International Center for Biosaline Agriculture

ICBA Annual Report 2015

Innovation—Impact—Partnership

نـزرع للغـد
ICBA
AGRICULTURE FOR TOMORROW

ICBA Key Facts

- ICBA is an international, non-profit agricultural applied research-for-development center
- Established in 1999, the Center works towards food, nutrition and water security in marginal environments
- It works within five thematic areas:
  - assessment of natural resources and management
  - climate change impacts and management
  - crop productivity and diversification
  - policies for resilience
  - aquaculture and bioenergy

Contents

Acronyms and Abbreviations

ADFSC	Abu Dhabi Farmers' Services Centre
AFESD	Arab Fund for Economic and Social Development
BADEA	Arab Bank for Economic Development in Africa
CAP	Coordinated Agricultural Project
CIMMYT	International Maize and Wheat Improvement Center
CODRA	Creating Opportunities to Develop Resilient Agriculture
CORDEX	Coordinated Regional Downscaling Experiment
CPET	Collaborative Program Euphrates and Tigris
EAD	Environment Agency – Abu Dhabi
FAO	Food and Agriculture Organization of the United Nations
GCC	Gulf Cooperation Council
GCM	General Circulation Model
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
IFPRI	International Food Policy Research Institute
IWMI	International Water Management Institute
KIA	Kuwait Investment Authority
MAWRED	Modeling and Monitoring Agriculture and Water Resources for Development
MENA	Middle East and North Africa
MoCCaE	Ministry of Climate Change and Environment [formerly Ministry of Environment and Water]
NARS	National Agricultural Research System
OCP	Office Chérifien des Phosphates
OPEC	Organization of the Petroleum Exporting Countries
SAA	Seychelles Agricultural Agency
SDG	Sustainable Development Goal
Sida	Swedish International Development Cooperation Agency
SSA	Sub-Saharan Africa
UAE	United Arab Emirates
USAID	United States Agency for International Development
WANA	West Asia and North Africa

Foreword

The International Center for Biosaline Agriculture in Dubai has made remarkable achievements in growing crops that are more tolerant of salty conditions, while being environmentally and economically sound. Farms are being revitalized to be as productive as possible and to grow vegetables.

With the growing global demand for water and food, in addition to the challenge of climate change impact, the UAE has been pioneering in testing alternative production systems and how to substitute conventional systems that use a lot of high-quality water. We know agriculture is the largest consumer of freshwater and the systems being installed by ICBA use up to a quarter less water than traditional methods. We are investing in the future of agriculture in the UAE by using less water and getting productive yield.

The ICBA's Annual Report for 2015 provides an overview of the year's work and achievements in research and development. Additionally, it offers recommendations and plans for the agriculture industry to help us achieve better outcomes for our environment and community, and maximize economic opportunities.

The recent establishment of the newly named Ministry of Climate Change and Environment is an important milestone. It clearly articulates the UAE's efforts in addressing the issue of climate change, through the implementation of comprehensive policies and initiatives to help preserve our unique environmental systems.

With the Ministry's redefined mandate, we are keen to play a leading role in the global efforts of combating climate change, and contributing to the implementation of strategies worldwide.

Climate change is already impacting our communities and environment, and is one of the most critical issues facing the region. Since the formation of the UAE, our leadership has been addressing sustainability at home and abroad. For more than a decade, the government has remained committed to renewable energy, research and development, infrastructure modernization and to working with the world to address the impact of climate change.

We are seizing this moment in history to protect our precious environment, while simultaneously creating new economic and social opportunities at home. And, this long standing international position and engagement in the development of strategies for dealing with climate change and environment will only strengthen over time.

The impact of climate change is not limited to weather alone. The domains of agriculture, aquaculture and food security are equally affected.

In terms of agriculture, the UAE's close proximity to the equator contributes to the paucity of fresh water resources. Access to potable water is therefore a long-term challenge, as climate variations further stresses fragile water resources. However, the UAE is establishing a strategic federal framework for the sustainable management of all water resources in the country that includes waste water recycling and ground water conservation. We are also investing in more efficient forms of desalination, including the use of renewable energy to power new, cutting-edge facilities.

Climate change affects ocean's temperatures, chemistry, food chains, currents and wind pattern, and this will subsequently change breeding cycles, abundance, and migrations of marine plants and animals. Aquaculture – industrial fish or shellfish farming – one of the world's fastest expanding food sectors with a current growth rate of about six percent a year, is also critically affected by the global phenomenon of climate change. Aquaculture appears to have the potential to make a significant contribution to meet this increasing demand for seafood in the UAE and the region, and therefore contributing to the overall food security.

Typically, the main components of food security are measured in terms of food availability, access and utilization or adequacy. The UAE's new methods of water resource management, by domino effect, will play a major role in local food production, which contributes to food security.

