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BIOSALINITY NEWS

FROM THE EDITOR

THIS current issue of *Biosalinity News* covers ICBA's recent news and activities and provides some scientific articles.

The main news are the departure of the Director General Dr Shawki Barghouti after leading ICBA for the past five years, and the appointment of a Deputy Director General, Dr Ahmed Al Sharif, who will lead the Center during the transitional period until the appointment of a new Director General.

In this issue you will read news about a recently awarded assignment for ICBA to undertake the formulation of a national strategy to improve plant and animal production in the United Arab Emirates; the development of nonconventional fodder production in the Emirate of Abu Dhabi; the inauguration of a new project in Sub-Saharan Africa; and an update on the regional project on climate change.

As well, this issue of the newsletter provides an overview of capacity development implemented recently and ICBA's participation in international and local conferences.

ICBA's scientists have written for our readers articles on stress-tolerant bacteria in the Arabian Peninsula; the benefits of salt-tolerant safflower; the monitoring of water resources for agriculture in the region; and reviewed the efficiency of irrigation systems in the United Arab Emirates.

ICBA welcomes contributions from readers, researchers and experts to publish scientific articles about successful stories on the use of marginal water and saline agriculture that are of interest to readers. Please send your contributions to:

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DIRECTOR GENERAL FINALIZES ASSIGNMENT

Dr Shawki Barghouti left the International Center for Biosaline Agriculture in April 2012 after the past five years as Director General.

On taking up his appointment in April 2007, Dr Barghouti led ICBA's implementation of the second strategic plan 2008-2012, which focuses on *Helping water-scarce countries to improve the productivity, social equity and environmental sustainability of water use through an integrated water resource system approach, with special emphasis on the effective use of marginal quality water.* Dr Barghouti's 35-year experience in international centers and institutions such as the World Bank, ICARDA and ICRISAT enabled the Center to establish significant relationships with a large number of research centers and donors locally, regionally and internationally.

The most important milestone during his leadership was the signing of the agreement between the Government of the United Arab Emirates and the Islamic Development Bank Group (IDB) in April 2010. This agreement provides core financial support to ICBA through equal contributions from the Ministry of Environment and Water (MOEW) and Environment Agency – Abu Dhabi (EAD), in addition to the contribution of the IDB Group. Over the last five years, ICBA's applied research and development programs have benefited from an increase in the contribution of regional and international donors leading to the appointment of more experts to undertake the additional research projects relating to marginal water quality and integrated water resource systems. Wherever possible, ICBA's endeavors include a focus on capacity development.

DR AHMED AL SHARIF TAKES UP DUTIES AS DDG

Dr Al Sharif, an Emirati national, took up the position of Deputy Director General in February 2012. Prior to his appointment, Dr Al Sharif had worked for the United Arab Emirates Ministry of Finance and Industry in a variety of managerial and supervisory positions. During this time Dr Al Sharif played a leading role in the process of establishing a new federal government body, the Emirates Authority for Standardization and Metrology, charged with developing and implementing standard specifications across the United Arab Emirates. The Authority collaborates actively with its equivalent institutions in the Gulf Cooperation Council countries, the Arab world and the International Organization for Standardization.

Building on his undergraduate and graduate education in Kuwait and Egypt respectively, Dr Al Sharif undertook at Bournemouth in the United Kingdom advanced studies in business management which culminated in him being awarded a PhD.

Dr Al Sharif's long experience in the Ministry and academic studies have resulted in an extensive knowledge and understanding of management strategies and principles, such as total quality management and the Six Sigma approach, which will help ICBA ensure the continuation of high standards of service delivery and financial probity.

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BIOSALINITY NEWS

STAFF AND PROJECTS UPDATES

MOEW UNDERSECRETARY VISITS ICBA

H.E. Dr Mariam Al Shenasi, Undersecretary, Ministry of Environment and Waterled a delegation to visit ICBA. The delegation discussed with ICBA Scientists its research and development programs and its interaction with the Ministry. ICBA has undertaken major projects for the Ministry, such as the Water Conservation Strategy in the United Arab Emirates. The Strategy was undertaken in 2010 in response to the United Arab Emirates government's vision for the sustainable development of natural resources and achieving water security. The strategic framework for the sustainable management of the water resources in the UAE was developed based on scientific analysis of the main factors affecting the supply and demand for water in the Emirates.

STAFF UPDATE

Mr Jassim Al Awadi, an Emirati national, joined ICBA in April as the Human Resources Officer. In this capacity, Mr Al Awadi is responsible for ICBA human resource functions such as recruitment, selection and compensation, performance appraisal, and professional development and training.

