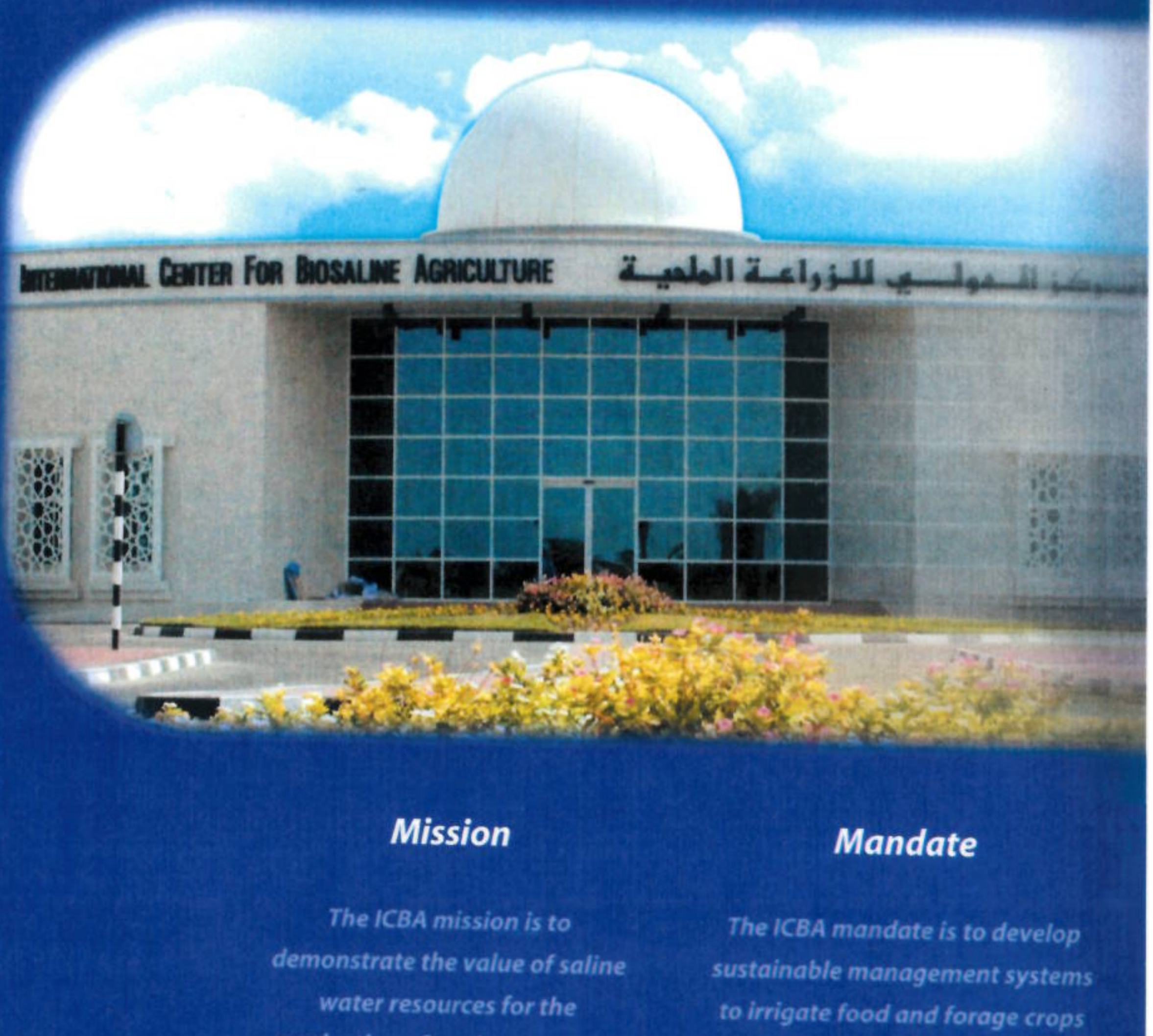
ICBA

Annual Report

YEAR 2001 1421/1422 H

INTERNATIONAL CENTER FOR BIOSALINE AGRICULTURE

About ICBA



Mission

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

Mandate

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

The International Center for Biosaline Agriculture (ICBA) *is an applied research and development (R & D) Center located in Dubai, United Arab Emirates (UAE). The Center was established with financial support from the Islamic Development Bank (IDB) and additional support from the Organization of Petroleum Exporting Countries (OPEC) Fund for International Development, the Arab Fund for Economic and Social Development (AFESD), the Dubai Municipality and the Government of the United Arab Emirates. The construction of the facilities commenced in 1997 and was completed in 1999. The Center began operations in September 1999. ICBA's objective is to develop and promote the use of sustainable agricultural systems that use saline water to grow forages, field crops, vegetables, fruits and trees. The Center does not intend to duplicate work already done by scientific institutes in salinity research, but will act as a focal point for technology development and genetic resource exchange for geographical areas facing problems of salinity and depletion of scarce fresh water. It is expected that the technologies the Center develops will be of global value and will help farmers facing problems of saline soils or salt-water irrigation to improve their production of food and feed in a sustainable manner.*

ICBA is initially focusing on problems faced by countries of the Gulf Cooperation Council, followed by other Islamic countries as well as other parts of the world grappling with increasing saline conditions.

The Center is unique in having modern, sophisticated facilities dedicated solely to the development of saline agriculture. It has also recruited renowned scientists working in various disciplines of saline agriculture to implement its R & D Program. The Center is mobilizing its resources to become a 'center of excellence' in the field of biosaline agriculture and intends to serve its clientele across the world.

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Foreword

Meeting water demand for human activities and ecosystems with dwindling freshwater resources is becoming increasingly challenging in many IDB-member countries, most especially in semi-arid and arid regions, where 80-90 percent of water is used for irrigated agriculture and livestock production. These countries are entering a "vicious circle" in which lack of water is constraining economic growth and development that will, in turn, limit investment in new water supplies and conservation. Consequently, the need to increase agricultural productivity per unit of water has never been so critical to improving the lives of millions of people, especially the poor, throughout the member countries.

This worrisome situation coupled with the rising problem of salinity, which according to the latest reports affects, in varying degrees, nearly half of the world's total irrigated area, led IDB, in partnership with the UAE Government, and with the support of the Arab Fund for Economic and Social Development and the OPEC Fund for International Development, to launch the International Center for Biosaline Agriculture (ICBA) to harness the vast saline water resources available in many member countries.

ICBA's noble mission is greatly challenging, indeed. To fulfill it, ICBA must work hand in hand with the concerned partners in member countries, who, in turn, should fully support it and help shape its programs and activities in order to make them responsive to their needs and concerns. ICBA's long-term achievements and sustainability will largely depend on this.

I firmly believe that ICBA with the support of all its partners, will continue to have an effective role in the on-going quest for solutions to better manage water resources in member countries, in order to satisfy domestic, agricultural, industrial and ecological water requirements.

Consequently, I wish to invite all concerned policy- and decision-makers in the member countries to extend support to this promising institution to enable it to achieve its noble objectives.

In conclusion, I wish to reiterate, on behalf of the ICBA Board of Trustees, our most sincere thanks to the host country, the United Arab Emirates, for the continuous support being provided to ICBA. Similarly, I wish to express our most sincere gratitude to both the Arab Fund and the OPEC Fund for their unequivocal support to ICBA's on-going activities.

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

Preface

This Annual Report records ICBA's second year of operations. This report confirms that ICBA is on course to play a pivotal role in promoting biosaline agriculture globally, thanks to continued support from our founding donor, the Islamic Development Bank, and its member countries, as well as regional and international donors.

Although it is often stated that reducing poverty, increasing food production and protecting natural resources are long-term endeavors, centers such as ICBA are challenged to solve immediate problems and develop technologies with a short-term payoff. Thus, in tackling the challenges of biosaline agriculture, ICBA utilizes a mix of strategies to address both present and future needs for sustainable agricultural production systems using saline water or in lands affected by salinity.

In 2001, ICBA made significant progress in implementing the Center's Strategic Research Plan 2000 - 2004. Notable highlights of 2001 follow.

- *ICBA collaborated with leading international and national research and development organizations, to test and evaluate salt-tolerant crops and forages, and halophytes. Recommendations for selection for further evaluation were made based on tests of over 70 salt-tolerant plants in the field.*
- *ICBA held training courses and workshops on biosaline agriculture. Over 100 technical staff from Gulf Cooperation Council (GCC) countries, the Middle East, Africa, and West Asia participated.*
- *In March 2001, ICBA convened the "First International Symposium on Biosaline Agriculture in Gulf Cooperation Council countries" in Dubai, United Arab Emirates. The 3-day event attracted 160 participants from 28 countries and fostered consensus on priority actions to advance biosaline agriculture.*
- *ICBA forged important links with future collaborators at the national, regional and international levels. Six Memoranda of Understanding were signed in 2001.*
- *ICBA completed its Resource Mobilization Plan 2000-2009 and submitted it to ICBA's founding donor, the Islamic Development Bank.*
- *ICBA was recognized as a partner of the Consultative Group on International Agricultural Research (CGIAR); as an Associate Member of the Asia Pacific Association of Agricultural Research Institutions (APAARI); and as a Consulting Partner of the Global Water Partnership (GWP).*
- *ICBA successfully secured grants and contractual work from international donors and from both the private and public sectors.*

With continuing support, the Center, through its mandate of promoting biosaline agriculture, will contribute significantly to increasing agricultural productivity as well as to improving livelihoods in many poor countries. I would like to take this opportunity to express thanks and appreciation to the host country, the United Arab Emirates, for all the help, support and encouragement it provides to ICBA. The cooperation received from all relevant agencies and organizations in the UAE is exemplary in all respects. I am confident it will continue for many years to come.

Dr. Mohammad Al-Attar
Chairman, Board of Directors, and
Director General, ICBA

Board of Trustees

Board of Directors

The governance and policies of the International Center for Biosaline Agriculture are in the hands of the Center's Board of Directors, a nine-member committee appointed by the Islamic Development Bank and the Center's host country, UAE. ICBA's Director General, Dr. Mohammad H. Al-Attar, chairs the Board of Directors. The Board of Directors is responsible to the Board of Trustees, which is chaired by the IDB President, Dr. Ahmad Mohamed Ali.

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Technical Programs

HIGHLIGHTS

In 2001, its second year of operations, ICBA's core projects continued as planned and several others were adde to meet the Center's mandate and mission. These projects were progressing well as ICBA staff continued t validate the salt-tolerance of germplasm acquired and establish their role within a sustainable productio management system. Further seed samples of salt-tolerant materials were acquired and the geneban swelled to over 6,000 accessions.

A collaborative project with the Environmental Research and Wildlife Development Agency (ERWDA) o mangroves in the UAE commenced in 2001. A date palm project involving 10 elite cultivars began at ICBA i collaboration with the Ministry of Agriculture and Fisheries (MAF), UAE. Eight ICRISAT pearl millet genotype and six sorghum varieties from Oman showed outstanding growth under saline irrigation at ICBA. Details o these collaborative activities follow.

ICBA made several important formal links with its future collaborators, at the national, regional an international levels. Memoranda of Understanding (MoUs) were signed with:

** Environmental Research and Wildlife Development Agency (ERWDA), UAE*
** King Abdulaziz City for Science and Technology (KACST), Kingdom of Saudi Arabia*
** Ministry of Agriculture, Animal Wealth and Irrigation, State of Khartoum, Sudan*
** Arab Authority for Agricultural Investment and Development (AAAID), Khartoum, Sudan*
** Arab Organization for Agricultural Development (AOAD), Khartoum, Sudan*
** International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India*


ICBA's main building

ICBA was inducted as an associate member of the Asia Pacifi Association of Agricultural Research Institutions (APAARI) and a a consulting partner of the Global Water Partnership (GWP).

ICBA successfully organized an international symposium o "Prospects of Saline Agriculture in the Gulf Cooperation Counci (GCC) Countries" in March. Three international training course were held at ICBA, primarily benefiting the GCC countries.

A proposal seeking support for training and networking activities for $200,000 over two years at ICBA was submitted to

the OPEC Fund for International Development. Although the funds were not received during the calendar year, the grant was approved by the donor toward the end of 2001, and the activities were set to commence in 2002. The Ruler's Court of Dubai decided to waive the cost of water used by the Center for its research and development activities. ICBA prepared its Resource Mobilization Plan 2000 - 2009, which was presented to its major founding donor, the Islamic Development Bank.

Several publications were produced. These included the first ICBA Annual Report 2000, ICBA Strategic Plan 2000-2004 and two issues of the Center's newsletter, Biosalinity News. *Additionally ICBA staff presented/ published 15 papers at regional and international scientific meetings.*

INTRODUCTION

ICBA focuses on strategic, applied, and adaptive research. Strategic research aims to produce a better understanding of the processes related to regionally and internationally significant problems of using saline water in agricultural production and greening. ICBA's applied research employs existing knowledge and innovative technology to solve problems of widespread importance in saline irrigated agriculture. ICBA's adaptive research aims to interpret the problems of its partners and beneficiaries, identify appropriate solutions and relevant prototype technologies, and fit these to the particular circumstances of the partner or beneficiary.

The implementation of such research activities at the regional level and across a broad spectrum of biosalinity-related issues poses major challenges. It is often difficult to reconcile the location-specific focus of our partners with ICBA's emphasis on international public goods research. Effective research partnerships are the principal means through which ICBA's outputs of strategic research will be locally adapted and evaluated.

