ICBA Annual Report 2004 (1424-1425H)

Annual Report

2004 (1424-1425H)

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 Development Bank-member countries and elsewhere.

Mandate

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

> 'Responding to challenges in areas such as economic productivity, agriculture, education, gender inequity, health, water, sanitation, environment, and participation in the global economy will require increased use of scientific and technical knowledge. Technological innovation and the associated institutional adjustments underpin long-term growth and must be at the center of any strategy to strengthen the private sector.'
>
> (Jeffrey D. Sachs, leading development economist and Director of the Earth Institute. UN Millennium Project. *Innovation: Applying Knowledge in Development*. Task Force on Science, Technology, and Innovation.)

Contents

ICBA's founding donors

Islamic Development Bank

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

Arab Fund for Economic and Social Development

The Arab Fund for Economic and Social Development (AFESD) is an autonomous regional Pan-Arab development finance organization.

AFESD assists the economic and social development of Arab countries through, firstly, financing development projects, with preference given to overall Arab development and to joint Arab projects; secondly, encouraging the investment of private and public funds in Arab projects; and, thirdly, providing technical assistance services for Arab economic and social development.

OPEC Fund for International Development

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

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

Ministry of Agriculture and Fisheries, United Arab Emirates

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

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Foreword

The new Strategic Framework of the Islamic Development Bank (IDB) is ambitious and challenging. The vision is very clear, to give the Bank a leading edge in promoting socio-economic development in member countries where there is a growing gap, not only between many IDB member countries and developed countries, but also between them and other developing countries.

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

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

The Bank's assistance in agriculture is targeted at areas that support the policies and activities of governments. These include irrigation and crop development and a key intiative, the establishment of the International Center for Biosaline Agriculture (ICBA) in 1999. ICBA was established specifically as a center of excellence for research and development in managing the grave salinity problems widespread in many member countries.

The Bank recognises that science and technology is a vital component of human development. The case for increasing this type of assistance is compelling. Although centers such as ICBA are small, their impact can be quite significant. The IDB is committed to continuing its support to ICBA and to encouraging member countries to cooperate in this endeavour by allocating funds to support these research and development efforts.

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To encourage support from member countries and donor agencies, in 2004, the final year of ICBA's first Strategic Plan, IDB commissioned the first External Program and Management Review of the Center. The Review was undertaken by a distinguished Panel of international experts and commends the Bank's investment in ICBA. It also provides an assessment of opportunities for the future role and direction of ICBA within the new Strategic Framework for the IDB.

Following this comprehensive Review of ICBA, I now look forward to the development, in consultation with the Center's collaborators and the end-users of ICBA's research and development, of ICBA's second Strategic Plan.

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

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

Message from the Chairman, Board of Directors, and Director General

The year 2004 was momentous for ICBA. Thanks to sustained efforts in resource mobilization over the past three years, ICBA secured major grants and contributions, amounting to over three-and-a-half-million dollars, for a multi-country four-year project to develop salt-tolerant forages in the West Asia and North Africa region.

The year 2004 also marked the five-year milestone since the establishment of ICBA in 1999. A major effort in 2004 focused on a comprehensive External Program and Management Review of the outcomes of ICBA's first Strategic Plan 2000-2004, by a distinguished international panel of experts.

The Review, based on a highly participatory process involving the center staff, made very valuable recommendations on the future development of ICBA.

The Review confirmed that ICBA is on track in focusing on the West Asia and North Africa countries in the first instance, where water scarcity is the most severe. However, in order to operate as a truly international center and attract the increasing support of donor agencies necessary to make a significant impact, the Review emphasized that a balanced geographical focus, including water poor countries from Africa, Asia and the Middle East is fundamental.

The Review commended ICBA's approach of using the model of the Consultative Group on International Agricultural Research centers as a benchmark and noted that the model would need to be adapted to reflect the specificities of ICBA and the present dependency of the Center on IDB.

The ICBA Board of Directors has endorsed in principle the recommendations made by the Review. The Board of Directors and ICBA management also made specific comments regading the report and recommendations. The report and comments were sent to IDB for necessary action.

I would like to express my deep appreciation to the Islamic Development Bank for commissioning the External Program and Management Review. I am confident that implementing the recommendations of the Review will provide the Center with added momentum in the quest to be a model strategic center of excellence for research and development cooperation.

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In conclusion, I would especially like to thank ICBA's Chairman, Board of Trustees, Dr. Ahmad Mohamed Ali, and Islamic Development Bank Vice-President for Operations, Mr. Amadou Cisse, for their support and visionary leadership.

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

Board of Trustees

Board of Directors

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

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Research highlights

National agricultural researchers in Egypt, Jordan, Syria and Tunisia are partners in assessing saline groundwater resources in West Asia and North Africa (WANA)

- Saline groundwater resources can contribute to the overall resource base in water-scarce countries in WANA
- But to use them sustainably we need to know the quantities and qualities available, their location and potential utilization options
- Initial conclusions suggest that information on saline water is limited and far from complete in all four countries
- Where saline water is available, socio-economic circumstances often limit its utilization

Farmers are involved in testing pearl millet and sorghum for saline land

- Selecting salt-tolerant crop varieties is a cost-effective option for managing salt-affected land in arid and semi-arid environments
- In coastal areas of Oman and the United Arab Emirates, sea water intrusion into groundwater is widespread
- Farmers in these areas are testing varieties of sorghum and pearl millet previously identified as tolerant to salt in trials at ICBA and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)

International Center for Biosaline Agriculture

Seven countries, three donors and three international agricultural research centers are partnering in a US$4 million project to demonstrate forage production with saline water in West Asia and North Africa

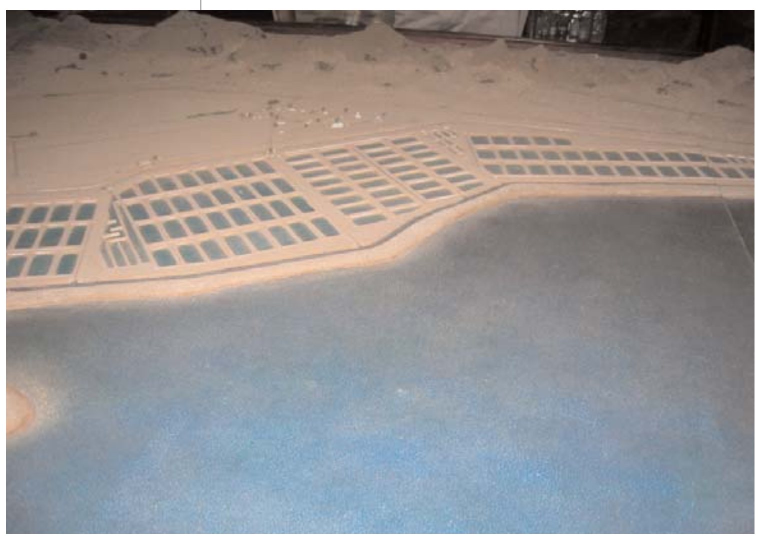
- Research shows that forages produced by irrigation with saline water can provide additional income to farmers in marginal lands
- Donors, NARS and IARCs are partners in a major 4-year project to integrate saline water into overall strategies of sustainable semi-arid and arid farm management

Improving on-farm resource management helps farmers to deal with dry-season salinity in coastal Bangladesh

- The introduction of drip irrigation technology on raised beds in southern Bangladesh is helping farmers grow cash crops during the dry season when coastal areas are affected by salinity and land is usually left fallow
- Drip irrigation on raised beds reduced salt accumulation in the root zone and water savings averaged 42%
- Yield of tomatoes improved by 95%, and by 87% for chilis. Net returns increased by 354% for tomatoes and 35% for chili

International Center for Biosaline Agriculture

Nutrient-rich saline industrial waste water produces biomass for enhancing the environment in desert areas



- A major prawn farming enterprise on the Red Sea coast produces large amounts of waste return seawater carrying a significant load of nutrients and organic matter
- A pilot project is investigating using this nutrient-rich resource to:
  - grow animal fodder,
  - stabilize canal banks with halophytes,
  - ameliorate the harsh environment by growing greenery,
  - generate biomass, and
  - expand natural mangrove stands on the barrier island offshore

Technical Programs Division

International Center for Biosaline Agriculture

Introduction

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

Table 1 summarizes the projects and activities undertaken by the Technical Programs Division in 2004.

Table 1 Technical programs projects and activities 2004

Project code	*Resources (cash or in kind)*	*Collaborators*	*Project title*	*Duration*
Genetic Resources Program				
GR01	ICBA	National and international genebanks	Acquisition, collection and conservation of plant genetic resources	2000-ongoing
GR02	ICBA		Seed increase of salt-tolerant germplasm	2000-ongoing
Production and Management Systems Program: Sustainable land and water use				
PMS07	Petroleum Development Oman	Petroleum Development Oman	Demonstration of biosaline agriculture at Nimr, Sultanate of Oman	2001-2004
PMS08	Sewerage Projects Committee (Abu Dhabi Municipality)	Sewerage Projects Committee (Abu Dhabi Municipality)	Managing salinity and water logging in coastal agricultural areas in Abu Dhabi. Phase 2	2003-2004
PMS09	ICBA, Bangladesh Agricultural Research Institute	Bangladesh Agricultural Research Institute	Demonstration of biosaline agriculture in salt-affected areas in Bangladesh	2003-2004
PMS21	ICBA, Pakistan Agricultural Research Council	Pakistan Agricultural Research Council	Use of low quality water for productive use of desert and salt-affected areas in Pakistan	2003-2005
PMS24	Public Works Department (Abu Dhabi)	Public Works Department (Abu Dhabi)	Greening pilot plot with salt-tolerant plants and halophytes, Qareen Al Eish	2003-2004
PMS28	Consultative Group on International Agricultural Research Comprehensive Assessment Competitive Research Grant Scheme	Egypt, Jordan, Syria, Tunisia	Harnessing salty waters to enhance sustainable livelihoods of the rural poor in four countries in West Asia and North Africa: Egypt, Jordan, Syria and Tunisia	2004
PMS32	ICBA, International Atomic Energy Agency, Ministry of Agriculture and Fisheries (United Arab Emirates)	Ministry of Agriculture and Fisheries (United Arab Emirates)	Feasibility study for biosaline agriculture in the United Arab Emirates	2004
PMS33	National Prawn Company (Saudi Arabia)	National Prawn Company (Saudi Arabia)	Utilization of return seawater for biosaline agriculture at National Prawn Company, Saudi Arabia	2004-2006
Production and Management Systems Program: Field and forage crop production				
PMS03	ICBA	United Arab Emirates University	Optimizing management practices for maximum production of two salt-tolerant grasses: *Sporobolus virginicus* and *Distichlis spicata*	2002-2006
PMS04	ICBA	United Arab Emirates University	Optimizing management practices for maximum prduction of three *Atriplex* species under high salinity levels	2002-2006

Project code	*Resources (cash or in kind)*	*Collaborators*	*Project title*	*Duration*
Production and Management Systems Program: Field and forage crop production (continued)				
PMS05	ICBA, Ministry of Agriculture and Fisheries (United Arab Emirates)	Ministry of Agriculture and Fisheries (United Arab Emirates)	Application of biosaline agriculture in a demonstration farm in the Northern Emirates of the UAE	2003-2006
PMS15	ICBA, International Crops Research Institute for the Semi-Arid Tropics, OPEC Fund	International Crops Research Institute for the Semi-Arid Tropics	Development of salt-tolerant sorghum and pearl millet varieties for saline lands	2003-2006
PMS16	United Arab Emirates University	ICBA, United Arab Emirates University	Development of sustainable salt-tolerant forages for sheep and goat production	2003-2006
PMS17	ICBA, International Center for Agricultural Research in the Dry Areas	International Center for Agricultural Research in the Dry Areas	Evaluation of salinity tolerance and yield in 280 barley varieties and accessions	2003-2004
PMS19	ICBA, International Crops Research Institute for the Semi-Arid Tropics	International Crops Research Institute for the Semi-Arid Tropics	Screening for salt-tolerance among large collections of buffelgrass (*Cenchrus ciliaris*), safflower, fodder beet and lablab	2003-2006
PMS27	International Fund for Agricultural Development, Arab Fund, OPEC Fund, NARS, ICBA	Jordan, Oman, Pakistan, Palestine, Syria, Tunisia, United Arab Emirates	Saving freshwater resources with salt-tolerant forage production in marginal areas of the West Asia and North Africa region - an opportunity to raise the incomes of the rural poor	2004-2007
PMS34	Consultative Group on International Agriculture Challenge Program on Food and Water through the International Rice Research Institute	International Rice Research Institute, Bangladesh Agricultural Research Institute, Rice Research and Training Center (Egypt), Rice Research Institute of Iran	Development of technologies to harness the productivity potential of salt-affected areas of the Indo-Gangetic, Mekong and Nile river basins	2004-2007
Production and Management Systems Program: Halophyte production				
PMS01	ICBA, International Center for Agricultural Research in the Dry Areas - Arabian Peninsula Research Program, Ministry of Agriculture and Fisheries (UAE)	International Center for Agricultural Research in the Dry Areas - Arabian Peninsula Research Program, Ministry of Agriculture and Fisheries (UAE)	Evaluation of irrigation practices and fertilizer requirements for optimizing productivity of three indigenous grass species	2000-2004
PMS12	ICBA		Water use and salt balance of halophytic species	2000-ongoing
PMS22	ICBA, National Salinity Research Center (Iran)	National Salinity Research Center (Iran)	Production of halophytes in Iran	2003-2005
PMS29	NyPa International, United States of America	NyPa International, United States of America	Propagation and development of *Distichlis spicata var. Yensen-4a* (NyPa forage) under arid conditions	2003-2005
PMS30	ICBA	Ministry of Agriculture and Fisheries, United Arab Emirates	Response of two prominent grasses: indigenous Dhai, *Lasiurus scidicus* and introduced African variety of *Cenchrus ciliaris* to water salinity	2004-2006

Project code	*Resources (cash or in kind)*	*Collaborators*	*Project title*	*Duration*
Production and Management Systems Program: Halophyte production (continued)				
PMS31	ICBA		Agroforestry trial using *Acacia ampliceps*, *Sporobolus arabicus* and *Paspalum vaginatum* at different salinity levels	2004-2006
Production and Management Systems Program: Horticultural crop production				
PMS06	ICBA	Ministry of Agriculture and Fisheries (United Arab Emirates)	Investigation of elite date palm and olive varieites for salt-tolerance	2001-2006
PMS23	ICBA, National Center for Agricultural Research and Technology Transfer (Jordan)	National Center for Agricultural Research and Technology Transfer (Jordan)	Expanding date palm cultivation under saline conditions in Jordan	2003-2007

Resources (cash or in kind)	*Collaborators*	*Activity*	*Duration*
Communication, Networking and Information Management Program			
ICBA	International organizations, national research institutions	Memoranda of Understanding	Ongoing
ICBA	International organizations, national research institutions	Collaboration	Ongoing
ICBA		Information management	Ongoing
ICBA		Publications, events and media	Ongoing
ICBA	COMSTECH	Networks	Ongoing
Training, Workshop and Extension Program			
ICBA		Training	Ongoing
ICBA		Workshops	Ongoing
ICBA		Seminars	Ongoing

Genetic Resources Program

The Genetic Resources Program promotes agricultural production and environmental greening under saline conditions. Objectives are to:

- identify and acquire germplasm of new species, and
- generate sufficient plant material for screening for salinity tolerance and testing by national agricultural research institutions

Acquisition, collection and conservation of plant genetic resources (GR01)

Duration: Ongoing

Collaborators: National and international genebanks

Resources: ICBA

Key points

- 191 accessions of 35 species acquired during the year
- Emphasis on obtaining bulk samples for testing in forage project
- Genebank holdings increase to 8189 accessions of 252 species

Significance of the project

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

Objectives

1. Identify and acquire plant species and varieties with potential for use in saline irrigated agriculture.
2. Create a well-documented germplasm collection as a resource for agricultural scientists.

Achievements 2004

Until now ICBA has added new receipts of germplasm to the genebank holdings (Appendix 1) immediately on arrival. However, this approach creates certain problems: seed received may not be viable or the species or accession may fail completely in ICBA trials due to lack of adaptation. ICBA will therefore change its procedures and will only add new germplasm to its collection when it has passed through initial trials, been multiplied and shown a level of salinity tolerance. Usually this will entail a maximum delay of one year between receipt of new germplasm and its listing in ICBA genebank holdings. However, to highlight the general directions that acquisitions and salinity screening trials are taking, ICBA will continue to report new receipts of germplasm as it receives them. A total of 191 accessions of 35 species were acquired in 2004 (Table 2) bringing the total holdings to 8189 accessions of 252 species.

ICRISAT provided bulk samples of seed of 82 sorghum and 58 pearl millet lines and populations for field trials under the aegis of the collaborative project (PMS 15 Development of salinity-tolerant sorghum and pearl millet varieties for saline lands). These were repetitions of lines and populations received earlier and are already represented in ICBA's collection.

In preparation for implementation of the multi-donor project Saving freshwater resources with salt-tolerant forage production in the WANA region, which will become operational in early 2005, ICBA targeted acquisition of bulk quantities and a wider range of forage species for inclusion in field trials, particularly those suitable for cooler regions, which are not well represented among the species with which ICBA has been working over the last few years. To date, bulk samples (4-25 kg) of seven fodder beet varieties, five forage sorghum hybrids, four forage rape varieties and a forage pennisetum variety have been obtained from commercial seed companies in Europe, Australia and Egypt. In addition, smaller samples of 26 varieties of 22 forage species were obtained from a seed company in Australia. The advantage of these varieties is that commercial supplies of seed are already available and any that are found promising can be obtained immediately in sufficient quantity for testing.

Within the framework of collaboration with the UAE Ministry of Agriculture and Fisheries, samples of 11 economically important species were obtained. These species are fodder and medicinal plants that are used or have been used traditionally in livestock-based livelihood systems. Some of these species are now difficult to find due to overgrazing or harvesting from the wild. These species will initially be established as a field genebank to provide seed and other propagation materials for salinity and productivity testing and conservation.

Dissemination outputs

During the first part of 2004, samples of germplasm were provided to the ICARDA program in Central Asia. We supplied 10 samples of each of barley, safflower, triticale, and sorghum; 5 samples of buffelgrass, 2 samples of *Atriplex* species, and one sample each of wheat and pearl millet for initial evaluation at ICARDA research sites in Uzbekistan. In addition, we provided samples of 21 barley lines to collaborators in Australia in exchange for samples of Australian breeding lines.

Plans 2005

During 2005, we will continue to negotiate supply of free test samples of commercial cultivars from seed companies, targeting cultivars of sunflower, fodder beet, fodder and oilseed rape, and other forage brassica species suitable for cultivation in the WANA region. In addition, we will continue to collect samples of forage species of grasses and legumes and multi-purpose shrubs and trees for salinity screening. In particular, we will aim to acquire germplasm of species that can provide winter forage for the cooler areas of the region.

Table 2 Accessions acquired in 2004

Scientific name	*Common name*	*No.*	*Orgin(s)*
Agropyron elongatum	Tall wheatgrass	1	Australia
Atriplex nummularia	Old man saltbush	1	Australia
Avena sativa	Oats	1	Australia
Beta vulgaris	Fodder beet	7	Belgium
Botrichloa insculptpta	Creeping bluegrass	1	Australia
Brassica napus	Fodder rape	4	Australia, UK
Cenchrus ciliaris	Buffelgrass	2	Australia, UAE
Cenchrus pennisetiformis	-	1	UAE
Cenchrus setigerus	-	1	UAE
Chamaecrista rotundiflolia	Roundleaf sensitive pea	1	Australia
Chloris gayana	Rhodes grass	1	Australia
Convolvulus virgatus	Bindweed	1	UAE
Digitaria sp.	-	1	UAE
Lavandula subnuda	Lavender	1	UAE
Macroptilium bracteatum	Burgundy bean	1	Australia
Medicago sativa	Alfalfa	2	Australia
Medicago scutellata	Medicago	1	Australia
Moringa peregrina	-	1	UAE
Panicum coloratum	Panic grass, Kleingrass	1	Australia
Paspalum dilatatum	Dallis grass, water grass	1	Australia
Paspalum notatum	Bahia grass	1	Australia
Pennisetum clandinestinum	Kikuyu grass	1	Australia
Pennisetum glaucum	Pearl millet	58	India (ICRISAT)
Phalaris arundinacea	Reed canary grass	1	Australia
Prosopis cineraria	Ghaf	1	UAE
Puccinellia ciliata	Alkali grass	1	Australia
Sorghum bicolor	Sorghum	82	India (ICRISAT)
Sorghum spp.	Sudan grass	8	Australia, Egypt
Stylosanthes scabra	Stylosanthes	1	Australia
Taverniera glabra	-	1	UAE
Tricholaena teneriffae	-	1	UAE
Trifolium fragiferum	Strawberry clover	1	Australia
Urochloa maxima	Guinea grass	1	Australia
Vicia villosa	Vetch	1	Australia
Ziziphus spina-christi	-	1	UAE
Total		**191**	

Seed increase of salt-tolerant germplasm (GR02)

Duration: Ongoing

Collaborators: N/a

Resources: ICBA

Significance of the project

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

Objectives

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

Achievements 2004

Barley Over 700 barley lines were established for initial evaluation. The material was predominantly improved lines from the ICARDA breeding program. The lines were sown in November 2003 and harvested in March/April 2004. Growth was excellent and clear discrimination between the test entries obtained. Approximately one quarter of the lines were selected on the basis of grain yield and agronomic characteristics for further evaluation. It was intended to sow all the selected lines in November 2004, but because of shortage of water only the 83 most promising entries were included.

Key points

- Successful multiplication of sorghum and pearl millet during winter season (October-February)
- Successful harvesting of buffelgrass seed, particularly in November-December harvests
- Adequate good quality seed for testing at ICBA and other locations produced

Buffelgrass (*Pennisetum ciliare*, syn. *Cenchrus ciliaris*): Seed of the accessions established at the end of 2003 as spaced plants was harvested twice during the year: between February and May and from November to December 2004. At flowering, the heads of the plants were contained in bags constructed of a non-woven polyurethane fabric used for horticultural protection. The objective was to protect the developing seed from bird damage and to catch seed that fell due to shattering of the panicles. The bagging was highly successful and resulted in higher yields of seed being obtained than in the past. In this way, good quality seed was obtained from 618 of the original set of 858 accessions in the two harvests.

The same bagging method was used for protection of the panicles on the 161 accessions of *Cenchrus ciliaris* established in late 2003 for seed increase. The method was equally successful with this material. However, spring flowering in these accessions was less prolific than in the spaced plants described above, possibly due to the fact that the plots were established later and had less time for growth before the onset of hot weather. However, by late 2004, growth of all the plants was excellent, flowering prolific and excellent seed set was observed. Good quality seed was obtained from 151 of the 161 accessions, with the best quantity and quality of seed obtained in the November-December harvest when the weather conditions were cooler and more favorable. These observations highlight the need for further experimentation to determine the optimum crop management requirements for seed multiplication of buffelgrass, and other perennial species, particularly regarding the best time to cut the grasses to induce fresh flushes of flowers during the cool season.

Sorghum and pearl millet In a trial to test the potential to produce seed of sorghum and pearl millet accessions during the cool season, 125 sorghum lines and a bulk of pearl millet were sown in October 2003. Both the lines and the bulk flowered and set seed early in 2004. The growth of the crops was good and excellent seed set and grain filling were obtained. The October sowing of sorghum and pearl millet was repeated late in 2004 with 353 sorghum and 30 millet varieties representing a wider range of agronomic types; growth, flowering and seed set of the lines were again excellent. It is concluded that both species can be effectively and reliably grown at ICBA with high multiplication rate and production of excellent quality seed.

Wheat Late in 2003 a set of 146 wheat introgression lines from CIMMYT derived from crosses of elite lines and wild relatives that have been shown to carry resistance to many different stresses was obtained. In addition, an observation nursery of 110 improved wheat lines was obtained from ICARDA. All these lines were planted, together with 59 landrace varieties from Oman, in November 2003 for initial evaluation and seed increase. The site for the initial evaluation was poor and the growth of the entries was severely affected, so that it was difficult to identify the best. The amount of seed harvested was also very limited. Therefore the complete set of 315 lines was sown again in November to obtain better discrimination. Also 160 single-head selections were added from a bulk sample of an Omani landrace to further evaluate the wide variation that was observed in the sample. In addition, 24 of the Omani landrace wheat varieties for which sufficient seed had been obtained in a salinity-screening nursery at three salinity levels (5, 10 and 15 dS/m) were sown. The growth of all the wheat lines has been much better in this second evaluation and good harvests are anticipated in 2005.

Plans 2005

Evaluation of perennial germplasm in the field will be continued and further harvests of seed obtained as appropriate. Various management options, particularly regarding the best time to cut back plants to synchronize heading and stimulate strong flushes of flowering will be tested. Selected lines and accessions of annual species will be further studied for salinity tolerance and yield, particularly for wheat.