Mr Al Awadi followed his undergraduate qualifications in accounting and business administration from the United Arab Emirates University with further studies in accounting in the UAE and USA leading to his graduation with the Certified Practising Accountant (CPA) certificate. His studies were followed by an extensive twenty-one year career at Etisalat; some highlights of that period were his involvement in the implementation of integrated service delivery and the development of business centers. Mr Al Awadi's long experience in Etisalat, an UAE-based telecommunications services provider currently operating in 18 countries across Asia, the Middle East and Africa, has equipped him with considerable professional skills in interacting with government institutions and dignitaries in the UAE.

Engineer Hani Jesri joined ICBA in May 2012 in the position of Webmaster. Eng. Jesri holds a degree in electronic engineering from the University of Teshreen in Syria. Before joining ICBA, Eng. Jesri had worked in the public and private sectors in Syria and the United Arab Emirates for more than 18 years. During this time Engineer Jesri developed many databases and networks that are now used in a number of government departments and private companies.

TREATED WASTEWATER TO ICBA

IN February, ICBA added a new source of water, treated wastewater, which is supplied by Dubai Municipality. Treated wastewater will allow ICBA to expand its projects at its research station, particularly in growing forage crops and landscaping plants. These projects will be implemented in collaboration with the UAE Ministry of Environment and Water, Dubai Municipality and other public and private institutions.

IMPROVING AGRICULTURAL PRODUCTIVITY IN SUB-SAHARAN AFRICA

AN integrated farming system strategy is the key to improve the capacity of agricultural land and reduce the poverty of rural communities in Sub-Saharan African (SSA) countries. By combining selective irrigation technologies and improved agronomic management practices, the implementation of an integrated farming system will increase agricultural productivity under local conditions. ICBA is currently leading efforts in SSA countries to benefit farmers by improving the performance of different production systems related to water quantity and quality, soil and crop suitability, appropriate soil, water and nutrient management practices. With funding from the Islamic Development Bank (IDB), the project is being implemented in Burkina Faso, Gambia, Mali, Mauritania, Niger, Nigeria and Senegal. The agricultural research system institutes from each partnering countries will implement the project in their respective countries.

The expected outputs of the project include: (i) a water resources database (documenting past and present conditions); (ii) identification of appropriate irrigation technologies suitable for (SSA) conditions; (iii) selection, demonstration and adaptation of diversified crop production packages; (iv) assessment of social and economic improvements due to the intervention; and (v) strengthening of regional capacity development for research and extension.

These outputs will assist in improving food security by providing a dependable supply of basic agricultural products. The consequent creation of jobs and strengthening of regional capacity will help to alleviate poverty which has resulted in sub-optimal migration to urban areas. The socio-economic impacts of the interventions will also be assessed. An Inception Workshop was organized in Dakar, Senegal, during October 2011 to kick-off the project by developing the specific work plans and budgets for each country in order to commence the four-year project in November 2011. This was followed by a technical meeting in April 2012 to update and finalize the work plans and conduct a workshop on data collection and monitoring for databases on water resources; technologies and water management, farming systems and socioeconomic aspects.

Burkina Faso **Gambia** **Mali** **Mauritania** **Niger** **Nigeria** **Senegal**

ADAPTATION TO CLIMATE CHANGE

THE Steering and Technical Committees meeting of the regional project *Adaptation to climate change in WANA marginal environments through sustainable crop and livestock diversification* was held in Amman, Jordan in February 2012. Members of the two committees discussed achievements of the project over the last 18 months and set the work plan for the current year. The project is jointly funded by the International Fund for Agricultural Development (IFAD), the Arab Fund for Economic and Social Development (AFESD), the Islamic Development Bank (IDB), and the OPEC Fund for International Development (OFID). ICBA has been coordinating the activities of the project since 2010 in collaboration with national agricultural research systems (NARS) in Jordan, UAE, Tunisia, Syria, Oman, Egypt, Palestine and Yemen. Late in 2011, ICBA and the Desert Research Center (DRC) in Egypt organized in Cairo a specialized workshop on socioeconomics, extension and information dissemination for working groups from participating countries. The workshop was followed by a seminar organized by ICBA and DRC to discuss project achievements in Egypt. The seminar was attended by representatives of local ministries, authorities, institutions, civil societies, NGOs and donors working in Egypt.

Members of Steering and Technical Committees visiting Khaldiyah Research Station in Jordan

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PROJECTS UPDATE

FORAGE PRODUCTION IN ABU DHABI

ICBA and the Farmers' Services Centre (FSC), based in Abu Dhabi, are collaborating to improve forage production through alternative forages and more cost-effective and efficient water use in the agricultural farms of the Western Region of Abu Dhabi Emirate. The project team will replace high water-use crops with alternative forages (annual and perennials) and implement different water and irrigation management strategies to optimize water use and crop (forage) productivity. The collaboration includes both scientific and technological support, as well as capacity development on different aspects of forage production and irrigation management.