ICBA's Research Programs

Broadly, ICBA's research structure consists of four technical programs:

- *Plant genetic resources*
- *Production and management systems*
- *Communication, information management and networking*
- *Training, workshops and conferences*

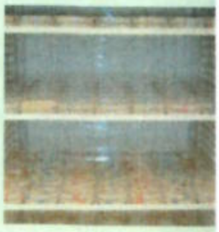
Within each of these programs, ICBA's work program is organized through a series of projects and activities, each with clearly defined problems (research) or needs (communication, information, networking, training and workshops) that are addressed, and with potential outcome(s).

Plant Genetic Resources

The Plant Genetic Resources Program introduces, collects, characterizes, evaluates, stores, and distributes potentially salt tolerant plants.

Objective

Promote agricultural production, environmental greening and revegetati under saline conditions by introducing, selecting, storing, and distributi potentially salt-tolerant plants, including halophytes.



CORE PROJECTS

Acquisition, Collection and Conservation

ICBA continued to acquire new species and accessions from different sou (Australia, Germany, ICARDA, ICRISAT, Oman, UAE and USA) of salt-tolerant potentially salt-tolerant germplasm. At the end of year 2001, the total numbe accessions available in ICBA's genebank reached more than 6600. The accessi represent 200 species, which belong to 63 genera and 16 families. The germplasm mainly compr forage grasses (43.1%) and forage legumes (39.5%). Forage shrubs of the *Chenopodiaceae* far represent 3.2%, and the remaining 14.2% is made up of the other thirteen families.

The ICBA germplasm collection (Appendix 1) originated from 80 countries spread over all the continents. However, a sizable part of the collection (30%) had its origins in West Asian and North Afri countries.

Seed Increase of Salt-tolerant Germplasm

In the Laboratory

Screening for salinity tolerance at the germination stage. For plant species with a large numbe accessions, a procedure of screening for salinity tolerance at the germination stage was adapted narrow down the number of accessions that will be evaluated on a wider field or controlled scale. following species and number of accessions/species were screened for salinity tolerance at 20 dS m

- Sorghum (302 accessions)
- Safflower (640 accessions)
- Triticosecale (500 accessions).

As many as 70 representative accessions of seven clusters of the Omani landrace barley were screened at 30 dS m^{-1} for salt tolerance.

The same 70 accessions of Omani landrace barley were evaluated for their protein and lysine content; their genetic diversity was also assessed based on allelic variability at eight isozyme loci. This part of the evaluation was carried out in cooperation with Yarmouk University, Jordan.

In the Field

Several species from the materials acquired in ICBA's genebank were selected as priority species for seed increase to be used in subsequent salinity tolerance evaluation procedures. Field seed increase will also serve in assessing growth potential and general adaptation to the local environmental conditions. This will facilitate the selection of accessions that will be used in field evaluation. The following species/accessions were planted for seed increase:

Cenchrus ciliaris (822 accessions): Ten single seedlings per accession were planted in the field. However, as a warm-season forage grass, establishment, growth and development of the plants were not satisfactory for most part of the winter season. Some 500 accessions of the species were able to set seed in the field, but most seeds were small and light in weight due to the prevailing harsh environmental conditions. Seed viability will be tested to ensure that only viable seed will be stored in the cold storage rooms and provided to ICBA scientists for field planting.

Some 300 accessions that either did not grow well or did not produce seed in the field were transplanted into pots in the greenhouse. Earlier in a preliminary experiment, some *C. ciliaris* accessions were successfully grown in the greenhouse and these produced large amounts of viable seed. The same procedure will be applied to alfalfa germplasm. Seeds of some accessions were collected both from the field and the greenhouse experiments. The seed production of *C. ciliaris* was very poor in the field while the accessions grown in the greenhouse produced a good quantity and quality of seed.

Cenchrus ciliaris seed increase and screening under field conditions, fall 2001

All accessions were replanted during the fall in a well-prepared field. All have been successfully established and showed excellent growth under local environmental conditions.


Barley seed increase and screening under field conditions, fall 2001

Omani landrace barley (1000 single-spike selections): Th selections, representing seven unique clusters of Oma landrace barley, were planted in the field for see multiplication and evaluation of their morphological trait Collected information was preserved in a database. Aft successful germination (~80%), only a small fraction of th plants (~5%) set seed. This was due to many interactin factors including soil spatial variability and lack of uniforr spatio-temporal water application.

These problems were corrected and a new field wa developed with the proper irrigation and fertilizer input. In November, 2080 accessions of Omani barle lines and improved barley lines from ICARDA's breeding program were planted in the new field. All line were fully established and showed extremely good growth given the harsh environmental conditions ir the region. This work is expected to lead to the identification of barley lines with good adaptation to harsh hot-dry environments and with favorable production traits.

Sorghum bicolor (302 accessions): Seeds were directly sown in the field; germination and seedling development were weak due to the same reasons mentioned above. Accessions that showed better germination under high levels of salinity were replanted during fall 2001 for seed increase.

Forage species (474 accessions): *Medicago sativa* (the top 193 salt-tolerant accessions), pearl millet (22 accessions), and *Lathyrus* sp. (259 accessions) were grown at ICBA. Low temperatures during winter delayed germination and development of most accessions. Planting will be redone during early spring in 2002.


Safflower seed increase and screening under field conditions, fall 2001

Carthamus tinctorius (640 accessions): The oil-crop commonly known as safflower is a potential forage crop under the right soil and climatic conditions. These accessions will be evaluated for both seed and biomass production under the prevailing environmental conditions at ICBA station.

Sporobolus virginicus, five months after transplanting

* Determine the appropriate fertilizer regime for maximum production.
* Assess the nutritional value of the two species in respons to the different salinity, irrigation and fertilizer levels.

Applications of the different management inputs ar currently underway. Valuable results are expected to b generated from this project on the economic feasibility an sustainability of forage production systems that are based o the use of non-conventional salt-tolerant grasses.

Optimizing management practices for maximum production of three Atriplex species (**Atriplex halimus, A. nummularia, A. lentiformis**) *under high salinity levels*

Establishment of research and demonstration field of three *Atriplex* species

Atriplex field three months after transplanting, growing at different densities

Nearly 5000 cuttings from the three species of *Atriplex* (sal bush) were produced during July. Between October an December, a 1.5-hectare research and demonstration fiel was established. Three factorial experiments wer implemented, one for each species. Several productio factors were used, including: three salinity levels (10, 20 an 30 dS m^{-1}), three irrigation levels (ET_0, 1.5 x ET_0 and 2 x ET_0 three population densities (2 x 2 m, 2 x 1.5 m and 2 x 1 m) an six different fertilizer treatments to determine the fou objectives similar to those of the two salt-tolerar grasses/studies and additionally to determine the optimu plant density for maximum production under all salinit levels applied.

All treatments are currently underway. Similar to the gras research, this project is expected to yield valuabl information and scientific evidence on the productio potential, feasibility and long-term sustainability of forag production systems that are based on the use of salt-tolerar forage shrubs. The grass and shrub systems are viewed t complement each other in providing forage materials f livestock.

Production and Management

The Production and Management Systems Program develops irrigation and land management systems that use saline water for crop production and evaluates field, forage, horticultural, and halophytic crop production under irrigation with water ranging from moderately to highly saline.

Field and Forage Crops

Objective

Evaluate and select new and improved varieties of field and forage crops and investigate improved management techniques for their ability to sustain economic production under irrigation with moderately to highly saline water.

CORE PROJECTS

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

More than 70,000 seedlings of each of the two grass species were produced by vegetative propagation for establishing large-scale research and demonstration fields. Two factorial experiments were implemented in the field during October-December, on about 6000 m^2, to evaluate the effects of several management inputs on the productivity of the two salt-tolerant grasses and for long-term monitoring of the biosaline agriculture system. Three salinity levels (10, 20 and 30 dS m^{-1}), three irrigation levels (ET_0, 1.5 x ET_0 and 2 x ET_0) and four fertilizer treatments of NPK (0, 40, 80 and 120 kg ha^{-1}) were used to:

Distichlis spicata, five months after transplanting

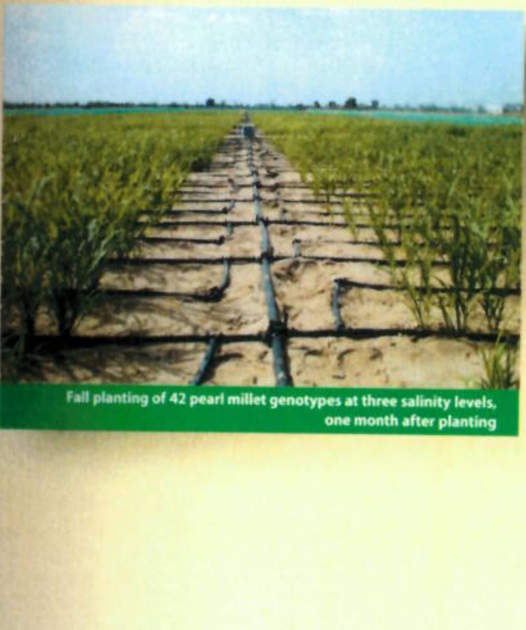
* Determine yield potentials of the two grasses when grown under high salinity levels, and the level at which the productivity remains economical.
* Determine the optimal irrigation level for maximum production of the two grasses and the level that minimizes salt accumulation in the soil.

COLLABORATIVE PROJECTS

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

Objectives

- *Evaluate yield potential (seed and total biomass production) of 42 pearl millet varieties grown under local environmental conditions and three salinity levels (5, 10 and 15 dS m^{-1}).*
- *Compare the response of the same set of genotypes to salinity during fall (October-November) and spring (March-April) planting.*
- *Select genotypes that are suitable to fall, spring or both planting seasons.*
- *Select the most promising accessions for forage or seed production or dual purpose for further evaluation.*
- *Compare the chemical composition of selected high and low yielding genotypes.*
- *Produce sufficient seed for further research and testing at selected national agricultural research systems in the region.*



Fall planting of 42 pearl millet genotypes at three salinity levels, one month after planting

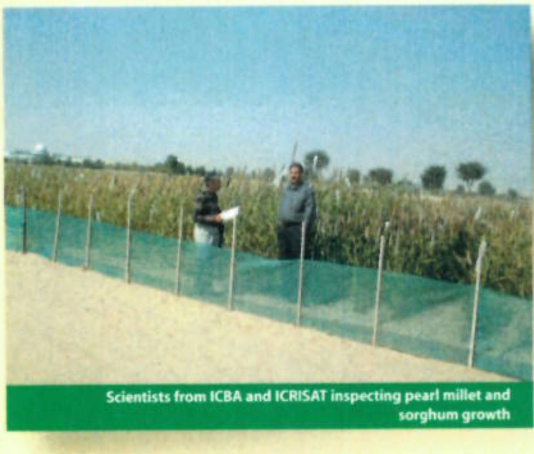
Evaluation of salinity tolerance, growth, yield potential and forage quality of 42 cultivars of pearl millet (*Pennisetum glaucum*) under field conditions

Based on previous promising results of the evaluation of several pearl millet genotypes, 42 new elite genotypes were acquired from ICRISAT through the collaborative research program with ICBA. They are being evaluated for salinity tolerance and general adaptation to the regional environmental conditions, with the ultimate objective of selecting salt-tolerant genotypes that are suitable for forage production and for dual purpose of seed and biomass production.

The fall experiment was planted in October. ICBA scientists will plant the same experiment in March 2002, and thus be able to compare results of both planting times and select pearl millet genotypes that are salt-tolerant and suitable for winter and/or summer growth.

Screening for salinity tolerance among selected pearl millet accessions

In addition to the elite varieties mentioned above, 48 pearl millet genotypes from ICRISAT's core collection that represent a wide range in the genetic diversity for biomass and seed production, were also acquired by ICBA.


Scientists from ICBA and ICRISAT inspecting pearl millet and sorghum growth


Harvesting of pearl millet and sorghum, fall planting

Objectives

- *Evaluate yield potential (seed and total biomass production) of 48 pearl millet accessions from ICRISAT's core collection under UAE environmental conditions.*
- *Evaluate salinity tolerance of pearl millet accessions under medium and high levels (10 and 15 $dS\ m^{-1}$)*
- *Compare the response of the same set of genotypes to salinity during fall (October-November) and spring (March-April) planting.*
- *Select the most promising accessions for forage or seed production or dual purpose for further evaluation.*

The experiment was planted in October and is expected to last 4 months. Initial observations indicated that there are wide variations in biomass and seed production among the genotypes and that there is a good potential for selecting genotypes with high production under high salinity levels.

The same experiment will be planted during March 2002. This will enable ICBA scientists to compare results of the fall and spring plantings and select pearl millet genotypes that are salt tolerant and suitable for winter and/or summer growth.

Screening for salinity tolerance among selected sorghum accessions

Objective

The objectives of the screening of 87 sorghum genotypes are identical to those screening studies involving 48 pearl millet genotypes mentioned earlier.

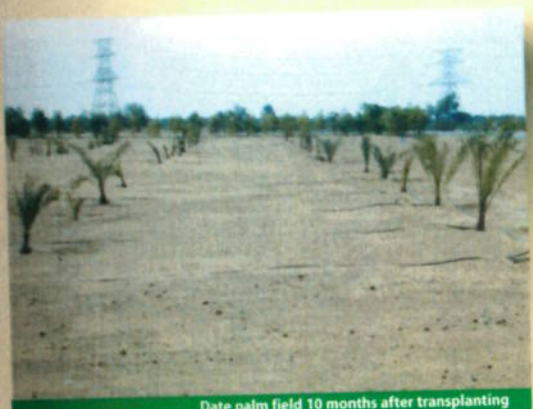
Similarly, 87 genotypes of sorghum were obtained from ICRISAT's core collection. They possess a wide range in production and growth traits. They are being evaluated for growth potential and salinity tolerance in fall and spring planting.