The pearl millet multiplication rate at ICBA is high and seed quality is excellent

Typical heads of Omani landrace wheat

Production and Management Systems Program

The objectives of the Production and Management Systems Program are to:

- evaluate and select new and improved varieties of field and forage crops and halophytes, and
- investigate sustainable and improved management techniques for economic production under irigation with moderately saline water

Sustainable land and water use

Demonstration of biosaline agriculture at Nimr, Sultanate of Oman (PMS07)

Duration: 2001-2004

Collaborator: Petroleum Development Oman

Resources: Petroleum Development Oman

Key points

- Biological treatment of oil process water and subsequent re-use for biosaline agriculture proved feasible from technical, economic, and social perspectives
- The work conducted and results achieved by ICBA will form the basis for possible application of commercialization of biosaline agriculture in oil field sites

Significance of the project

Petroleum Development Oman (PDO) produces 550,000 cubic meters per day of saline process water along with its oil production. This process water is not readily usable as it contains oil and heavy metal contaminants and is being disposed of by injection into deep water aquifers through a costly and energy intensive process. In an attempt to reduce production costs, PDO decided to investigate the use of inexpensive biological treatment systems and biosaline agriculture for developing an environmentally-friendly solution to water disposal.

ICBA scientists designed and implemented a biological treatment system in the year 2002 capable of treating process water to an acceptable level. In the year 2003, a biosaline agriculture pilot project designed by ICBA scientists was completed and various forestry species were growing.

These production systems will serve as a model for the utilization of similar poor quality water in the region.

Acacia trees thriving on treated process water in Nimr

Objectives

1. Treatment of contaminated saline water through biological systems.
2. Using treated process water in a biosaline agriculture pilot project.

Progress 2004

A comprehensive economic evaluation of the entire treatment-water reuse process was conducted by a team from Alterra-ILRI, Wageningen University. ICBA scientists provided vital input for this evaluation which concluded that the system is viable economically, technically, and socially. The results of this evaluation will be used as background for commercialization of the entire process. In the meantime, plants were growing and setting seeds. Success was noted for halophytic trees and shrubs.

Plans 2005

The project has now been completed.

Managing salinity and waterlogging in coastal agricultural areas in Abu Dhabi (PMS08)

Duration: 2002-2004

Collaborator: Sewerage Projects Committee (Abu Dhabi Municipality)

Resources: Sewerage Projects Committee (Abu Dhabi Municipality)

Key points

- Salinity of drainage water dropped from 12 dS/m to 2.5 dS/m
- The hydrogeological investigation and concept design developed by ICBA helped reduce the cost significantly, while maintaining the effectiveness of the system

Significance of the project

Salinity and waterlogging affect many agricultural coastal areas in Abu Dhabi. Lack of rainfall combined with absence of natural drainage resulted in accumulation of brackish irrigation water in natural depressions and subsequent rise of soil salinity. In some areas, these problems appeared in just two years of operation and agriculture was abandoned in severely affected farms. Owing to the success of the reclamation activities in a 55-hectare pilot area in Al Ajban agricultural area, the Sewerage Projects Committee (SPC) requested ICBA to perform a hydrogeology investigation and develop concept designs for two additional farming areas, Al Nahda and Al Shahama. A drainage system was installed in Al Nahda in early 2004.

Objectives

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

Progress 2004

The concept design developed by ICBA was implemented and contracting activities were completed in 2004.

Reclaimed farm in Al Nadha

Drainage water outflow was diverted for re-use. Salinity monitoring conducted by a third party revealed that drainage water salinity dropped from 12 dS/m to 2.5 dS/m. The productivity of affected farms was restored in just 3 months. The hydrogeology investigation and concept design developed by ICBA helped reduce the cost significantly, while maintaining the effectiveness of the system.

Plans 2005

The project has now been completed.

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

Duration: 2003-2004

Collaborator: Bangladesh Agricultural Research Institute

Resources: ICBA, Bangladesh Agricultural Research Institute

Significance of the project

Bangladesh is a developing country with a population of 140 million inhabitants growing at an alarming rate. To meet the food demands of the increased population, salt-affected lands estimated at 0.88 million hectares, must be cultivated.

Average annual rainfall in various parts of Bangladesh is estimated at 3,000 mm. However, the larger part of this precipitation occurs during the monsoon season, starting in June. During the dry months of March and April, salinity problems, resulting from seawater intrusion, are more acute and lands are commonly left fallow as crop production is inhibited by the presence of salts. Seawater intrudes into agricultural fields as a result of the near-sea-level topography of coastal areas.

Economic cash crops in Bangladesh such as tomatoes and chili, can be grown with proper management of soil and water. One such technology is the use of raised beds irrigated through drip irrigation. The combination of raised beds and drip irrigation systems permit proper leaching of salts from the rootzone.

Objectives

The overall objective of this study is to use soil and water management techniques to mitigate salinity resulting from the shallow saline water table. Specific objectives are:

1. Grow four crops using drip irrigation systems on raised beds and compare yield and salinity results against those for common agricultural practices in Bangladesh

Key points

- Improvised drip irrigation systems were used on raised beds to grow cash crops during the dry season
- At the end of the growing season, rootzone salinity using raised beds and drip systems was one-sixth that of flat beds and conventional irrigation
- Tomatoes and chili had benefit-cost ratios of 5.3 and 1.9 respectively

Fallow land in Southern Bangladesh during the dry season

2. Convert yield data into economic returns and evaluate overall economics.

Achievements 2004

In the year 2003 an experiment was established in the Noakhali district in Southern Bangladesh. Four crops namely tomato, chili, barley, sunflower were grown. Tomato and chili were grown under:

1. Furrow irrigation and raised beds

2. Drip irrigation and raised bed, and

3. No irrigation in flat beds.

Barley and sunflower were grown with:

1. Furrow irrigation

Tomatoes growing on raised beds with improvised drip systems

Farmers observing yield of tomato during the field day

2. Beds, furrows and no additional irrigation, which is the common practice amongst farmers in Bangladesh.

Water was conveyed using a hand pump into elevated tanks raised 1.5 meters above ground. Yield was measured for each treatment along with periodic measurements of soil salinity.

Yield comparisons for tomatoes and chili revealed that the yield doubled with raised beds and drip irrigation, when compared to conventional methods of no irrigation on flat planting beds. The increase in yield is attributed to a localized irrigation causing lower soil salinity which was one sixth that of no irrigation treatments by the end of the season (Figure 1).

Economic analyses indicated that cultivation of tomatoes and chili is quite profitable using drip systems combined with raised beds. Tomato yield was measured at 63 tons per hectare while chili yield was 2 tons per hectare. The benefit cost ratios for tomatoes and chili were 5.3 and 1.9 respectively. The cultivation of barley and sunflower did not prove economical.

A field day was conducted on 23 March 2004 to demonstrate the results. Over 60 farmers participated. Farmers were quite interested in the procedures promoting plant growth during the fallow season.

Plans for 2005

Tomatoes and chili will be grown again along with cucumbers and watermelon. The latter two crops will substitute for barley and sunflower. A larger experimental plot will be cultivated and more emphasis will be placed on socio-economic indicators. Again a field day will be organized towards the end of the project.

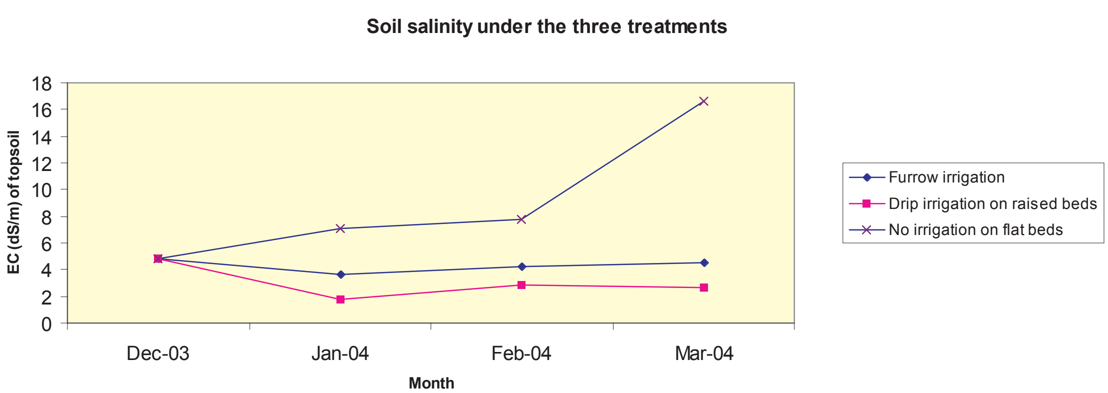


Figure 1 Average soil salinity for the three treatments on tomatoes

Use of low quality water for productive use of desert and salt-affected areas in Pakistan (PMS21)

Duration: 2003-2005

Collaborator: Pakistan Agricultural Research Council

Resources: ICBA, Pakistan Agricultural Research Council

Significance of the project

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

The project began in January 2003. This project is being implemented by Pakistan Agricultural Research Council (PARC) in collaboration with ICBA, Dubai, UAE.

Objectives

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

Key points

- Agronomic methods tested were able to ameliorate the saline-sodic soil for establishment of economically important salt-tolerant plants
- Demonstration of biosaline agriculture to farmers on highly degraded lands

Achievements 2004

Work started at three saline sites representing different ecological regions in Pakistan on:

i. Evaluation of water management strategies for silvo-horticultural systems in salt affected soils; and

ii. Performance of silvo-horticultural systems under various irrigation treatments.

The main thrust of the work is to select suitable species for forage and fruit production, and to improve the soil structure through green manuring.

Initial establishment at the three sites did not give satisfactory results due to highly saline-sodic soils. Only 15-20% plants were able to survive. Hence the area was replanted after gypsum application and growing *Sesbania sesban* for one growing season. This improved the soil properties and later on new planting of *Psidium guajaval* and *Grewia asiatica* were undertaken. The plants showed 52% survival at Bhalwal and 78% at Pindi Bhattian.

Plans 2005

Work will continue on different silvo-cultural practices for growing *Sesbania sesban*, *Chloris gayana* and sorghum with the fruit species. Detailed analyses of soil will also be done to evaluate the soil salinity changes as a result of these silvo-cultural practices. A Farmer's Day will be held in 2005 in addition of developing technology packages for rural farmers.

Greening pilot plot with salt-tolerant plants and halophytes, Qareen Al-Eish (PMS24)

Duration: 2003-2004

Collaborator: Public Works Department, Abu Dhabi

Resources: ICBA, Public Works Department, Abu Dhabi

Significance of the project

Qareen Al-Eish belongs to H.H. Sh. Sultan Bin Zayed Al Nahyan located about 170 km west of Abu Dhabi. This property is being developed and managed by the Public Works Department, Emirate of Abu Dhabi, in collaboration with several public and private institutions. The total area of Qareen Al-Eish is estimated at 100 km^2. Water is supplied to Qareen Al-Eish through a number of pipelines transporting water from a well field located 40 km away. This water has a salinity of 12.43 dS/m as measured in a storage tank on site. Fresh desalinated water is also supplied from Al-Marfa' area.

Opportunities exist for the establishment of salt-tolerant and halophytic plants throughout Qareen Al-Eish, in an effort to save valuable fresh water. Water would thus consist of a mix of fresh water, brackish water, and seawater. The resulting volume would be large enough to cover many of the agricultural plots in Qareen Al-Eish. At the request of PWD, ICBA designed a Biosaline Agriculture Demonstration Plot for ~3 ha.

Objectives

1. Demonstrate the use of halophytes for landscape purposes.
2. Implement soil and water management principles in a biosaline agriculture scheme.

Achievements 2004

A pilot project for demonstration of biosaline agriculture was designed and implemented in Qareen Al-Eish. About 20 halophytic species, including grasses, trees and shrubs were reared at ICBA and transplanted in the pilot project during early 2004. Irrigation was through drip and an extensive drainage system for leaching of salts was installed. Initially, the plants were irrigated with water with a salinity of 12.5 dS/m. This salinity was raised gradually until 42.85 dS/m.

Except for one species, the rest of them showed more than 75% survival after one year. Growth rate varied between different species and on the nature of the plants (Tables 3 and 4).

Three species of grasses and one creeper were evaluated in the trial. All the four species exhibited 100% survival for all the transplants made. Since grass species have shallow roots and propagate profusely by stolons, they were confined again to the wetting region of the soil and hence did not show any significant difference in the area of the plant growth.

The species studied have a very high potential to be used as landscape plants, forestry, forage/fodder (biomass), fuelwood, windbreak, bioenergy, etc and as a multi-purpose tree species have values for environmental improvement and carbon sequestration.

During the study period, soil salinity was monitored regularly to manage the salts. The management practices used were appropriate to the conditions and hence the soil EC and EC_{iw} remained more or less at equilibrium. This also resulted in high survival and growth of test plants.

Key points

- Twenty different halophytic species successfully grown with seawater salinity of ~30,000 ppm (42.85 $dS.m^{-1}$)
- Management practices used were appropriate to control soil salinity. Soil EC and EC_{iw} remained more or less at equilibrium. This also resulted in high survival and growth of test plants

Table 3 Growth of *Atriplex* species irrigated with high salinity water after six months

	Plant Height	*Shoot Volume (m^3)*			*Plant Height*	*Shoot Volume (m^3)*
	Atriplex nummularia				*Atriplex lentiformis*	
Survival (%)	100			Survival (%)	100	
Mean	57.0	0.2469		Mean	117.6	0.8012
Stand. Error	2.16	0.0303		Stand. Error	1.9	0.0658
Minimum	21.0	0.1125		Minimum	70.0	0.3596
Maximum	112.0	0.0647		Maximum	163.0	1.3134
	Atriplex halimus				*Atriplex undulata*	
Survival (%)	100			Survival (%)	100	
Mean	41.3	0.0845		Mean	68.7	1.2763
Stand. Error	0.7	0.0079		Stand. Error	1.0	0.0767
Minimum	27.0	0.0181		Minimum	42.0	0.6072
Maximum	58.0	0.1643		Maximum	92.0	2.1176
	Atriplex canescens				*Atriplex cinerea*	
Survival (%)	98.2			Survival (%)	48.8	
Mean	79.7	0.5762		Mean	24.0	0.0495
Stand. Error	1.8	0.0797		Stand. Error	1.4	0.0068
Minimum	49.0	0.2722		Minimum	6.0	0.0027
Maximum	116.0	1.2856		Maximum	50.0	0.1121

Table 4 Variation in plant survival and growth of tree species evaluated at Qareen Al-Eish

S. No.	*Plant Species*	*Survival (%)*	*Mean Height & Standard Error (cm)*	*Plant Height Minimum (cm)*	*Plant Height Maximum (cm)*
1	*Acacia farnesiana*	92.85	150.73 + 5.53	59	215
2	*Zizyphus jujuba*	89.28	86.301 + 2.72	33	128
3	*Parkinsonia aculeata*	100.00	97.12 + 4.37	40	184
4	*Acacia ampliceps*	92.85	89.31 + 4.39	17	284
5	*Salvadora persica*	96.43	86.01 + 2.72	33	128
6	*Conocarpus lancifolius*	78.57	37.62 + 1.16	19	62
7	*Tamarix articulata*	97.62	30.73 + 1.57	8	55

Halophytic species grown with saline water equivalent to seawater salinity at Qareen Al-Eish

Plans 2005

This project was completed at the end of 2004.

Harnessing salty waters to enhance sustainable livelihoods of the rural poor in four countries in West Asia and North Africa: Egypt, Jordan, Syria and Tunisia (PMS28)

Duration: 2004

Collaborators: Egypt, Jordan, Syria, Tunisia

Resources: Consultative Group on International Agricultural Research Comprehensive Assessment Competitive Research Grant Scheme

Key points

- Project funded under the Comprehensive Assessment Program of International Water Management Institute
- Evaluation of the scope for irrigated saline agriculture using groundwater to contribute to poverty alleviation and improved livelihoods
- Substantial scope for impact, but pilot projects are needed to detail the economic benefits and make a convincing case

Significance of the project

Based on a proposal submitted in 2003, ICBA was awarded $75,000 under the aegis of IWMI's Comprehensive Assessment Program to conduct a desk study to assess the potential contribution of saline groundwater resources to agricultural production in Egypt, Jordan, Syria and Tunisia.

Objectives

1. Assess of the saline groundwater reserves in four countries in WANA; and
2. Assess the potential for use of saline groundwater in irrigated agriculture to contribute to improved livelihoods and poverty alleviation.

Achievements 2004

National consultants or teams of consultants were recruited from each of the study countries between January and March 2004 to prepare national reports. The teams prepared and submitted draft reports by mid-June.

In late June, a workshop was convened at ICBA to discuss the findings and the approaches taken. An international consultant facilitated the workshop. Following the discussions during the meeting, the national teams modified their initial drafts and submitted final reports at the end of August. Based on the national reports and the outputs of the workshop, the international consultant prepared a synthesis report that summarized the indicators of potential for successful saline irrigated agriculture, identified specific areas in each country where there is maximum scope to impact favorably on poverty and improve the livelihoods of the poor and pointed the way forward to quantify the impacts more precisely.

The main points of the synthesis report were presented in a policy brief to guide decision makers. In addition, a bibliography of approximately 500 references on the use of saline water for plant production was prepared as a resource for saline irrigated agriculture researchers.

Results

Available information on saline groundwater is limited and far from complete in all the countries and that the specific situations in each country are very different. Precise quantification of saline groundwater resources was not possible. However, expert opinion allowed areas within each country with the greatest scope for saline irrigated agriculture to be pinpointed. This was based on a general understanding that adequate quantities of saline water and marginal land were available, livestock-based farming systems prevailed, and the socio-economic circumstances offer few alternatives to poor farmers. Possible cropping options with potential to contribute to poverty alleviation and improved livelihoods could be identified but precise conclusions on their economic viability could not be reached because of the absence of sufficient data. The study concluded that pilot projects to collect further information would be required to allow the economic and social impact of saline irrigated agriculture to be detailed.

Dissemination outputs

Four national reports, a synthesis report, a bibliography of sources of information on saline groundwater and a policy brief on use of saline groundwater were produced and submitted to the donor.

Plans 2005

The national reports, synthesis report, bibliography and policy brief will be published and disseminated in 2005. Publication will be both as documents and by electronic means. The target audience will be national policy makers, national and international scientists, donor agencies, and others with interest in water issues.

Participants of the workshop held to discuss project approaches and findings

National consultants from the study countries, the international facilitator and ICBA staff at the workshop

Feasibility study for biosaline agriculture in the United Arab Emirates (PMS32)

Duration: 2004

Collaborators: Ministry of Agriculture and Fisheries (United Arab Emirates)

Resources: ICBA, International Atomic Energy Agency, Ministry of Agriculture and Fisheries (United Arab Emirates)

Key points

- Update of current agricultural production systems under salinity conditions in UAE
- Selection of target areas, mainly abandoned agricultural farms, to use as demonstration sites for biosaline agriculture
- Evaluating the socio-economical prospects of biosaline agriculture

Significance of the project

ICBA prepared a Strategic Document for the United Arab Emirates in collaboration with the Ministry of Agriculture and Fisheries (MAF), UAE, which was approved by the International Atomic Energy Agency in 2002. In 2003, IAEA also approved a grant for the UAE (ICBA and MAF) to prepare a Feasibility Report on 'Biosaline Agriculture in UAE'. This would serve as a baseline to prepare the National Program on Biosaline Agriculture for UAE.

Objectives

The Feasibility Study, in general, will have the following broad objectives:

1. Compilation of existing farm data and filling the gaps on:
   - Saline water resources and extent; salt-affected agricultural areas in UAE.
   - Farm facilities; including farm equipment, irrigation/drainage systems, etc.
   - Cropping pattern in UAE and marketing strategies.
2. Update existing data on soil and water quality and quantity in UAE.
3. Prepare guidelines for the National Program document.

Achievements 2004

In 2004, ICBA scientists along with scientists from Ministry of Agriculture and Fisheries and Abu Dhabi Municipality started working on the following sections of the Feasibility Report:

1. Introduction,
2. Background information and identification of gaps,
3. Development and expansion of Biosaline Agriculture in UAE, and
4. Criteria for site(s) selection of National Project.

The draft of the report has been completed for distribution among the ICBA and MAF staff. This would be followed by preparing the final report for submission to IAEA and UAE government.

Plans 2005

The Feasibility Report will be completed in 2005.

Utilization of return seawater for biosaline agriculture at National Prawn Company, Saudi Arabia (PMS33)

Duration: 2004-2006

Collaborators: National Prawn Company (Saudi Arabia)

Resources: National Prawn Company (Saudi Arabia)

Key points

- Effluent from shrimp farming could be used to grow halophytes
- Expansion of mangrove plantations can enhance aquaculture

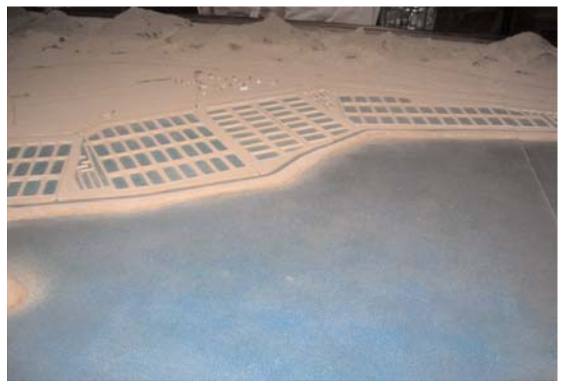
Significance of the project

The National Prawn Company (NPC) currently produces 7,000 tons of prawns per year. The establishment of additional farming facilities will raise the production to a target of 30,000 tons per year within the next few years. Water is supplied at a flow of 80 cubic meters per second and discharged from farms to a drainage canal and then back to the Red Sea some 40 kilometers from the supply point. This water contains a significant load of nutrients and organic matter resulting from the production and rearing activities in individual farms.

Throughout the operation, this water has always been considered to be a waste product. However, opportunities exist for using this water for biosaline agriculture, particularly as a high load of organic matter is present. Biosaline agriculture can serve either for greening, forage production, or sand stabilization purposes.

Opportunities also exist to increase the biodiversity of the marine ecosystem through enlargement of existing mangrove plantations and introducing new species. There is a sizeable stand of local mangrove species (*Avicennia marina*) along the inner shores of the project area. Increasing the diversity and the coverage of this stand will add to the aesthetic value of this project. Mangroves can also be used as a natural environment for some fish species.

Objectives



Model of the National Prawn Company farming facilities on the Red Sea

1. Establish research and development activities leading to a large-scale utilization of return sea water for the production of halophytes.
2. Expansion of mangrove plantation at the barrier island and return water canal.
3. Establish research and development activities for selection and planting of plants/ground cover for the stabilization of dikes.

Achievements 2004

Following a survey of the production facility, two sites were selected for the initial establishment of halophytes. The first site is a 3 hectare site which will be used as a shadehouse nursery for production, propagation and acclimatization of various halophytes. The second site is a 10 hectare pilot experimentation site for testing the tolerance of halophytes to varying degrees of salinity.

Designs for layout and irrigation systems were prepared for both sites. The establishment of both facilities was completed by end of December 2004.

In a parallel effort, 23 halophyte species were propagated and prepared at ICBA. These species include grasses, ground covers, shrubs and trees that have proven their tolerance to extreme levels of salinity. Plants will be shipped upon establishment to NPC to form the initial stock of the shadehouse. NPC staff is also collecting seeds of mangroves from existing stands at the barrier island for further propagation in the drainage canal.

Plans for 2005

Shadehouse plants will be propagated and transplanted in the pilot farm. The plan is to start testing for salinity tolerance and select successful species. Salt-tolerant grasses will be used for forage production and stabilization of dikes and open areas along with selected ground covers. Tolerant species of shrubs and trees will be used for windbreak purposes. A significant effort is also planned for establishing mangroves in the drainage canal and enlarging the existing stand at the barrier island.

Halophytes for testing at the National Prawn Company being propagated at ICBA

Natural seashore vegetation at the National Prawn Company site

Seawater canal bringing water to the prawn ponds at the National Prawn Company site

Field and forage crop production

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

Duration: 2002-2006

Collaborator: United Arab Emirates University

Resources: ICBA

Significance of the project

Long-term field studies on the economic feasibility and sustainability of forage production systems based on the use of non-conventional salt-tolerant grasses and highly saline water are very limited. In order to assess such forage production systems two highly salt-tolerant grasses were selected and a large field for research and demonstration was established at ICBA's headquarters. The two species, *Sporobolus virginicus* and *Distichlis spicata,* were selected based on previous evaluation for salinity tolerance, nutritional value, suitability for mechanical harvesting, and handling for economic large-scale production.

Objectives

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

Achievements in 2004

According to the biomass production program, four cuts were completed in 2004 in March, June, August and November. In addition, chemical and nutritional analyses of plants samples from three harvests were achieved in 2004 in collaboration with UAE University in Al-Ain and Abu Dhabi Agricultural Laboratory. Irrigation, fertility and salinity treatments were applied throughout the year and their impact on yield and quality was taken into consideration.

> **Key points**
>
> - Mean annual dry biomass production over all salinity levels reached nearly 33 t/ha in *Distichlis* and 28.5 t/ha in *Sporobolus*
> - Maximum yields achieved at high fertility levels. *Distichlis* yield reached 36.5 t/ha and 35.25 t/ha at 100 kg/ha and 150 kg/ha of NPK respectively, while *Sporobolus* yields reached 32.8 and 32.3 t/ha
> - The two species responded in different ways to increased levels of irrigation. *Distichlis* yield increased significantly, while *Sporobolus* yield declined at irrigation levels equivalent to twice ET_0

Results

Highlights of production and chemical analysis are presented here.