In 2011, ICBA established three model farms to introduce alternative forage production systems after the use of the water-thirsty Rhodes grass was stopped. Since then some non-conventional, salt-tolerant shrubs, trees and grasses have been planted under high salinity conditions (i.e. water salinity exceeding 15 dS m^{-1}; 11,000 ppm). In addition, a number of annual crops that have dual potential (as crops and as forages) have also been introduced in these model farms. To demonstrate efficient water use in irrigation, selective modern irrigation

The Open Day at Madinat Zayed in the Western Region of Abu Dhabi Emirate was attended by local farmers, FSC extension staff and ICBA scientists

systems (including automatically controlled irrigation systems, flow meters and soil moisture/salinity sensors) designed for these alternative forages have been installed on the farms.

ICBA, in collaboration with the FSC, has arranged an 'Open Day' to demonstrate the technologies used for growing alternative forages with saline water. An earlier capacity development opportunity organized by ICBA was a training course in late 2011 for extension officers in the Western Region to familiarize them with the new crops and management systems.

IMPROVED WATER RESOURCES MANAGEMENT

THE ability to harness cutting edge space–based earth observations and modeling to help solve water issues in the MENA region is the subject of a project being supported by USAID, NASA and the World Bank and implemented at ICBA. A workshop was organized recently in ICBA's headquarters with representatives from USAID, NASA, the World Bank and water experts from Morocco, Tunisia, Lebanon, Egypt and Jordan to formulate work plans for the MAWRED project, which takes its name from the Arabic for 'source'.

ACHIEVING IRRIGATION EFFICIENCIES AND SUSTAINABILITY

ICBA expanded recently its research on existing irrigation water use in the United Arab Emirates in order to recommend to decision makers and planners strategies for sustainable irrigation development in different agro-climatic zones of the UAE. The agriculture sector in the UAE is the main consumer of water (60%), followed by the domestic and industrial (32%) sectors with the remaining 8% being wasted or lost. Groundwater, which has been used extensively for agriculture, has long been over-exploited, resulting in falling well yields and increasing water salinity. These constraints, exacerbated by increasing soil salinity, have resulted in rendering many areas incapable of supporting cultivation of anything other

The agricultural sector in the UAE consumes 60% of available groundwater resources

than a few salt-tolerant crops such as Rhodes grass and dates. Moreover, groundwater is being polluted by nitrates from the excessive use of chemical fertilizers in agricultural farming. In many aquifers, nitrate levels exceed drinking water health guidelines.

The current irrigation practices in the country are based on extensive water use rather than water demand management. This practice, which provides considerable socio-economic support to citizens, has been encouraged by large government subsidies. Its development over the last 20 years has been largely unplanned and has not taken into consideration the suitability of soil and water resources. This study calls for sustainable agricultural development by using (i) marginal water such as saline groundwater and reclaimed municipal wastewater; (ii) salt-tolerant crops (particularly those with a local advantage); and (iii) water saving measures via irrigation water management and application techniques. ICBA researchers collected data on soils, agro-climate, field crops, irrigation practices, groundwater and water quality from three distinct agro-climatic zones of UAE - sub-humid, arid and hyper-arid. The research findings will be evaluated to inform strategic recommendations to undertake sustainable irrigation development tailored for the different agro-climatic zones. At the Dubai research station, ICBA applied its technical expertise to improve irrigation planning and irrigation scheduling through precise assessment of all components of the water balance equation, thus ensuring that the goal of irrigation – to supply the correct amount of water required and no more – is achieved. In the current year, barley was the crop used in the weighing lysimeter to extend findings from ICBA's research program into the crop water use of difference crops/forages and developing crop efficient values.

MAWERD–MODELING AND MONITORING AGRICULTURE AND WATER RESOURCES DEVELOPMENT

HARNESSING LEADING EDGE MODELING AND SPACE SCIENCE DEVELOPMENTS

REGIONAL- and country-scale modeling of groundwater and surface resources is being developed under a partnership between ICBA and NASA's Goddard Space Flight Center. This program harnesses cutting edge space-based earth observations and modeling and represents a new era in hydrological modeling and water resources assessment in the region. Running at the International Center for Biosaline Agriculture in Dubai, the model, named MAWRED (Modeling and Monitoring Agriculture and Water Resources Development; and an Arabic word meaning 'source') is producing not only current observations of water amounts, but is also generating future values under the latest climate change projections.