The experiment was planted in October and expected to last 4 months. Preliminary observations showed that a few of the sorghum genotypes evaluated have potential for growth and salinity tolerance under the relatively low temperature conditions during the mild winters of the region.

The same experiment, along with other newly acquired materials, will be planted during March 2002. As with earlier-mentioned studies, ICBA scientists will be able to compare results of both planting times and select sorghum genotypes that are salt tolerant and suitable for winter and summer growth conditions of the region.

UAE Ministry of Agriculture and Fisheries (MAF) Collaboration

Investigation of ten elite UAE date palm varieties for salt tolerance


Date palm field 10 months after transplanting

Objective

Study the long-term effects of salinity on the fruit quality and quantity of the ten best date palm varieties in the UAE.

Ten most preferred date palm varieties (Khalas, Faradh, Barhi, Lulu, Djibri, Naghal, Khasab, Khanizi, Shahle and Abu Maan) in the UAE were selected in collaboration with the UAE MAF.

The ten varieties were planted during May/June in a replicated field experiment under three salinity levels and five replications of each variety for a total of 150 trees. By the end of 2001, most of the date-palm trees survived the summer and showed signs of new growth. Up to 29 trees did not show satisfactorily establishment and initial growth. They will be replaced with saplings of the same age and growth status during 2002. Irrigation at three salinity levels (5, 10 and 15 dS m^{-1}) will be applied at the end of the replacement stage.

UAE University Collaboration (M.Sc. student's thesis research project)

Objectives

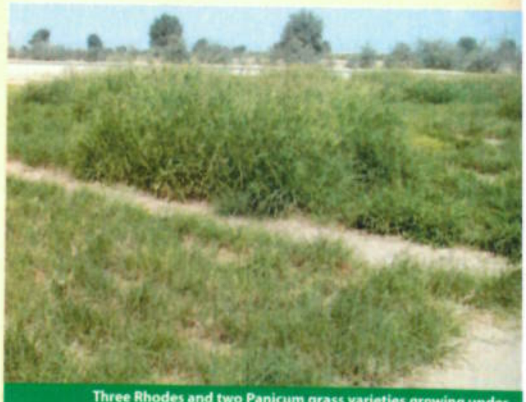
- *Compare salinity tolerance among different cultivars of Rhodes grass (*Chloris gayana *cvs. Pioneer, Callide and Katambora) and Panicum grass (*Panicum maximum *cvs. Green and Gatton).*
- *Evaluate the nutritional value of the different species/varieties in response to different salinity levels.*
- *Evaluate water use efficiency (WUE) of the different species/varieties in response to two moisture levels.*

Effects of irrigation water salinity on growth and forage quality of some salt-tolerant species under UAE conditions

Rhodes grass (*Chloris gayana*) considered to be the best irrigate forage grass with the large cultivated area and highe productivity in the UAE in particul and in the GCC countries in general. Although it is very well adapted to hot environments, the high wat demands of the crop and the increasing salinization of underground water are becoming importa issues in determining the future potential of the crop in the region. Variations under farmers' fie conditions in salinity tolerance were observed among several Rhodes and Panicum grass varieti commercially available in the region. Such variations among cultivars in response to salinity and in wat use efficiency have not been systematically evaluated.

The experiment was established in May. Three salinity levels (5, 10 and 15 dS m^{-1}) and two moisture leve (ET_0 and 1.3 ET_0) were applied. Periodical observations and measurements of growth and othe parameters are underway. Data analysis and a summary of results will be completed during 2002.


M.Sc. student from UAE University working on his research at ICBA


Three Rhodes and two Panicum grass varieties growing under three salinity levels

OTHER RESEARCH RELATED ACTIVITIES

Mass production of two salt-tolerant grasses: **Sporobolus virginicus** *and* **Distichlis spicata**

The two species were targeted by ICBA among the prime salt-tolerant forage grasses. In order to generate sufficient plant materials for large-scale research and demonstration plots, a few hundred plants of the two species were established from seeds and cuttings. Consequently, the plants were used to establish mother fields of the two species during the first quarter of 2001. A few months later mother fields reached full coverage and mass production of transplants started in July. By November over 70,000 plants of each species were produced and used in the establishment of the two research and demonstration plots.

Clockwise from top left: Stages in the establishment of a large-scale research and demonstration field

Mass production of three Atriplex *species:* A. halimus, A. lentiformis *and* A. nummularia

Similar to the procedure used for the grasses, mother fields of three *Atriplex* species were established in March. Mass production of nearly 5000 plants of the three species started in July. The plants were allowed to grow for three months prior to transferring them to a 1.6 ha permanent research and demonstration field.

Establishment of mother fields and mass production of cuttings from three *Atriplex* species

Field evaluation and seed production of eight selected pearl millet and sorghum genotypes

Eight pearl millet genotypes, from ICRISAT's breeding program, and six sorghum varieties from Oman were planted in mid-March for seed production under local environmental conditions. Both growth and seed production were outstanding in all varieties studied. Based on these initial results, larger scale field experiments were planned and conducted at a later stage under different salinity levels. (See Collaborative Projects, page 23).

Growth potential of different varieties of pearl millet and sorghum at ICBA

Halophyte Production

Halophytes

Early farmers and pastoralists recognized the high fodder quality, high water-use efficiency, and deferred production of certain halophyte species. Recently, halophytes have been incorporated in pasture-improvement programs in many salt-affected regions of the world.

Halophytes are an untapped genetic resource that could be used to develop crops that can be grown in saline environments. These wild plants, if domesticated, can utilize saline water and soil resources for agricultural production. Their seeds, fruits, roots, tubers, or foliage can be used directly or indirectly as food. Some seed-bearing halophytes are potential sources of grain and oil.

Objective

To evaluate and select new and improved varieties of halophytes for agricultural production and greening projects. Plants selected will persist and produce at salinities of 15,000 ppm (21.5 dS m^{-1}) and greater.

CORE PROJECTS

Mass Screening of Halophytes

Selection of germplasm is the first step towards proper identification and propagation of plant material for productivity management. Though a number of genera and species are known or found to be salt tolerant, with high productivity and

Objectives

- *Rapid screening of halophytic and salt-tolerant germplasm for greenhouse and field trials.*
- *Identification of germplasm with desirable characteristics for field experiments.*

Experimental set-up for rapid screening of halophytes

good nutritional (for forage) and wood (for timber) value suitability of the seeds always depends upon the ge source(s) and the prevailing edaphic and climatic condit Some species are also known to be physiologically adapte saline conditions. Consequently progenies produced thr seeds do not exhibit salt-tolerance traits and fail to germi and grow under saline conditions. In many cases, species, species and genotype/ecotype have been known to s entirely different responses. Different accessions of a si species grown exhibit different responses within diffe geographical boundaries.

A glasshouse hydroponics system was designed and set up in ICBA to rapidly screen germpl collected from different parts of the world.

The screening set-up was constructed using a locally fabricated hydroponics system to rapidly reliably evaluate the salt-tolerance of plant species. The system utilizes 10 cm diameter plastic pots fi with gravel. The pots have a drainage outlet at the bottom. Water application is controlled throug timer and the drainage water for each salinity treatment (3-40 dS m^{-1}), prepared in 1/4th Hoagl solution, is collected and re-circulated to the saline water tank and re-used for irrigation.

This report summarizes the results of 24 different accessions of *Triticosecale* and 36 of *Melilotus officin*

Variation in shoot and root length and spike formation of *Triticosecale* as affected by different salinity levels

***Triticosecale* (Triticale) accessions.** Different accessions of *Triticosecale* wl fully exposed to the different salinity levels over four weeks respon differently. Accessions #29185 and 520123 exhibited 100% survival at all sali levels, whereas, accessions #429227 and 508249 exhibited 100% survival at 12 and 15 dS m^{-1}. This was due to low germination in some of the replica rather than the effect of salts during the growth stage. Accessions # 429206 a # 429290 showed poor germination and survival. Not only did the accessi show differences in growth due to salinity, but they also exhibited differen in spike formation.

Growth of plants also exhibited similar response to that of survival of plar Those which showed better survival also showed better plant height (sh

Measuring shoot length in *Triticosecale* accessions

and root length) and increased number of leaves. Accession # 429185 showed maximum shoot length and was not affected by salinity treatments followed by accessions #429227, 520123 and 429231. Root length for most of the accessions studied did not vary significantly with different salinity levels. Maximum root length was observed in accessions # 429303, 491409 and 445679. As expected, the root length for some of the accessions did not show a strong relationship to the shoot length; however, the root-shoot relationship appears to be associated with biomass rather than length.

Higher fresh and dry weight of shoots was observed in accession # 429227 (which exhibited higher survival and better plant height) followed by 429194 and 429231. Maximum fresh and dry weight was observed at different salt levels followed by a reduction. Accessions 429227 and 520123 showed non-significant differences among all the salt levels and had better response even at 15 dS m^{-1}. A reduction in weight after 3 dS m^{-1} was evident in accessions # 429194 and 429231; after 6 dS m^{-1} in Acc. # 429185, 429215 and 429303; after 9 dS m^{-1} in accessions # 491409 and 508249.

Root weight showed a different trend among the accessions as compared to shoot weight but appears to be related to the translocation of metabolites from root to shoot and vice versa depending upon the stage of growth (vegetative or reproductive). Accessions # 429185 and 520123, which exhibited a higher survival percentage and plant height, did not exhibit higher vegetative biomass, though exhibiting higher tolerance to salt.

***Melilotus officinalis* accessions.** When grown under non-saline conditions, the seeds of *M. officinalis* showed poor viability. Hence, later on, both survival and growth exhibited discrete growth patterns at different salinity levels.

Accessions such as AMES 19261 are reported to be highly salt tolerant and hence 40% survival was evident under salinity up to 40 dS m^{-1}, even though some of the replicates in other salinity treatments failed to germinate and survive. In addition, accessions # PI 342804 and 342720 also survived at 40 dS m^{-1}, but these accessions exhibited very poor germination for the rest of the salt treatments. On the other hand, accessions # 213328, # 230531 and # 314719, survived most salinity treatments, though the percentage germination remained very low. However, in spite of some very high germination values, no definite conclusion can be drawn for *M. officinalis* accessions due to significant absence of replicates for other salt treatments. It is necessary to try the same lot of accessions again with a higher percentage of germination to obtain meaningful conclusions.

Lysimeter set-up

Water use and salt balance in halophytes

Soil salinity build-up occurs as a result of imbalance between irrigation and crop evapo-transpiration rates, when water is removed from the soil surface at higher rates than is added, leaving behind the salts. Management of soil salinity requires a good knowledge of the water requirement of a particular species to optimize the irrigation amount and frequency. As a result, water needs to be moved beyond the root zone of a species, pushing the salts deeper in the soil profile. However, in spite of irrigation scheduling, many other factors, such as temperature, humidity, soil texture and water salinity cause the daily evapo-transpiration rates to fluctuate and as a result, upward salt movement takes place, affecting plant growth.

Salt-water balance can be calculated using modeling techniques. However, it is important to find the relationship of water quality and quantity on soil salinity and yield parameters.

Objectives

- *Develop productivity management of promising halophytic species for forage using lysimeters.*
- *Study the effects of water quality/quantity, harvest period and frequency, and their nutritional aspects for optimizing productivity.*

The experiment was conducted using drainage lysimeters with six-week old seedlings of *Salvadora persica* transplanted in each lysimeter and irrigated with 8 different levels of salinity (5-40 dS m^{-1}). Two different irrigation levels of 1.0 and 1.5 times the water requirement were applied for each salinity treatment, with three replicates. Water was supplied using a drip irrigation system connected to a variable salinity source. The volume of the drained water was measured after irrigation to determine the water use of plants.

Drainage water measurement of a lysimeter

The growth of *S. persica* plants was monitored at different stages. Different levels of irrigation at 1 and 1.5 times the water requirement did not have any significant effect on plant height and plants showed more-or-less similar heights under all treatments, with a slight reduction from 35 dS m^{-1}

(Figure 1). Measurements of drained water showed a higher volume of water irrespective of salinity treatments during low temperature periods, owing to low evapo-transpiration rates.

Growth of *S. persica* in a drainage lysimeter

Relative growth rates of plants for different treatments, and salt-water balance based on salt content in soil, plant parts and drainage water will be calculated after one year of growth.

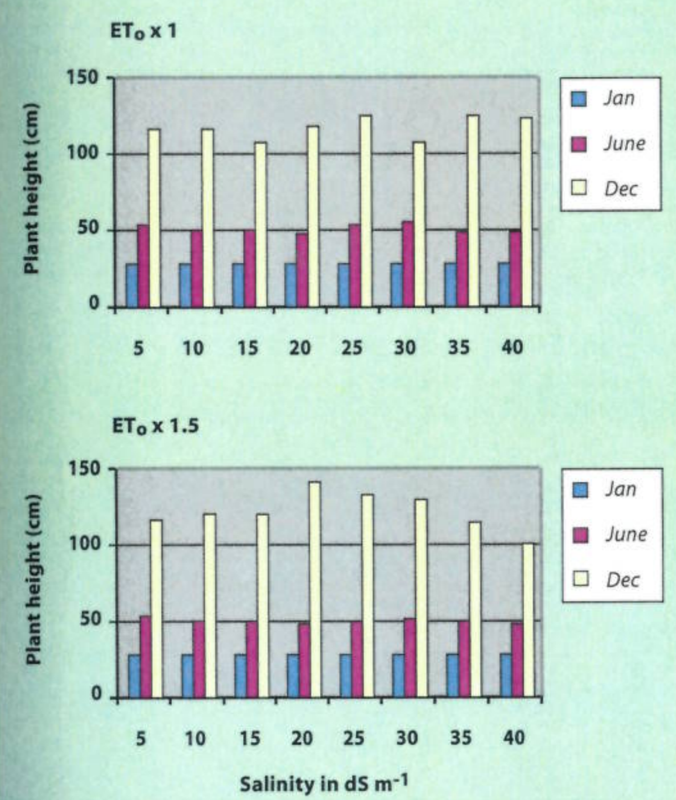


Figure 1. Plant height of *Salvadora persica* as affected by different levels of salinity and volume of irrigation water

COLLABORATIVE PROJECTS

International Atomic Energy Agency (IAEA) and Ministry of Agricultur and Fisheries (MAF) Collaboration

Sustainable utilization of saline groundwater and wastelands for plant productio

Objectives

- *Demonstrate on a pilot scale and study the utilization of salt-affected lands and different water quality (fresh or saline) for growing salt-tolerant plant species (grasses, shrubs and trees).*
- *Demonstrate the favorable effects of plant growth on soil fertility and productivity.*

In 1995, an IAEA and Ministry of Agriculture and Fisheries, U concept paper on 'Economic utilization of salt-affected land a saline groundwater to grow salt-tolerant plant species' led to t approval and execution of a six-year project in different countri including, Morocco, Tunisia, Egypt, Syria, Iran and Pakistan. T project, apart from introducing and demonstrating salt-tolera plants, will study the management of irrigation water, monit groundwater dynamics and transfer technology to end users.