According to a recent study, the UAE imports more than 90 percent of its food supply. With rapid population growth, of both expats and nationals, food imports are expected to more than double by 2030. This increase in demand requires us to find solutions in order to secure sustainable and reliable sources of food through initiatives such as the National Biodiversity Strategy and the UAE Sustainable Fisheries Programme.

Dr. Thani Ahmed Al Zeyoudi,
Minister of Climate Change and Environment of the United Arab Emirates

From left to right: Prof. Abdulrahman Alsharahan, H.E. Dr. Thani Ahmed Al Zeyoudi, Dr. Ismahane Elouafi

ICBA had quite a rich year. The year 2015 saw the Center grow further, continue to share improved technologies and varieties with a wide range of stakeholders, and communicate more research results on innovations for marginal environments.

Focused on the five research and four enabling innovations set out in the Strategy 2013-2023, ICBA continued to contribute to improved food, nutrition and water security for some of the most vulnerable populations around the world.

One of the most important international events last year was the adoption of a new set of goals - Sustainable Development Goals (SDGs) – in lieu of the Millennium Development Goals to end poverty, protect the planet, and ensure prosperity for all. To reflect this, we mapped our research portfolio and aligned it with seven relevant SDGs. Our Center is committed to contributing to the achievement of the Sustainable Development Agenda 2030 by focusing on helping people living out of marginal environments.

During the year, we launched several new initiatives, including a project with the Qatar National Research Fund to study the feasibility of nano-filtration for desalinization of seawater to irrigate vegetable crops in greenhouses. Another project with the Arabian Gulf University is focused on mapping soil salinity in Bahrain and the United Arab Emirates (UAE), while a project in Central Asia looks at the use of non-conventional water resources to strengthen water and food security in trans-boundary watersheds of the Amu Darya River basin.

Our scientists also continued studies on quinoa in different locations in the Middle East and North Africa and Central Asia. We joined forces with the Food and Agriculture Organization (FAO) to initiate a global program on collaborative research and extension on quinoa in drylands. The purpose is to test an inclusive agribusiness model with quinoa to create more opportunities for smallholder farmers and agribusinesses.

As policy support is an integral part of our work, ICBA led an international consortium to develop the Investment Strategy for Food Security in Kuwait, which serves as a road map for investing in key commodities for Kuwait, both under normal and crisis situations for 20 years.

In 2015, our Center also saw an increase in the number and quality of research output. Our scientists published 68 articles, including 25 in international peer-reviewed journals, two of which were published in *Nature Communications* (impact factor = 11.47) and *Bulletin of the American Meteorological Society* (impact factor = 11.5).

All this work was possible thanks to support from many financial contributors and scientific partners. We would like to thank all of them for continuing to make this happen.

Prof. Abdulrahman Alsharhan
Chair, Board of Directors

Dr. Ismahane Elouafi
Director General

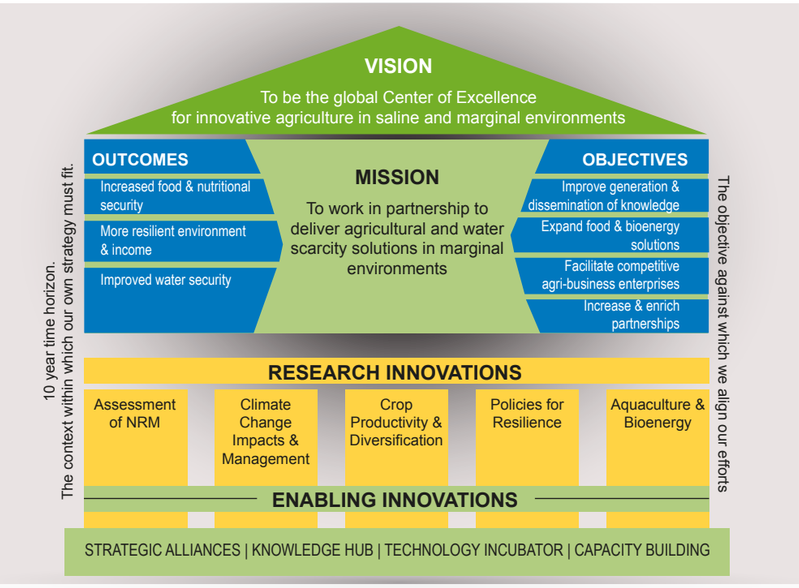
Mid-Range Business Plan Review

ICBA developed a new strategy in 2013 that expanded its vision and mission from focusing solely on problems of salinity to addressing the closely linked challenges of income, water, nutrition, and food security in all marginal environments[1].

In 2015, ICBA conducted a Mid-Range Review of its Business Plan 2013-2016 to evaluate the progress so far, establish a baseline for monitoring and evaluation processes, and inform the preparation of the 2017-2019 Business Plan.