Biomass production at large field scale

Large-scale dry matter production from the nearly 0.6 ha of both grass species over four harvests were less in comparison with 2003 production. Mean annual dry biomass production over all salinity levels reached nearly 33 t/ha in *Distichlis* and 28.5 t/ha in *Sporobolus*, with maximum yield recorded at the medium salinity level of 20 dS/m (Figure 2). Total annual production in *Distichlis* reached nearly 30 t/ha at the high salinity level and 37 t/ha at the medium level (Figure 3). While in *Sporobolus* total annual dry yield ranged from 26.5 t/ha at the high

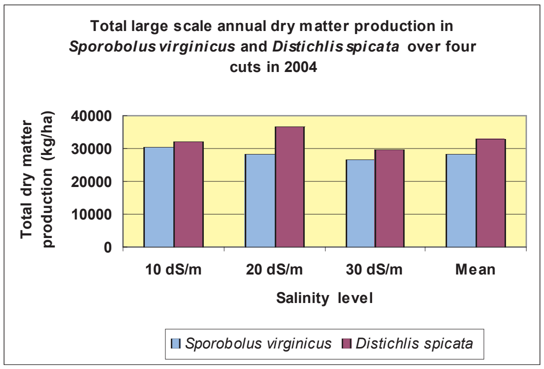


Figure 2

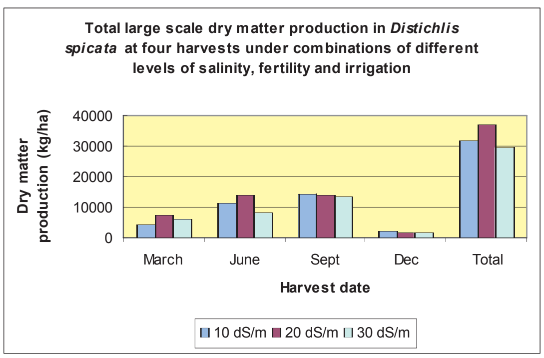


Figure 3

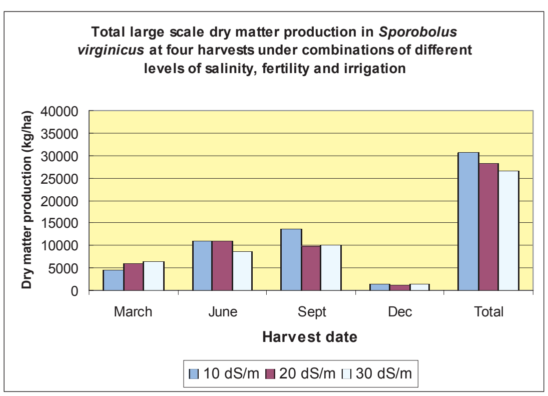


Figure 4

salinity to 30.5 t/ha at the low level (Figure 4). Seasonal variations in yield were also very large as in the previous season. Spring and summer growths were very much higher than winter and fall growths. Maximum yields were

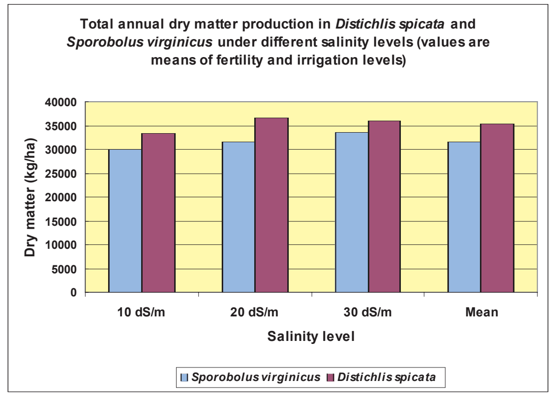


Figure 5

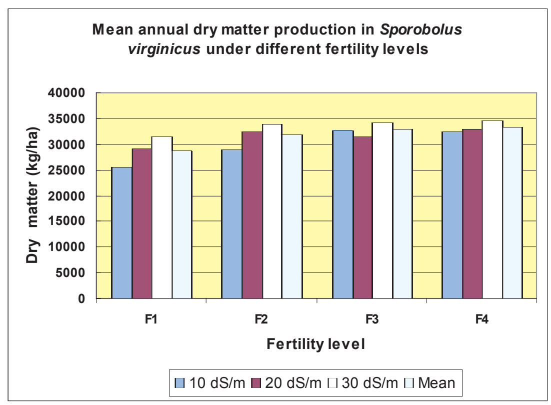


Figure 6

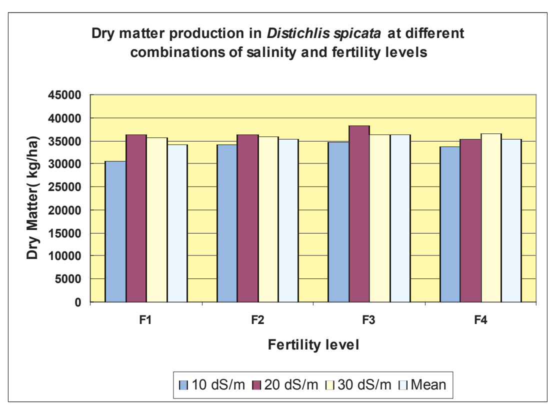


Figure 7

recorded in September harvest. *Distichlis* yield ranged from 13.5 to 14.5 t/ha, while *Sporobolus* yield from 10 to

13.5 t/ha according to salinity level (Figures 3 and 4). Low winter and fall temperature greatly limited growth of both species. Winter yields were in the order of 1.2-2.5 t/ha in both species, with *Sporobolus* attaining lower yields than *Distichlis*.

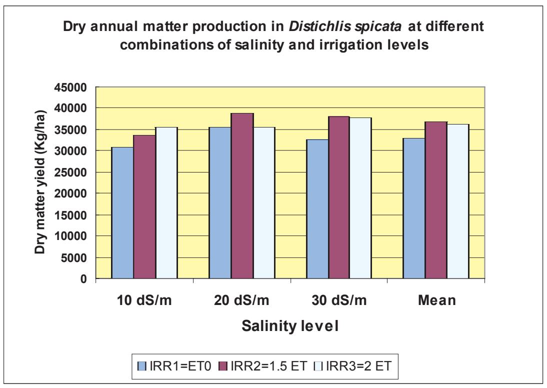


Figure 8

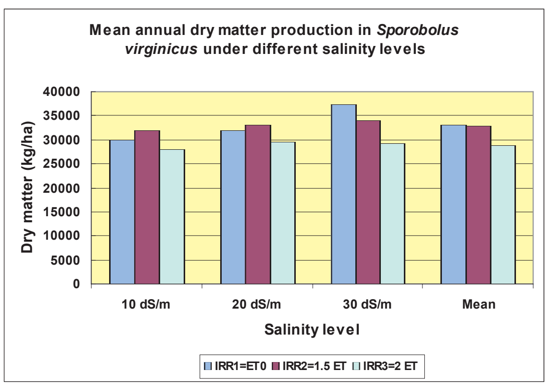


Figure 9

Biomass production response to management inputs

The effects of different fertility and irrigation treatments on yield under different salinity levels are summarized in figures 5-7. Total annual dry matter production based on sampling from the different treatments showed higher yield levels close to the previous season. *Sporobolus* yield reached 33.5 t/ha and *Distichlis* reached 36 t/ha at the high salinity level (30 dS/m). Maximum yields were achieved at third and fourth fertility levels, which are equivalent to 40-20-20 units of NPK and 60-30-30 units of NPK respectively. *Distichlis* yield reached 36.5 t/ha and 35.25 t/ha at the F3 and F4 respectively, while *Sporobolus* yield reached 32.8 and 32.3 t/ha.

The two species responded in different ways to increased levels of irrigation. In *Distichlis*, mean dry yield over all salinity levels increased significantly with the increase in irrigation level from 33 to 36.8 to 36.3 t/ha at application rate equivalent to ET_0 to 1.5 ET_0 and 2 ET_0. The effects of increase in irrigation quantities were very evident at the high salinity level. Yield reached nearly 38 t/ha at high irrigation levels. Contrary to *Distichlis*, increase in irrigation quantities reduced *Sporobolus* mean yields from 33 t/ha at ET_0 to 28.9 t/ha at 2 ET_0 (Figures 8 and 9). At the high salinity level, *Sporobolus* yield reached 37.3 t/ha at ET_0 irrigation level and dropped to 29.2 t/ha at the high irrigation level.

In conclusion, maximum dry matter yield achieved by both higher levels of fertility and irrigation in *Distichlis* and in *Sporobolus* by high levels of fertility and moderate levels of irrigation.

Forage quality and chemical analysis

The unique character of both grass species is their ability to keep mineral content of the tissue at low levels even at high salinity. Figures 10-13 show protein and ash percentages for the two species under various salinity and fertility levels. Previously it was noted that *Distichlis* generally had higher protein and ash contents than *Sporobolus*. In this season the two species were similar in ash and protein contents. Ash contents increased with an increase in salinity in both species, but fertility level did not significantly affect ash content. Crude protein content increased significantly with salinity in both species and to a lesser degree with increase in fertility.

Seasonal variations in ash and protein content are also evident. Seasons with high growth rates (spring and summer) are characterized by higher ash percentage and lower protein content in both species in comparison with seasons with lower growth rates, fall and winter (Figures 13 and 14).

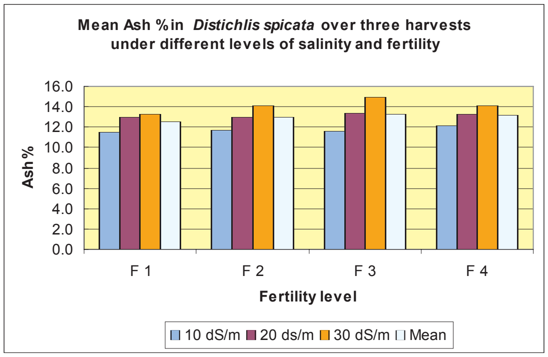
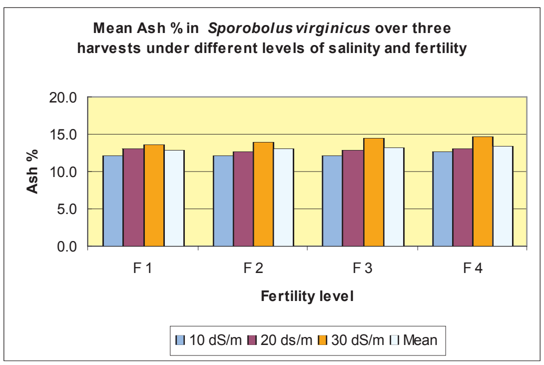


Figure 10



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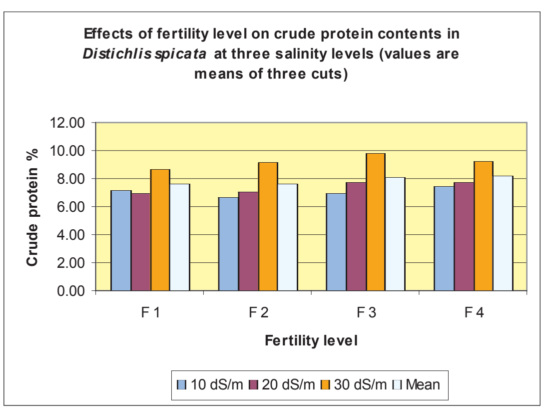


Figure 12

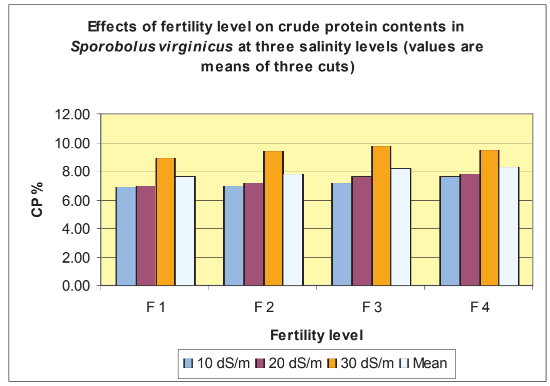


Figure 13

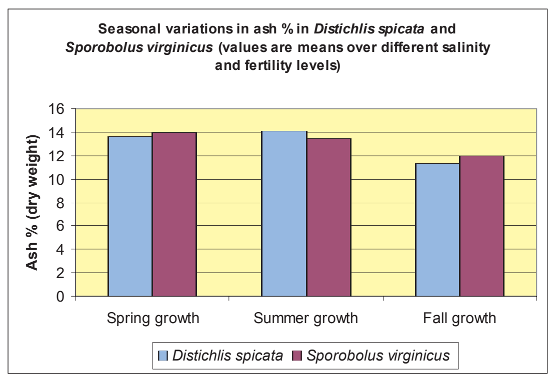


Figure 14

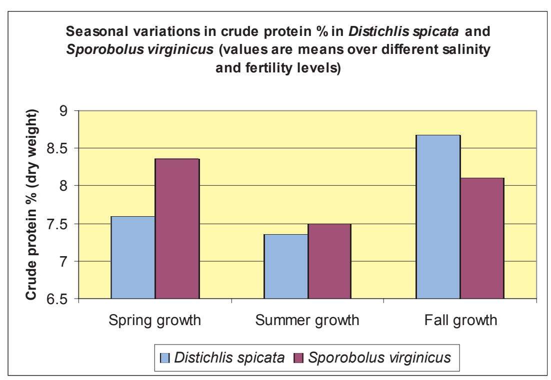


Figure 15

Field management and production of *Sporobolus* and *Distichlis*

Plans for 2005

Four more cuts for biomass production are targeted for 2005. Extensive soil salinity monitoring is underway. Chemical and nutritional analysis will be performed on several cuts in 2005. Solid conclusions about the performance of the two species under various salinity levels and about optimum management practices that lead to maximum and sustainable yield will be drawn.

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

Duration: 2002-2006

Collaborator: United Arab Emirates University

Resources: ICBA

Key points

- Total biomass production is higher in *A. lentiformis* than *A. nummularia* and *A. halimus* at all salinity levels
- Different fertility levels had minor effects on total yields of the three species at all salinity levels
- Irrigation levels did affect yield at low and medium salinity, but negatively affected yield at high salinity (30 dS/m)

Significance of the project

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

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

Objectives

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

Achievements in 2004

Similar to the grass project, in 2004 all treatments were applied. Monitoring of soil moisture and salinity levels under each treatment is underway. Plant samples are being analyzed for chemical composition and nutritional values. Only one cut was completed in 2004. Due to slow growth following the first cut, no further cuts were taken during 2004.

Results

Biomass production in the three *Atriplex* species followed similar trends to 2003. Total harvestable biomass was higher at the high salinity level with *A. lentiformis* producing more than *A. nummularia* and *A. halimus* (Figure 16). At 30 dS/m, *A. lentiformis* fresh yield was nearly 8.2 t/ha, *A. nummularia* 4.4 t/ha and *A. halimus* 5.5 t/ha. However, leaf fresh weights were comparable in *A. lentiformis* and *A. halimus*. Stem production is significantly higher in *A. lentiformis* than the other two species (Figures 16-18).

Various combinations of fertility and irrigation levels showed that applications of six different fertility levels of NPK did not affect total yields of the three species at all salinity levels (Figure 19). Irrigation levels also affected yield at low and medium salinity, but negatively affected yield at high salinity (30 dS/m) (Figure 20). Further analysis of salt accumulation under each combination of salinity and irrigation will indicate whether this is due to higher levels of salts at the high irrigation and salinity treatment.

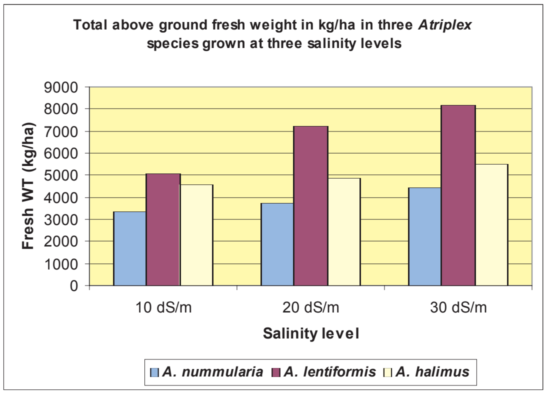
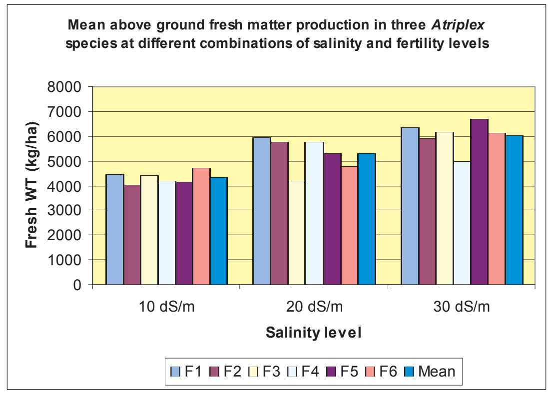


Figure 16



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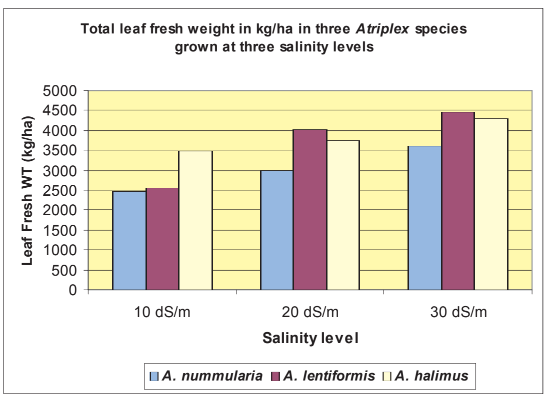


Figure 17

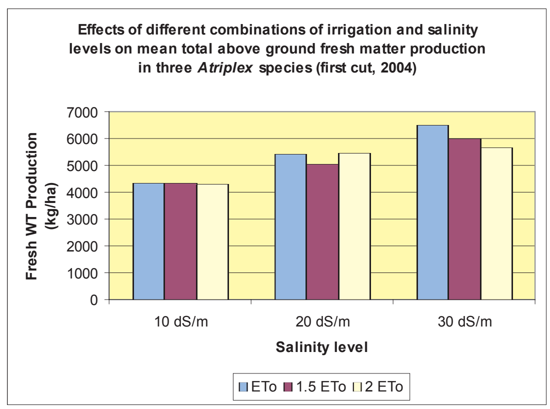


Figure 20

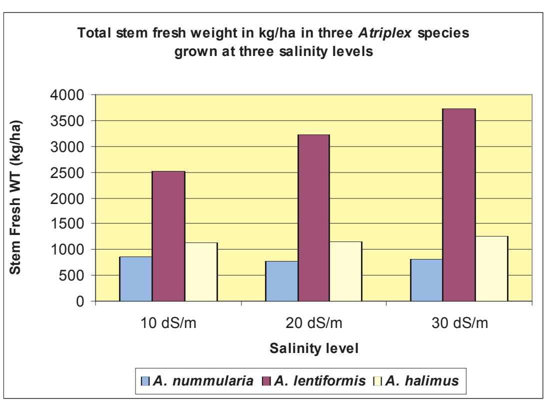


Figure 18

Plans for 2005

The focus in 2005 will be on monitoring and evaluation of the performance of the three species under the various management practices. In addition, evaluation of nutritional values and feeding trials to goats and sheep will take place in 2005. Assessment of optimal management practices will be determined during 2005.

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

Duration: 2003-2006

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

Resources: ICBA; Ministry of Agriculture and Fisheries (United Arab Emirates)

Key points

- Biosaline agriculture demonstration farm was established on salt-affected and abandoned farm in the UAE
- Various conventional and non-conventional forage production systems were successfully established in 2004
- The farm already drawing considerable attention of officials, professionals and farmers in the region

Significance of the project

Irrigated agriculture in the UAE has increased dramatically over the last 30 years. Yet few farmers are trained in the special skills and techniques. This project will demonstrate biosaline agriculture techniques to farmers and show how sustainable and profitable plant production is possible on farms affected by moderate to high levels of salinity. The demonstration farm will be a model for salt-affected farms in the region.

Objectives

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

Achievements in 2004

ICBA and MAF developed a plan for demonstrating biosaline agriculture on 0.5 ha in Ras Al-Khaimah (UAE), including appropriate irrigation and drainage methods, and cropping systems. In June of 2004, a new site was selected for-long term use. The farm selected was abandoned due to high salinity damage. Salinity of irrigation water is more than 20 dS/m and soil salinity 15-17 dS/m.

Installation of irrigation and drainage systems was completed in October 2004. Planting of highly salt-tolerant accessions of winter crops, like barley and fodder beet, and perennials took place thereafter. Establishment and growth of several crops is very encouraging despite the high soil and irrigation water salinities.

Plans for 2005

Plant production systems will be tested and other plant species will be introduced as the project progresses. Highly salt-tolerant grasses and shrubs, such as *Sporobolus*, *Distichlis* and *Atriplex*, will be planted in 2005. A large number of selected salt-tolerant barley, pearl millet and *Cenchrus ciliaris* (buffel grass) will be planted in early 2005. Farmers and MAF technicians will be involved in the process. Results will be evaluated and plans will be adjusted to achieve the objectives of demonstrating best practices for biosaline agriculture in salt-affected farms in the region.






Establishment of the demonstration farm at Ras Al-Khaimah

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

Duration: 2003-2006

Collaborator: Institute for Crop Research in the Semi-Arid Tropics (ICRISAT)

Resources: ICBA, OPEC Fund, ICRISAT

Key points

- Salt-tolerant nurseries of pearl millet and sorghum comprising 25-30 genotypes were developed and evaluated at several NARS and farmers' fields in UAE and Oman
- Yield in top performing genotypes ranged from 13 to 23.3 t/ha of dry matter at 15 dS/m
- Salinity tolerance were assessed in two sets comprised specialized breeding materials the screening of which will assist the pearl millet improvement activities at ICRISAT
- New 40-50 salt-tolerant genotypes of pearl millet and sorghum were selected for further field evaluation

Significance of the project

Soil and irrigation water salinity has emerged as a major crop production problem worldwide. It has been estimated that annually agricultural production over 2 million hectares of land is lost to salinization. Engineering and agronomic options have been applied to the management of salt-affected soils, but these are not practical everywhere, primarily because of highly prohibitive costs, or because of agro-climatic conditions. Also, these options provide location-specific solutions and have annual recurring costs. Development and adoption of salt-tolerant crop varieties has been proposed as one cost-effective option to manage salt-affected lands. The goal of this project is to improve agricultural productivity in salt-affected arid and semi-arid environments of the Near East and Asia through the development of pearl millet and sorghum genotypes with high grain and fodder yields and improved salt tolerance.

Objectives

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

Achievements in 2004

The first annual progress report covering activities and achievements during the period July 2003-July 2004 was submitted jointly by ICBA and ICRISAT to the OPEC Fund for International Development.

A second coordination meeting between the project teams from ICBA and ICRISAT took place in late November 2004 at ICRISAT's headquarters in India. Research progress in 2003-2004 and a detailed workplan for 2005 and schedule of activities were developed by the project team.

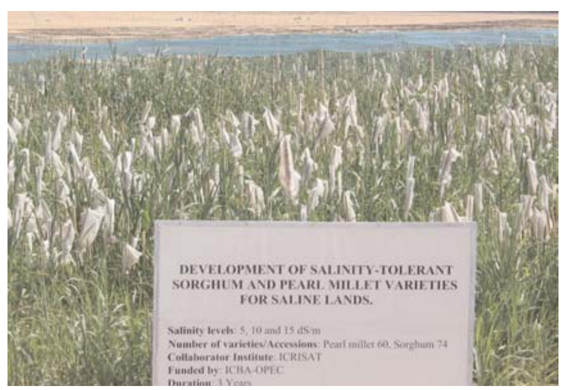
Research results

Based on results of previous evaluations of a large number of pearl millet and sorghum genotypes, nurseries of salt-tolerant genotypes of both species were assembled in 2004. Thirty varieties and germplasm genotypes of pearl millet and 61 sorghum genotypes were evaluated under field conditions in a late spring planting at three salinity levels: 5, 10 and 15 dS/m. The same set of pearl millet and a smaller set of 26 sorghum genotypes were also evaluated in a farmer's field in Oman.

The sorghum field at ICBA's headquarters suffered from several soil problems in addition to insufficient salinity level control. Therefore, results were disregarded and the experiment was repeated in a late summer planting. Results will be included in the 2005 report.

Pearl millet yield under different salinity levels

Thirty selected genotypes and checks were evaluated at ICBA's research facilities under three salinity levels. Total above ground biomass production varied significantly among the group (Figures 21-26). However, several genotypes were able to maintain high yields even at 15 dS/m. Yield in top performing genotypes at the high salinity level ranged from 13 to 23.3 t/ha of dry matter. Several genotypes shown in figures 21-23, showed high stability in yield across the salinity levels evaluated. Such genotypes will be evaluated on a large scale in farmers' fields in 2005.