In 2000, ICBA was invited to join the project through the UAE Ministry of Agriculture and Fisheries. ICB therefore, joined the team in 2000 as part of the second phase of the IAEA project.

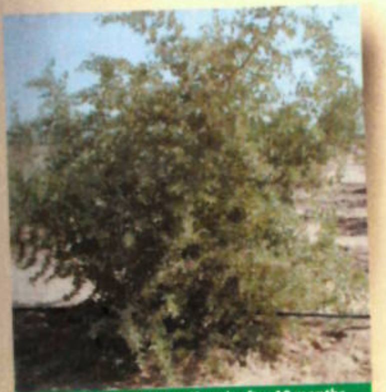
Seeds of different species/accessions were obtained from different sources for the demonstration tri (Table 1). Different species were grown at different times as and when the seeds were available.

Table 1. Description of plant species and experimental set-up.

(All species were irrigated by drip irrigation @ 3.8 L/hour for one hour per day)

Plant species	Growth stage	Seed source	Date of planting	Plot size (m)	Inter-plant distance (m)	Salinity of water (dS m^{-1})
Atriplex lentiformis	Seeds	USDA Acc#SFD-89 F7	Nov.2000	24 x 24	2	25
A. canescens	Seeds	USDA Acc#SFD-99 F2	Nov.2000	24 x 24	2	25
A. undulata	Seedlings	Dept of Agric WA	Mar.2001	24 x 24	2	25
A. nummularia	Seedlings	Dept of Agric WA	Mar.2001	24 x 24	2	25
Leucaena leucocephala	Seedlings	Pakistan	Nov.2000	24 x 24	3	25
Salvadora persica	Seedlings	Local (UAE)	Nov.2000	24 x 24	3	25
Sesbania aculeata	Seedlings	IAEA	Apr.2001	15 x15	2	25
Kochia indica	Seedlings	IAEA	Apr.2001	15 x15	2	25
Acacia nilotica	Seedlings	IAEA	Apr.2001	15 x15	3	25
A. ampliceps	Seedlings	IAEA	Apr.2001	15 x15	3	25

Growth of salt-tolerant plant species



Growth of *A. lentiformis* after 10 months

Different species were monitored for their growth parameters. Plant height varied with species and nature of plants. Woody *Atriplex* species reached up to 80-90 cm in 9 weeks whereas, shrubby species like *Atriplex canescens* and *A. undulata* ranged between 60 and 75 cm. The growth rate of all the species was high during the summer (March-June) and minimal during winter.

Shoot volume of the *Atriplex* species, calculated from height and the two right angle diameters of the plants (multiplied with a constant depending on the shape of the plants), exhibited a progressive increase with time. The woody species, namely *A. nummularia* and *A. lentiformis* have a greater plant volume due to their growth habit. However, all the four species more or less show the same growth rate, indicating that their absolute values may be different owing to their habitat, but the rate remains unaffected.

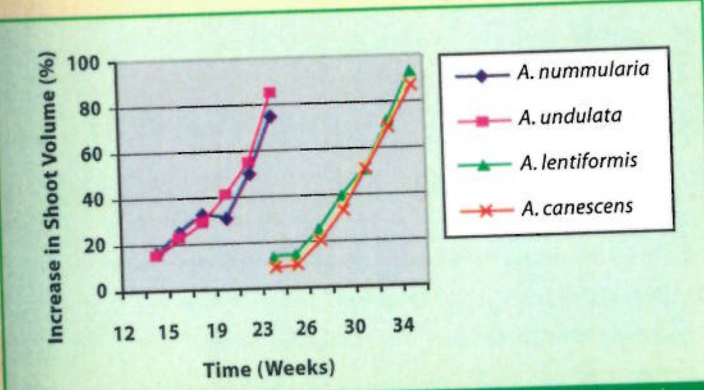


Figure 2. Percentage increase of shoot volume in different *Atriplex* species.

The tree species included some fast growing species such as *Leucaena leucocephala, Sesbania aculeata* and *Acacia ampliceps* along with the slow growing *Acacia nilotica*. Though *L. leucocephala* exhibited maximum growth in height, the growth of *A. ampliceps* was significantly better than all the test species overall. Growth of the two *Acacia* species, namely *A. nilotica* and *A. ampliceps*, was also significantly different, though both the species had similar height after 7 months. The annual, *Kochia indica*, also showed a high growth rate even when irrigated with saline water of 25 dS m^{-1}.

Left to right: *Acacia ampliceps* and *Acacia nilotica*

Plant training and water management for establishment of windbreak plants in shallow water table areas

Objectives

- *Replicate the natural conditions that would enable indigenous plants to grow in arid environments with minimal water application.*
- *Develop a water management scheme that would encourage indigenous plants to tap into shallow water table sources.*
- *Develop a demonstration pilot project where indigenous plants are growing with no external water application.*

Indigenous species of trees and shrubs in the Arabian Peninsula are known for their ability to withstand abiotic stresses such as heat, drought, and salinity, and therefore are the main constituents of any greening project. With an evolved root system and an adequate tolerance to salinity, naturally existing plants in the desert survive on brackish water drawn from shallow aquifers. The purpose of this research is to develop methodologies for conditioning indigenous plants to become more efficient water users, by using less water and water of low quality. In essence, plants are stimulated to develop long roots in the greenhouse. Upon transplanting, the plant that has already an evolved root system is stimulated to develop its roots further using appropriate irrigation management practices.

Several tree species, *Prosopis tamarugo*, *Acacia arabica*, *Leucaena leucocephala* and *Prosopis cineraria* were grown for eight weeks in plastic tubes each having a length of 1.5 m and a diameter of 5 cm. Towards the end of the year 2000, 249 plants were transplanted into the field. In November 2001, 300 additional plants consisting of *Acacia arabica* and *Prosopis cineraria* were transplanted in a repetition of the earlier experiment.

One-year-old deep-rooted *Acacia arabica*

Of the first batch of 249 plants, only 12 plants survived the summer of 2001 although 80% were still alive by June 2001. The reason for this large proportion of mortalities was attributed to the stage of growth of plants upon transplanting. Plants that survived the summer were far more developed at the time of transplanting than other plants. In terms of species, mortalities were largest amongst *Prosopis tamarugo*, which is native to Chile while *Acacia arabica*, which is native to the Arabian Peninsula had the largest number of surviving plants. For this reason the next plot consisted of *Acacia arabica* and *Prosopis cineraria*, another local species. By December 2001, a new batch of 300 deep-rooted plants was transplanted.

International Center for Agricultural Research in the Dry Areas (ICARDA) Collaboration

Evaluation of irrigation practices and fertilizer requirements for optimizing productivity of three indigenous grass species

Objectives

- *Evaluate water use efficiency, salinity tolerance, and fertilizer requirements of* Coelachyrum piercei, Cenchrus ciliaris, *and* Chloris gayana.
- *Determine the appropriate irrigation system and irrigation management practices for the above species.*

Introduction of plant species/varieties/accessions has been one of the major developments that has taken place in modern agriculture. Species developed by conventional and modern biotechnological methods have been evaluated and put under production systems in other parts of the world under compatible environmental conditions. However, in many cases, locally grown species are known to be more salt-tolerant than introduced germplasm of the same species.

From earlier studies, many naturally occurring species have been identified in the Arabian Peninsula region that can tolerate high temperature, drought and salt stresses. Efforts were then made to introduce these species under saline water irrigation. This was followed by analyzing other characteristics such as water use efficiency, seed production, and forage quality.

The Arabian Peninsula Regional Program (APRP) of the International Center for Agricultural Research in the Dry Areas (ICARDA) is studying this aspect of land rehabilitation using such species in collaboration with the national agricultural research systems (NARS) in the region. This trial tested the genetic material under different salinity regimes and rates of water application.


Experimental area of three grass species

Seeds of *Cenchrus ciliaris, Coelachyrum piercei,* and *Chloris gayana* provided by the ICARDA-APRP program were directly seeded in a factorial design experiment. Different plots were assigned for three salinity levels (3,500, 7,000 and 10,500 ppm, corresponding to EC 5, 10 and 15 dS m^{-1}), three irrigation treatments (100% ET, two treatments for 50% ET with different irrigation frequency) and three levels of nitrogen fertilizer with four replicate sub-plots. All the plots were irrigated with drip irrigation.

Plant harvest was initiated in December to assess the biomass productivity under various levels of treatment. *Chloris gayana* exhibited higher shoot biomass as compared to other species for all the salinity treatments (Table 2). Moisture percentage in all the test species also varied significantly with salinity treatments and irrigation frequency, ranging from 12-36%.

Table 2. Range of biomass productivities (t ha^{-1}) of three grass species under three salinity levels. (All data are based on 100% ET irrigation level treatment)

Salinity treatment	Weight	*Cenchrus ciliaris*	*Coelachyrum piercei*	*Chloris gayana*
5 dS m^{-1}	Fresh Wt Dry Wt	16.57 - 18.39 9.48 - 10.96	12.76 - 16.58 4.96 - 9.03	16.66 - 17.51 10.84 - 12.08
10 dS m^{-1}	Fresh Wt Dry Wt	6.16 - 7.10 4.48 - 5.42	5.54 - 6.20 3.66 - 5.06	5.49 - 7.53 4.57 - 5.49
15 dS m^{-1}	Fresh Wt Dry Wt	5.83 - 7.20 4.26 - 5.66	3.95 - 4.72 2.57 - 4.10	5.84 - 7.14 4.38 - 5.73


Area after harvest

Soil samples were collected for various treatments at two different depths of 0-75 and 75-150 cm and analyzed for electrical conductivity and pH. After the harvest, EM-38 measurements were taken for soil salinity measurements for individual replicate plants. With soil sampling at different plant points and different treatments, the variation in soil salinity was significantly high. However, in general, soil salinity appeared to be higher in the upper soil profile (0-75 cm) where *Chloris gayana* were grown. At high salinity water treatments the soil salinity ($EC_{1:5}$) showed variation between 2.26 and 7.72 dS m^{-1}.


Reed bed for treating oil process water

SPECIAL PROJECTS

Assessment and Management of Saline Process Water for the Nimr Reed Beds

Petroleum Development Oman (PDO), a private sector company in Oman, is experimenting with new ways for using the saline water produced along with oil. This process water is procured along with oil extracted at a water-oil ratio of 4:1. Initially, this process water was injected in deep aquifers at high pressures and at high cost. Following a meeting with senior staff at ICBA, PDO became interested in using such water for biosaline agriculture with potential economic returns and environmental


Inflorescent reeds in a reed bed

benefits. ICBA was requested by PDO to develop the concept and oversee its implementation.

The first step was to improve the quality of the process water. Collected water samples had noticeable oil content and some heavy metals. Treatment was needed before applying this water to agricultural lands.

PDO developed a biological treatment using a pioneering design of reed beds (*Phragmites australis*). The bacteria on the root system of the reeds digest the oil droplets while negatively charged clay particles of the rhizosphere absorb heavy metals. Water draining from these beds was expected to be more saline but pollutant-free.

For a number of reasons, the reed beds did not function as predicted. Reed plants were not healthy and the drainage water had significant oil content and some residual heavy metals. Following a series of visits to the reed bed site in Nimr, about 700 km south east of Muscat, ICBA scientists performed a thorough evaluation of reed beds from both design and management perspectives. Analyses involved soil, water, and plant samples.

Recommendations from these analyses were presented to senior officials from PDO. The implementation of these recommendations improved the reeds' health. Oil-in-water content of drainage water dropped from over 100 ppm to less than 15 ppm. This drainage water had a salinity of 14.9 dS m^{-1} and was suitable for use in biosaline agriculture activities.

As a follow up, ICBA was requested to design a new reed bed system that would incorporate all the recommendations of earlier investigations. This design was prepared and the implementation of the project began in December 2001.

ICBA was also requested by PDO to synthesize all beneficial uses of biosaline agriculture projects worldwide and develop a concept design for a 1.5 hectares pilot demonstration site. This pilot project will be irrigated entirely with treated process water.

Managing Salinity and Waterlogging in Abu Dhabi Farms

Several coastal agricultural areas in the Emirate of Abu Dhabi are covered with a clayey soil layer with low permeability. External additions of irrigation waters have caused waterlogging and soil salinity problems


Salt deposits on agricultural land in Al-Ajban

on farms located in natural depressions. The evaporation of stagnant water containing dissolved salts causes soil salinity in such areas.

