECO Solutions AG, Zurich, Switzerland and ICBA signed a MoU on 26 April 2009 for field testing and demonstration of water technologies including sub-surface pipe irrigation equipped with fertigation technology, and small-scale water treatment plants at ICBA.

Kuwait Institute for Scientific Research (KISR) and ICBA signed on 25 October a Memorandum of Understanding to formalize an already strong existing partnership.

ICBA and KISR Director Generals after signing the MoU

Networking

Global Biosalinity Network. GBN promotes collaboration between individuals involved in research and development on biosaline agriculture. An on-line registration form is available at www.biosaline.org/join.cfm

Inter-Islamic Network for Biosaline Agriculture. INBA was established during the 10th General Assembly Meeting of the Standing Committee on OIC member 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 Organisation of Islamic Countries (OIC) in the field of biosaline agriculture. Dr Shoaib Ismail serves as Coordinator for the network.

INBA targets national, regional, and international institutions in developing and developed countries, and aid agencies, in particular those in the Organization of the Islamic Conference (OIC) member states. News and other updates on INBA and other Inter-Islamic network activities are posted at INBA's web page (see ICBA website: www.biosaline.org). In addition, INBA news is published in the ICBA newsletter Biosalinity News.

Publishing

The following ICBA publications were produced during 2009:

- *ICBA Annual Report 2008 – Highlights* (English and Arabic)
- *ICBA Annual Report 2008 – Technical Report* (English)
- *Biosalinity News* Vol. 10 No. 1 (English and Arabic)
- *Biosalinity News* Vol. 10 No. 2 (English and Arabic)
- *Biosalinity News* Vol. 10 No. 3 (English and Arabic)
- 2010 Calendar (in English, Arabic and French)
- *Research at ICBA Agricultural Station* Brochure (English and Arabic)
- *The United Arab Emirates and ICBA: Partnership in Action* Brochure (English and Arabic)
- *ICBA Around the World* Brochure (English and Arabic).

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Shahid SA, Dakheel AJ, Mufti KA and **Shabbir G**. 2009. Automated in-situ salinity logging in irrigated agriculture. European Journal of Scientific Research. 26(2): 288-297.

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Media

Media coverage of ICBA was generated by distributing newsletters, annual reports and news releases. The local Arabic and English press covered ICBA regularly.

ICBA also received requests for articles and features for a variety of regional and international newsletters and magazines. Articles submitted were published in the Landscape (a Dubai magazine) and others.

Administration and Finance

Administration and Finance

Board of Directors

ICBA Board of Directors (BoD) held one meeting in May 2009 under the chairmanship of Mr Fawzi al Sultan. At the meetings the BoD attended to strategic matters regarding the ICBA Strategy Plan 2008-2012, Resource Mobilization, ongoing projects, new proposals, ICBA future funding and the Audit Report 2008.

Meeting of Board of Directors in June

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 maximize their opportunities to meet the scientific team and learn about the Center's work.

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
- Bio MYC (Germany and Dubai office)
- Provision of information and lectures to students from the UAE University
- McGill University, KSU, Australian universities and institutions.

Human Resources

During the year, one staff member left the Center:

1. Mr Yousif Salim Hedar — Research Technician

From January to December 2009, three new employees joined ICBA:

1. Mrs Irene Bolus — General Accountant
2. Mrs Henda Mahmoudi — Visiting Scientist
3. Dr Khalil Ahmed Ammar — Hydrogeologist

Due to budgetary constraints, the following posts remained vacant during the year 2009:

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

ICBA intends to fill these positions in 2010 and to consider recruiting additional staff with expertise in disciplines that reflect the research thrusts of the Center's Strategic Plan 2008-2012.

ICBA Management has started implementing a Performance Appraisal and Evaluation System for promotion and incentive purposes.

Information Technology

System Enhancement

1. Installation of wireless network covering ICBA building using N-Technology that supports MIMO (Multiple Input, Multiple Output) utilizing multiple radios to transmit and receive at the same time to maximize wireless networking performance.
2. Fixing the firewall configuration to allow proper Windows update.
3. Upgrading email software from Exchange Server 2007 RTM to Exchange Server 2007 Service Pack1 and then updating by Rollup 5, thus realizing many enhancements.
4. Moving all users from the old mail system to the new one and activating the new outlook web access (OWA), thus equipping all staff with enhanced capabilities to improve business productivity.
5. Establishing a disaster recovery system for all PC models after installing the standard applications with latest updates.
6. Upgrading most of the old computers to become faster and reliable. Furthermore 10 PCs from the computer lab have been upgraded to benefit consultants hired on a temporary basis by ICBA.
7. Fixing all faulty UPS units.