Pearl millet and sorghum at ICBA

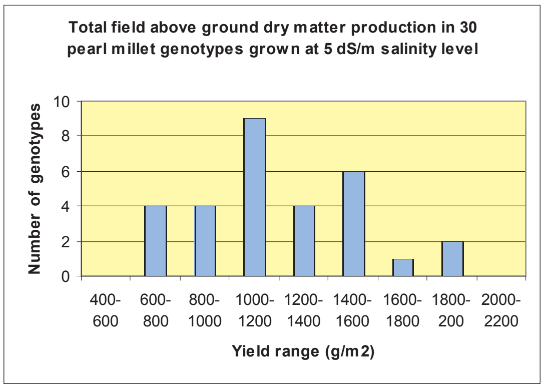


Figure 21

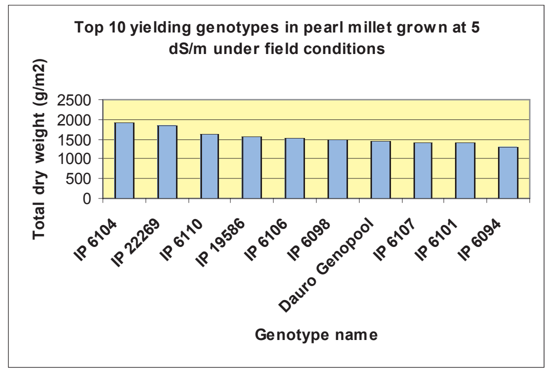


Figure 24

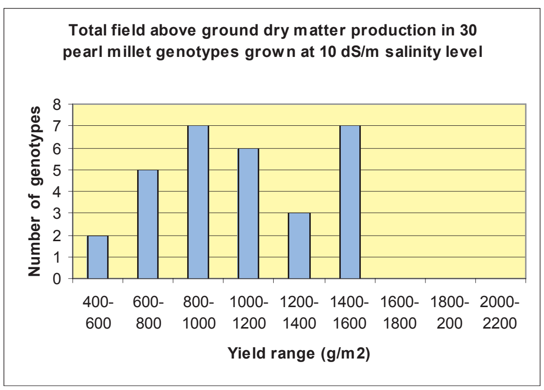


Figure 22

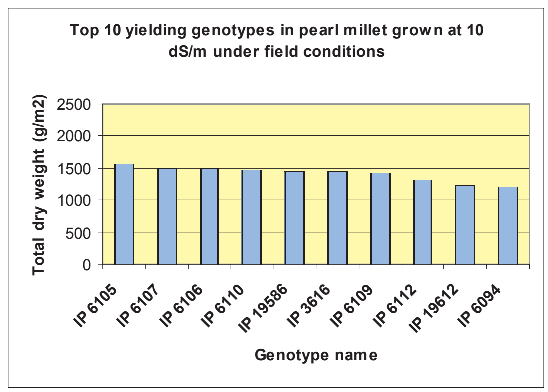
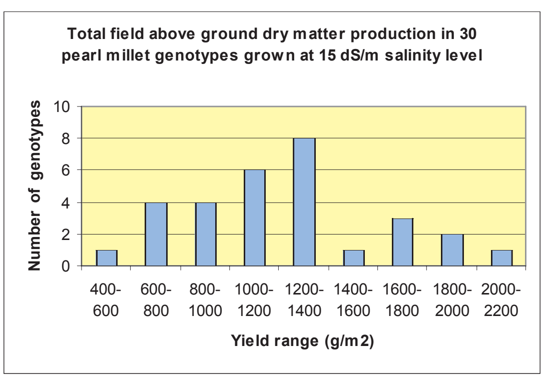


Figure 25



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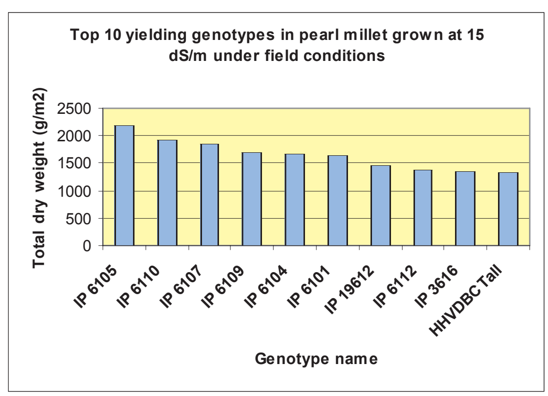


Figure 26

Evaluation of the same materials in a farmer's field in Oman showed similar trends to the observed response at ICBA. Several of the top performing genotypes were similar at both sites (Figure 27). However, yield levels were lower, due to diseases, nematodes and the presence of a soil hardpan that limited drainage. Measures will be taken to reduce the negative effects of such factors in 2005. Similarly, the yield of sorghum genotypes was affected by the poor growth conditions at the selected site (Figure 28).

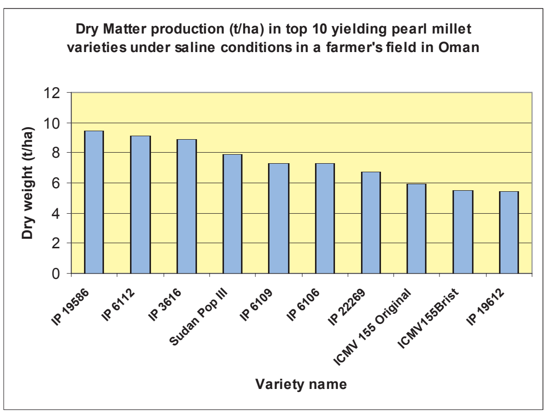


Figure 27

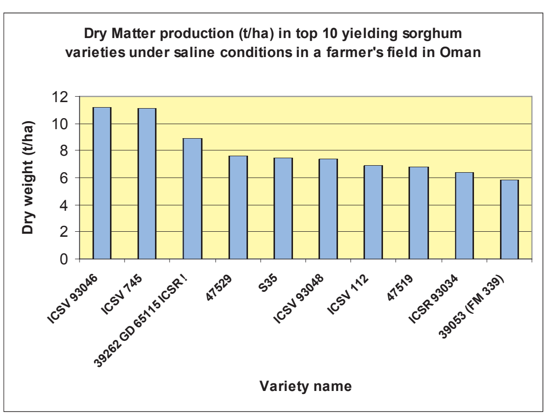


Figure 28

Evaluation of new pearl millet and sorghum genotypes

As described in the 2003 report, more than 300 genotypes of each of pearl millet and sorghum were provided by ICRISAT for salinity evaluation. They were screened in large pots under field conditions at a single salinity level of 10 dS/m. Two cycles of screening were completed in 2004, a third one is currently underway.

Pearl millet

Three sets of pearl millet germplasm were included in the screening. The first set comprised 61 elite varieties and 50 landrace varieties with potential for direct use in saline conditions.

The other two sets comprised specialized breeding materials the screening of which will assist the pearl millet improvement activities at ICRISAT. The first of these sets tested the salinity tolerance of 90 elite B-lines with the aim of identifying tolerant male-sterile lines for breeding tolerant hybrids. The second set tested parents of mapping populations available at ICRISAT. Twenty lines, 80 hybrids (from each of the 20 lines crossed on four male-sterile lines) and the four B-lines corresponding to the male-sterile parents of the hybrids were tested. The results of this line × tester set will identify crosses where the parents contrast for high and low salinity tolerance. The mapping population progeny from such crosses could then be evaluated for salinity tolerance to identify molecular markers for genes contributing to salinity tolerance. The results of screening both these sets of material will be forwarded to ICRISAT for analysis and decisions on future directions.

A summary of the results of salinity screening is shown in the following figures (Figures 29-31). Mean dry biomass was 58.1 g/plant in the elite and landrace germplasm, 45.7 g/plant in the elite b-lines and 72 g/plant in the hybrids of the mapping population. Best performing elite lines will be selected for further field evaluation and comparison with the best salt-tolerant pearl millet genotypes identified so far at both ICBA and ICRISAT.

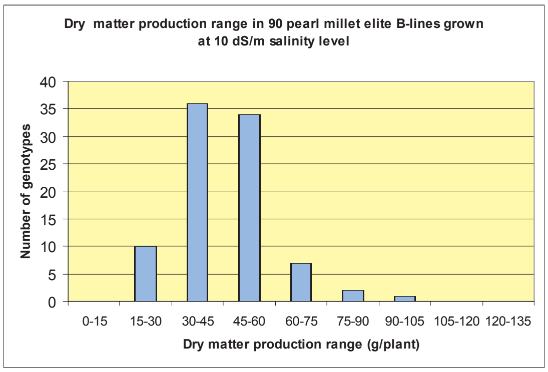


Figure 29

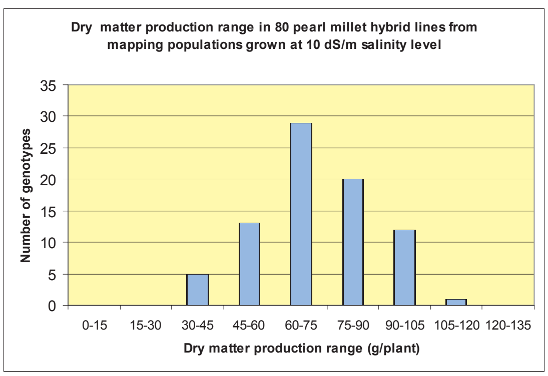


Figure 30

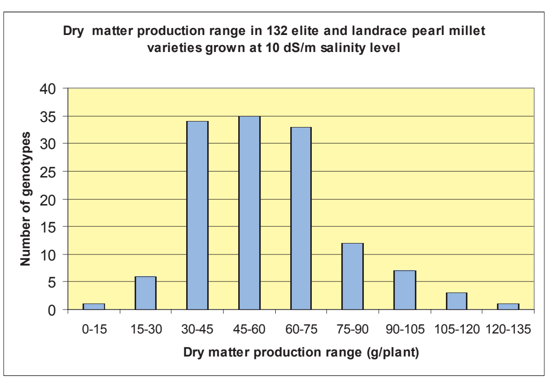


Figure 31

Sorghum

Considerable variations in dry matter production among the 306 new sorghum genotypes were observed at 10 dS/m (figure 32). Top performing genotypes will be selected for further field evaluation in 2005.

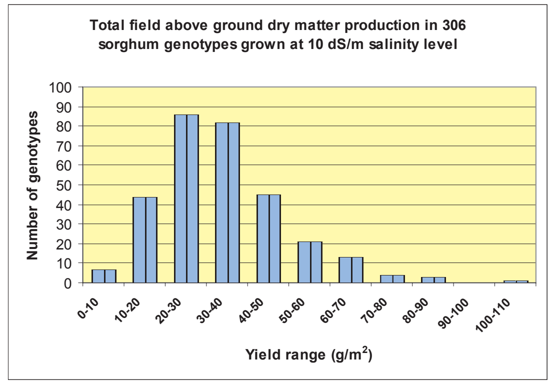


Figure 32

Plans for 2005

The selected pearl millet and sorghum salt-tolerant nurseries will be evaluated at both ICBA and in farmers' fields in the UAE and Oman. Best performing sorghum and pearl millet lines identified in the pot screening will be included in field evaluation in 2005. Controlled and field evaluation of salinity tolerance among the pearl millet and sorghum genotypes will take place at both ICBA and ICRISAT during 2005. In addition initial sets of selected genotypes will be evaluated in farmers' fields in other countries in the WANA region during 2005 and subsequent years.

Trials related to the development of optimum production practices will be initiated at ICBA during 2005. Various management practices will be applied to a selected group of salt-tolerant genotypes of pearl millet and sorghum. In 2005, ICRISAT will also develop mapping populations for future use in identifying molecular markers of QTLs associated with salinity tolerance.

Chemical and nutritional analysis will also be performed during 2005 on selected genotypes of both sorghum and pearl millet.

Development of sustainable salt-tolerant forages for sheep and goat production (PMS16)

Duration: 2003-2006

Collaborator: United Arab Emirates University

Resources: ICBA, United Arab Emirates University

Significance of the project

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

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

Potential for practical applications

First Component

1. Development of alternative sustainable forage production systems that utilize marginal environmental resources such as saline water, salt-affected soils and underutilized sub-coastal lands.

2. Increase forage and fodder resources available for sheep and goat fodder.

3. Save some fresh water resources currently used in forage production.

4. Improve environmental conditions in areas that are currently unproductive.

5. The research results will lead to the development of production packages for optimum forage production under saline conditions that are easily transferable and applicable by the local agricultural community.

Second Component

1. Development of such systems will lead to a substantial reduction of production costs, through the introduction of salt-tolerant plants as a source of forages instead of using fresh water irrigated grass (i.e. Rhodes grass hay).

2. In addition, using indigenous animals, adapted to the local environment, will help in conservation of these breeds and accordingly lead to optimum utilization of the available resources (land, water, animals).

Key points

- Local sheep and goats fed a diet of 100% *Sporobolus* grass hay maintained high feed intake and body composition comparable with conventional forages
- It is initially concluded that replacing traditional grass hay with *Sporobolus* and *Distichlis* hay in indigenous lamb feeding in the UAE is feasible, with no negative impact on animal performance

Objectives

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

1. To develop sustainable salt-tolerant forage production

systems which are less resource demanding and utilize marginal lands and salt water resources.

2. To develop sustainable sheep and goat production systems based on the use of salt-tolerant forages.

Several experiments are planned within this project. Objectives of each component are listed below:

First component

Experiments I and II Optimizing productivity of two salt tolerant forage grasses, *Sporobolus virginicus* and *Distichlis spicata*, and three salt tolerant forage shrubs, *Atriplex halimus, A. lentiformis* and *A. nummularia* under high salinity levels.

Objectives

- To determine the yield potential of the two grasses and three shrubs when grown under high salinity levels, and the level at which the productivity remains economic.
- To determine the optimum irrigation levels for maximum production of the two grasses, and three shrubs, and the level that minimizes salt accumulation in the soil.
- To determine the appropriate fertilization regime for maximum production.
- To assess the nutritional value of the two grasses and three shrub species in response to the different salinity, irrigation and fertilizer levels.

Second component

Experiment I Productive and reproductive performance of two breeds of sheep, fed different levels of *Sporobolus* grass hay (irrigated with highly saline water).

Objective

- To evaluate the effects of feeding diet containing different levels of *Sporobolus* grass hay on the performance of two different breeds of sheep (one indigenous breed and one exotic breed).

Experiment II Weight gain, carcass characteristics and feed intake of ram lambs, fed different levels of *Sporobolus* grass hay (irrigated with highly saline water).

Objective

- To evaluate the effects of feeding diet containing different levels of *Sporobolus* grass hay on growth performance of lambs from three different breeds of sheep (two indigenous breeds and one exotic breed).

Experiment III Weight gain and carcass characteristics of goat kids, fed different levels of *Distichlis* grass hay (irrigated with high saline water)

Objective

- To evaluate the effects of feeding diet containing different levels of *Distichlis* grass on the performance of goat kids from two breeds of goat (one indigenous and one exotic).

Experiment IV Performance of indigenous sheep fed *Atriplex* irrigated with highly saline water.

Objective

- To evaluate the effects of feeding diet containing different levels of *Atriplex* plants on productive and reproductive performance, and feed intake of the local sheep.

Achievements in 2004

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

For ICBA this project is a continuation of projects PMS03 and PMS04. Therefore, the first component that is related to production of salt-tolerant grasses and shrubs is already in progress. Results were reported in a previous section. Forages produced at ICBA are delivered to the UAEU Farm for use in the feeding trials and for nutritional analysis.

For the second component, *Sporobolus* feeding trials were completed in 2004. *Distichlis* feeding trials are underway, while *Atriplex* feeding trials will start in early 2005. Feeding trials aimed at evaluating the effects of diets containing different levels of *Sporobolus virginicus* hay on growth, feed and water intake, and body composition in indigenous lambs were completed. Initial assessment of the results showed that daily feed intake was significantly higher for animals fed a diet of 100% *Sporobolus* grass hay than those animals fed a diet of either 0.0% or 33.4% *Sporobolus* grass hay. Water consumption was higher for lambs fed different levels of *Sporobolus* grass hay in comparison to those in the control. Average daily gain was not affected by treatment diet and carcass and non-carcass component were also not affected by treatment diet. It is initially concluded that replacing traditional grass hay with *Sporobolus* hay in indigenous lamb feeding in the UAE is feasible without a negative impact on animal performance. Similar trends in feeding trials of Awassi sheep were observed with 70% of *Sporobolus* hay in diet leading to higher weight gain in comparison with feeding traditional grass hay such as Rhodes grass. Further details of these feeding trails will be available in subsequent reports.

Plans for 2005

The project will be at full gear during 2005. Plant production trials and optimization of production of salt-tolerant forage grasses and shrubs will be well established and generate information about the productive potential of these species under salinity and their value in animal feeding. Chemical analyses will be also performed extensively on plant materials produced under various salinity levels. Initial assessment of optimum management practices will also be available at the end of 2005.

Sporobolus and *Distichlis* hay feeding trials with local sheep, goats and introduced Awassi sheep, at the United Arab Emirates University

Evaluation of salinity tolerance and yield in 70 barley varieties and accessions (PMS17)

Duration: 2003-2004

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

Resources: ICBA, ICARDA

Key points

- A nursery of 25 salt-tolerant genotypes were developed and distributed for evaluation in NARS and farmers' fields in UAE and Oman
- Top performing barley genotypes maintained total yield levels of 10-12 tons per hectare and seed yields of between 3-4 tons per hectare

Significance of the project

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

Objectives

1. Evaluate salinity tolerance among a selected group of 70 best performing genotypes of improved and landrace barley from among a group of 280 genotypes that were evaluated during 2003.
2. Select salt-tolerant genotypes for large-scale field evaluation of productivity and optimum management under salinity.
3. Provide national programs in the region with sufficient seeds of barley genotypes with improved salinity tolerance for field evaluation.

Evaluation of selected barley genotypes and accessions at three salinities

4. Provide collaborator institutes with information about salinity tolerance among their barley accessions for further use in breeding for better salinity tolerance in barley.

Achievements in 2004

The 70 genotypes, elite germplasm from the ICARDA barley breeding program and accessions from local Omani landraces, were evaluated in 2003/2004 for salinity tolerance under field conditions at three salinity levels: 5, 10 and 15 dS/m.

Initial assessment of data showed wide ranges in growth and yield potential of both biomass and seed among the 70 genotypes evaluated (Figure 33).

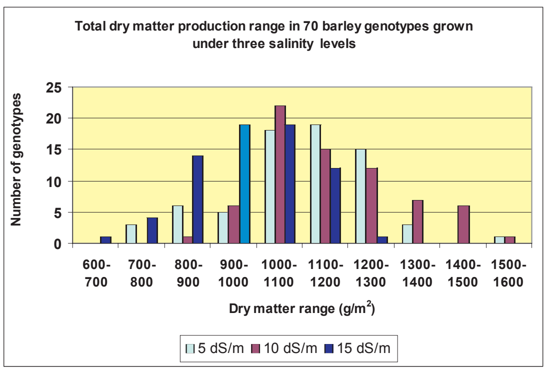


Figure 33

Total dry matter and seed production under the three salinity levels for the top 20 genotypes are shown in figures 34-36. Under low salinity, production reached levels that are comparable to other low-stressed environments. Even at high salinity levels some genotypes maintained total yield levels of 10-12 tons/ha and seed yield of between 3-4 tons. Due to intensive cycles of field selection, the top 20 genotypes were all high in seed and biomass production. Such yield levels are within the range of economic return in barley cultivation. Further improvement through management will also lead to improvement of seed and biomass production.

Plans for 2005

Based on biomass production and seed yield, a group of 20-25 genotypes were identified and planted at ICBA and at selected NARS sites in UAE and Oman during 2005. These trials will include evaluation under the same three salinity levels and assessment of yield and nutritional value among the selected genotypes. Similarly, sufficient seeds of the best performing genotypes will be produced and made available to interested national programs for in-country field evaluation and selection within the WANA region. Additional barley materials acquired from various sources will be further evaluated for salinity tolerance.

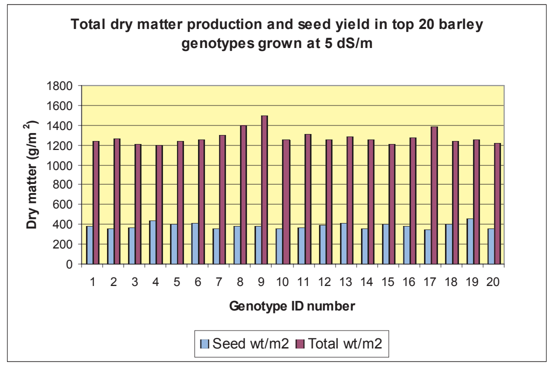


Figure 34

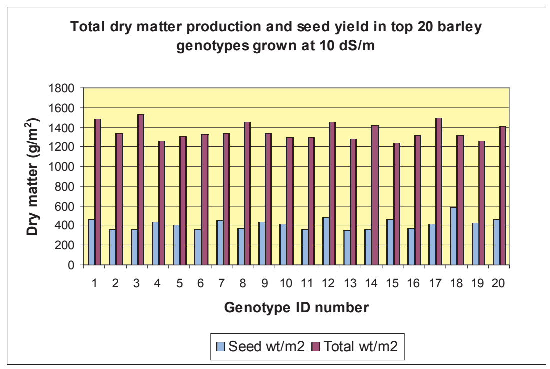


Figure 35

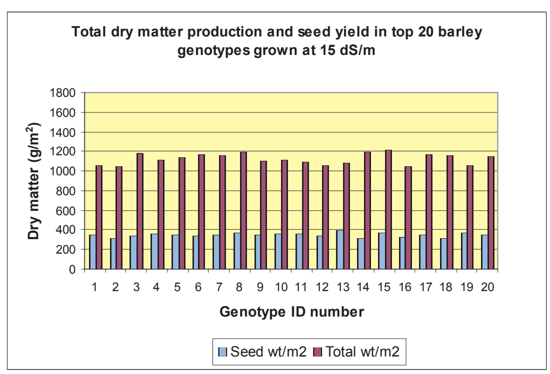


Figure 36

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

Duration: 2003-2006

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

Resources: ICBA, ICRISAT

Key points

- A nursery of 40 salt-tolerant buffel grass genotypes was selected from a larger group for field evaluation at ICBA, NARS and farmers' fields in the region
- High yielding genotypes were identified for salinity ranges up to 25 dS/m

Significance of the project

As stated previously, the Production and Management Systems Program at ICBA focuses on developing forage and crop production systems that fit all types of salt-affected environments. Emphasis is placed on several species that can be used as forages. Buffel grass (*Cenchrus ciliaris*) is among the forage grasses that are targeted for salinity levels higher than the limits suitable for conventional crops. One hundred and sixty buffel grass genotypes have been under evaluation for salinity tolerance for the last two seasons. Evaluation started at 10 dS/m and progressed to 25 dS/m.

Objectives

1. Assess performance of 160 accessions of *Cenchrus ciliaris*, including 8 local races, under moderate to very high salinity levels up to 25 dS/m.
2. Select promising genotypes for further evaluation at a large scale under field conditions and various salinities.

Achievements in 2004

Initial results on the performance of buffel grass are shown below for the range yield among the accessions of each species in response to the salinity levels used in the evaluation. Results show that variations in response among accessions are wide. Selection of genotypes for subsequent field evaluation and improvement of salinity tolerance is therefore feasible. Figures 37-39 show dry matter production in 160 genotypes at salinities of 15, 20 and 25 dS/m. Even at high salinity and after 18 months growth in pots, there are many genotypes that show consistently high yields and no sign of stress. These genotypes were identified and seeds produced in sufficient quantities for field evaluation at ICBA and several other NARS sites in the region.