The Sewerage Projects Committee (SPC) in collaboration with the Extension Department of the Municipality of Abu Dhabi retained ICBA to conduct an investigative study in these areas and propose practical solutions to restore agricultural productivity on affected farms. This study would be conducted in collaboration with SPC and an assigned project consultant, Parsons International Ltd (Parsons).

Due to the severity of the problem, it was decided to initiate the activities in the Al-Ajban agricultural area. The Al-Ajban agricultural area comprises 600 farms and covers more than 1,600 hectares. An initial grid consisting of 28 farms was selected in consultation with SPC and Parsons for the investigative study. Piezometers were installed in these farms to monitor ground water elevation, and water and soil samples were collected for analysis. The objective was to quantify the extent of the problem and determine patterns of ground water movement. As water is a scarce commodity throughout UAE, the identification of pollutants through chemical analyses would also help determine the best re-use alternatives.

In a separate effort, a topographical investigation was conducted throughout Al-Ajban. A basic topographical map was prepared and used in conjunction with the analyses.


Waterlogged farm at Al-Smeeh, Abu Dhabi

A "sink" area was identified from the synthesis of the results. This area involves six neighboring farms with a shallow water table and extreme soil salinities. A drainage system installed in this area will have a large radius of influence and excess salts can then be leached to restore agricultural productivity. A network of about 50 piezometers was installed in these farms and the neighboring area to closely monitor changes in ground water and salinity. SPC also adopted the drainage system configuration proposed by ICBA. Construction of this system started in late 2001 and is due for completion in 2002. Once this system becomes operational, excess water will be drained over the course of six months and an affected area of over 20 hectares of agricultural land will be reclaimed. SPC is also considering another proposal by ICBA to re-use drainage water in a biosaline agriculture set-up for greening purposes.

Communication, Information and Networking

Objectives

- *Inform well-targeted audiences.*
- *Increase awareness of the activities of the Center.*
- *Establish an international network of collaborative research programs.*

NEWSLETTER/POSTERS

ICBA published the third and fourth issues of the newsletter *Biosalinity News* in both English and Arabic. They were distributed to over 1200 individuals representing over 600 organizations. The publications were well received by readers.

ICBA published its first Annual Report on activities in 2000. The report was published separately in three languages - English, Arabic and French. ICBA published its Strategic Plan 2000 - 2004 in English, which has evoked positive feedback.

Twelve large 4-color posters were produced on ICBA's research objectives and activities, mentioning prominently its donors: the Islamic Development Bank, the OPEC Fund for International Development (OPEC Fund) and the Arab Fund for Economic and Social Development (AFESD). These were displayed prominently at the Consultative Group on International Agricultural Research (CGIAR) Mid Term Meeting in Durban, South Africa, in May, and at the CGIAR Annual Meeting at the World Bank Headquarters, Washington D.C., USA, held in October/November.

ICBA updated its brochure and produced two posters on ICBA's Mandate and Mission, and video footage for the OPEC Fund Anniversary Film.

FORGING FORMAL LINKAGES

Memoranda of Understanding (MoUs) were signed with the following organizations:

- Environmental Research and Wildlife Development Agency (ERWDA), Abu Dhabi, UAE
- International Crop Research Institute for Semi-Arid Tropics (ICRISAT), India

Signing of the MoU with ICRISAT, 2001

- King Abdulaziz City for Science & Technology (KACST), Saudi Arabia
- Arab Authority for Agricultural Investment and Development (AAAID), Sudan
- Arab Organization for Agricultural Development (AOAD), Sudan
- Ministry of Agriculture, Animal Wealth and Irrigation, State of Khartoum, Sudan

These MoUs identified areas of mutual interest and paved the way for collaborative work in biosaline agriculture between ICBA and these sister organizations. (Appendix 3)

ICBA is now recognized as a consulting partner of the Global Water Partnership (GWP). The GWP is committed to supporting the implementation of integrated water resources management worldwide. GWP's mission is to support countries in the sustainable management of their water resources.

ICBA's commitment to the world body is to endeavor to efficiently maximize sustainable agriculture and horticulture by using saline and low-quality water, thus conserving global fresh water resources, especially the dwindling fresh water resources in UAE and other GCC countries, currently partially utilized in a unsustainable manner for agriculture and landscape management activities.

PARTICIPATION IN CONFERENCES

ICBA staff attended and participated in the following conferences:

- Environment 2001, Abu Dhabi, UAE, 4 - 8 February. Dr. M. Al-Attar chaired the session on Marine Environment and Prof. Dr. F. Taha chaired the session on Desertification.
- Fifth Annual Gulf Water Meeting, Doha, Qatar, 26 March. Dr. B. Hasbini presented a paper at the Conference.
- First International Symposium on Ornamental Horticulture in the GCC Countries, Al Ain, UAE, 5 - 7 March. Prof. Dr. F. Taha presented an invited paper in the Symposium.
- Second International Conference on Date Palms, Al Ain, UAE, 25 - 27 March. Dr. A.A. Jaradat presented a paper at the Conference.
- International Union of Soil Science, 25-27 June, Riverside, California, USA. The meeting was attended by Dr. M. Al-Attar, Prof. Dr. F. Taha and Dr. B. Hasbini.

- Planning meeting in Japan of the Third World Water Forum (WWF3), which is scheduled to take place in February 2003 as part of a joint IDB-ICBA delegation. Mr. A. Hariri attended. Consequently, ICBA and IDB were encouraged to lead a session on "Sources of alternate waters for irrigated agriculture" at WWF3 and a virtual conference session on the Internet that will precede the actual WWF3.
- Conference on *Prosopis cineraria*: a biometrical approach to study its genetic diversity for in situ conservation and sustainable utilization at the Faculty of Sciences, UAE University, 1 May. Dr. A.A. Jaradat attended.
- International Conference on Halophyte Utilization and Regional Sustainable Development of Agriculture held in Huanghua City, China, 15-22 September 2001. Dr. S. Ismail presented a paper at the Conference while another paper by Dr. A. Dakheel was accepted by the Conference organizers.
- International Seminar on "Genetics and Molecular Biology of Stress Tolerance in Plants", Tubitek, Turkey, 19 - 22 February. Mr. A. Hariri and Dr. S. Ismail participated.
- International Symposium and Workshop on Arid Zone Environments: Research and Management Options for Mangrove and Salt-Marsh Ecosystems, Abu Dhabi, UAE, 22 - 24 December. Dr. M. Al-Attar and the entire technical team of scientists attended.
- APAARI meeting, Thailand, 12 - 14 November. Dr. Faisal Taha participated.
- Water Week Program, Sri Lanka, 14 - 15 November. Dr. Faisal Taha participated.

NETWORKING AND PUBLIC AWARENESS

- ICBA initiated scientific co-operation with scientists working at the International Crop Research Institute for the Semi Arid Tropics (ICRISAT) near Hyderabad. Dr. A. Dakheel and Mr. J. Abraham visited the Central Arid Zone Research Institute (CAZRI) in Jodhpur, India. ICRISAT provided ICBA with a large amount of genetic material of pearl millet, sorghum, pigeonpea, groundnut and forage grasses, all of which had potential for salinity tolerance.
- ICBA established strong links with NyPa International, which is an R&D commercial company in the USA. Dr. M. Al-Attar and Prof. Dr. F. Taha had fruitful meetings with the company officials in June.
- ICBA prepared and produced a CD-ROM about the Center. The 20-minute program is interactive and provides details about the Center's history, mission, programs, staff and on-going activities.


Director of Technical Programs with NyPa scientists, June 2001

- ICBA staff were interviewed by reporters of prominent dailies and magazines published in the UAE. A five-part presentation on ICBA was telecast by Dubai TV in August. An interview on 'Environmental Protection' involving ICBA staff was telecast on 7 July.
- ICBA participated in the following events with the display of its publications and posters:
  - Environment 2001, Abu Dhabi, UAE, 4 - 8 February.
  - Environment Day, Al Ain, UAE, 18 February.
  - ICBA Symposium on Prospects of Saline Agriculture in the GCC Countries, 18 - 20 March, Dubai, UAE.
  - Monthly meeting of Emirates Environmental Group, Dubai, UAE, 26 May.
  - An ERWDA Workshop on Environment for High School Teachers, 14 June.
  - IDB's 26th Meeting, 20 - 24 October, Algeria.
  - CGIAR Meeting, 29 October - 2 November, USA.

ICBA LIBRARY

By the end of the year 2001, ICBA's Library had a collection of over 1500 books and journals to benefit ICBA staff and members of its networks. A consultant reviewed the current state and needs of the ICBA library and prepared a report on the future requirements and needs of ICBA in this area. A Library Assistant was appointed for conducting the regular activities of the Library.

Objective

Promote exchange of information and experience.

TRAINING COURSES AT ICBA

Irrigation with Brackish Water, 12-16 May

Objectives

- *Introduce the concept of irrigation with saline water.*
- *Enhance the skills of irrigation operators in management of salt-affected lands.*

Participants consisted of 16 agricultural engineers from the Ministry of Agriculture and Fisheries, Dubai Municipality, Abu Dhabi Municipality, Al Ain Municipality, Environment Protection Authority of Sharjah, UAE, Ministry of Agriculture and Fisheries of Oman and ICBA.

This course provided participants with material collected from various publications on the uses of brackish and saline water in agriculture and the necessary design and management principles to ensure a sustainable production. The field demonstrations and experiments enhanced the participants' understanding of these principles. Significant feedback gleaned from the questionnaire distributed expressed the need for a special course on drainage design.


Participants listen to ICBA scientist

Certificates of completion were issued to those who successfully completed the course.

As a result of this training course conducted at ICBA, the Municipality of Abu Dhabi officially requested ICBA to design a drainage system for a farm severely affected by salts from a shallow brackish water table. (See Special Projects, page 27). An objective was to demonstrate the effect of drainage in an area where at least 34 similar farms are affected by the same problem.

Propagation and Management of Halophytes, 20-24 October

Objectives

- *Introduce the concept of biosaline agriculture and the role of halophytic species in agricultural development systems.*
- *Provide hands-on training on management of halophytes including agricultural practices.*
- *Introduction of forage quality concepts through analytical methods.*

This course provided basic information on site-specific selection of plant species and management practices that can be applied in dry and wasteland areas, using saline water resources for viable agricultural production systems.

Fourteen participants from various Ministries and municipalities attended the training course. Eight different sessions were held during the five days, including both lectures and hands on field training on field designs, planting methods, monitoring growth, assessing biomass productivity, irrigation methods, assessing soil salinity, and analytical methods for evaluating forage quality. The participants were also introduced to new equipment used in biosaline research.

Participants inspect vegetative propagation of halophytes

Genebank Operations: Germplasm and Data Management, 22 - 26 December

Objectives

- *Improve the capabilities of scientists and technicians in the national agricultural research programs to conduct regular genebank activities independently.*
- *Ensure that genebanks are run according to international standards.*

The aim of this training course was to ensure that genebanks are run according to international standards, paving the way for conservation of viable germplasm material with high genetic diversity, and easy access to information and germplasm. Twenty participants from UAE, Oman, Kuwait and ICBA gained from attending the course. A manual for the training course was developed and distributed to participants and potential users.


Participants learn the process of conservation

Post-graduate Training (M.Sc.) for a UAE National

ICBA is supervising research for an M.Sc. student from the UAE University. Technical and administrative support is also provided by ICBA.

WORKSHOPS

First International Symposium on "Prospects of Saline Agriculture in Gulf Cooperation Council (GCC) Countries"

ICBA held its First International Symposium "Prospects of Saline Agriculture in the Gulf Cooperation Council (GCC) Countries" in Dubai, UAE, from 18 to 20 March 2001 under the patronage of His Excellency Saeed Bin Mohammad Al-Raqabani, the Minister of Agriculture and Fisheries, UAE. This Symposium was organized in collaboration with the Islamic Development Bank (IDB), the International Center for Agricultural Research in Dry Areas (ICARDA) and the UAE Ministry of Agriculture and Fisheries (MAF). His Excellency Saeed Bin Mohammad Al-Raqabani inaugurated the Conference with an opening statement followed by a speech by His Excellency Dr. Ahmad Mohamed Ali, the President of the Islamic Development Bank. Other statements were also made by the Management of ICBA and ICARDA. More than 160 delegates from 22 countries, mainly IDB member countries, attended the Symposium. The attendees endorsed specific recommendations supporting research and development work on biosaline agriculture and ICBA's efforts in this regard. ICBA received excellent feedback from VIPs and participants who commended the organization of the Symposium, the papers presented and the scientific exchange of information among attendees. ICBA was requested to convene international conferences on biosaline agriculture on a biannual basis.



Scenes from ICBA's first International Symposium, March 2001

ANNUAL REPORT YEAR 2001 1421/1422H

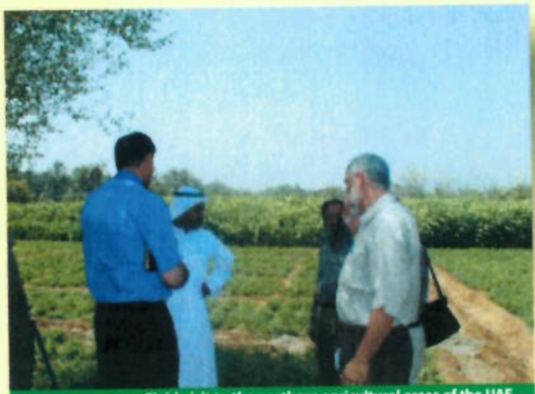
International Symposium on "Research and Management Options for Mangrove and Salt Marsh Ecosystems"

ICBA co-sponsored an International Symposium on "Research and Management Options for Mangrove and Salt Marsh Ecosystems", held 22 - 24 December in Abu Dhabi, UAE. The other co-sponsors were ERWDA, United Nations Environment Programme, Regional Office for West Asia (UNEP/ROWA) and Japan Oil Development Company (JODCO).