With agriculture continuing to use the major share of water in most countries, an important component of this program is the linked development of land-use/crop maps that are coupled with water in an irrigation model. This supports an assessment of the impact of existing and future water use in irrigation so facilitating collaborative initiatives in both water and agriculture policy.

Outputs from the modeling will include regional water balances, groundwater and surface water levels, climate change predictions of water availability, and drought monitoring. While at the national scale, data outputs will include ground- and surface-water resources levels, land-use and crop-type information as well as values for irrigation use.

Land Data Assimilation Systems (LDAS)

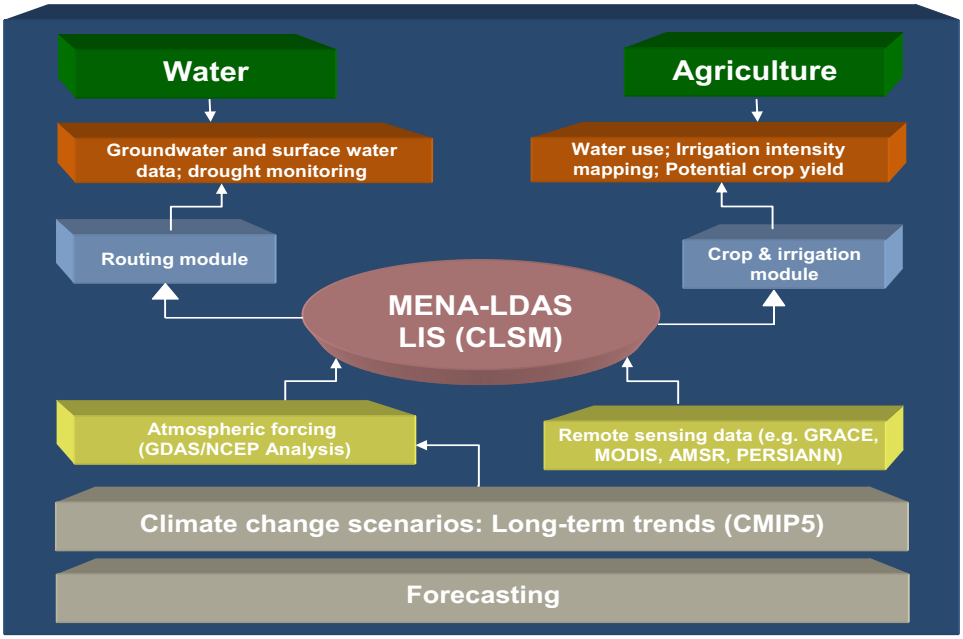
LDAS are computer models that use various mathematical equations to represent natural processes. They differ from traditional models in that sophisticated methods are applied to constrain predictions using observed data - from field measurements or satellite sensors - so increasing their accuracy.

SOUND WATER MANAGEMENT STARTS WITH GOOD DATA PROVISION

GROUNDWATER resources are under increasing pressure in the Middle East and North Africa (MENA) region and declining levels in many aquifers highlight the need for careful future management. Given the growing need for water in many economic sectors, decision-makers need to understand current resource limits and the impacts of future conditions, as they develop policies balancing demands. The provision of timely data is an important input into this process and yet in many MENA countries such information is limited.

DEVELOPING REGIONAL HUB WATER, AGRICULTURE AND CLIMATE CHANGE MODELING

AS well as developing new knowledge, the MAWRD program also focuses on developing communities of practice in this area. The team is working closely with ministries responsible for water and for agriculture as well as with remote sensing centers to bring both new data and modeling knowledge to the specific problems of individual countries. Researchers and policy developers are able to spend time at the ICBA modeling center to develop their capacity and to focus on modeling particular areas of relevance.



SAFFLOWER: A SALT-TOLERANT OIL CROP FOR THE ARID ENVIRONMENTS

A MEMBER of the thistle family (Compositae/ Asteraceae), Safflower (*Carthamus tinctorius* L.) is a multi-purpose salt-tolerant crop grown in various parts of the world. Its origin is believed to be in the Levant where it was domesticated more than 4,000 years ago. Safflower is an annual herbaceous bush with many branches that terminate in the *capitulum* (the flower head), which is surrounded by stiff bracts. Its composite flower head includes 20-180 florets and has different colors (white, yellow or orange). Following germination, the seedling produces a circular arrangement of leaves called a rosette. After one month approximately the central main stem emerges. The stem may grow to maximum length (30-150 cm) at the time of flowering. Both stems and branches have leaves which generally possess numerous hard spines that deter animals such as goats, sheep and camels to graze on plants. Safflower produces white seed which is four sided and has a thick and smooth hull (pericarp). The average seed length is 6-7 mm and the average seed weight is 40 mg. The plant has a long taproot system that can grow to 2-4 m deep in the soil.