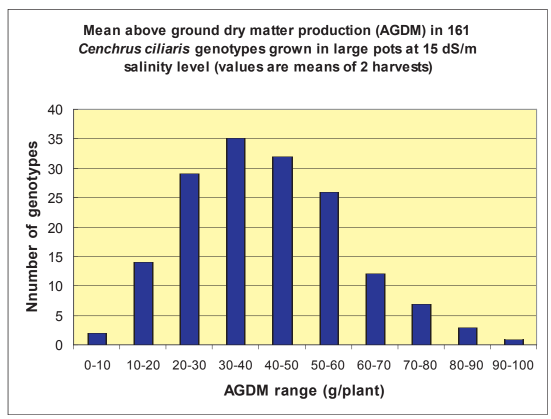


Figure 37

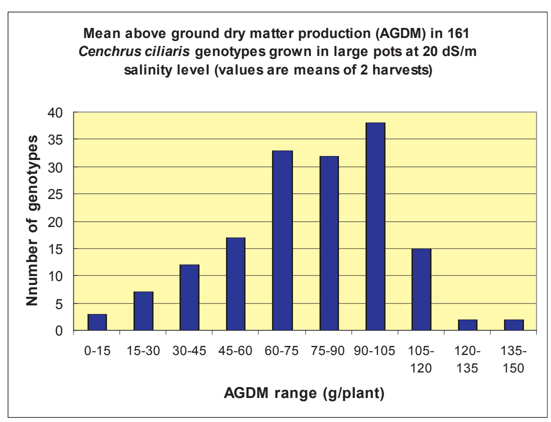
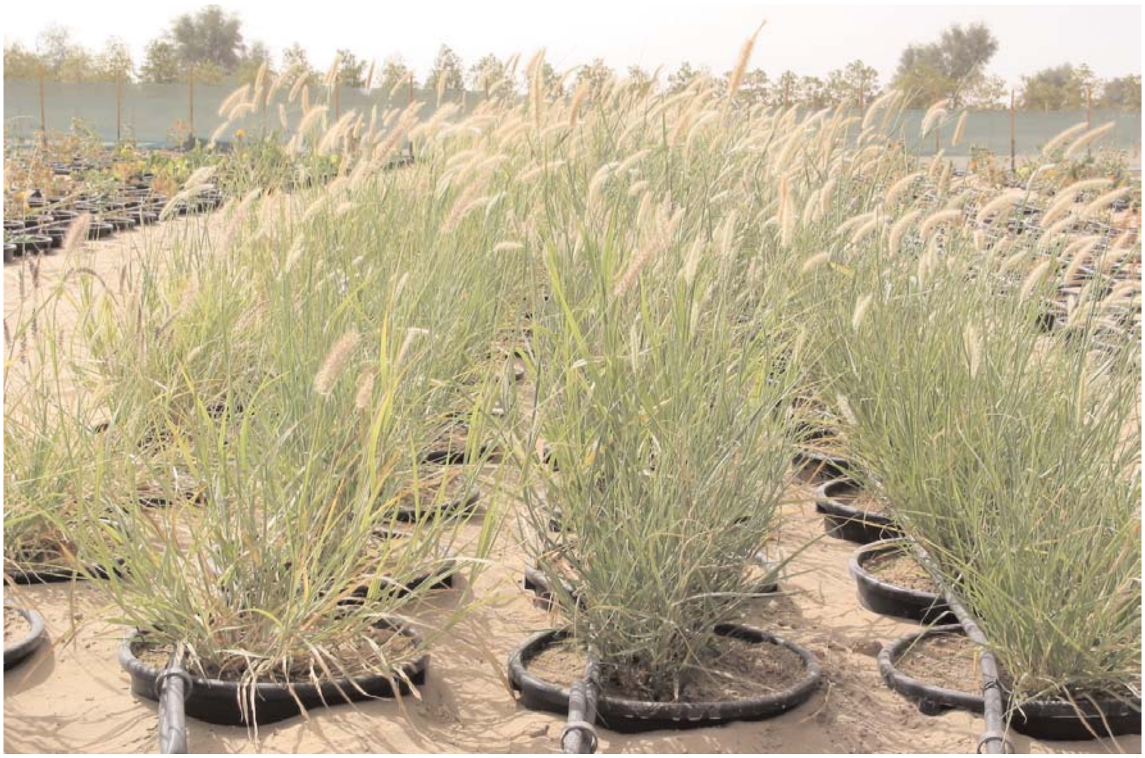


Figure 38



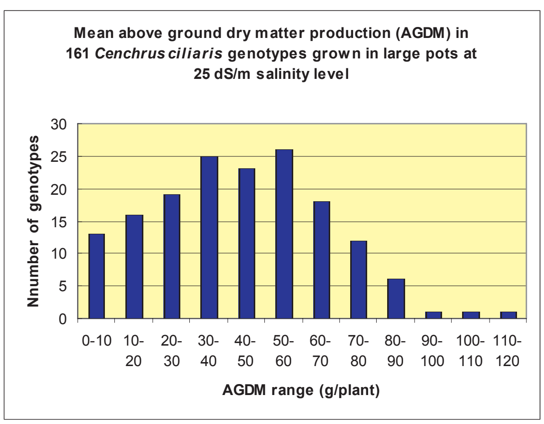


Figure 39

Screening of *Cenchrus ciliaris* under high salinity in a controlled system

Plans for 2005

A set of the 40 best performing genotypes under various salinity levels, was selected for field evaluation. Planting is underway at 3-4 sites in the region with salinity levels ranging from 10-25 dS/m. Nutritional analysis will be performed on selected genotypes.

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

Duration: 2004-2007

Collaborators: Naional Agricultural Research Systems in Jordan, Pakistan, Palestine,Oman, Syria, Tunisia, United Arab Emirates

Resources: International Fund for Agricultural Development, Arab Fund, OPEC Fund, NARS, ICBA

Key point

- The design work confirmed the project approach and proposed research activities to contribute to improvements in livelihood in dry mixed-farming areas of West Asia and North Africa

Significance of the project

The concept note for the program 'Saving freshwater resources with salt-tolerant forage production in marginal areas of the West Asia and North Africa (WANA) region --- an opportunity to raise the incomes of the rural poor' was accepted into the International Fund for Agricultural Development (IFAD) pipeline for financing. On this basis, ICBA was requested by IFAD to prepare a full design for the program.

Members of the ICBA team met with representatives of national implementing institutions and visited potential project locations to discuss demonstration site selection in Pakistan and Oman in December 2003, in Tunisia, Jordan and Palestine in January 2004, and in Syria in February 2004.

Relationship of research activities to livelihood strategies of the rural poor

The project design focused on research activities on salt-tolerant forage production (8 dS/m-25 dS/m or more) to improve livelihoods in the dry (up to 150 mm year) mixed-farming areas of Jordan, Oman, Pakistan, Palestine, Syria and Tunisia.

The target population in **Jordan** was identified as the farmers and pastoralists in the Azraq area of Zarqa Governorate in the northeast of the country with a secondary target in the adjacent Mafraq Governorate.

In **Pakistan**, the project will be implemented in Kaslian village in the Barani Village Development Project area and in Shorkot. In Kaslian village, farmers' income derives mostly from livestock production. Farmers rely on wheat stubble for animal forage, which in many years is insufficient and forces farmers to buy forage or sell livestock. Shorkot is located in an arid region with an average annual rainfall of 250 mm. The scarcity of forage prevents the livestock industry from expanding.

The target area for the project in **Palestine** is the Jericho Governorate of the Jordan Valley on the West Bank. Livestock production suffers from a shortage of feed concentrate and scarce natural pastures. Feeding costs make up 75% of production costs.

In **Oman**, the project will target the Batinah Plain, where small farmers who rely on agriculture as their main source of income have been adversely affected by increasing salinity and their livelihoods threatened. Forage is in short supply and silage, for example, is imported from as far away as Europe.

In **Syria** the project targets 750,000 sheep owners who also own agricultural land in the marginal lands of the Badia. About one third of this group is believed to fall below the poverty line. Rainfed agriculture is banned, particularly barley cultivation, following large-scale degradation of the rangelands caused by excessive utilization placing high pressure on forage supplies and constraining productivity.

In **Tunisia** the project targets the southern area in general and particularly the Tataouine Governorate and part of the Douz Delegation in the Kebili Governorate. Livestock production is the main activity in the area, which has a deficit in animal feed. Salinity of groundwater is a major constraint to irrigated crop and forage production. A number of farms have been abandoned because of high water salinity.

Lessons learned

Technical issues Jordan, Oman, Pakistan, Syria and Tunisia have undertaken significant research on aspects of salinity over more than a decade. In particular, the International Atomic Energy Agency projects executed in Jordan, Pakistan, Syria and Tunisia over the last decade have identified significant salt-tolerant germplasm, including grasses, shrubs and trees, which are available to this project. The design visits confirmed the need to ensure that research activities are specific, are matched to resources and capacities, and are not over ambitious.

Gender Few women are likely to be directly involved in project activities. Nevertheless, it is women who are primarily responsible for livelihood activities such as caring for livestock, processing livestock products for the family, and selling or exchanging livestock products over and above those needed for the household. Improvements in animal feed supplies and animal productivity thus indirectly benefit women. Moreover, when livestock products such as milk and meat are reduced in the diet as a result of drought or other stresses, mothers and children are particularly affected and become malnourished because vegetables and lentils replace meat and milk as protein foods. Women will thus indirectly benefit from project outcomes.

Plans 2005

The design work confirmed the project approach and proposed research activities to contribute to improvements in livelihood in the dry mixed-farming areas, some of the poorest regions in these countries.

Potential crops for each country and potential sites were identified and partners agreed in principle on the scope and extent of project activities. The decisions on implementation at different sites and the sequence of testing of species will be made in the project initiation meeting early in 2005.

The close links with ongoing comprehensive IFAD program initiatives also increase the potential for the success of the project, not only at the project level, but in promoting broader development objectives in the poorer regions of the six countries.

In Tunisia the project targets the southern area

In Syria the project targets 750,000 sheep owners in the marginal lands of the Badia

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

Duration: 2004-2007

Collaborators: International Rice Research Institute; Bangladesh Agricultural Research Institute; Rice Research and Training Center, Egypt; Rice Research Institute of Iran

Resources: Consultative Group on International Agricultural Research Challenge Program on Food and Water through the International Rice Research Institute

Key points

- ICBA participation in a collaboration with IRRI funded through the CGIAR Challenge Program on Food and Water
- ICBA's role is to help identify crops that fit into rice-based cropping systems in salt-affected areas, particularly for Iran, Egypt and Bangladesh
- Initial focus on forage beet and forage rape

Significance of the project

ICBA contributed to a project proposal submitted by the International Rice Research Institute (IRRI) and approved for funding under the CGIAR Challenge Program on Food and Water, coordinated by the International Water Management Institute. A letter of agreement with IRRI was signed in September 2004 to cover ICBA's inputs into the project. ICBA's role centers on identification of possible crops and cultivation methods to fit into rice-based cropping systems, particularly suitable off-season crops to follow rice in the Nile delta of Egypt, the Caspian Sea basin of Iran and in coastal areas of Bangladesh.

Objectives

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

Achievements 2004

The project was approved for funding and ICBA participated in an inception workshop held in the Philippines in March 2004 during which detailed work plans were developed. An initial visit was paid to rice-growing areas of Iran during April 2004 to understand the salinity situation and existing cropping pattern.

Later in the year, ICBA acquired samples of fodder beet and fodder rape for testing for this project. These crops were chosen based on the fact that canola is already being grown after rice in Iran and sugar beet in Egypt. Identifying more salinity tolerant cultivars of these crops would permit earlier sowing and a longer growing season. Testing of the salinity tolerance of the cultivars was initiated at the end of 2004 in the field, in pots, and in hydroponic-based tests, the results of which will be reported in 2005.

Plans 2005

Screening of forage beet and brassica varieties will continue during the first part of the year. Selected varieties or lines will be made available for field testing in Egypt and Iran late in 2005 together with samples of other species identified in ICBA's core salinity screening activities, for example, safflower, pigeonpea and forage legumes. Activities undertaken in PMS09 ‘Demonstration of biosaline agriculture in salt-affected areas in Bangladesh’ also contribute to this project.

Halophyte production

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

Duration: 2001-2004

Collaborator: International Center for Agricultural Research in the Dry Areas - Arabian Peninsula Research Program; Ministry of Agriculture and Fisheries (United Arab Emirates)

Resources: ICBA, International Center for Agricultural Research in the Dry Areas - Arabian Peninsula Research Program; Ministry of Agriculture and Fisheries (United Arab Emirates)

Significance of the project

Forage is among the main agricultural produce in UAE and Gulf Cooperation Council countries. However, due to deteriorating water quality and low water use efficiency for most of the species, there is an urgent need to introduce species, which are more tolerant (to salt and water stresses) and have high water use efficiency. Indigenous species are better choice as they are already adapted to the prevailing conditions.

Two native species, *Coelachyrum piercei*, *Cenchrus ciliaris* were evaluated against the currently grown forage grass *Chloris gayana*. Trials conducted at different salinity levels, fertilizer and irrigation quantity treatments provided information on the extent of salt tolerance in the native species and management practices to optimize their productivities.

Objectives

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

Key points

- *Cenchrus ciliaris* showed similar salt tolerance as *Chloris gayana*, but high water use efficiency
- Better lines of *C. ciliaris* could replace Rhodes grass that has high water consumption

Achievements 2004

Growth and productivity of indigenous grasses were assessed over a range of salinity and fertilizer treatments to evaluate the optimum requirements. Long-term effects of saline water irrigation on soil properties were monitored continuously.

Biomass production (Figures 40-42) varied with salinity from 3000-10500 ppm salts (5-15 dS/m). *C. gayana* exhibited higher shoot biomass (fresh, dry and ash-free dry weight) as compared to other species at low salinity treatments. However, it showed a high reduction of 41% at 15000 ppm salinity level, as compared to 3500 ppm salinity. In contrast, *C. ciliaris* exhibited only 21% reduction at 15000 ppm salinity level compared to low salinity levels. All the three grasses showed higher ash-free dry weight (AFDW) at nitrogen application rate of 40 kg/ha and irrigation level of 100% ET_0 (ET_0 x 1.0) followed by water application at 50% ET_0 in split dose.

Soil salinity measured by soil sampling followed by soil-water extraction, and by EM-38 for all treatments showed no significant variation reference to the different treatments applied for all the species.

Plans 2005

The trial was undertaken for three years and meaningful results have been obtained to demonstrate the potential of indigenous species. The experiment was terminated at the end of 2004.

International Center for Biosaline Agriculture

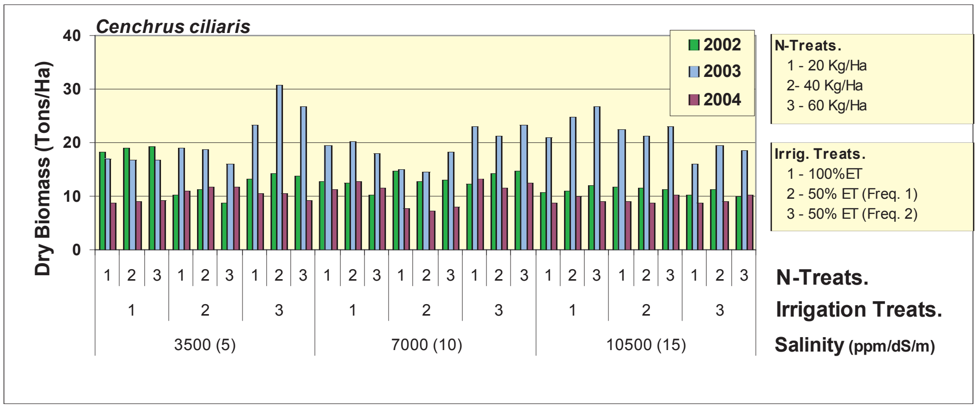


Figure 40 Biomass production *Cenchrus ciliaris*

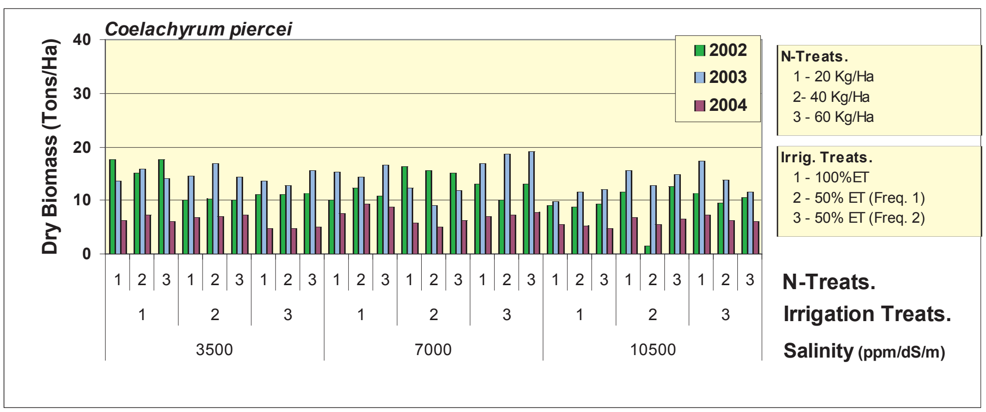


Figure 41 Biomass production *Coelachyrum piercei*

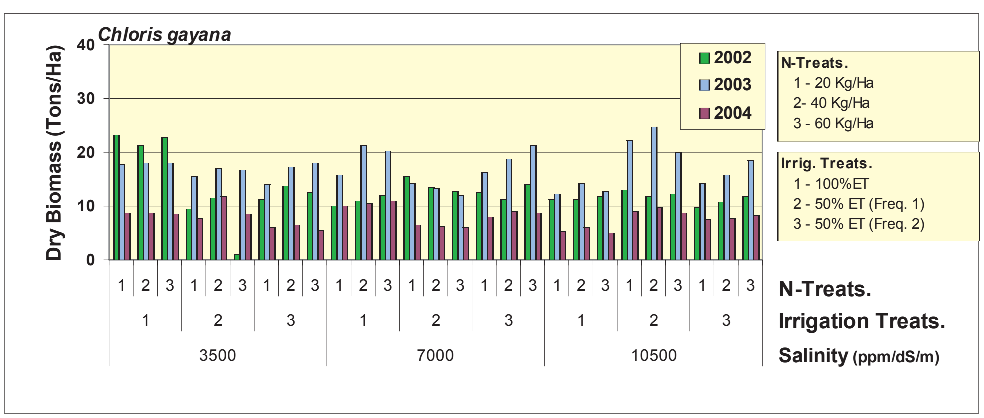


Figure 42 Biomass production *Chloris gayana*

Water use and salt balance of halophytic species (PMS12)

Duration: Ongoing

Collaborator: n/a

Resources: ICBA

Significance of the project

Simulation of field situations under controlled conditions provides basic information regarding salinity tolerance and water requirement of a test species. This also provides information on the leaching requirement in different soil types and salt movement outside and inside the plants, to use water efficiently. The issue of efficient removal of drainage/leached water is also important to avoid salinity and waterlogging. However, in many areas, this is one of the greatest limitations. Another approach is to use the drainage water as this is a valuable resource. This water which is usually more saline than the primary irrigation water can be used to grow plants with higher salinity tolerance. A model study was initiated to evaluate the prospects of using such methodology.

Objectives

1. To develop productivity management of promising halophytic species for forage. Plant genotypes exhibiting salt tolerance to be tested in lysimeters for their productivity management.
2. To study the effects of water quality/quantity, harvest period and frequency, and their nutritional aspects for optimizing productivity.
3. To simulate studies related to re-use of drainage water for efficient water utilization, minimum drainage disposal, and maximizing productivities for increasing salt tolerant plants and halophytes.

Achievements 2004

Haloxylon salicornicum was tested at a range of salinity from low to high sea water salinities (5-40 dS/m) with irrigation volume of ET_0 x 1.0 and ET_0 x 1.5. Relationships are established between soil and water parameters with the growth of test species. Height of *H. salicornicum* showed reductions from 30 dS/m at ET_0 x 1.0, however, no significant changes in plant growth were observed at ET_0 x 1.5. Dry biomass was higher when irrigated with higher volume of water. Shoot:root ratio was lower at ET_0 x 1.0, but was more at ET_0 x 1.5, when irrigated with water of higher salinities.

In an another study initiated in 2004 using lysimeters, five sets of different plant species (including grasses, shrubs and trees) were grown with increasing salinity of drainage water. Preliminary results show higher growth rates for *C. lancifolius* and *A. ampliceps* among tree species and woody *Atriplex* among the saltbushes. Among the grasses, *Distichlis* and *Sporobolus* produced higher biomass as compared to other grasses.

Key points

- Higher volume of water (ET_0 x 1.5) produced relatively higher biomass of *Haloxylon salicornicum* and lowered soil salinity
- Three-step lysimeter study demonstrated that re-use of drainage water is also an option to increase productivity at difficult sites

Experiment to determine drainage water use and salt balance of grass and shrub species in the three-step lysimeter

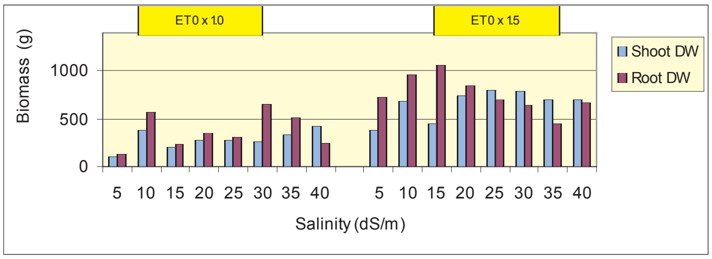


Figure 43 Dry biomass of *Haloxylon salicornicum* at different levels of salinity and irrigation

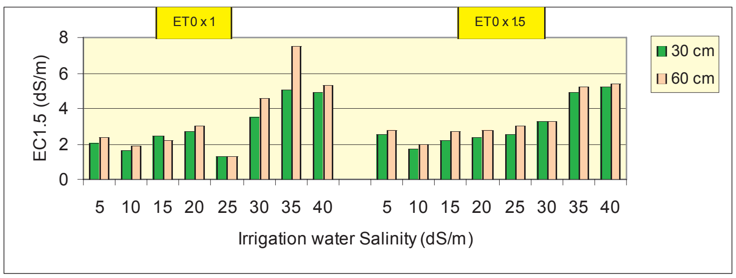


Figure 44 Soil salinity in *Haloxylon salicornicum* as affected by water application rate and salinity of irrigation water

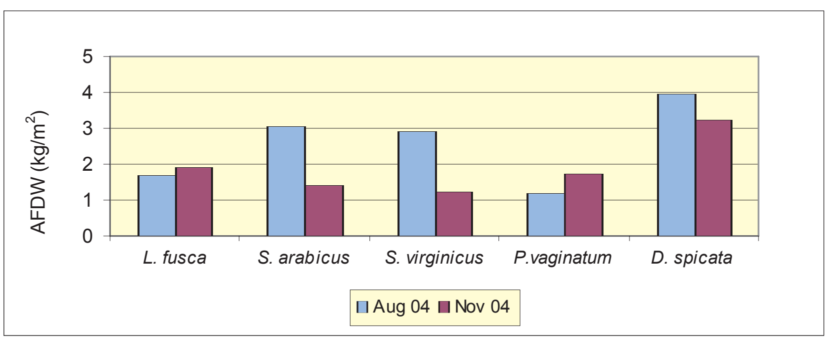


Figure 45 Ash-free dry weight of grass species tested in three-step lysimeter studies

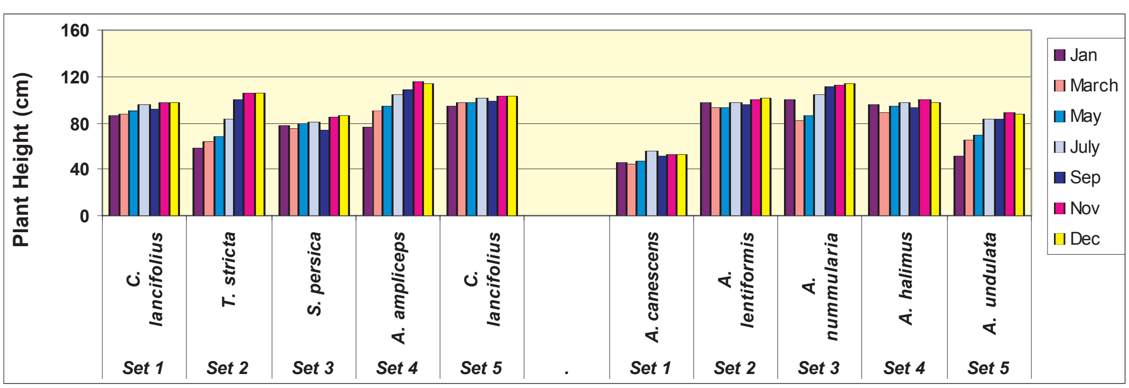


Figure 46 Growth rate of test species in lysimeters as affected by the salinity of irrigation and drainage water

Table 5 Salinity of irrigation and drainage water (in dS/m) used to irrigate grasses, shrubs and trees in five sets. Data in the table show seasonal variations in salinity and groups of plants

		Plant Species	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Set 1	Top *	*Leptochola fusca*	11.04	11.33	9.41	10.51	11.39	11.33	10.72	11.72	10.99	11.55	11.45	11.46
	Middle	*Conocarpus lancifolius*	12.14	19.17	20.71	21.18	21.21	20.69	22.03	22.24	20.72	23.48	21.21	22.81
	Bottom	*Atriplex canescens*	14.94	20.68	24.08	23.71	23.46	24.41	24.95	25.37	24.32	31.23	25.45	27.21
		Drained water	14.45	22.09	27.78	27.69	28.72	29.88	31.46	33.35	32.08	32.74	32.91	34.77
Set 2	Top	*Sporobolus arabicus*	12.16	11.10	9.30	11.91	11.01	10.76	11.12	12.19	10.92	11.41	11.71	11.97
	Middle	*Tamarix stricta*	11.97	19.36	18.33	19.78	20.05	19.78	20.99	21.72	21.02	22.75	24.12	23.96
	Bottom	*Atriplex lentiformis*	13.46	20.71	26.64	27.08	23.59	25.76	25.53	24.67	24.11	26.15	30.04	27.50
		Drained water	14.54	21.75	30.19	31.43	32.17	31.93	35.05	36.29	31.12	33.57	31.47	30.50
Set 3	Top	*Sporobolus virginicus*	11.11	11.43	9.31	12.13	10.88	11.71	11.6	11.76	10.11	11.39	10.61	11.85
	Middle	*Salvadora persica*	11.82	19.21	23.14	24.09	21.59	24.12	22.22	23.73	21.41	24.05	24.25	23.28
	Bottom	*Atriplex nummularia*	14.44	20.46	28.27	29.78	24.55	28.24	28.32	27.93	28.03	30.64	30.12	26.81
		Drained water	14.85	22.32	30.32	30.24	31.79	31.36	31.09	35.16	32.24	33.71	31.17	30.24
Set 4	Top	*Paspalum vaginatum*	10.88	11.31	9.28	9.56	10.33	10.83	11.78	11.86	10.91	11.62	9.36	10.01
	Middle	*Acacia ampliceps*	11.76	19.71	21.26	21.86	22.35	21.64	23.06	24.27	21.45	21.41	21.75	21.55
	Bottom	*Atriplex halimus*	13.12	21.48	28.51	30.18	29.24	29.68	29.77	29.66	28.72	24.54	30.33	30.33
		Drained water	15.13	22.26	30.85	31.61	34.58	33.44	34.88	37.61	33.22	32.58	31.62	32.87
Set 5	Top	*Distichlis spicata*	10.51	11.40	9.17	9.16	9.85	11.40	10.93	11.83	11.29	11.48	11.40	10.93
	Middle	*Conocarpus lancifolius*	11.68	19.54	20.06	20.69	20.44	22.14	22.84	26.08	22.62	22.84	22.14	22.84
	Bottom	*Atriplex undulata*	14.19	20.78	27.47	28.52	28.52	28.52	31.07	32.31	27.15	27.01	28.52	31.07
		Drained water	14.86	22.11	29.71	30.35	32.68	32.24	34.28	36.81	34.57	35.03	32.24	34.28

* The first lysimeter (top) in all sets are irrigated with water of 10 dS/m

Three-step lysimeter

Bottom step in three-step lysimeter

Plans 2005

Simulation studies using the three-step lysimeter will continue to give more in-depth studies of salt and water movements in the soil and test plant species for appropriate salinity and amount of irrigation water under field conditions.