Extension

- A four-day field visit to the Western Agricultural Area of the Emirate of Abu Dhabi was conducted in April. The results of observations and sample analyses as well as potential areas for future collaboration were compiled in a report with inputs from various ICBA scientists. This report was presented to the Extension Department of Municipality of Abu Dhabi.

Four-day visit to the western agricultural area of Abu Dhabi



Field visit to the northern agricultural areas of the UAE

- A field visit to the northern agricultural areas of the UAE was conducted on 22, 26 and 27 May. Salinity issues and productivity problems were discussed with engineers from the Ministry of Agriculture and Fisheries. Potential areas for co-operation with ICBA were identified. A substantive report was compiled and submitted to H.E. the Minister of Agriculture and Fisheries, UAE.

INFRASTRUCTURE DEVELOPMENT

New Shadehouse

Although ICBA commenced operations in September 1999, infrastructure development continues at the Center to keep pace with ICBA's growing research and development activities. Resource constraints prevented the full infrastructure development. However, during the year ICBA managed to raise some funds, at the cost of the projected technical program implementation.

New Shadehouse

The construction of the 36 m x 18 m shadehouse was completed in early October 2001. This new facility will be used for relevant greenhouse activities such as growing desert plants and hardening plant species prior to field establishment.

Irrigation System

ICBA's irrigation system was modified and expanded to accommodate new experimental requirements. Collaborative projects have specific requirements for water and salinity.

Modifications:

- Connecting the medium salinity (6 dS m^{-1}) main line to the high salinity (20 dS m^{-1}) main line thus providing high salinity water to 16.5 hectares out of 35 hectares of experimental plots initially served only by medium salinity water.
- Installation of seawater irrigation systems in two experimental plots with a total area of 2,500 m^2, growing various halophytes, including a number of mangrove species.
- Installation of a variable salinity system over 2000 m^2 for testing different forages for their salinity tolerance.

Expansion:

- Design and installation of new drip irrigation systems over an experimental area of 1.5 hectares for seed increase.
- Design and installation of bubbler irrigation systems over 1.5 hectares of experimental plots for testing the salt tolerance of 10 varieties of date palms.
- Installation of a variable salinity irrigation system for experiments conducted within the new shadehouse.

All the above activities complement on-going operations including water supply for the Center's landscape and maintenance activities.

Windbreak Fences

Windbreak fences extending over 800 m around the perimeter of the experimental farm were established to protect young seedlings from blowing sands. These fences, made up of 421 plants of *Azadirachta indica* (neem), *Acacia francieana*, and *Conocarpus* sp., have proven effective in reducing wind speed and improving growing conditions for the plants.

New Equipment

As part of an on-going collaborative program, the International Atomic Energy Agency (IAEA) supplied a neutron probe, a set of soil augers, a soil penetrometer, a groundwater depth meter, a groundwater sampler, a Geographic Positioning System (GPS) unit and two EC meters.

Preparation of Two Permanent Research Fields

i. A 0.6-hectare field plot was prepared to accommodate long-term research and demonstration of two salt-tolerant grass species using a sprayer irrigation system.
ii. A 1.2-hectare research and demonstration field was prepared for long-term research and monitoring of a forage production system focusing on the use of salt-tolerant forage shrubs.

The preparation of the fields included the following steps:

- Leveling and cleaning of the site.
- Trenching and installation of irrigation lines. All main and lateral irrigation lines were installed at 70-100 cm below the surface. Individual sprayer heads can be unscrewed at 10 cm depth. This layout will facilitate mechanization of all field operations.
- The field was divided into three sections, each section for a distinct salinity level. Within each salinity level, three irrigation levels were designed (ET_O, 1.5 x ET_O and 2 x ET_O). Valves and control systems were installed to generate the required salinity and irrigation levels.

From left to right: Leveling of the field; preparing trenches; installing irrigation lines

Administration and Finance Services

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

ADMINISTRATION

Administrative and Financial Manuals. ICBA hired a consultant who prepared a Finance Policy, Purchasing and Inventory Control Manual, Recruitment Policy, Research Manual, and Preventive Maintenance manual.

Organizational Structure. ICBA Management approved the Organizational Structure to include three main branches, namely the Director General's Office, the Technical Programs Division, and the Administration and Finance Division. There are four major research program areas in the Technical Programs Division. Job profiles were also approved allowing for future expansion prospects for the Center.

The Statute. ICBA's statute was printed and distributed.

Construction of the training building

Facilities. The Center contracted the services of M/s Higgs & Hill to construct a training building. Work on the building began in late October and is scheduled for completion in March 2002. The facility will house a lecture room for 95 people and a computer room for 27 people, and will be used to provide training in the field of biosaline agriculture to scientists and technicians from the developing IDB member countries.

A new telephone system to monitor all outgoing calls of the Center was installed by M/s Scientechnic.

STAFFING

On completion of his secondment to ICBA in July, Mr Hariri, ICBA's Deputy Director General, returned to the Islamic Development Bank (IDB). He is now working in the office of the President, IDB. Mr Hariri, a national of Saudi Arabia, was responsible for overseeing the construction of the facilities at ICBA and later for building and nurturing ICBA's Administrative Services. He has made impressive contributions to the Center in its early years.

The following staff joined the Center:

- Dr. Abdullah Dakheel, Field and Forage Crops Scientist (January)
- Mr. Jugu Abraham, Donor Relations Specialist (March)
- Mr. Ghassan Sarris, Administration and Finance Officer (March)
- Mr. Ibrahim bin Taher Al-Mehrizi, Government Liaison Officer (September)
- Mrs. Ann Bostock, Administrative Assistant Technical Programs (January)
- Mr. Wameedh Monther Yousuf, Farm Technician (March)
- Ms. Sohila Vahidipoor, Library Assistant (April)
- Mr. Sami Barakey, General Accountant (July)
- Mr. Ghazi Abu Rumman, Laboratory Technician (December)

INFORMATION TECHNOLOGY

During the period, ICBA upgraded the computer network and maintained its website. The network was expanded to handle the increased demand in terms of staff and frequency of use. Two new servers were added to handle the extra load.

EMPLOYEE CAPACITY BUILDING

To improve the employees' capabilities, effectiveness and efficiency, ICBA developed a staff development plan. Ten staff members benefited from the plan.

DONOR RELATIONS

ICBA Resource Mobilization Plan

ICBA prepared its Resource Mobilization Plan 2000 - 2009, which was presented to its major founding donor, the Islamic Development Bank.

Exemption from Water Charges from Dubai Rulers' Court

On 10 October, the Ruler's Court of Dubai decided to exempt ICBA from charges of water supplied to the Center for research purposes. This decision of in-kind support by the Rulers of Dubai is a significant contribution to ICBA, valued at US$ 0.375 million per annum. This decision emphasizes the progressive commitment of the Ruler of Dubai and of the UAE towards agricultural research and efforts to conserve natural resources in the Near East and other parts of the developing world.

OPEC Fund Grant for Training and Networking

The OPEC Fund for International Development approved ICBA's proposal that sought support for its training programs and the web-based Global Salinity Network. However, while ICBA requested US$1.05 million over 3 years, the donor indicated its intent to provide US$ 200,000 over 2 years. This sum will only partially support ICBA's proposed training activities and the operations of the web-based Global Salinity Network. The donor clarified that its support for training activities is restricted to the least-developed member countries of the Islamic Development Bank.

Contract Research for Petroleum Development Oman (PDO)

PDO, a private sector company, has signed a series of minor consultancy contracts and one major contract with ICBA. ICBA has already billed PDO for US$ 21,500 of which US$ 18,000 has actually been received. Other minor contracts are still in the process of implementation. A major contract for $190,000 to treat the Nimr Reed Beds and establish plots for biosaline agriculture is being developed by PDO and is likely to be approved in 2002.

Solving Waterlogging in Abu Dhabi Farms

Another project with the Emirate of Abu Dhabi to solve waterlogging and resulting salinity in important farm areas of the Emirate will provide ICBA with approximately US$ 60,000.

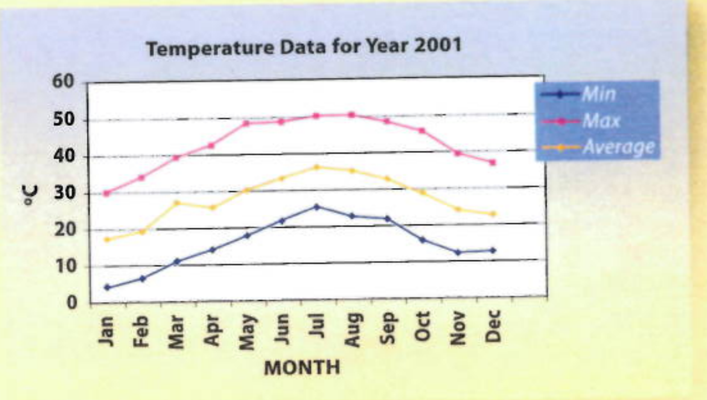
Appendixes

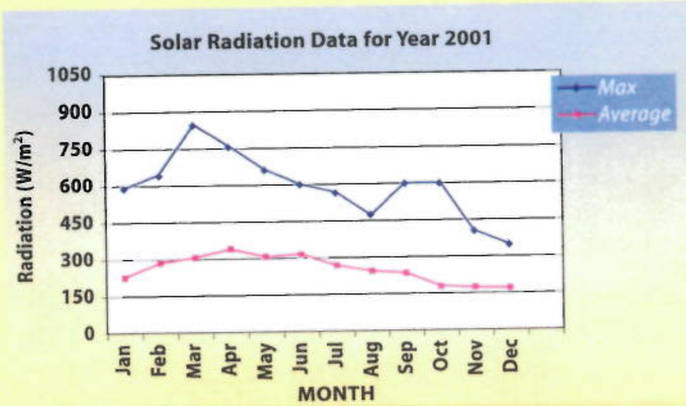
APPENDIX 1 – SUMMARY OF ICBA'S GENEBANK HOLDINGS DECEMBER 2001

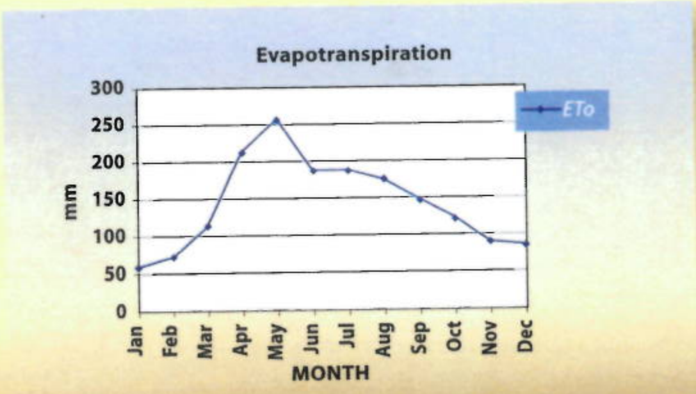
SN.	Genus	Family	Number of accessions	Number of species	Nature of Crop
1	*Agropyron*	Gramineae	1	1	Forage
2	*Arachis*	Fabaceae	9	1	Oilseed/forage
3	*Astraglus*	Fabaceae	69	23	Forage
4	*Atriplex*	Chenopodiaceae	42	9	Forage
5	*Beta*	Chenopodiaceae	49	1	Forage
6	*Cajanus*	Fabaceae	71	1	Forage/pulse
7	*Calligonum*	Polyganaceae	3	2	Forage
8	*Carthamas*	Asteraceae	641	2	Oilseed
9	*Cassia*	Caesalpiniaceae	1	1	Forage
10	*Cassia*	Fabaceae	1	1	Forage
11	*Cenchrus*	Gramineae	796	1	Forage
12	*Centrosema*	Fabaceae	1	1	Forage
13	*Chenopodium*	Chenopodiaceae	121	1	Forage
14	*Chloris*	Gramineae	116	1	Forage
15	*Clitoria*	Fabaceae	1	1	Forage
16	*Coelachyrum*	Gramineae	1	1	Forage
17	*Crotalaria*	Fabaceae	5	1	Forage
18	*Cyperus*	Cyperaceae	2	1	Forage
19	*Dichanthium*	Gramineae	11	1	Forage
20	*Digitaria*	Gramineae	1	1	Forage
21	*Dipterygium*	Capperidaceae	13	1	Forage
22	*Echinochloa*	Gramineae	145	9	Forage
23	*Farsetia*	Brassiaceae	2	1	Forage
24	*Haloxylon*	Chenopodiaceae	1	1	Forage
25	*Hedysarum*	Fabaceae	16	5	Forage
26	*Heliotropium*	Boraginaceae	3	1	Forage
27	*Hordeum*	Gramineae	12	1	Forage
28	*Hymenocorpos*	Fabaceae	2	1	Forage
29	*Indigofera*	Fabaceae	5	2	Forage
30	*Jaubertia*	Rubiaceae	2	1	Forage
31	*Lablab*	Fabaceae	44	1	Forage
32	*Lasiurus*	Gramineae	9	1	Forage