Safflower grows well in relatively deep and well drained soils. Sandy loam soil with good water holding capacity is considered to be best for the crop. At germination, the optimum temperature is 15.5°C, while at flowering time 24-32°C will give the higher seed yield. The seed rate is 10-25 kg ha^{-1} with 45-60 cm of row spacing. In arid lands the seed yield is about 500 kg ha^{-1} while in irrigated areas it may produce more than 1000 kg ha^{-1}, but with improved agronomic practices the yield can be doubled. Mexico is the biggest producer of safflower seed followed by India which has the largest area under safflower cultivation. The United States of America, Kazakhstan, Ethiopia and China are other important safflower-growing countries.

Safflower seed can contain 24-36% good quality oil

Safflower is a highly branched plant

Safflower is a drought-tolerant crop which fares reasonably well in dry or semi-arid regions providing moisture at sowing time. The Safflower plant has a strong, deep and extensive root system which can penetrate hard subsoil creating conduits which ultimately make water and air movement into the soil possible. Due to its profound root system the plant can survive long drought spells by extracting deep subsoil water at the depth of 4 m.

Among different environmental strains, salinity is a serious threat to various crops. Both soil and water salinity, particularly in arid and semi-arid areas, can reduce crop production significantly. Safflower is considered to be a moderate to high salt-tolerant crop that makes it better than wheat and equal to barley for planting in saline soils and therefore its cultivation on salt-affected land can prove beneficial to farmers. It is tolerant of sodium with its salinity threshold value being 6.4 dS m-1 for the seed yield. Salinity at medium level does not seem to affect its seed yield and oil quality, though it impairs the seed germination. However, the crop can also help in hampering the spread of salinity in arid areas. Safflower has a deep root system and long-growing period which help in lowering the brine water tables from recharge areas to hinder the expansion of salinity as well as water-logging in affected areas.

In areas where birds, rodents and other animals are a problem to various crops, safflower which is relatively secure due to its spiny nature can be grown successfully with modest maintenance. Safflower planting in between different cereal crops breaks the lifecycle of diseases like crown and root rot as it is not a carrier of these plant infections. Safflower planting in cereal cropping system is also less laborious as it does not need further land tilling. Being a late-sowing crop, it can replace the crops that fail for a variety of reasons.

Safflower seed contains 24-36% oil, which does not have flavor and color and is nutritionally closer to sunflower oil. It has two types of oil based on different fatty acids composition: polyunsaturated and monosaturated produced by different safflower genotypes. The polyunsaturated oil contains about 80% linoleic acid and 15% oleic acid making it suitable for soft margarine production and salad oil. Since this class of oil polymerizes on

heating, it is less appropriate for cooking especially frying. Polyunsaturated oil is also used in the production of cosmetics, paints, varnish, drugs, lubricants and biodiesel. The monounsaturated type of safflower oil possesses around 80% of oleic acid and 15% linoleic acid which makes it comparable to olive oil. This kind of oil is excellent for frying. Various scientific studies have revealed that the daily use of safflower oil leads to a decrease in body fat and increase in muscle weight. Monounsaturated oil also helps to improve blood sugar, inflammation and good cholesterol (HDL). After the extraction of oils from seed the leftover meal which contains 20-45% protein is used to feed poultry and livestock. In addition to oil production, safflower seed is used as birdseed and to feed some domestic and wild animals.

It is not only the seed oil which is beneficial; its flowers (petals) can also be used for different purposes. The safflower petals are being used as an inexpensive alternate for saffron as it has almost the same color and flavor. Since synthetic colors and dyes are thought to be hazardous for health, some of them can be replaced with brilliant safflower petals, which in the past had been used to dye fabrics and other stuff. Apart from coloring, the petals are considered to have some medicinal properties to cure high blood pressure, rheumatism, arthritis, infertility and some other ailments.

Safflower produces gorgeous flowers of various colors that give it high ornamental value. Though most safflower growing countries cultivate safflower for its oil, it has huge scope to be used for fresh-cut and dried flowers. In Europe, where safflower is grown mainly for ornamental purposes, cut-flowers worth millions of dollars are sold every year. It is possible to introduce it as an ornamental in other parts of the world where it is grown mainly as an oilseed crop. Some work in China, India, Iran and the USA has been done to select the spineless cultivars, which is necessary for successful floriculture. However, more breeding effort is required to evolve improved spineless safflower varieties.