Production of halophytes in Iran (PMS22)

Duration: 2003-2005

Collaborator: National Salinity Research Center, Iran

Resources: ICBA; National Salinity Research Center, Iran

Significance of the project

Iran has an estimated 27 Mha of salt-affected lands. Considering the vast areas of salt-affected land in Iran, and its rich, diverse plant communities of halophytes, the prospect of biosaline agriculture in Iran seems promising. A collaborative project was initiated with the National Salinity Research Center at Yazd in Iran in January 2003. Earlier studies in Iran had demonstrated the successful establishment of some shrub and tree halophytes and the feasibility of the production of some halophytic forage species. Studies on proper agronomic techniques for economic production of some halophytic species as animal fodder could lead to farm-based use of halophytes.

Objectives

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

Achievements 2004

Studies were conducted in (i) pots in an open condition at NSRC headquarters in Yazd, using *Atriplex lentiformis*, *A. nummularia*, *A. halimus*, *A. canescens* and *Kochia indica*; and (ii) under field conditions at Sadooq Salinity Research Farms. For the pot studies, plants were irrigated with saline water of 14 dS/m and for field studies with 10 dS/m. Test species were tested against salinity, fertilizer applications and irrigation methods.

Preliminary results showed highest dry leaf biomass was obtained for *Atriplex halimus* followed by *Kochia indica*. Increasing the level of nitrogen (50 kg/ha) had significant effect on biomass for all test species as compared to other N-treatments.

A Farmer's Day was held in July 2004 for about 120 farmers in the Yazd region. In addition to explaining the concepts of saline agriculture, the participants were taken to field sites to observe the management practices used for test species. The participants were also provided with literature and brochures on saline agriculture.

Key points

- Both *A. halimus* and *A. nummularia* produced high forage yield and showed the same leaf:stem ratio, considered to be an important index for evaluating halo-forage species
- Application of nitrogen fertilizer at a level of 50 kg/ha, without any phosphorous fertilizer, increased forage yield
- For these species, the highest water use efficiency was for a drip irrigation system followed by bubbler and furrow systems

Plans 2005

The trials will continue until mid-2005 followed by a final report and publication of significant achievements. In addition another Farmer's Day and a Final Project Meeting are scheduled for 2005.

Atriplex was studied in pots at 14 dS/m at Yazd

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

Duration: 2003-2005

Collaborator: NyPa

Resources: ICBA, NyPa

Key points

- NyPa forage has been grown successfully when irrigated at up to 45 dS/m water salinity
- Air dry biomass showed no significant variation between 25 and 40 dS/m
- Sodium sulphate treatment at 6 mM increased the air-dry biomass of NyPa forage

Significance of the project

This project uses the germplasm and technology developed by NyPa International for testing NyPa forage (*Distichlis spicata var. Yensen 4a*) as forage species that can be irrigated with seawater. The study looks into the potential of this grass to be grown in coastal arid and humid conditions of the region using seawater for irrigation. If proved to be successful and feasible, this would provide a very good opportunity for the region where seawater is abundant and barren coastal areas can be converted into forage production areas.

Objectives

1. Demonstration of growth of NyPa forage under local conditions using highly saline water.
2. Expansion of NyPa forage material in agreement with NyPa International and NyPa Arabia.

Achievements 2004

Two trials were set during 2004, (i) using three different salinity regimes of water (10, 25 and 40 dS/m), and (ii) evaluating the application of different doses of sodium sulfate on biomass productivity. The grass exhibited very good growth even at the higher salinity level. Non-significant differences were observed in stem height and number of stems. Plants were harvested twice for each plot and sub-plots after six months of establishment. Figures 47 and 48 show the air-dry biomass with reference to salinity, irrigation rates and sodium sulphate treatments. Plants grown with sodium sulfate treatments showed higher productivities at 25 dS/m as compared to those grown without sodium sulfate.

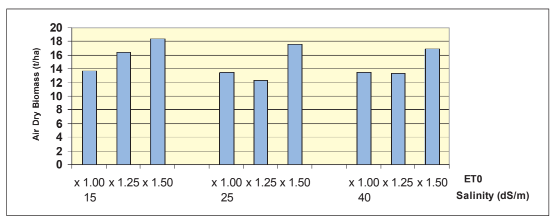


Figure 47 Air-dry biomass of *Distichlis spicata* grown at three salinities and irrigation rates

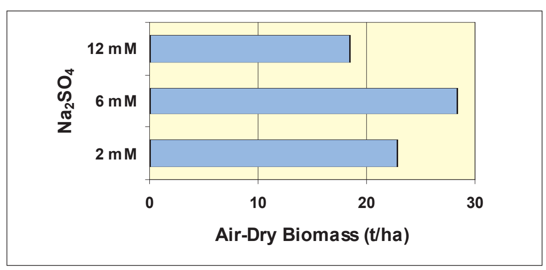


Figure 48 Air dry biomass of *Distichlis spicata* grown at 25 dS/m salinity of irrigation water and ET_0 x 1.25, with different rates of sodium sulphate fertilizer

Plans 2005

Growth of grasses will be monitored closely after repeated harvest of the plants. Plants will be harvested quarterly to evaluate the full potential as forage that can be grown with seawater irrigation. In addition, to estimate its nutritional values, the plants will be taken to a larger demonstration plot.

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

Duration: 2004-2006

Collaborator: Ministry of Agriculture and Fisheries, United Arab Emirates

Resources: ICBA

Significance of the project

The research assesses the responses of the two grass species to different levels of saline irrigation water on growth, productivity and nutrient values. Preliminary studies conducted by the Ministry of Agriculture and Fisheries, United Arab Emirates, have demonstrated that the species are not only well adapted to the harsh environment in the Arabian Peninsula region, but have good potential to withstand low levels of soil fertility. The African variety of *C. ciliaris* has tolerance to both salinity and drought conditions.

Objectives

1. To study the responses of the test grass species to different levels of saline irrigation water.
2. To evaluate the growth, dry matter yield and nutritive value of these species.

Achievements 2004

Seeds of grasses were germinated in Jiffy bags and established seedlings were transplanted in the field at salinity levels of 5, 10 and 15 dS/m. Seedlings were transplanted for better establishment. However, due to high temperatures, seedling survival was relatively poor. The area will be replanted with another batch of seedlings in 2005.

Plans 2005

Growth and productivity of the test species will be evaluated under different salinity levels. Nutritional value of these grasses will be studied at different growth periods of the year.

Seeds were germinated in Jiffy bags and established seedlings were transplanted in the field at salinity levels of 5, 10 and 15 dS/m

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

Duration: 2004-2006

Collaborators: n/a

Resources: ICBA

Significance of the project

The economic prospects of multi-species production systems have gained importance, particularly related to increased productivity per unit area. In these systems, more than one type of plant species is integrated with a livestock component to increase productivity in a unit area. Agroforestry provides the opportunity to integrate different grasses, shrubs and trees in a single production system. This not only increases production, but also enriches and regulates minerals in the soil.

During the last three years, two salt-tolerant grasses (*Sporobolus arabicus* and *Paspalum vaginatum*) and one tree species (*Acacia ampliceps*) have been tested at ICBA, and in collaboration with ICBA's partners, under different salinity conditions. All the species have shown good potential, in terms of salt-tolerance, productivity and nutrient content, for introduction into integrated forage production systems. The trial is an approach to integrate these species for optimizing productivity.

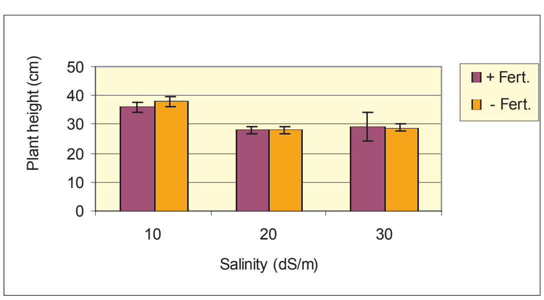


Figure 49 Plant height for *A. ampliceps* did not show any significant effect of fertilizer treatments

Key point

- Two grass and one tree species were established in an integrated agroforestry system at salinities of up to 30 dS/m

Objectives

1. To test the potential of the grass and tree species in an integrated form for increased productivity.
2. Evaluate the nitrogen placement after fixation by the legume *Acacia ampliceps*.
3. Evaluate the potential of mixed forage of grasses and trees for animal feed.

Achievements 2004

The system is being tested at three salinity levels (10, 20 and 30 dS/m) with and without fertilizer treatments. Plant height for *A. ampliceps* did not show any significant effect from fertilizer treatments, which can be attributed to its N-fixing ability. The trial was commissioned in April 2004 and the grasses will be harvested in 2005.

Plans 2005

Growth and productivity of the different species will be evaluated at three salinity levels (10, 20 and 30 dS/m) without any fertilizer treatments. Nutritional value of these grasses will be studied at different growth periods of the year.

A. ampliceps shows good potential for introduction into integrated forage production systems

Horticultural crop production

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

Duration: 2001-2006

Collaborators: Ministry of Agriculture and Fisheries (United Arab Emirates)

Resources: ICBA, Ministry of Agriculture and Fisheries (United Arab Emirates)

Key points

- After two years of salinity treatments, marked effects on growth and development of 10 date palm varieties are evident
- Lulu, Jabri, Khinizi and Abu Mann seem to be the best performing date palm varieties at salinities of up to 15 dS/m

Significance of the project

This long-term experiment, planned to run for five to six years, will provide valuable information on the salinity tolerance of ten elite United Arab Emirates date palm varieties. In collaboration with the Ministry of Agriculture and Fisheries, United Arab Emirates, ten of the most preferred date palm varieties - Khalas, Farad, Barhi, Lulu, Jabri, Naghal, Ekhisab, Khinizi, Shahle and Abu Mann - were selected for investigation. The ten varieties were planted in 2001 in a replicated field experiment at three salinity levels, with five replications of each variety, totaling 150 trees. Few studies have examined the long-term effects of salinity on date palm growth and productivity from establishment to maturity. In November 2002, eight varieties from Saudi Arabia were planted in the same field under the same salinity treatments, along with four varieties of olive. The group of 18 elite varieties will provide a sound database for the evaluation of salinity impact on date palm production in the region.

Objectives

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

Achievements in 2004

Three salinity levels (5, 10 and 15 dS/m) were applied in late 2002 and fine-tuned in 2003. The growth and development of each plant is being monitored by collecting data on basic traits such as height, trunk diameter, number of leaves and phenology. As the ten varieties have dissimilar characteristics, the relative growth will be used to compare development of the different varieties at the three salinity levels. Three sets of data were collected on the ten varieties and further data collection is planned for 2005. Salinity treatments were applied in late 2003 on the additional eight varieties. Growth data are being collected and will be presented in subsequent reports. Extensive soil salinity monitoring is underway, along with chemical analysis of vegetative parts.

Results

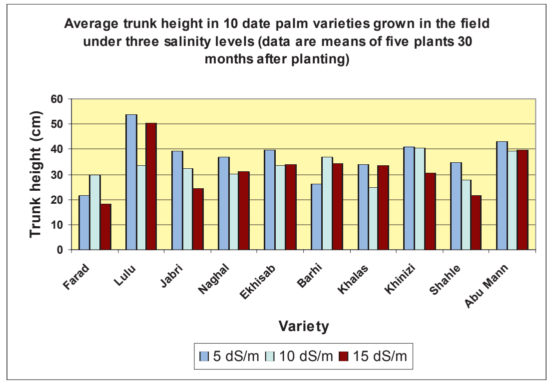
The ten varieties showed considerable variations in relative growth under the three salinity levels. Few

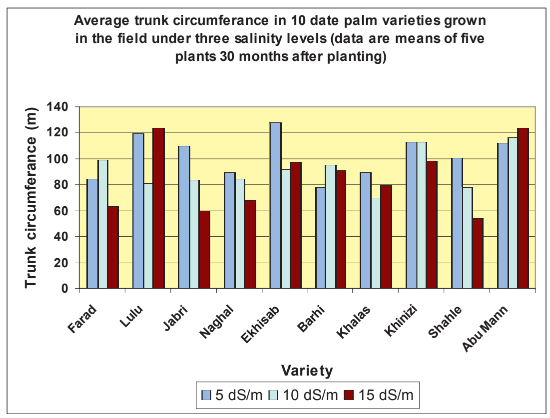
Field growth of 18 date palm varieties at three salinities, 5, 10 and 15 dS/m varieties were able to maintain good growth indicators, like trunk height, trunk circumference and number of leaves at the three salinity levels (Figures 50-52). For all the traits studied, Lulu, Jabri, Khinizi and Abu Mann seem to be the best performing varieties at the salinity ranges used. Further analysis of collected data and plant materials will give better indications of salinity tolerance in the studied varieties.

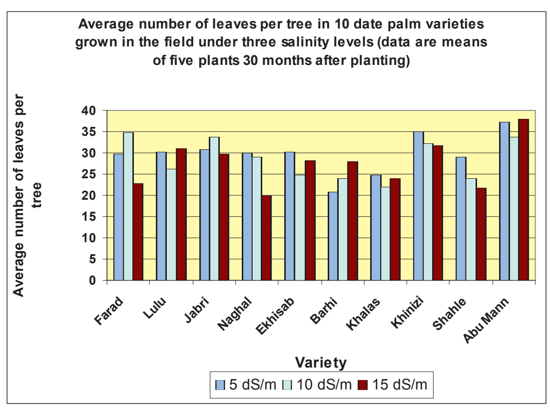
Plans for 2005

Monitoring of plant growth and soil salinity will continue during 2005 to establish a long-term database for date palm growth in saline conditions. Monitoring soil salinity under each variety and salinity treatment is currently under way. Tissue analysis for various traits will also be performed and reported in 2005.

Relative growth is used to compare development of the varieties







Figures 50 (top), 51 (middle), 52 (bottom) Data on the growth and development of each plant were collected including basic traits, such as height, trunk diameter, number of leaves and phenology

Expanding date palm cultivation under saline conditions in Jordan (PMS23)

Duration: 2003-2007

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

Resources: ICBA, National Center for Agricultural Research and Technology Transfer (Jordan)

Key points

- Bilateral project with National Center for Agricultural Research and Technology Transfer, Jordan
- Exploring the potential to expand date palm cultivation from its present very limited level

Significance of the project

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

Fifteen varieties of date palm were established at two testing sites in the Jordan Valley

Objective

Explore the potential to expand the area of date palm cultivated in Jordan.

Achievements 2004

Fifteen varieties of date palm - 13 female and 2 male - were established at two testing sites, Karamah and Ghor Safi, in the Jordan Valley. Irrigation equipment was ordered and installed at the two sites in April and the date palm seedlings transplanted in May. Twelve date palm varieties for the trials were purchased from a private company and the remaining three were provided by the tissue culture laboratory at the National Center for Agricultural Research and Technology Transfer. Collection of weather data and baseline data on the soil and water conditions at the two sites was initiated and continues to be routinely monitored. Collection of data on plant growth and chemical analyses of different tissues will be initiated after the seedlings are well established.

Plans 2005

Chemical analysis of the irrigation water applied to the plots at both sites will be carried out monthly to monitor the water quality. Chemical and physical analysis of the soils at different depths in the profile will be carried out three times per season at both sites to determine the effects of irrigation. Plant growth will be measured on all the seedlings and chemical status of different tissues will be periodically monitored.

Communication, Networking and Information Management Program

The overall objective of the Communication, Networking and Information Management Program is to:

- promote the exchange of information and experience among those involved in biosaline agriculture research and development in the region and throughout the world

Communication, networking and managing information activity: Memoranda of Understanding

Duration: Ongoing

Activities 2004

Four Memoranda of Understanding were signed in 2004. The MOUs establish organizational links with a view to exchanging information and developing collaborative relationships relating to the delivery of technologies for managing saline environments.

Arab Center for the Studies of Arid Zones and Dry Lands

ICBA signed a MOU with the ACSAD on 24 February 2004. ACSAD, an organization of the Arab League, is an applied research and development center located in Damascus, Syria.

Commonwealth Scientific and Industrial Research Organization (CSIRO), Australia

ICBA and the Commonwealth Scientific and Industrial Research Organization signed a MOU to cooperate in areas related to managing salinity on 8 April 2004.

National Prawn Company, Saudi Arabia

The MOU with the National Prawn Company, Saudi Arabia, signed on 7 June 2004, was followed up with the signing of an agreement for a two-year project for utilization of return seawater for biosaline agriculture at National Prawn Company, Saudi Arabia.

Signing of the MOU with the Commonwealth Scientific and Industrial Research Organization, 8 April 2004

Key point

- Establishing formal Memoranda of Understanding or similar agreements paves the way for access to technolgy and exchange of information

Institut National de Recherches Agronomiques du Niger

The signing of the MOU with the Institut National de Recherches Agronomiques du Niger in July 2004 is being followed up with a proposal submitted to COMSTECH for capacity building and development of a biosaline agriculture project.

Signing of the MOU with Arab Center for the Studies of Arid Zones and Dry Lands, 24 February 2004

Signing of the MOU with the National Prawn Company, Saudi Arabia, 7 June 2004

Communication, networking and managing information activity: Collaboration

Duration: Ongoing

Collaborators: National agricultural research systems

Key point

- Joint projects with national agricultural research systems in Bangladesh, Iran, Jordan, Pakistan and the United Arab Emirates promote technologies to manage salinity

Activities 2004

ICBA collaborates on six on-going projects in the United Arab Emirates. In addition, one new joint project began in 2004 with the Ministry of Agriculture and Fisheries to study the feasibility for biosaline agriculture in the United Arab Emirates (PMS32).

ICBA also has ongoing joint projects in Bangladesh, Iran, Jordan and Pakistan.

Plans 2005

In 2005 ICBA will be collaborating with seven countries for implementation of the WANA salt-tolerant forage project.

Joint project with the Bangladesh Agricultural Research Institute

Table 6 Collaborative projects 2004

Organization	*Project*	*Location*	*Start*	*End*
Bangladesh Agricultural Research Institute (BARI)	Demonstration of biosaline agriculture in salt-affected areas in Bangladesh (PMS09)	Bangladesh	2003	2004
National Salinity Research Center, Iran	Production of halophytes in Iran (PMS22)	Iran	2003	2005
National Center for Agricultural Research and Technology Transfer, Jordan	Expanding date palm cultivation under saline conditions in Jordan (PMS23)	Jordan	2003	2007
Pakistan Agricultural Research Council	Use of low quality water for productive use of desert and salt-affected areas in Pakistan (21)	Pakistan	2003	2005
Ministry of Agriculture and Fisheries, UAE	Evaluation of irrigation practices and fertilizer requirements for optimizing productivity of three indigenous grass species (PMS01)	ICBA HQ	2000	2004
Ministry of Agriculture and Fisheries, UAE	Investigation of elite date palm and olive varieties for salt-tolerance (PMS06)	ICBA HQ	2001	2006
Ministry of Agriculture and Fisheries, UAE	Application of biosaline agriculture in a demonstration farm in the Northern Emirates of the UAE (PMS05)	Ras Al Khaimah, UAE	2003	2006
Ministry of Agriculture and Fisheries, UAE	Feasibility study for biosaline agriculture in the United Arab Emirates (PMS32)	UAE	2004	2004
United Arab Emirates University	Optimizing management practices for maximum production of two salt-tolerant grasses: *Sporobolus virginicus* and *Distichlis spicata* (PMS03)	ICBA HQ	2002	2006
United Arab Emirates University	Optimizing management practices for maximum production of three *Atriplex* species under high salinity levels (PMS04)	ICBA HQ	2002	2006
United Arab Emirates University	Development of sustainable salt-tolerant forages for sheep and goat production (PMS16)	UAEU	2003	2006

Communication, networking and managing information activity: Information management

Duration: Ongoing

Activities 2004

Implementation began on cataloguing the book and report collection in the Library of Congress classification system. Spine labels and book cards are being prepared and re-shelving the 500 books by Library of Congress classification number is in progress.

The WEBLIS library cataloguing software was tested and it was found that the modifications needed would be extensive and costly. Alternative software to provide a web interface to the library catalogue was investigated. Two suitable packages were reviewed and a proposal and budget were developed for the integrated library system, including web access to holdings.

Plans 2005

Work will continue on cataloging the collection, including incorporation of the Arabic holdings into the cataloguing system.

Table 7 Information services activities 2004

Activity	*2003*	*2004*
Books acquired and entered in Access database	337	67
Reprints acquired and entered in Access database	66	42
Species compiled and entered in Salt-Tolerant Plants database	110	1
WINISIS catalogue entries	507	358
Information resources purchase requests	52	31
Information/ document/search requests	83	58

Key points

- A specialized collection of information resources for information on salinity issues
- Now being catalogued in the Library of Congress classification system

Implementation began on cataloguing the book and report collection in the Library of Congress classification system

New acquisitions on display in the library

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

Duration: Ongoing

Activities 2004

A key tool for dissemination of information is a comprehensive and well-maintained stakeholder database. By the end of 2004 the ICBA stakeholder database held contact details of 2358 individuals. The information in the database is used for targeted distribution of annual reports, newsletters, and other ICBA communication activities.

Image database

In addition to the client database, an image database on the ICBA network is available to all staff. The image database holds over 14,600 images relating to ICBA projects and activities. Images are catalogued by topic and year, and are a resource for reports, publications and presentations.

Publications 2004

In 2004 publication of the Annual Report and *Biosalinity News* in French was discontinued because of budget constraints. Table 8 lists publications produced in 2004.

Key points

- Dissemination of information on salinity issues
- Newsletter reader survey provided feedback on information needs

Newsletter reader survey

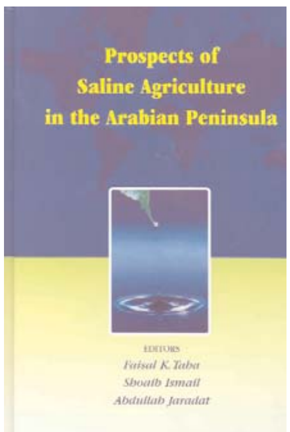
Feedback on the newsletter *Biosalinity News* was sought by means of a reader survey included in the volume 4 issue 3 and volume 5 issue 1 newsletter mailings. Many readers took the opportunity to provide feedback and suggestions, which included:

- Requests for an internet discussion forum facilitated by ICBA
- Expressions of interest in contributing to a scientific journal on salinity and to the newsletter
- Requests for other ICBA technical publications
- Requests to increase the size of the newsletter and include more technical content and data
- Expressions of interest in collaborative projects
- Expressions of interest in participating in training courses, workshops, conferences on salinity
- Information on institutions and projects.

Table 8 ICBA publications 2004

Title	*Month*	*Print run*
Biosalinity News Vol 5 No 1 English	February	2500
Biosalinity News Vol 5 No 1 Arabic	June	2000
Biosaline agriculture: Challenges and opportunities for products from field to market Program and abstracts	June	500
Biosalinity News Vol 5 No 2 English	August	2500
Biosalinity News Vol 5 No 2 Arabic	October	2000
Biosalinity News Vol 5 No 3 English	December	2500
Biosalinity News Vol 5 No 3 Arabic	December	2000
ICBA Annual Report 2003 English	August	1500
ICBA Annual Report 2003 Arabic	October	1000
ICBA project snapshots	August	2500
Partners in biosaline research and development: ICBA and IDB-member countries	August	2000
Partners in biosaline research and development: ICBA and the Islamic Republic of Iran	August	1000
Proceedings: Symposium on biosaline agriculture	September	500
Bookmark calendar 2005	August	4000

Table 9 Distribution of ICBA annual reports and newsletters 2004							
	English		*Arabic*		*French*		*Total*
Year	*Recipients*	*Countries*	*Recipients*	*Countries*	*Recipients*	*Countries*	*Recipients*
2000	314	48	302	17			616
2001	635	72	472	17	28	13	1135
2002	908	91	659	20	164	51	1731
2003	1055	91	758	24	180	51	1993
2004	1314	112	883	30	-	-	2197



Symposium proceedings published in 2004

ICBA booth at the Consultative Group on International Agricultural Research Annual Meeting, Mexico, October

Media coverage 2004

Media coverage of ICBA is generated primarily by distribution of newsletters, annual reports and news releases to a media list, followed up by direct contact. The local Arabic press covers ICBA regularly.