SN.	Genus	Family	Number of accessions	Number of species	Nature of Crop
33	*Lathyrus*	Fabaceae	254	3	Forage
34	*Leptochloa*	Gramineae	3	1	Forage
35	*Leucaena*	Mimocaceae	237	1	Forage
36	*Lotus*	Fabaceae	446	21	Forage
37	*Lupinus*	Fabaceae	260	6	Forage
38	*Lycium*	Solanaceae	1	1	Forage
39	*Medicago*	Fabaceae	509	40	Forage
40	*Melilotus*	Fabaceae	483	2	Forage
41	*Ochradenus*	Resedaceae	5	2	Forage
42	*Oryzopsis*	Gramineae	1	1	Forage
43	*Panicum*	Gramineae	26	2	Forage
44	*Paspalum*	Gramineae	3	2	Forage
45	*Pennisetum*	Gramineae	147	4	Forage
46	*Phalaris*	Gramineae	1	1	Forage
47	*Prosopis*	Fabaceae	2	2	Forage
48	*Rhanterium*	Asteraceae	2	1	Forage
49	*Simmondsia*	Bauxaceae	16	1	Oilseed
50	*Sorghum*	Gramineae	447	4	Forage/grain
51	*Sphaerocoma*	Caryophyllaceae	2	1	Forage
52	*Sporobolus*	Gramineae	77	15	Forage
53	*Stipagrostis*	Gramineae	1	1	Forage
54	*Stylosanthes*	Fabaceae	2	2	Forage
55	*Tephrosia*	Fabaceae	1	1	Forage
56	*Trifolium*	Fabaceae	1	1	Forage
57	*Trigonella*	Fabaceae	13	1	Forage
58	*Triticosecale (Triticale)*	Gramineae	992	1	Forage/grain
59	*Triticum*	Gramineae	59	1	Forage/grain
60	*Uroahloa*	Gramineae	1	1	Forage
61	*Vicia*	Fabaceae	11	1	Forage
62	*Vigna*	Fabaceae	408	1	Forage/pulse
63	*Ziziphus*	Rhamnaceae	2	1	Forage
	Total		**6609**	**200**	

APPENDIX 2 – SUMMARY OF WEATHER INFORMATION AT ICBA STATION







APPENDIX 2 (continued) – SUMMARY OF WEATHER INFORMATION AT ICBA STATION (2001)

Month	Temperature (°C)				Relative Humidity (%)				Sunshine	Solar Radiation (W/m²)				Windspeed (km/hr)				Rainfall (mm)		ETo (mm)	
	Min	Max	Av	Med	Min	Max	Av	Med	Hrs	Min	Max	Av	Med	Min	Max	Av	Med	Total	Total to Date	Monthly	Total to Date
Jan	3.7	29.5	16.9	15.6	23.7	100.0	75.0	78.5	10.2	0.0	586.0	224.0	275.0	0.0	34.1	8.0	6.6	8.0	8.0	57.8	57.8
Feb	6.0	33.6	18.9	17.2	16.3	100.0	71.5	72.1	10.3	0.0	639.0	282.7	302.0	0.0	37.6	8.1	6.9	0.1	8.1	70.5	128.3
Mar	10.5	38.8	26.6	21.9	15.2	100.0	62.9	66.5	10.2	0.0	844.0	304.2	351.0	0.0	36.0	9.0	5.3	0.0	8.1	111.3	239.6
Apr	13.5	42.1	25.2	24.2	8.2	100.0	56.2	64.2	8.8	0.0	755.0	340.1	404.0	0.0	31.0	7.8	6.0	0.0	8.1	211.3	450.9
May	17.4	48.0	29.9	31.5	8.32	100.0	46.7	47.8	9.7	0.0	657.0	304.5	337.0	0.0	34.4	7.7	8.1	0.0	8.1	254.5	705.4
Jun	21.3	48.3	32.9	31.8	9.6	100.0	56.2	51.7	12.2	0.0	595.0	312.7	337.0	0.0	30.5	7.6	6.1	0.0	8.1	184.9	890.3
Jul	24.9	49.8	35.9	36.2	14.3	98.9	49.1	44.2	11.3	0.0	559.0	265.8	298.0	0.0	34.4	8.9	7.4	0.0	8.1	185.0	1075.3
Aug	22.3	49.9	34.8	33.7	11.4	100.0	49.0	47.4	11.4	0.0	470.0	241.9	266.0	0.0	30.4	7.4	5.2	0.0	8.1	173.1	1248.4
Sep	21.4	48.0	32.4	32.5	14.4	100.0	62.8	60.1	11.1	0.0	595.0	231.3	248.0	0.0	35.0	5.7	4.2	0.0	8.1	146.6	1395.0
Oct	15.5	45.3	28.4	29.9	13.6	100.0	67.2	60.2	8.3	0.0	595.0	177.5	257.0	0.0	22.2	3.1	4.5	0.0	8.1	120.3	1515.3
Nov	11.8	39.0	23.7	23.5	10.6	103.0	68.5	47.4	8.8	0.0	399.0	170.5	205.0	0.0	30.9	5.6	4.9	0.0	8.1	88.4	1603.7
Dec	12.2	36.3	22.2	20.4	21.3	103.0	77.1	49.5	7.6	0.0	346.0	169.7	201.0	0.0	23.2	4.9	3.9	0.0	8.1	83.3	1687.0
Av	15.0	42.4	27.1	26.5	11.9	100.0	61.9	57.5	9.6	0.0	586.7	252.1	289.9	0.0	31.6	7.0	5.8				

APPENDIX 3 – MEMORANDA OF UNDERSTANDING/AGREEMENTS AND PARTNERSHIPS

Memoranda of Understanding/Agreements

February

- Environmental Research and Wildlife Development Agency (ERWDA), UAE

March

- International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India

May

- Arab Authority for Agricultural Investment and Development (AAAID), Sudan
- King Abdulaziz City for Science and Technology (KACST), Kingdom of Saudi Arabia

October

- Arab Organization for Agricultural Development (AOAD), Sudan

December

- Ministry of Agriculture, Animal Wealth and Irrigation, State of Khartoum, Sudan
- Arabian Saline Water Technology Co. (BEHAR), Kingdom of Saudi Arabia

Partnerships

- Associate Member of the Asia-Pacific Association of Agricultural Research Institutions (APAARI)
- Global Water Partnership (GWP)
- Consultative Group on International Agricultural Research (CGIAR)

APPENDIX 4 – VISITORS TO ICBA, 2001

Ministers

- H.E. Saeed Bin Mohammad Al Raqabani, Minister of Agriculture & Fisheries, UAE
- H.E. Dr. Faisal Hassan Ibraheem, Minister of Agriculture, Animal Wealth and Irrigation, Khartoum State, Sudan
- H.E. Mr. Sleiban Omar Adan, Minister of Housing, Building, Environment & Reclamation, Djibouti

Diplomatic Missions

- H.E. Defallah H. Shumelah, Ambassador of Yemen, Abu Dhabi, UAE
- H.E. Joost Wolfswinkle, Ambassador of the Netherlands,Abu Dhabi, UAE
- H.E. Humood Frrag Bin Nader, Consul General of Saudi Arabia, Dubai, UAE
- H.E. Mr. Ahmad Mahjoob, Consul General of Sudan, Dubai, UAE
- H.E. Mr. Asoke Mukherjee, Consul General of India, Dubai, UAE
- Mr. Raid Abu Haddrah, Commercial Attaché, the Netherlands Embassy, Abu Dhabi, UAE
- Mr. Fadel Al Naqeeb, Cultural Consultant, Yemen Embassy, Abu Dhabi, UAE

International Centers/Organizations

- Dr. William D. Dar, Director General, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India
- Dr. Salem Al-Louzi, Director General, Arab Organization for Agricultural Development (AOAD), Khartoum, Sudan
- Dr. Mervat Badawi, Director of Technical Department, Arab Fund for Economic and Social Development (AFESD), Kuwait
- Mr. Abdul Hameed Al-Zaqalaei, Economic Advisor, Arab Fund for Economic and Social Development (AFESD), Kuwait
- Dr. Omar Mohammad Jouda, Regional Coordinator for Water, United Nations Economic and Social Commission for Western Asia (ESCWA), Beirut, Lebanon
- Dr. Abbas Kesseba, International Fund for Agricultural Development (IFAD), Egypt
- Mr. Adnan Shihab Eddin, Director of Technical Cooperation Programme, International Atomic Energy Agency (IAEA)
- Dr. Eddy De Pauw, Natural Resources Management Program, International Center for Agricultural Research in the Dry Areas (ICARDA), Syria
- Dr. Fawzi Karajeh, Natural Resources Management Program, International Center for Agricultural Research in the Dry Areas (ICARDA), Syria

- Dr. Miguel Clusner Godt, UNESCO-MAP, France
- Dr. Benno Boer, UNESCO, Qatar
- Dr. Andreas Kuck, Team Leader, GTZ, Amman, Jordan

Islamic Development Bank (IDB)

- Mr. Abdelrafie Abdelmutalib, IDB, Jeddah, Saudi Arabia
- Mr. Suliman Ahmed Salim, Director, Operations and Projects Department-3, IDB, Jeddah, Saudi Arabia
- Dr. Abdoul Aziz Al-Khalaf, Advisor, IDB, Jeddah, Saudi Arabia
- Mr. Jamil A. Darras, The Head, Central Accounting Section, Finance Dept., IDB, Jeddah, Saudi Arabia

United Arab Emirates (UAE) Local Authorities

- Eng. Rashid Mohammad Khalfan Al Shereqi, Deputy Minister, Ministry of Agriculture and Fisheries, Dubai, UAE
- Mr. Abdul Latif Bin Hammad, Deputy Minister of Planning, UAE
- Mr. Rashid Abdul Rahman Al-Nuaimi, Manager of Planning Department, Ministry of Planning, UAE
- Eng. Mohammad Seif Al-Arriefi, Deputy Director of Zayed Center, Abu Dhabi Municipality, Abu Dhabi, UAE
- Eng. Salem Al-Shekeily, Director of the Agronomy Research Laboratory, Abu Dhabi Municipality, Abu Dhabi, UAE
- Eng. Abdoul Monem Al-Marshoudi, Agriculture Extension, Abu Dhabi Municipality, Abu Dhabi, UAE
- Dr. Abdoulla Al-Najjar, Director of Research, Sharjah University, Sharjah, UAE
- Mr. Abdul Rahman Al Shamsi, Manager, Research Station, Agriculture Department, Al-Ain, UAE
- Mr. Ahmad Mohammed Abdulkarim, Director of Public Parks & Horticulture Dept, Dubai Municipality, Dubai, UAE
- Mr. Hamdan Al-Shaer, Director of the Environment Dept., Dubai Municipality, Dubai, UAE
- Mr. Ibrahim Yacoub Ali, Manager of the Office of Development and Follow-up for Environment & Public Health, Dubai Municipality, Dubai, UAE
- Mr. Mohammad Abdoul Rahman Hassan, Director of the Marine Environment Section, Dubai Municipality, Dubai, UAE
- Mr. Nabil Mahfood Bin Haydar, Manager of the Agricultural Services Section, Dubai Municipality, Dubai, UAE
- Mr. Mohammad Ali Salem Al-Shamsi, Researcher in Applied Genetics and Plant Tissue Planting, Dubai Municipality, Dubai, UAE
- Mr. Mustapha Bin Ali Al-Shewiani, Director of Planning Dept., Sharjah Government, UAE
- Dr. Ibrahim Sidawi, Executive Director, Center of Externally Funded Research Activities, UAE University, Dubai, UAE

Others

- Dr. Nicholas Yensen, Manager of NyPa International, USA
- Dr. Ragab Ragab, Prinicipal Research Scientist, Centre for Ecology & Hydrology, Institute of Hydrology, UK
- Prof. Ali Al Jaloud, King Abdulaziz City for Science and Technology, Saudi Arabia
- Dr. Rafiq Ahmad, Biosaline Research Project, University of Karachi, Pakistan
- Dr. Yousuf Al- Ahaiji, Kuwait Institute for Scientific Research (KISR), Kuwait
- Ms. Yasmin Al-Lawati, Process, Concept Engineer, PDO LLC, Oman
- Dr. Elias Al-Tijani, Water Management & Irrigation Institute, University of Jezira, Sudan
- Prof. Dr. Adel El Prince, King Faisal University, Saudi Arabia
- Dr. Parviz Rezvan Moghaddam, Ferdowsi University, Iran
- Dr. Peter Dominy, University of Glasgow, UK
- Dr. Shafqat Farooq, Nuclear Institute for Agriculture & Biology, Pakistan
- Dr. Cherif Harrouni, Institute National de Recherche Scientifique et Tec Institut Agronomique et Veterinaire Hassan II, Morocco
- Dr. Mohammad Al Malboobi, National Research Center for Genetic Engineering & Biotechnology, Iran
- Dr. James Oster, University of California, USA
- Dr. Zahid Hussain, Pakistan Agriculture Research Council, Pakistan
- Mr. Avaz Koocheki, Ferdowsi University, Iran
- Dr. S.A.M. Cheragi, National Salinity Research Center, Iran
- Dr. Mussaddag Janat, Syrian Atomic Energy Commission, Syria
- Mr. Hussain Jawad Al Laith, Ministry of Works & Agriculture, Bahrain
- Dr. Donald S. Loch, Leader - Turf Research, Dept. of Primary Industries, Queensland Government, Australia
- Cr. Del Cole, Division 1 Councillor, Cooloola Shire Council, Queensland, Australia
- Mr. Safwan Al-Sughaier, Administration and Financial Director of the Agricultural Services Center, Khalil, Palestine
- Mr. George Heading, Farm Manager - Desert Agriculture Project, GRM International Pty. Ltd
- Dr. Philip Bunn, Supervisor, Engineering Programs, Al Ain Higher Colleges of Technology, UAE
- Dr. Mansour K. Mansour, Faculty Electronics Engineering Programs, Al Ain Higher Colleges of Technology, UAE
- Dr. Sabih Al Lami, Faculty Engineering Programs, Al Ain Higher Colleges of Technology, UAE
- Mr. Mohammed Al-Sakhan, Director of Range and Forestry Dept. Ministry of Agriculture and Water, Saudi Arabia