Safflower planting at ICBA


One flower might produce about 20 seeds


Spineless safflower varieties are ideal for cut-flowers


The orange color safflower petals are used to make cheap alternate for saffron

Safflower also has great potential as a fodder crop. The spineless cultivars can be used as forage to feed farm animals at any phase, while spiny safflower accessions are used at the early stage when plant lack spikes. Green safflower plant is used to make high quality silage to feed livestock. The use of safflower as fodder seems to improve the fertility rate in ewes considerably. One hectare of safflower can produce about 22 tons of dry matter with good digestibility.

The International Center for Biosaline Agriculture (ICBA) has a collection of 640 genotypes of safflower that belong to more than 20 different countries around the world. Thorough research on more than 630 safflower accessions was carried out in 2000-01 and 20 different physiological, morphological and yield related characteristics of the genotypes were studied to identify oil, forage and ornamental types (Jaradat and Shahid, 2006*). In addition, the genotypes were investigated to identify their tolerance against salinity. The evaluation of the germplasm set showed the presence of vast diversity, particularly within the safflower accessions from the Middle East, which is considered to be the center of origin for the crop. The accessions with better yield and other desirable characteristics can be introduced as a multi-use crop into various farming systems with salinity problems. Furthermore, the safflower breeders can utilize the variation within the collection to evolve cultivars of desired traits under different growing environments, especially in different countries of the Arabian Gulf. ICBA is also providing safflower seed to different agricultural scientists working in the UAE and overseas. Till now more than 450 seed samples have been distributed to various research centers around the world to facilitate safflower study, especially in relation to its salt tolerance.

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ISOLATION OF STRESS-TOLERANT RHIZOBIA FROM THE UAE SOILS

By fixing atmospheric nitrogen into ammonia, legumes provide an easy and inexpensive way to enhance soil fertility and agricultural productivity

LEGUMINOUS plants through their symbiotic relationship with certain gram-negative soil bacteria, collectively known as rhizobia, help to fix atmospheric nitrogen. The bacteria form nodules on the roots or rarely on the stem of the legume hosts and by fixing atmospheric nitrogen into ammonia; they provide an easy and inexpensive way to enhance soil fertility and agricultural productivity. Several environmental factors, in addition to limiting the growth and productivity of N2-fixing plants, affect the rhizobium-legume symbiotic relationship. These include soil salinity and pH, nutrient deficiency, heavy metal toxicity, and temperature and soil moisture extremes. While nitrogen-fixing legumes tolerant of such stresses present an important alternative to improve productivity, the free-living rhizobia with genetic potential for stress tolerance are equally important for effective nodulation and enhanced productivity under extreme agroclimatic conditions.

As with higher plants, the most problematic environments for the survival and persistence of the microorganisms including the rhizobia are marginal lands with low rainfall, extremes of temperature, saline and acidic soils of low nutrient status and poor water-holding capacity typical of the desert regions such as the Arabian Peninsula. Rhizobial populations are known to vary in their tolerance to major environmental stresses and the free-living rhizobia nodulating the leguminous hosts are expected to be tolerant to the adverse conditions prevailing in the region.

The International Centre for Biosaline Agriculture (ICBA), in association with the Birla Institute of Technology and Science (BITS) Pilani-Dubai, has recently undertaken a study to examine the characteristics of the naturally occurring rhizobia associated with the cowpea plants in fields irrigated with saline water at ICBA research station in Al Ruwayyah, Dubai. The rhizobia, isolated from the root nodules, were purified and characterized by means of colony morphology and sequencing of the PCR amplified 16S rDNA. A

sequence homology search carried out with BLAST (Basic Local Alignment Search Tool) maintained by the National Library of Medicine (NLM), USA, identified the rhizobial isolates as *Sinorhizobium kostiense* (Syn. *Ensifer kostiensis*) and *S. terangae* (Syn. *E. terangae*). Both the isolates, together with the standard cowpea strain (*Bradyrhizobium* sp. Strain TAL-169) were tested for growth performance or tolerance to a wide range of stresses including temperature (20-50°C), salinity (0-100 dS m^{-1}) and heavy metals (Cu, Ca, Mg, Zn, Fe) by inoculating on Yeast Extract Mannitol Agar (YEMA) plates and in YEM broth (without agar, in Erlenmeyer flasks) cultures. Growth was assessed by measuring the colony diameter after incubation at 28°C for 4 days in YEMA plates and measuring the optical density (OD) at 600nm after incubation for 48 hr in broth cultures. Marked differences were found among the three species in terms of tolerance to different stresses both *S. terangae* and *S. kostiense* showing substantial tolerance to salinity, high temperatures and heavy metals, compared to the standard strain TAL-169. Thus, while growth was inhibited at 10 dS m^{-1} in TAL 169, *S. terangae* and *S. kostiense* tolerated up to 100 dS m-1 salinity in YEM medium (equivalent of approx. 1000 mM NaCl). Similarly, for temperature, while TAL-169 was unable to grow at 40°C, *S. kostiense* and *S. terange* showed tolerance up to 40 and 50°C, respectively. For heavy metals, while TAL 169 did not grow in any of the cultures at the concentrations tested (i.e. 50 µg/ml for Zn and Mg and 100 µg/ml for Cu, Ca and Fe) and *S. terangae* was highly sensitive to Cu, *S. kostiense* tolerated all the metals.