In addition, ICBA receives requests for articles and features for a variety of newsletters and magazines. Articles have been published in the *Daily Star* (Lebanon), *OPEC Newsletter*, *COMSTECH Newsletter*, and *Arab Water World* amongst others.

Visitors

Over 500 scientists, donors, government officials, ministers, diplomats, representatives of the private sector and others interested in biosaline agriculture have visited ICBA since 1999. Programs of discussion, presentations and field visits are arranged for each visitor or group of visitors to explore opportunities for collaboration.

Plans 2005

Time will be devoted to the development of the next strategic plan and the communication and information components of the plan. Once developed, the new plan will be published and disseminated.

Table 10 Participation in exhibitions 2004		
Exhibition	*Date*	*Place*
Flowers Week, Abu Dhabi	17-22 February	Abu Dhabi
Sharjah Flower Show	1-5 March	Sharjah
WETEX	22-24 March	Dubai
Biosaline Agriculture from Field to Market	7 June	Dubai
IDB Annual Meeting	11-15 September	Teheran
CGIAR Annual meeting	25-29 October	Mexico

Communication, networking and managing information activity: Networking

Duration: Ongoing

Activities 2004

ICBA coordinates two networks: The Inter Islamic Network on Biosaline Agriculture (INBA) and the Global Biosaline Network (GBN).

Inter Islamic Network on Biosaline Agriculture

INBA is a non-political, non-profit, independent, and autonomous body promoting biosaline agriculture under the auspices of the Organization of the Islamic Conference (OIC) Ministerial Committee on Scientific and Technological Cooperation (COMSTECH). The network is coordinated by ICBA for promotion of information exchange and technical experiences among OIC members.

INBA objectives

- To establish a mechanism for coordinating research on biosaline agriculture among participating countries and organizations.
- To provide and arrange expertise on different aspects of biosaline agriculture for institutions and countries that need such support.
- To train human resources in the field of biosaline agriculture among Muslim Ummah countries.
- To work with other international institutions and donors to strengthen the work on biosaline agriculture among Muslim countries.

INBA activities in 2004

Preparation of a research scientists database continued in 2004 and is still progress. This will be compiled and published in 2005. The consultancy reports on the successes of biosaline agriculture in some OIC member countries/regions have been finalized and will be published in 2005. The emphasis is on summarizing the economic impacts and recommendations for future work.

Key points

- Networks promote collaboration between individuals and organizations involved in salinity research and development
- The United Arab Emirates provided financial support to the Inter-Islamic Network on Biosaline Agriculture (INBA) realizing its importance in Organization of the Islamic Conference members
- INBA organized a seminar on 'Reuse of Marginal Water in Irrigation', in collaboration with Inter-Islamic Network on Water Resources Development and Management (INWRDAM)
- INBA and ICBA co-sponsored a one-day seminar on 'Biosaline Agriculture: Challenges and opportunities for products from field to markets', with the UAE Ministry of Agriculture & Fisheries

Important news related to INBA and other Inter-Islamic networks was published in the ICBA Newsletter and posted on the ICBA web site.

INBA organized an international workshop on 'Reuse of Marginal Water in Irrigation', 3-6 January 2004, in collaboration with the Inter-Islamic Network on Water Resources Development and Management (INWRDAM). The workshop provided an opportunity to the various scientists from OIC member countries to meet and exchange their research experiences and scientific achievements in order to enhance cooperation. The workshop was attended by a large number of experts and policy makers from Islamic countries, directly involved in marginal water use for irrigation. Twenty-five delegates from twelve countries, including Bangladesh, Egypt, Jordan, Lebanon, Malaysia, Oman, Pakistan, Sudan, Syria, Turkey, Tunisia and UAE attended.

INBA organized an international workshop on 'Reuse of Marginal Water in Irrigation', 3-6 January 2004, in collaboration with the Inter-Islamic Network on Water Resources Development and Management

INBA co-sponsored a one day seminar on ‘Biosaline Agriculture: Challenges and Opportunities for Products from Field to Markets’, on 7 June, at the Dubai Chamber of Commerce and Industry, UAE. The seminar was jointly organized by the International Center for Biosaline Agriculture (ICBA), UAE Ministry of Agriculture and Fisheries, and INBA.

INBA plans 2005

INBA will continue its efforts on:

- Preparation of a dataqbase of research scientists
- Organizing seminars and workshop for INBA members and participants from OIC member countries
- Providing literature access facilities to member countries
- Training courses. INBA has prepared a proposal on 'Apprenticeships for human capacity building in biosaline agriculture in Islamic countries' which has been submitted to COMSTECH and IDB for funding. INBA envisages that COMSTECH will fund four apprentices during 2005 from OIC countries.
- INBA will continue to post important events related to INBA and other networks on the INBA page at http://www.biosaline.org. INBA will also publish news and articles in ICBA’s newsletter.

Global Biosaline Network

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

GBN activities 2004

At the end of 2004 the network had 284 registered members from 55 countries. With funds provided from the OPEC Fund, the network provides members with free access to bibliographic databases Agricola, AGRIS and CABCD.

GBN plans 2005

The future development of the network will be considered during the preparation of ICBA’s next strategic plan.

Training, Workshops and Extension Program

The objectives of the Training, Workshops and Extension Program are to:

- provide specialized courses for scientists and technicians in aspects of managing salinity
- organize seminars and meetings to exchange information on managing salinity
- identify priority areas that need to be addressed locally, regionally and globally

Training, workshops and extension: Training

Duration: Ongoing

Collaborators: International Center for Agricultural Research in the Dry Areas, International Water Management Institute

Resources: ICBA; Bank Keshavarzi, Iran; Northwestern Integrated Community Development Program, Self-Proclaimed Somaliland; Islamic Development Bank; Office of HH President of the United Arab Emirates

Key points

- Workshops on technologies for managing salinity were held in Iran and Central Asia
- Two courses on design of irrigation systems were held for staff of the Ministry of Agriculture and Fisheries, UAE
- Two officers from self-proclaimed Somaliland received an introduction to agronomic practices for saline lands

Activities 2004

Table 11 summarizes ICBA's capacity development activities in 2004.

Workshop on biosaline agriculture in Iran

The Bank Keshavarzi, Iran, funded a workshop on 'Principles and Application of Biosaline Agriculture in Arid and Semi-Arid Regions with Reference to Iran', 14-15 April 2004. The workshop was held in Babolsar, Iran and attended by over 50 participants.

Capacity development in agriculture in saline conditions for Northwestern Integrated Community Development Program (self-proclaimed 'Somaliland')

In March 2004, two Community Development Officers of the Northwestern Integrated Community Development Program (NWICDP) participated in a four-day intensive

Table 11 Capacity building 2004

Capacity building activity	*Title*	*Venue*	*Organized by*	*Dates*	*Participants from*	*Number of participants*	*Funding*
Intensive introduction	Biosaline technologies and agronomic practices	ICBA HQ	ICBA	13-16 March	Self-proclaimed Somaliland	2	Northwestern Integrated Community Development Program (joint program financed by Belgian Survival Fund and IFAD)
Specialized course	Design of irrigation systems	ICBA HQ	ICBA	27-31 March	Ministry of Agriculture and Fisheries,	11	
Workshop	Principles and application of biosaline agriculture in arid and semi-arid regions with reference to Iran	Babolsar, Iran	ICBA	14-15 April	Iran	51	Bank Keshavarzi, Iran
Specialized course	Design of irrigation systems	ICBA HQ	ICBA	17-19 May	Ministry of Agriculture and Fisheries,	11	
Workshop	Biosaline agriculture: principles and applications with reference to the Central Asia and Caucasus region	Tashkent, Uzbekistan	ICBA, ICARDA, IWMI	2-9 September		37	The Office of HH President UAE, Islamic Development Bank

Two Community Development Officers of the Northwestern Integrated Community Development Program at ICBA

Staff from the Ministry of Agriculture and Fisheries, UAE, participating in a course on design of irrigation systems at ICBA

interactive introduction to agronomic practices and crops for successful agricultural production in saline conditions at ICBA. NWICDP provided funds for the training.

Training course in Tashkent, Uzbekistan

With the support of the IDB Governor in Uzbekistan, IDB provided funds for a training course facilitated jointly by ICBA, the International Center for Agricultural Research in the Dry Areas and the International Water Management Institute, in Tashkent in September 2004. Participants from six countries in the region took part.

Specialized courses in irrigation design

Two specialized courses on 'Design of irrigation systems' were held in March and May, attended by a total of 22 staff from the Ministry of Agriculture and Fisheries, UAE.

Scholarships

During the year, the University of Sydney-Orange, Australia, offered two part-fee waiver scholarships a year for MSc students nominated by ICBA.

Plans 2005

West Asia and North Africa region salt-tolerant forage project and Central Asia capacity building

Capacity building is included as a component of the WANA salt-tolerant forage project, and activities will include Central Asian countries.

Participants of the course on 'Biosaline agriculture: principles and applications with reference to Central Asia and the Caucasus'

Niger

A capacity building project is being developed jointly with the NARS of Niger.

Afghanistan and Central Asia

The IDB has approved a concept for capacity building in Afghanistan. The proposal provides for a workshop to build capacity in setting priorities for biosaline agriculture that will lead to development of a proposal for a project for which funding has also been approved.

Training, workshops and extension: Seminars

Duration: Ongoing

Collaborators: International Center for Agricultural Research in the Dry Areas (ICARDA), International Water Management Institute (IWMI)

Resources: ICBA; Inter-Islamic Network on Biosaline Agriculture, Islamic Development Bank, Nakheel, Dubai Islamic Bank, Arab Authority for Agricultural Investment and Development, Ministry of Agriculture and Fisheries UAE, Dubai Chamber of Commerce and Industry

Activities 2004

Seminar 'Biosaline Agriculture: Challenges and Opportunities for Products from Field to Market'

ICBA and the Ministry of Agriculture and Fisheries, UAE organized a seminar 'Biosaline Agriculture: Challenges and Opportunities for Products from Field to Market' in Dubai on 7 June 2004, to promote biosaline agriculture products and encourage investment in biosaline agriculture.

Invited speakers included scientists and the chief executive officers of biosaline enterprises from USA, Australia, The Netherlands, Eritrea, India, Pakistan and the UAE. The seminar was attended by around 200 participants from the UAE Ministry of Finance and Industry, the UAE Ministry of Agriculture, Dubai Chamber of Commerce and Industry, ministers and senior government officials in the agriculture, environment and irrigation sectors in Gulf Cooperation Council countries, representatives of large agricultural investment companies from the GCC region and other countries.

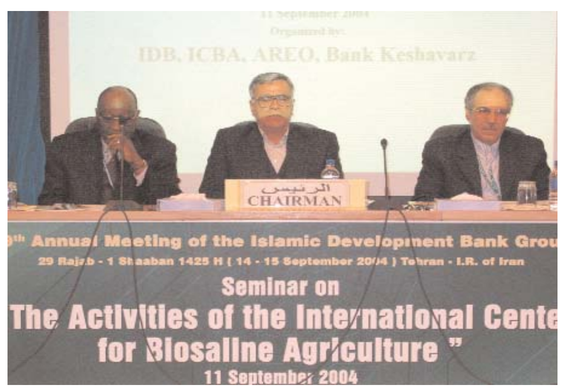
Seminar 'Biosaline Agriculture: Prospects and Potential in Arid Regions, with Reference to Iran'

A seminar on 'Biosaline Agriculture: Prospects and Potential in Arid Regions, with Reference to Iran' was held 11 September 2004, at the IDB annual meeting in Teheran, Iran.

Key points

- A seminar to promote biosaline agriculture products and encourage investment in biosaline agriculture was held in Dubai
- A seminar on the prospects and potential for biosaline agriculture in arid regions was held in Iran

Seminar on 'Biosaline Agriculture: Challenges and Opportunities for Products from Field to Market' at the Dubai Chamber of Commerce and Industries



Seminar at the IDB annual meeting in Teheran, Iran

Plans 2005

Plans for seminars in 2005 will be developed during the year.

Administration and Finance Division

Administration and Finance Services

The Administration and Finance Services effectively carried out its activities and provided support to the Technical Division of the Center. The highlights of the Division's activities are summarised below.

Key points

- The Finance Unit completed tagging the Center's fixed assets
- The first phase of the computer network migration plan was completed

Activities 2004

Insurance

ICBA staff continued to be insured for life and medical throughout the year 2004. ICBA buildings and facilities were also insured throughout the year 2004. The Life and Medical insurance is being provided by ALICO whereas the property insurance is being provided by Norwich Union.

Capital Assets

The Finance Unit has been able to finish tagging the fixed assets of the Center in the year 2004.

Government Relations Office, Abu Dhabi

The Government Relations Office which was opened in Abu Dhabi in July 2002, played an important role in the year 2004 in reaching out to governmental and semi-governmental organizations in Abu Dhabi.

Staffing

Dr. Abdullah Abboudi, who joined ICBA in April 2003 on secondment from the Ministry of Agriculture and Fisheries, United Arab Emirates, completed his assignment in March 2004.

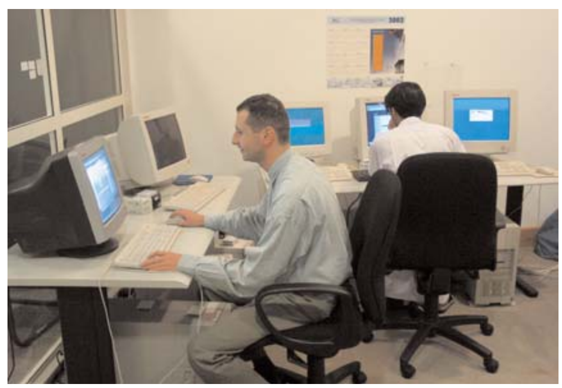
Dr. Shabbir Shahid joined ICBA as Salinity Management Scientist. Dr. Shahid is a Pakistani national.

ICBA bade farewell to Mrs. Mae Cutler, the Librarian. Mrs. Randa Koleilat was recruited in her place.

ICBA also bade farewell to Mrs. Jane Roberts, the Administrative Assistant to the Director, Technical Programs. Mrs. Diane Giessen was recruited to replace Mrs. Roberts.

Information Technology

During the year, ICBA has been constantly upgrading the computer network and maintaining its website. ICBA has completed the first phase of the network migration plan that was started towards the end of the year 2003.



The first phase of the network migration plan was completed

ICBA bade farewell to Librarian, Mrs. Mae Cutler

Resource mobilization

Activities 2004

Thanks to concerted efforts in resource mobilization, sources of funds for ICBA research and development have increased steadily, particularly in the last three years. Funds mobilized reached new highs in 2004.

Highlights for 2004 include approval of funding of four components of the multi-country, multi-donor project 'Saving freshwater resources with salt-tolerant forage production in marginal areas of the West Asia and North Africa region - an opportunity to raise incomes of the rural poor' including two major one-million dollar grants.

Another landmark highlight in resource mobilization during the year was the first financial donation to ICBA's core funds from the host country, the United Arab Emirates. Previously, the UAE has supported ICBA with in-kind support, such as free land, and a waiver of water charges.

Multi-donor, multi-country project funded

During 2004 several components of the multi-donor co-financed project 'Saving freshwater resources with salt-tolerant forage production in marginal areas of the WANA region' received firm commitments for funding, and some of these approved funds were released to ICBA.

The proposal for this project was developed by ICBA in December 2002. In 2003, an initial component of support, committing US$200,000 over three years, for a project to develop salt-tolerant sorghum and pearl millet forages, was funded by the OPEC Fund. This component will benefit the UAE, Oman, India, Iran, Sudan and Yemen.

Late in 2003, the International Fund for Agricultural Development (IFAD) provided a grant of US$21,000 for the design mission for the project.

These initial grants, from the OPEC Fund and IFAD, paved the way for more significant support in 2004.

Key points

- Major donors fund four components of the multi-country, multi-donor project to develop salt-tolerant forages in West Asia and North Africa, including two one million dollar grants
- First financial donation to ICBA's core funds from the host country, the United Arab Emirates

Early in 2004, the Consultative Group on International Agricultural Research (CGIAR) provided ICBA with a grant of US$75,000 through the Competitive Grant Scheme of the Comprehensive Assessment of Water Management in Agriculture. ICBA's proposal was one of the eight projects selected for funding in a global competition. The CGIAR funds from the Governments of The Netherlands and Switzerland were routed to ICBA through the International Water Management Institute (IWMI) in Colombo, Sri Lanka. While US$45,000 of the committed sum was released during 2004, the remaining sum will be released in 2005.

The Arab Fund for Economic and Social Development (AFESD) provided ICBA a grant of US$1,000,000 over a four-year period (2004-2008) to

Sheep are a major component of the farming system in marginal areas of southern Tunisia and developing salt-tolerant forages has the potential to raise farmers' incomes in this region support the implementation of the project in six Arab countries (Jordan, Palestine, Oman, Syria, Tunisia, and the United Arab Emirates). An initial disbursement of approximately US$169,000 was made by the donor in 2004.

IFAD has now signed a grant with ICBA committing US$1,350,000 over a three-year period (December 2004-2007) and this grant is likely to be extended by another year to support implementation of the project in six countries (Jordan, Pakistan, Palestine, Oman, Syria, and Tunisia). These funds will be released to ICBA in 2005.

Finally, the component of the project relating to capacity building in some of the target countries and other countries in Central Asia was approved by the OPEC Fund for International Development. ICBA's proposal requested US$774,000 over three years, and approximately US$400,000 was approved. The agreement was signed by the Director General in Vienna, Austria, at the OPEC Fund headquarters in October 2004.

Thus a total of US$221,000 was committed on the project in 2003, while an additional US$2,825,000 was committed in 2004, adding up to a total donor commitment of over US$3 million. These sums exclude the in-kind contributions to the project committed by the participating national agricultural research systems (NARS) and ICBA.

ICBA recognises that the successful implementation of this project will build the Center's credibility with respect to future funding from key donors and will garner acceptance by seven important NARS.

Core funds from the United Arab Emirates

An unrestricted grant of US$400,000 was provided by The Private Office of HH the President of the UAE in 2004. In addition, The Private Office provided US$50,000 for the Inter-Islamic Network on Biosaline Agriculture.

This grant is a milestone for ICBA as it constitutes the first source of unrestricted core funds from a source other than IDB and achieves a major goal of ICBA's Resource Mobilization Plan.

Participants from six Central Asian countries in the joint ICBA, ICARDA, and IWMI training course in Tashkent, September 2004, funded by the Islamic Development Bank

Resources mobilized for capacity building

Iran The Bank Keshavarzi, Iran, funded a workshop on 'Principles and Application of Biosaline Agriculture in Arid and Semi-Arid Regions with Reference to Iran', 14-15 April 2004. ICBA received US$16,720 as consultancy fees and towards the costs of ICBA staff travel, accommodation and related expenses.

Self-proclaimed 'Somaliland' In March 2004, two Community Development Officers of the Northwestern Integrated Community Development Program (NWICDP) participated in a four-day intensive interactive introduction to agronomic practices and crops for successful agricultural production in saline conditions at ICBA. NWICDP provided US$4,000 for the training.

Central Asia The IDB provided US$30,000 for a joint ICBA, ICARDA, and IWMI training course in Tashkent in September 2004, for participants from six countries in Central Asia.

Niger Two ICBA staff traveled to Niger to develop a capacity building project jointly with the NARS of Niger. A proposal seeking US$150,000 is in the advanced stages of approval in IDB after being cleared by the COMSTECH Secretariat in Pakistan.

Scholarships from an Australian university

During the year, the University of Sydney-Orange offfered two part-fee waiver scholarships for MSc students nominated by ICBA.

New outreach projects in IDB-member countries

Feasibility study in the United Arab Emirates ICBA received US$40,000 from the International Atomic Energy Agency (IAEA) for a consultancy for a feasibility study for biosaline agriculture in the United Arab Emirates.

Halophyte garden in Abu Dhabi, United Arab Emirates In September 2004, the Public Works Department of Abu Dhabi provided ICBA with a grant of US$59,375 to establish a halophyte garden at Qareen Al-Eish, a one-hundred square kilometers private property belonging to HH Sheikh Sultan Bin Zayed Al Nahyan located some 170 kilometers west of Abu Dhabi. The property is being developed and managed by the Public Works Department of the Emirate of Abu Dhabi in collaboration with several public and private institutions.

National Prawn Company, Saudi Arabia In July 2004, ICBA signed a US$155,594 contract with the National Prawn Company in the Kingdom of Saudi Arabia to implement a 2-year project for the production of halophytes utilizing return seawater, seawater, and underground saline water. This is a major activity that links aquaculture with biosaline agriculture and will have considerable relevance to other counties if successful. This is the third time ICBA has received major support from the private sector for ICBA. Previously, ICBA has received contracts from Petroleum Development Oman and BEHAR (Kingdom of Saudi Arabia).

Table 12 Resource mobilization 2004

Donor (cash or in-kind)	*Potential collaborators*	*Project title/Activity*	*Amount*	*Duration*
CGIAR Comprehensive Assessment Competitive Research Grant Scheme (coordinated by IWMI)	NARS: DRC (Egypt), MWRI Egypt, NCARRT Jordan, SMAAR Syria, IRESA Tunisia	Harnessing salty water to enhance sustainable livelihoods of the rural poor in four countries in WANA	US$75,000	2004
IFAD	Oman, Pakistan, Syria, Jordan/Palestine, Tunisia	Saving freshwater resources with salt-tolerant forage production in the WANA region: Design mission	US$21,000	2003-2004
IFAD	Oman, Pakistan, Syria, Jordan/Palestine, Tunisia	Saving freshwater resources with salt-tolerant forage production in the WANA region	US$1,350,000	2004-2007
Arab Fund	Oman, Syria, Jordan/Palestine, Tunisia, UAE	Saving freshwater resources with salt-tolerant forage production in the WANA region	US$1,000,000	2004-2008
NWICDP, Somaliland	IFAD	Somaliland training	US$4,000	2004
National Prawn Company (KSA)		Biosaline Agriculture at NPC Site, Al Laith, KSA	US$155,594	2004-2005
Nakheel		Seminar	US$10,000	2004
Dubai Islamic Bank		Seminar	US$6,793	2004
AAAID		Seminar	US$5,978	2004
Bank Keshavarzi		Training in Iran	US$16,720	2004
Private Office of HH President of UAE	COMSTECH	ICBA core funds and INBA	US$450,000	2004
IAEA	MAF (UAE)	Feasibility study	US$40,000	2004
Abu Dhabi PWD		Qareen Al-Eish	US$59,380	2003-2004
IDB	NARS of Uzbekistan	Training Course for Central Asian NARS in Tashkent	US$30,000	2004
CGIAR Challenge Program on Water	IRRI, NARS of Iran , Bangladesh, and Egypt	Technologies to harness productivity potential of salt-affected areas	US$40,000	2004-2007

Seminar on 'Challenges and Opportunities for Products from Field to Market'

ICBA mobilized financial resources from Nakheel (US$10,000), the Dubai Islamic Bank (US$6,793) and Arab Authority for Agricultural Investment and Development (US$5,978) for the seminar at short notice. In-kind support from the UAE Ministry of Agriculture and Fisheries, and the Dubai Chamber of Commerce and Industry was also received.

CGIAR Challenge Program on Water and Food

As a partner of the CGIAR Challenge Program, ICBA was provided US$40,000 over three years to develop technologies to harness productivity potential of salt-affected areas in Egypt, Bangladesh and Iran.

Concept Notes on Afghanistan and Central Asia

Two of three concept notes submitted to the Islamic Development Bank in January 2003 were approved in May 2004. Both relate to Afghanistan. One proposal will provide US$40,000 while the other will provide a sum of between US$300,000-400,000.

IWMI/ICARDA/ICBA joint project in Central Asia

ICBA staff worked with two CGIAR Centers, ICARDA and IWMI, on a proposal for submission to the Asian Development Bank. The US$700,000 project will be implemented over three years.

Committed Funds

Payments received in 2004 against 2003 contracts
ICBA received US$54,945 from the Abu Dhabi Municipality in the early months of 2004 in payment for consultancy contracts completed in 2003. Similarly, US$18,000 from Petroleum Development Oman, was recovered for contracts completed in 2003. Unfortunately, ICBA has not been able to recover US$22,500 from the private company BEHAR for work completed in 2002.

Plans 2005

ICBA will enhance its efforts to identify new donors and diversify its donor base, especially with regard to its core operations. Over the years, the sources of funds for ICBA have increased from two donors in 2000 to 17 donors in 2004. ICBA hopes to keep up the momentum on this front. Much of this effort will be affected by the final report of the External Program and Management Review and implementation of the Review's recommendations.

In 2005 ICBA will market the Center's core portfolio segmented by donor-supported sectors, taking into consideration the changing external environment and ICBA's new strategic plan 2005-2009.

Geographically, ICBA will gradually increase its activities in Central Asia and Africa, as both regions will attract donor support in the near and medium term.