- Mr. Abdulhakim Al Nasr, Director of National Parks, Saudi Arabia
- Dr Nico Marcar, Senior Research Scientist, Division of Forest and Forestry, CSIRO, Australia
- Dr. Samira Islam, King Abdul Aziz University, Saudi Arabia
- Ms. Fotoh Al-Qattan, Manager, Public Relations, KISR, Kuwait
- Dr. Zahurul Karim, Secretary, Ministry of Fisheries and Livestock, Bangladesh
- Dr. Stewart Routledge, Executive Director, GRM, Queensland, Australia
- Mr. Khaled Nazal, Manager, Emirates Bio Fertilizer Factory, Al-Ain, UAE
- Dr. Tsutomu Enoki, Faculty of Agriculture, University of the Ryukuys (UR), Japan
- Mr. Yoichi Sano, Faculty of Agriculture, University of the Ryukuys (UR), Japan
- Ms. Sumie Watanabe, Faculty of Agriculture, University of the Ryukuys (UR), Japan
- Mr. Mohamad-Amin Adam, Assistant Director General, Ministry of Environment & Rural Development, Mogadishu, Somalia
- Dr. Asad Ullah Bin Ahmad Al-Ajami, Director of the Water and Soil Research Laboratories, Ministry of Agriculture and Fisheries, Oman
- Dr. Philipp Magiera, CIM-Integrated Expert, Jordan Valley Authority (JVA), Amman, Jordan
- Eng. Artur Vallentin, Agricultural Adviser, GTZ, Amman, Jordan
- Prof. Abdullah Abdelmonem, Director, Plant Pathology Research Institute, Agriculture Research Center, Egypt
- Eng. Nedal Katbeh, Senior Researcher, Ministry of Environmental Affairs, Palestinian Authority, West Bank, Palestine

APPENDIX 5 – PUBLICATIONS & PRESENTATIONS

ICBA's Strategic Plan 2000-2004 was printed and presented to the Board of Trustees. The distribution is in progress. The 70-page, 4-color document was widely appreciated. The document outlines the new challenges in biosaline agriculture that will face the scientists at ICBA.

ICBA's Annual Report 2000 was printed in English, Arabic and French. The staff of IDB did the French translation. This 42-page document was the first annual report of the Center.

ICBA Statute (bi-lingual – Arabic and English)

Abstracts. International Symposium on "Prospects of Saline Agriculture in the GCC Countries" 18-20 March, 2001, Dubai, UAE.

Biosalinity News– newsletter of the International Centre for Biosaline Agriculture Vol. 2, 2001, Nos. 1 and 2. English and Arabic.

Abdulla, M. and B. Hasbini. 2001. "Prospects for Biosaline Agriculture in the United Arab Emirates." International Symposium on Prospects of Saline Agriculture in the GCC Countries, Dubai, UAE, 18 - 20 March.

Al-Zarooni, H. and A.A. Jaradat 2001. "A Core Collection of Omani Landrace Barley for Salt-Tolerance and Forage Production." Paper accepted for presentation at CSSA Annual Meeting, Charlotte, North Carolina, USA, 22 - 26 October.

Bhat, N., F. K. Taha and A. Al-Nasser (editors). 2001. Mangrove Ecosystems: National Distribution, Biology and Management. Proceedings, Published by Kuwait Institute for Scientific Research (KISR). 265 pages.

Bhat, N.R., M. Shahid, Al Zalzaleh and F.K. Taha. 2001. " Establishment of Mangrove Plantations for Protection and Enrichment of Kuwait's Coastline: Priorities, Procedures and Problems." International Symposium on Prospects of Saline Agriculture in the GCC Countries, Dubai, UAE, 18 - 20 March.

Dakheel A, J. Peacock and G.A. Alhadrami. 2001. "Potential for Developing Sustainable Plant Production Systems for Salt-Affected Areas in the Arabian Peninsula". Accepted for presentation at the "International Symposium on Halophytes", China, 15-21 September 2001.

Dakheel, A.J., G.A. Alhadrami and J.M. Peacock. 2001. "Yield Potential and Nutritional Value of Five *Atriplex* Species Grown in the UAE Under Different Salinity and Fertilizer Levels." International Symposium on Prospects of Saline Agriculture in the GCC Countries, Dubai, UAE, 18 - 20 March.

Hasbini, B., I. McCann, M.M. Al Mulla and J.W. Kijne. 2001. "A Model Equation for Crop Selection for Arid Land Agriculture." International Symposium on Prospects of Saline Agriculture in the GCC Countries, Dubai, UAE, 18 - 20 March.

Hasbini B.A., F.K. Taha and M.H. Al-Attar. 2001. "Irrigation Systems for Biosaline Agriculture in Arid Zones". Presented during the International Symposium on "Sustained Management of Irrigated Land for Salinity Management and Toxic Element Control" organized by the International Union of Soil Science and George E. Brown Salinity Laboratory, USDA, Riverside, California.

Ismail S. 2001. "Sustainable Production of Halophytes for Forage Fodder: Successes, Limitations and Prospects". Accepted for presentation at the "International Symposium on Halophytes", China, 15-21 September 2001.

Ismail, S and K.U. Rehman Butt. 2001. "Halophytes: Potential Source for Forage and Landscaping Progress and Prospects." International Symposium on Prospects of Saline Agriculture in the GCC Countries, Dubai, UAE, 18 - 20 March 2001.

Jaradat A.A. 2001. "Plant genetic resources for salt tolerance in the Mediterranean Region." Proceedings of the International Symposium on "Prospects of saline agriculture in the GCC countries" Dubai, UAE, 18 - 20 March 2001.

Taha, F.K. 2001. "Developing Sustained Greenery in Arid Zones: The Role of Research and Development (R & D) in Ornamental Horticulture and Landscaping." International Symposium on Horticulture and Landscaping in the Arabian Peninsula, Al Ain University, UAE, 5 - 7 April.

Taha, F.K. and M. Al-Attar. 2001 "The International Center for Biosaline Agriculture (ICBA): Combating Salinity and Developing Sustainable Agriculture." International Symposium on Prospects of Saline Agriculture in the GCC Countries, Dubai, UAE, 18 - 20 March.

Taha F., A.A. Jaradat and S. Ismail. 2001. "Proceedings of the International Symposium on Prospects of Saline Agriculture in the GCC Countries, Dubai, UAE, 18 - 20 March, 2001. In preparation.

Shahid, M.A., A.A. Jaradat. and H.I. Malkawi. 2001. "Biological Characterization of Oman Barley Landrace." Paper accepted for presentation at CSSA Annual Meeting, Charlotte, North Carolina, USA, 22 - 26 October.

APPENDIX 6 – CORE STAFF AS ON 31 DECEMBER 2001

Office of the Director General

Dr. Mohammad Al-Attar	Kuwait	Chairman of the Board of Directors/Director General
Mr. Ibrahim Bin Taher Al-Mehrizi	UAE	Government Liaison Officer
Mr. Jugu Abraham	India	Donor Relations Specialist
Mrs. Hemmat Lashin	Egypt	Executive Secretary

Technical Programs

Prof. Dr. Faisal Taha	USA	Director, Technical Programs
Dr. Abdullah Jaradat	USA	Plant Genetic Resource Scientist
Dr. Abdullah Dakheel	Syria	Field and Forage Crops Scientist
Dr. Shoaib Ismail	Pakistan	Halophyte Agronomist
Dr. Bassam Hasbini	Lebanon	Irrigation Management Scientist
Mr. Peter Eichorn	Germany	Farm Management Consultant
Mrs. Mae Cutler	Canada	Library Consultant
Mr. Mohammad Shahid	Pakistan	Plant Genetics Laboratory Technician
Mr. Khalil ur Rahman	Pakistan	Halophyte Laboratory Technician
Mr. Anas Assainar	India	Irrigation and Farm Technician
Mr. Ghazi Abu Rumman	Jordan	Agronomy Laboratory Technician
Mr. Wameedh Monther	Iraq	Farm Technician
Mrs. Ann Bostock	UK	Administrative Assistant
Mr. Ghazi Al Jabri	Syria	Administrative Assistant-Communications
Miss Sohila Vahidipoor	Iran	Library Assistant

Administration and Finance

Mr. Ghassan Sarris	Canada	Administration and Finance Officer
Mr. Jamal Telmasani	Saudi Arabia	Acting Facilities Supervisor
Mrs. Souhad El Zahed	Lebanon	Office Administrator and End User Support
Mr. Waseem Ali	Pakistan	Administrative Assistant
Mr. Sami Barakey	Palestine	General Accountant
Mrs. Shazia Khan	India	Administration Assistant

APPENDIX 7 – AUDITED FINANCIAL STATEMENTS

Statement of Activities

For the year ended 31 December 2001

(Currency: US Dollar)

	2000	2001
Revenues:		
Grants - unrestricted	2,091,461	2,294,864
Contribution	–	273,318
Other income	6,264	103,655
Total Revenues	**2,097,725**	**2,671,837**
Expenses:		
Salaries	698,517	999,662
Benefits	706,825	638,290
Suppliers	132,080	122,153
Board expenses	5,568	9,353
Contract services	51,884	87,686
Travel	68,995	112,619
Maintenance	66,250	78,219
Depreciation	207,534	282,139
Irrigation water expenses	85,950	273,318
Others	74,122	68,398
Total Expenses	**2,097,725**	**2,671,837**
Excess of revenues over expenses	–	–

Statement of Financial Position

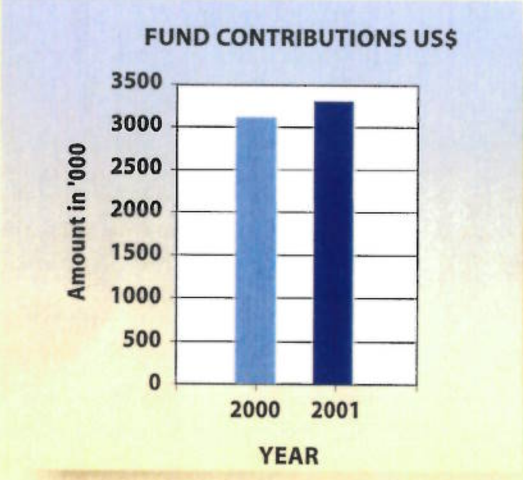
For the year ended 31 December 2001

(Currency: US Dollar)

	2000	2001
Assets		
Current Assets:		
Cash and bank	1,339,047	2,254,915
Accounts receivable	50,000	8,934
Prepayments and other assets	26,396	56,161
Total Current Assets	**1,415,443**	**2,320,010**
Property, plant and equipment, net	6,272,302	6,338,836
Total Assets	**7,687,745**	**8,658,846**
Liabilities and fund balances		
Current Liabilities:		
Accrued expenses and other liabilities	1,135,742	1,414,820
Total Current Liabilities	**1,135,742**	**1,414,820**
Provision for end-of-service benefits, net	11,129	22,286
Total liabilities	**1,146,871**	**1,437,106**
Fund Balances		
Capital invested in property		
plant and equipment, net	6,272,302	6,338,836
Capital fund	268,572	882,904
Total fund balances	**6,540,874**	**7,221,740**
Total liabilities and fund balances	**7,687,745**	**8,658,846**

ICBA's external auditors, M/s Arthur Anderson & Co, have issued an unqualified audit report on the Year 2001 financial statement.

APPENDIX 8 – DONOR CONTRIBUTIONS



	2000	2001
IDB	$3,000,000	$3,249,375
OPEC Fund	$250,000	
PDO		$18,489
BEHAR		$22,500
AFESD		$43,874
TOTAL	**$3,250,000**	**$3,334,238**

APPENDIX 9 – LIST OF ACRONYMS

AAAID	Arab Authority for Agricultural Investment and Development
AFESD	Arab Fund for Economic and Social Development
AOAD	Arab Organization for Agricultural Development
APRP	Arabian Peninsula Regional Program
APAARI	Asia Pacific Association of Agricultural Research Institutions
BEHAR	Arabian Saline Water Technology Company
CAZRI	Central Arid Zone Research Institute, India
CGIAR	Consultative Group on International Agricultural Research
CSIRO	Commonwealth Scientific and Industrial Organization
EC	Electrical Conductivity
ERWDA	Environmental Research and Wildlife Development Agency
ESCWA	United Nations Economic and Social Commission for Western Asia
GCC	Gulf Cooperation Council
GPS	Geographic Positioning System
GWP	Global Water Partnership
IAEA	International Atomic Energy Agency
ICARDA	International Center for Agricultural Research in the Dry Areas
ICBA	International Center for Biosaline Agriculture
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDB	Islamic Development Bank
IFAD	International Fund for Agricultural Development
JODCO	Japan Oil Development Company
JVA	Jordan Valley Authority
KACST	King Abdulaziz City for Science and Technology, Saudi Arabia
KISR	Kuwait Institute for Scientific Research
MAF	Ministry of Agriculture and Fisheries, UAE
MoU	Memorandum of Understanding
NARS	National Agricultural Research Systems
OPEC	Organization of Petroleum Exporting Countries
PDO	Petroleum Development Oman
R&D	Research and Development
SPC	Sewerage Projects Committee, Abu Dhabi
UAE	United Arab Emirates
UK	United Kingdom
UNEP/ROWA	United Nations Environment Program/Region Office for West Asia
UNESCO	United Nations Educational, Scientific and Cultural Organization
UR	University of the Ryukuys
USA	United States of America
USDA	United States Department of Agriculture
WUE	Water Use Efficiency
WWF3	Third World Water Forum, Japan

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