A study of the ability of the different strains to nodulate cowpea seedlings grown in pots and irrigated with saline water showed that TAL-169 failed to form any root nodules when the water salinity was above 6 dS m^{-1}, whereas *S. kostiense* and *S. terangae* were effective in forming nodules even at 12 dS m^{-1} salinity. Between the two strains, *S. kestiense* was more efficient as the 5-weeks old seedlings had a mean number of 26.2 nodules per plant compared to 9.0 nodules per plant with *S. terangae.*

Although *Sinorhizobium terangae* and *S. kostiense* were previously isolated from the root nodules of leguminous trees in Senegal, Sudan and Kenya, this is the first report of their occurrence in the Arabian Peninsula. It is also significant that *S. kostiense* isolated from the UAE has considerably higher tolerance to the environmental stresses compared to the strains from Sudan, which tolerated only 1% NaCl (i.e., 170 mM) and a maximum growth temperature of 38-40°C, and were also sensitive to heavy metals. Since the cowpea seed used for planting was not inoculated with rhizobia and there was no recent history of cultivation of other leguminous crops in the same field, it is obvious that the rhizobia are naturally occurring native strains, able to survive and persist under extreme environments. The tolerance to environmental stresses, especially high salinity and temperature, make these rhizobia highly valuable inoculums to improve the productivity of the leguminous crops cultivated in marginal and salt-affected soils.

Development of colony in the Yeast Extract Mannitol Agar media

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BIOSALINE AGRICULTURE TECHNOLOGIES FOR AFRICA

ICBA organized, in late 2011, at its headquarters in Dubai a training course on *Biosaline Agriculture Technologies and its Role in the Mitigation of Climate Change in Africa*. The course was attended by 22 participants from 12 African countries: Eritrea, Kenya, Liberia, Mauritius, Mozambique, Namibia, Nigeria, Seychelles, Swaziland, Tanzania, Uganda and Zambia.

This two-week course was the third in a series of capacity development programs for African countries organized by ICBA since 2007. These programs are funded by the Arab Bank for Economic Development in Africa (BADEA) which provides financial and technical support for the non-Arab African countries, including capacity development.

Participants, MOEW representative and ICBA staff at the training workshop

His Excellency Engineer Sultan Alwan, Assistant Undersecretary for External Audit, Ministry of Environment and Water, attended the opening ceremony and Engineer Abdul Majid Al-Burawi, BADEA, attended the closing ceremony.

During the training program, the participants visited Sharjah Plants and Natural History Museum, Dibba Research Station of the Ministry of Environment and Water and the Date Palm Tissue Culture Laboratory of the United Arab Emirates University in Al Ain.

WASTEWATER TECHNIQUES IN THE ARAB WORLD

IN collaboration with the Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD), ICBA organized in Amman, Jordan, a training course on *Techniques for the use of treated wastewater in agricultural production and its role in food security in the Arab world*. The course was hosted by the National Center for Agricultural Research and Extension (NCARE) in Jordan.


Participants of the training course in Amman, Jordan

Thirty-one participants from 14 Arab countries: Jordan, UAE, Bahrain, Tunisia, Algeria, Syria, Iraq, Oman, Palestine, Kuwait, Lebanon, Egypt, Morocco and Yemen attended the course. The course was conducted as part of the activities of the project on *The safe use of treated wastewater in agriculture in the Arab world*, which is being implemented by ICBA in collaboration with ACSAD and the national agricultural research systems (NARS) in Jordan, Tunisia and Oman. This project represents one theme of the regional project on *Adaptation to climate change in WANA marginal environments through sustainable crop and livestock diversification* which is implemented by ICBA in collaboration with NARS in Jordan, UAE, Tunisia, Syria, Oman, Egypt, Palestine and Yemen. This regional collaboration is funded by the International Fund for Agricultural Development (IFAD), the Arab Fund for Economic and Social Development (AFESD), the Islamic Development Bank Group (IDB), and the OPEC Fund for International Development (OFID).