Considerable importance will be given to adding new co-financiers to the mega-forage project and implementation of the project. A well-implemented and publicized project will attract additional investors. ICBA firmly believes that additional support from IDB is possible by seeking support through various windows in the Bank.

Similarly ICBA is hopeful that the project will put ICBA on the map as a major international non-profit research and development center in the Middle East with regard to institutions such as the World Bank, the United Nations Environmental Programme and the Global Environmental Facility. If such major players see the importance of addressing regional and global issues such as water and salinity jointly with IDB, there will be scope for additional growth and visibility for all institutions involved.

Appendices

Appendix 1

Summary of genebank holdings (December 2004)

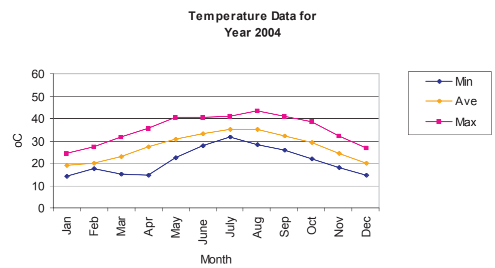
Serial No.	Genus	Family	Number of accessions	Number of species	Nature of Crop
1	*Agropyron*	Poaceae	1	1	Forage
2	*Arachis*	Fabaceae	32	1	Oilseed/forage
3	*Asphodelus*	Liliaceae	2	1	Forage
4	*Astragalus*	Fabaceae	70	23	Forage
5	*Atriplex*	Chenopodiaceae	43	9	Forage
6	*Avena*	Poaceae	2	1	Forage/grain
7	*Beta*	Chenopodiaceae	57	1	Forage
8	*Botrichloa*	Poaceae	1	1	Forage
9	*Brassica*	Brassicaceae	4	1	Forage
10	*Cajanus*	Fabaceae	71	1	Forage
11	*Calligonum*	Polygonaceae	3	2	Forage
12	*Carthamus*	Asteraceae	641	2	Oilseed
13	*Cassia*	Caesalpiniaceae	1	1	Forage
14	*Cenchrus*	Poaceae	872	3	Forage
15	*Centrosema*	Fabaceae	1	1	Forage
16	*Chamaecrista*	Fabaceae	1	1	Forage
17	*Chenopodium*	Chenopodiaceae	121	1	Forage
18	*Chloris*	Poaceae	117	1	Forage
19	*Clitoria*	Fabaceae	1	1	Forage
20	*Coelachyrum*	Poaceae	2	1	Forage
21	*Convolvulus*	Convolvulaceae	1	1	Forage/medicinal
22	*Crotalaria*	Fabaceae	5	1	Forage
23	*Cyperus*	Cyperaceae	2	1	Forage
24	*Dichanthium*	Poaceae	11	1	Forage
25	*Digitaria*	Poaceae	1	1	Forage
26	*Dipterygium*	Capparidaceae	8	1	Forage
27	*Echinochloa*	Poaceae	145	9	Forage
28	*Farsetia*	Brassicaceae	2	1	Forage
29	*Haloxylon*	Chenopodiaceae	1	1	Forage
30	*Hedysarum*	Fabaceae	16	5	Forage
31	*Heliotropium*	Boraginaceae	3	1	Forage
32	*Hordeum*	Poaceae	751	1	Forage/grain
33	*Hymenocarpos*	Fabaceae	2	1	Forage
34	*Indigofera*	Fabaceae	5	2	Forage
35	*Jaubertia*	Rubiaceae	2	1	Forage
36	*Lablab*	Fabaceae	44	1	Forage
37	*Lasiurus*	Poaceae	9	1	Forage
38	*Lathyrus*	Fabaceae	269	3	Forage
39	*Lavandula*	Lamiaceae	1	1	Aromatic/medicinal
40	*Leptochloa*	Poaceae	3	1	Forage
41	*Leucaena*	Mimosaceae	237	1	Forage
42	*Lotus*	Fabaceae	446	21	Forage
43	*Lupinus*	Fabaceae	264	18	Forage

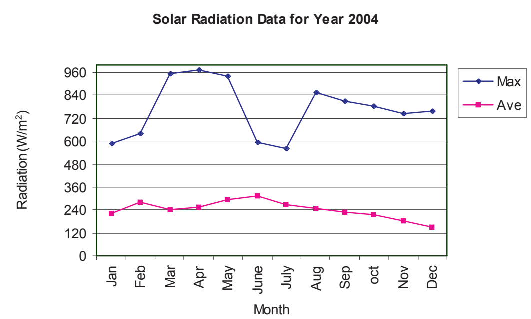
Serial No.	*Genus*	*Family*	*Number of accessions*	*Number of species*	*Nature of Crop*
44	*Lycium*	Solanaceae	1	1	Forage
45	*Macroptilium*	Fabaceae	1	1	Forage
46	*Maireana*	Chenopodiaceae	1	1	Forage
47	*Medicago*	Fabaceae	512	40	Forage
48	*Melilotus*	Fabaceae	481	2	Forage
49	*Moringa*	Moringaceae	1	1	Browse tree
50	*Ochradenus*	Resedaceae	5	2	Forage
51	*Oryzopsis*	Poaceae	1	1	Forage
52	*Panicum*	Poaceae	28	2	Forage
53	*Paspalum*	Poaceae	5	4	Forage
54	*Pennisetum*	Poaceae	251	5	Forage
55	*Phalaris*	Poaceae	1	1	Forage
56	*Prosopis*	Mimosaceae	3	2	Forage
57	*Puccinellia*	Poaceae	1	1	Forage
58	*Rhanterium*	Asteraceae	2	1	Forage
59	*Scorpiurus*	Fabaceae	19	1	Forage
60	*Simmondsia*	Simmondsiaceae	29	1	Oilseed
61	*Sorghum*	Poaceae	691	4	Forage/grain
62	*Sphaerocoma*	Illecebraceae	2	1	Forage
63	*Sporobolus*	Poaceae	77	18	Forage
64	*Stipagrostis*	Poaceae	22	2	Forage
65	*Stylosanthes*	Fabaceae	2	2	Forage
66	*Taverniera*	Fabaceae	1	1	Forage
67	*Tephrosia*	Fabaceae	1	1	Forage
68	*Thinopyrum*	Poaceae	1	1	Forage
69	*Tricholaena*	Poaceae	1	1	Forage
70	*Trifolium*	Fabaceae	156	17	Forage
71	*Trigonella*	Fabaceae	13	1	Forage
72	*Triticum*	Poaceae	205	1	Forage/grain
73	*Urochloa*	Poaceae	1	1	Forage
74	*Vicia*	Fabaceae	56	2	Forage
75	*Vigna*	Fabaceae	408	1	Forage/grain
76	*X Triticosecale*	Poaceae	936	1	Forage/grain
77	*Ziziphus*	Rhamnaceae	3	1	Forage
		Total	**8,189**	**252**	

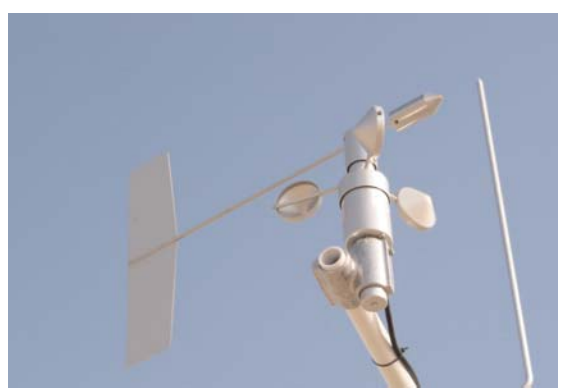
Appendix 2

Summary of weather data, ICBA station 2004

Month	Temperature (oC)				Relative Humidity (%)				Sun	Solar Radiation (W/m^2)				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	14.1	24.2	18.9	19.2	39.0	82.0	64.0	60.5	8.3	0.0	586.0	224.5	275.0	6.0	21.0	14.0	13.5	3.2	3.2	58.4	58.4
Feb	17.5	27.2	20.0	22.4	34.0	79.0	62.5	56.5	8.9	0.0	639.0	282.7	302.0	8.0	30.0	14.0	19.0	8.8	12.0	70.5	128.9
Mar	15.3	31.7	22.8	23.5	20.0	80.0	70.0	50.0	9.5	0.0	957.2	240.1	60.5	8.3	28.8	8.3	18.6	25.7	37.7	156.7	285.6
Apr	14.5	35.4	27.1	25.0	20.0	70.0	60.0	45.0	10.6	0.0	975.0	255.9	54.0	9.4	32.4	9.4	20.9	5.1	42.8	202.7	488.3
May	22.3	40.4	30.7	31.4	10.0	70.0	60.0	40.0	11.2	0.0	941.9	291.0	50.0	10.1	43.9	10.1	27.0	11.9	54.7	262.0	750.3
Jun	28.0	40.4	33.0	34.2	25.0	79.0	55.0	52.0	11.5	0.0	595.0	312.7	55.0	7.0	19.0	16.0	13.0	0.0	54.7	205.0	955.3
Jul	31.7	41.0	35.1	36.4	29.0	70.0	54.0	49.5	11.0	0.0	559.0	265.8	54.0	8.0	21.0	15.0	14.5	0.0	54.7	185.0	1140.3
Aug	28.5	43.3	34.9	35.9	20.0	70.0	60.0	45.0	10.7	0.0	857.4	249.3	52.5	6.1	27.7	6.5	16.9	2.0	56.7	163.4	1303.7
Sep	25.7	40.8	32.4	33.3	20.0	80.0	70.0	50.0	10.2	0.0	812.3	226.3	56.0	5.8	25.9	5.8	15.9	3.0	59.7	169.6	1473.3
Oct	21.8	38.4	29.2	30.1	20.0	90.0	80.0	55.0	9.5	0.0	782.7	216.2	57.5	5.8	24.5	5.8	15.1	2.8	62.5	120.3	1593.6
Nov	17.9	32.3	24.2	25.1	30.0	90.0	80.0	60.0	8.8	0.0	745.0	184.9	60.0	7.2	25.6	7.2	16.4	8.9	71.4	86.4	1680.0
Dec	14.5	26.6	20.2	20.6	40.0	90.0	80.0	65.0	8.3	0.0	760.6	147.2	64.0	7.8	27.7	7.8	17.8	29.2	100.6	98.1	1778.1
Av	21.0	35.1	27.4	28.1	25.6	79.2	66.3	52.4	9.9	0.0	767.6	241.4	95.0	7.5	27.3	10.0	17.4				







Appendix 3

Publications, presentations, reports and meetings

Publications

Taha, F., S. Ismail and A. Jaradat. 2004. *Prospects of saline agriculture in the Arabian Peninsula.* Proceedings of the International Symposium on 'Prospects of Saline Agriculture in the GCC countries', 556 pp. Amherst Scientific Publishers, Amherst, USA

Chouikhi, A., and S. Ismail. (Eds.). 2004. Marine pollution and the impacts of seawater desalination plants on coastal environment. Proceedings of INOC-INBA Workshop, Dubai, United Arab Emirates, 333 pp., Published by INOC-INBA, Turkey

Papers in refereed journals

Jaradat, A.A., M. Shahid and A. Al-Maskri. 2004. Genetic diversity in the Batani Barley Landrace from Oman: I. Spike and seed qualitative and quantitative traits. *Crop Science.* 44:304-316

Jaradat, A.A., M. Shahid and A. Al-Maskri. 2004. Genetic diversity in the Batani Barley Landrace from Oman: II. Response to salinity stress. *Crop Science.* 44:997-1007

Presentations

Hasbini B.A., Y.M. Al Lawati, S.I. Ismail. 2004. Biological treatment of oil process water for use in biosaline agriculture. 14th Stockholm Water Symposium organized by the Stockholm International Water Institute (SIWI), Stockholm, Sweden

Ismail S. 2004. Challenges of biosaline agriculture in the Middle East. In: 1st Plant Nutrition Business Seminar, 29 March-1 April, 2004. Organized by SQM-ADFERT-Hydro, Abu Dhabi, United Arab Emirates

ICBA reports

Waterlogging and Salinity Assessment and Mitigation, Al Shahama. Submitted to Sewerage Projects Committee, Abu Dhabi Municipality.

ICBA publications

Biosalinity News Vol. 5 Nos. 1, 2, 3 English, Arabic

Biosaline Agriculture: Challenges and Opportunities for Products from Field to Market Seminar program and abstracts

ICBA Annual Report 2003 English, Arabic

IICBA Project snapshots

ICBA and the Islamic Republic of Iran

ICBA and IDB-member countries

Meetings

21-22 February, Workshop on Elaboration of the Central Asian Republics Initiative for Land Management (CARILM), Almaty, Kazakhstan. Dr. S. Ismail, Mr. J. Abraham

10-11 March, 100th Anniversary of the International Association of Applied Biologists (AAB), London, UK. Prof. Dr. F.K. Taha

18-19 March, Ocean Desert Enterprises (ODE) to discuss future collaborative projects. Amsterdam, The Netherlands. Dr. M. Al Attar, Prof. Dr. F.K. Taha

24-25 March, IRRI Inception Workshop for the challenge program on water and food (CPWF) Project number 7, Philippines. Dr. J. Stenhouse

4-6 April, National Prawn Company to discuss collaboration, site visits and development of potential projects, Saudi Arabia. Dr. M. Al Attar, Prof. Dr. F.K. Taha, Dr. A. Dakheel, Dr. B. Hasbini, Dr. S. Ismail

13-16 April, Workshop 'Principles and application of biosaline agriculture in arid and semi-arid regions, with reference to Iran', Babolsar, Iran. Dr. M. Al Attar, Prof. Dr. F.K. Taha, Dr. A. Dakheel, Dr. B. Hasbini, Dr. J. Stenhouse

23-27 April, Agricultural Research and Extension Authority (AREA), Yemen. Dr. M. Al Attar, Prof. Dr. F. K. Taha

26 April, Sultan Qaboos University to discuss concept note for project developed jointly by ICBA, Arid Ideas, MAF and SQU, Muscat, Oman. Dr. A. Dakheel

5-8 May, Wageningen Review of the Nimr Fields, Oman. Dr. B. Hasbini

12-15 May, Salinity meeting incorporating brainstorming sessions and field visits, to develop a project proposal for possible funding from GEF, Tashkent, Uzbekistan. Prof. Dr. F. K. Taha, Dr. A. Dakheel

27 June-1 July, Frontis workshop 'Biosaline Agriculture', Wageningen, Netherlands. Prof. Dr. F. K. Taha

20-23 July, Meetings and field visits with Institut National de Recherches Agronomiques du Niger (INRAN) Niger regarding possible collaboration under COMSTECH-funded project, Niger. Dr. S. Ismail, Mr. J. Abraham

30 July-3 August, Visit NPC to develop work plan and site preparation according to project agreement, National Prawn Company, Saudi Arabia. Dr. A. Dakheel, Dr. B. Hasbini

14-20 August, 2004 World Water Week, Stockholm, Sweden. Dr. B. Hasbini

1-12 September, Workshop 'Principles and application of biosaline agriculture in arid and semi-arid regions, with reference to Central Asia and the Caucasus', Tashkent, Uzbekistan. Dr. M. Al Attar, Prof. Dr. F.K. Taha, Dr. A. Dakheel, Dr. B. Hasbini

9-14 September, IDB Annual Meeting, Teheran, Iran. Dr. M. Al Attar, Prof. Dr. F.K. Taha, Mr. I. Bin Taher, Mr. G. Al-Jabri

9-14 October, Meetings with AAAID to finalize ICBA/AAAID forage proposal, Khartoum, Sudan. Prof. Dr. F.K. Taha, Dr. A. Dakheel, Dr. B. Hasbini

25-29 October, CGIAR Annual Meeting, Mexico. Prof. Dr. F.K. Taha, Mr. J. Abraham

Appendix 4

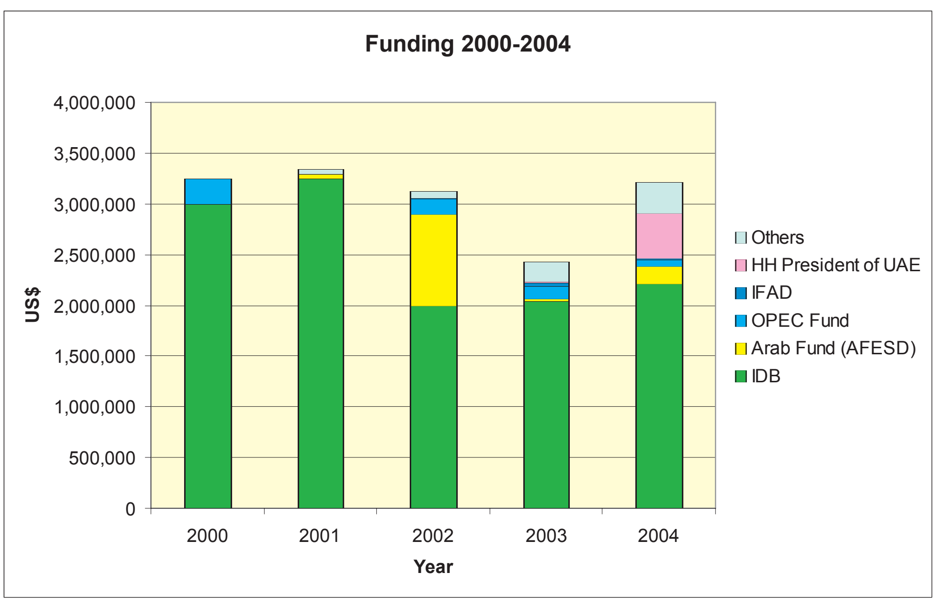
Core staff 31 December 2004

Office of the Director General		
Dr. Mohammad Al-Attar	Kuwait	Chairman of the Board of Directors/Director General
Mr. Ibrahim Bin Taher	UAE	Government Liason Officer
Mr. Jugu Abraham	India	Donor Relations Specialist
Miss Abeer Eliyass	Jordan	Executive Secretary
Mrs. Ayat Abed Rasheed	Jordan	Office Assistant
Mr. Akhtar Ali	India	Driver
Technical Programs		
Prof. Dr. Faisal Taha	USA	Director, Technical Programs
Dr. Abdullah Dakheel	Syria	Field and Forage Crops Scientist
Dr. John Stenhouse	UK	Plant Genetic Resources Specialist
Dr. Shoaib Ismail	Pakistan	Halophyte Agronomist
Dr. Bassam Hasbini	Lebanon	Irrigation Management Scientist
Dr. Sandra Child	Australia	Communications Specialist
Dr. Shabbir Shahid	Pakistan	Salinity Management Scientist
Mrs. Randa Koleilat	Lebanon	Librarian
Mr. Ghazi Abu Rumman	Jordan	Agronomy Laboratory Technician
Dr. Mohammad Shahid	Pakistan	Plant Genetic Laboratory Technician
Mr. Khalil ur Rehman	Pakistan	Halophyte Laboratory Technician
Mr. Basil Al Aaraj	Jordan	Irrigation and Farm Technician
Mr. Wameedh Monther	Iraq	Farm Technician
Mrs. Diane Giessen	South Africa	Administrative Assistant
Mr. Ghazi Al Jabri	Syria	Administrative Assistant-Communications
Mr. Mohammad Shah	Pakistan	Tractor Driver/Farm Laborer
Mr. Saif Ul Islam Gul	Pakistan	Laborer
Mr. Balagurusamy Santhanakrishnan	India	Laborer
Administration and Finance		
Mr. Ghassan Sarris	Canada	Administration and Finance Officer
Mr. Ghassan Al Eid	Lebanon	IT and Computer Supervisor
Mr. Jamal Telmasani	Saudi Arabia	Facilities Supervisor
Mrs. Souhad El Zahed	Lebanon	Administrative Services Supervisor
Mr. Sami Barakey	Palestine	General Accountant
Mr. Bilal al Salem	Jordan	Administrator/Government Relations

Appendix 5

Financial support

Donor contributions 2000-2008 US$					
	2000	*2001*	*2002*	*2003*	*2004*
IDB	3,000,000	3,249,375	1,999,946	2,040,000	2,215,000
Arab Fund (AFESD)		43,874	900,000	20,000	169,000
OPEC Fund	250,000		140,000	130,000	70,000
IAEA			18,612	139	40,000
PDO (Oman)		18,489	31,409	106,000	18,000
Abu Dhabi Municipality			27,734		67,337
BEHAR (KSA)		22,500			
IFAD			9,600	28,700	3,300
USAID/ICARDA				78,350	
Comstech				4,969	
HH President of UAE				20,000	450,000
DFID (UK)				3,000	
NWICDP (Somaliland)					4,000
Bank Keshavarzi (Iran)					16,720
CGIAR--CA (IWMI)					45,000
National Prawn Company (KSA)					31,000
Abu Dhabi PWD Qareen Al Eish					59,380
Nakheel					10,000
Dubai Islamic Bank					6,793
AAAID					5,978
CGIAR--CP (IRRI)					5,000
Total	**3,250,000**	**3,334,238**	**3,127,301**	**2,431,158**	**3,216,508**



Appendix 6

Audited financial statements

Statement of activities year ended 31 December 2004

		2004 US$	2003 US$
Revenues	Grants - unrestricted	2,687,659	2,728,432
	Grants - restricted	41,742	18,727
	Contribution for training courses and research	394,036	232,968
	Contribution from outreach projects	95,670	236,447
	Other income	26,429	24,266
	Total revenues	**3,245,536**	**3,240,840**
Expenses	Salaries	1,134,479	1,135,806
	Benefits	747,694	730,445
	Supplies	98,581	113,973
	Board expenses	23,197	18,987
	Contract services	87,856	113,278
	Travel	89,131	103,022
	Utilities	112,334	114,474
	Maintenance	116,095	110,395
	Water expense for irrigation	-	-
	Depreciation	304,721	312,318
	Expenses related to grants restricted	41,742	18,727
	Expenses against training courses and research	394,036	232,968
	Expenses related to outreach projects	95,670	236,447
	Total expenses	**3,245,536**	**3,240,840**
Excess of revenues over expenses		-	-

Statement of financial position at 31 December 2004

		2004 US$	2003 US$
ASSETS			
Current assets	Bank balances and cash	1,184,881	874,230
	Receivable from donors	46,017	146,047
	Accounts receivable - other	63,773	107,695
	Receivables from staff	47	995
	Prepayments	39,998	37,662
		1,334,716	1,166,629
Non-current assets	Property, plant and equipment	6,669,569	6,955,864
		6,669,569	6,955,864
TOTAL ASSETS		**8,004,285**	**8,122,493**
LIABILITIES AND NET ASSETS			
Current liabilities	Accounts payable	101,335	137,455
	Accrued expenses and other payables	104,997	134,486
		206,332	271,941
Non-current liabilities	Employees' end of service benefits	46,109	36,910
		46,109	36,910
Net assets	Unrestricted - unappropriated	6,669,569	6,955,864
	Unrestricted - appropriated	442,981	460,533
	Temporarily restricted	639,294	397,245
	Total net assets	**7,751,844**	**7,813,642**
TOTAL LIABILITIES AND NET ASSETS		**8,004,285**	**8,122,493**

Appendix 7

Acronyms

AAAID	Arab Authority for Agricultural Investment and Development
ACSAD	Arab Center for the Studies of Arid Zones and Dry Lands
AFESD	Arab Fund for Economic and Social Development
AFDW	ash-free dry weight
AFLP	amplified fragment length polymorphism
APRP	Arabian Peninsula Research Program
BARI	Bangladesh Agricultural Research Institute
BEHAR	Arabian Saline Water Technology Company
CGIAR	Consultative Group on International Agricultural Research
CIMMYT	International Maize and Wheat Improvement Center
COMSTECH	Organization of the Islamic Conference Standing Committee on Scientific and Technological Cooperation
CSIRO	Commonwealth Scientific and Industrial Research Organization, Australia
DfID	Department for International Development, UK
DRC	Desert Research Council, Egypt
EC	Electrical Conductivity
ERWDA	Environmental Research and Wildlife Development Agency, United Arab Emirates
FAO	Food and Agriculture Organization
GBN	Global Biosaline Network
GCC	Gulf Cooperation Council
IAEA	International Atomic Energy Agency
ICARDA	International Center for Agricultural Research in the Dry Areas
ICBA	International Center for Biosaline Agriculture
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDB	Islamic Development Bank
IFAD	International Fund for Agricultural Development
INBA	Inter-Islamic Network on Biosaline Agriculture
INRAN	Institut National de Recherches Agronomiques du Niger
IRRI	International Rice Research Institute
IWMI	International Water Management Institute
MAF, UAE	Ministry of Agriculture and Fisheries, United Arab Emirates
MoU	Memorandum of Understanding
NCARTT	National Center for Agricultural Research and Technology Transfer, Jordan
NIBGE	National Institute for Biotechnology & Genetic Engineering, Pakistan
NSRC	National Salinity Research Council, Pakistan
NWICDP	Northwestern Integrated Community Development Program
OPEC	Organization of Petroleum Exporting Countries
PARC	Pakistan Agricultural Research Council
PDO	Petroleum Development Oman
SPC	Sewerage Projects Committee, Abu Dhabi
UAE	United Arab Emirates
UAEU	United Arab Emirates University
USAID	United States Agency for International Development
WANA	West Asia and North Africa