New Hardware/Software Purchases

1. Adding a new file server with much higher space capacity (1 TB) than the old one (Windows 2000) with a new server with quad processor and 800 GB of free space. This new environment has enhanced printing services.
2. Upgrading the accounting software Peachtree 6.0 (1998) to Peachtree Premium Accounting 2009.
3. Replacing the current Etisalat ADSL router with a new professional one from Linksys (a division of Cisco), that provides many features preventing attack and enhancing internet speed.
4. Providing new color laser printers with duplex capability, FAX, Copier, and scanner and new heavy duty laser printer that supports duplex capability.
5. Acquisition of new desktops and laptops.

Facilities Management

As a continuation of the facilities management program, a new plan for work space utilization was established in order to provide additional safe and healthy working environment for ICBA staff and the visiting scientists.

The additional work areas include offices, laboratories, and parking spaces for the staff and visitors.

Greenhouses 1 and 2 are being converted to accommodate the general laboratory equipment and the plant genetic resources lab. The plan also includes modifying the training section of the auditorium building to become a VIP conference room equipped with audio/visual and video conferencing system. As part of the field re-arrangements, a new parking shed for farm equipments and machineries will be erected between the farm general store and the labor camp. The labor camp will be renovated with new dining-room and some changes in the landscaping and surrounding area. A new sweet water line (fresh water) to the site for utility use will be introduced.

As per ICBA's policy, the preventive maintenance program was regularly conducted with close monitoring to minimize any sudden or unexpected break-downs.

FINANCE

Budget and Expense analysis for 2009

The external auditors have issued their report on the Center's financial statement for the year 2009. The following audited statements show the grants and contributions, programs and expenses, as well as the Center's financial position at the end of the year.

International Center for Biosaline Agriculture, Dubai, United Arab Emirates *Audited Statement of Activities for the year ended in December 31, 2009 (In United States Dollars)*		
	2009	**2008**
Grants and contributions		
Grants unrestricted	4,407,146	4,285,315
Contributions for training courses and research	1,737,638	1,116,908
Other income	12,627	4,078
Total grants and contributions	6,157,411	5,406,301
Programs and other expenses		
Employees' salaries and benefits	(3,263,536)	(3,234,580)
Expenses on training courses and research	(1,737,638)	(1,116,908)
Travel	(51,686)	(121,026)
Depreciation of property and equipment	(380,853)	(384,410)
Supplies and utilities	(212,678)	(224,873)
Maintenance	(139,683)	(157,101)
Contract services	(47,134)	(88,084)
Board of directors expenses	(62,719)	(42,129)
Assets written off	(144,798)	-
Other expenses	(116,686)	(37,190)
Total programs and other expenses	**(6,157,411)**	**(5,406,301)**
Excess of revenues over expenses	**-**	**-**

International Center for Biosaline Agriculture, Dubai, United Arab Emirates *Audited Statement of Financial Position as of December 31, 2009 (In United States Dollars)*		
	2009	**2008**
Assets		
Current assets		
Cash and cash equivalents	6,143,069	4,164,575
Due from employees	3,298	11,598
Prepayments	38,682	76,783
Other receivables	5,570	-
Total current assets	**6,190,619**	**4,252,956**
Non-current assets		
Property and equipment	5,879,456	6,313,761
Total Assets	**12,070,075**	**10,566,717**
Liabilities and net assets		
Current liabilities		
Donors payables	907,281	658,449
Accruals and other payables	401,126	340,577
Non-current liabilities		
Provision for employees' end of service indemnity	192,128	127,581
Total Liabilities	**1,500,535**	**1,126,607**
Net Assets		
Unrestricted Un-appropriated		
- Property and equipment	5,879,456	6,313,761
- Others	378,621	-
Unrestricted - Appropriated	2,177,143	1,798,817
Temporarily restricted	2,134,320	1,327,532
Total Net Assets	10,569,540	9,440,110
Total Liabilities and Net Assets	**12,070,075**	**10,566,717**

Acronyms and abbreviations

AFESD	Arab Fund for Economic and Social Development
BADEA	Arab Bank for Economic Development in Africa
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
NCARTT	National Center for Agricultural Research and Technology Transfer (Jordan)
NPC	National Prawn Company (Saudi Arabia)
OASE/ODE	Organization for Agriculture in Saline Environment/Ocean Desert Enterprises
OFID	OPEC Fund for International Development
OPEC	Organization of the Petroleum 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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