IDB SEMINAR IN SUDAN

ALONGSIDE the 37th annual meeting of the Islamic Development Bank Group (IDB) held in Khartoum, Sudan, ICBA organized on the 1st April 2012 a seminar on *Applications of biosaline agriculture technologies and marginal quality water in IDB member countries.*

The seminar was chaired by His Excellency Mohammad Jamal Al-Saati, Director, Operations Policy and Services Department, IDB and member of ICBA's Board of Directors.

Experts in the field of biosaline agriculture, water resources and environment from local ministries and institutions in Sudan in addition to representatives of regional organizations operating in Sudan and some of IDB officials came together to share their expertise. His Excellency Dr Mohammed Hassan Goubarah, Undersecretary of the Ministry of Agriculture and Forestry in Sudan, and His Excellency Birama Sidibe, Vice President for Operation, IDB, attended the seminar. A representative of the University of Khartoum gave a presentation on *Saline agriculture in Sudan* and two members of the Arab Organization for Agricultural Development discussed *The utilization of treated wastewater to produce biofuel in the Arab region*. Dr Abdullah Dakheel from ICBA shed light on *The role of ICBA in developing the utilization of biosaline agriculture technologies in IDB-member countries.*

The ICBA delegation to Sudan also participated in the associated exhibition and attended the other seminars organized by IDB. As well they met with officials of the Ministry of Agriculture and Forestry and other organizations to discuss potential collaboration.

SIXTH WORLD WATER FORUM IN FRANCE

THE ICBA-led delegation comprising experts from the United States, Mexico, India, Palestine, Morocco and the United Kingdom as well as representatives of international research centers including the International Institute for Water Management (IWMI) and the Food and Agriculture Organization of the United Nations (FAO) participated in the 6th World Water Forum which was held in Marseille, France from 12th to 17th March 2012. The delegation's well-attended session on the *Use of non-conventional water of lower quality for agriculture and aquaculture* outlined international solutions to the challenges related to the use of saline water and treated wastewater for food production. Over 35,000 people from 173 countries attended the Forum to discuss and debate solutions for water and sanitation which were carried forward by the World Water Council to Rio de Janeiro (Brazil) for the United Nations Conference on Sustainable Development Rio+20 from June 20th to 22nd 2012.

BIOSALINITY NEWS

KNOWLEDGE SHARING

WATER AND FOOD SAFETY

WITH the theme for this year's international World Water Day being Water and Food Safety, Dubai Municipality organized a series of public awareness seminars to draw attention to the issues. Dr Khalil Ammar, ICBA's water resources management scientist, discussed on 18 April the role of ICBA in conserving water resources in the United Arab Emirates in particular and the region in general through an integrated water resource management (IWRM) approach.

With this approach, the water gap between supply and demand could be bridged through demand management, instead of the current approach which relies mainly on increasing. Dr Ammar outlined the *UAE's Water Conservation Strategy* which was developed by the Ministry of Environment and Water in collaboration with ICBA in 2010. He explained that if the UAE were able to rationalize the per capita water consumption to be within the international levels of 200 liter per capita per day rather than the current consumption of 370 liters per capita per day, then the country would be able to delay by up to 14 years the expensive investment needed for desalinated water, the main water resource in the UAE.

Dr Ammar outlined also the use of innovative technologies such as sensor technology and sub-drip irrigation that can reduce water use in agriculture and emphasized the important role of marginal water, particularly brackish/saline water, in supplementing freshwater and reducing the demand for limited groundwater resources.

AL AIN SECOND AGRICULTURE SYMPOSIUM AND EXHIBITION

ICBA participated in the Al-Ain 2nd agriculture symposium and exhibition which was organized by the Abu Dhabi Food Control Authority from 22 to 25 February 2012 in Al-Ain, United Arab Emirates. Dr Khalil Ammar, ICBA's water resources management scientist, explained to symposium delegates *The role of ICBA in utilising saline water in agricultural production.*

The exhibition was visited by officials and experts in the areas of water, agriculture and environment, and many members of the general public, as well as school and university students.

Mr Ibrahim bin Taher, ICBA s PR Manager, explaining the role of the Center to young students

WETEX 2012

ICBA participated in the *Water, Energy, Technology and Environment Exhibition (WETEX) 2012*, which was organized by the Dubai Electricity and Water Authority in collaboration with the Government of Dubai and the Supreme Council of Energy.

A large number of government agencies and private sector companies from more than 100 countries around the world participated in this annual important exhibition held from 13th to 15th March 2012 in Dubai, United Arab Emirates.