Some of the achievements during the review period are:

- Successful engagement with partners helped to raise USD 19,289,239 in non-core funding for research and development in marginal environments;
- Strategic partnerships with 15 new governmental and non-governmental organizations, universities, and international research institutions and donor organizations;
- Preparation of water, salinity and food strategies for various GCC countries to inform policy- and decision-making based on scientific evidence;
- An increase in the number of publications in high-impact factor peer-reviewed journals;
- A total of 574 (441 men and 133 women) participants benefitted from advanced technical capacity-building programs in different countries;
- An increase in the number of female scientists, making up 27 percent of all scientists.



ICBA Strategic Framework

1. Marginal environments are defined in the ICBA Strategy 2013-2023 as biophysical marginality such as lack of water, poor soils, or salinity, and socio-economic marginality including gender, poor markets, and inefficient property rights systems.

Way Ahead: 2030 UN Sustainable Development Agenda and ICBA

On September 25, 2015, UN member nations adopted the 2030 Agenda for Sustainable Development at the United Nations Sustainable Development Summit. The Agenda is a plan of action for people, planet and prosperity.

It includes a new set of goals - the 17 SDGs and 169 targets - to end poverty, protect the planet, and ensure prosperity for all.

The SDGs seek to build on the Millennium Development Goals and complete what these did not achieve. They are integrated and indivisible and balance the three dimensions of sustainable development: the economic, social and environmental.

Each goal has specific targets to be achieved over the next 15 years. Of note is the fact that small-scale food producers, a primary focus of ICBA, feature more prominently in the goals.

The Center believes that the SDGs cannot be achieved without significant and strategic investments in innovations in agriculture in marginal environments. Poverty and undernourishment are endemic in marginal environments; 115 million people in Asia and 178 million people in Sub-Saharan Africa are considered poor, making up 25.3 and 45.9 percent of the total populations in these regions respectively. The absolute number of poor living in marginal environments is highest in Sub-Saharan Africa, but the highest proportion is in the Middle East and North Africa region. Investments in marginal areas are unlikely to generate the highest returns, but these are the areas where the poor are concentrated.

Climate change is forecast to impact negatively on marginal environments, undermining global and national efforts to ensure food, nutrition and water security and end poverty set out in the SDGs. So it is critical to focus more efforts on climate change adaptation and mitigation strategies in marginal environments. However, as traditional agricultural methods and crops fall short of producing needed outcomes, the focus should be on non-traditional crops and technologies that are adapted to marginal environments. Hence, it is necessary to introduce into agriculture in these areas salt-, heat- and drought-tolerant crops and practices of using marginal water and land resources.

ICBA's current research portfolio is aligned with the SDGs and the Center will contribute to the SDGs by increasing its focus on targeting marginal environments. ICBA's contributions map mainly onto the following SDGs: No Poverty (SDG 1), Zero Hunger (SDG 2), Clean Water and Sanitation (SDG 6), Affordable and Clean Energy (SDG 7), Climate Action (SDG 13), Life on Land (SDG 15) and Partnership for the Goals (SDG 17).

It is ICBA's position that the SDGs can only be achieved by tackling challenges in marginal environments. Global food and nutrition security and poverty reduction are impossible unless the diverse needs of people living in these environments are properly addressed.

Effective irrigation system boosts crop yields in Senegal

Djiby Mbaye was one of many farmers who installed the Californian irrigation system on ICBA's recommendation on a plot of 0.5 ha in Mbayène village in Senegal. He planted improved seed of onion provided by ICBA in this field. At the same time, he planted vegetables in another 0.4 ha plot using a three-cylender pump. During the middle of the cropping season, the water level in the river stream dropped due to low rainfall. The traditional three-cylender pumps commonly used to extract irrigation water from streams stopped working which resulted in complete damage of vegetables on the 0.4 ha plot. However, the Californian system continued accessing irrigation water which saved his onion crop on the 0.5 ha area. Consequently, he was able to harvest 6 tonnes of onion, which gave him an income of 1,000 USD. This yield was 20 percent higher than the yield obtained by farmers in the area using traditional seed. Encouraged by the performance of the Californian system and the yield of the improved onion seed, Djiby decided to use his income from the onion field to install the Californian irrigation system on another 0.8 ha plot to ensure his crop production for the next cropping seasons. Realizing the benefits of the Californian irrigation system during the times of water shortages, many neighboring farmers visited his field to learn more about it. They also approached the ICBA project team for further assistance.

Research Innovations

Assessment of Natural Resources in Saline and Marginal Environments

Saline and marginal environments, characterized by lack of water and high levels of soil and water salinity, are not suited to traditional agriculture. Yet some 1.4 billion people make a living from farming in these environments. Most are subsistence farmers who face the constant risk of losing much or all of their harvests to salinity and drought. As a result, poverty and malnutrition are endemic

In 2015, the IDB-funded project on Integrated Crop and Seed Production Systems in Sub-Saharan Africa (SSA) came to a successful conclusion as it demonstrated to farmers in Burkina Faso, Senegal, Nigeria, Mauritania, and Mali how to increase overall farm productivity through irrigation technologies and management practices.

The Center also focused on improving regional collaboration on water management in the Middle East and North Africa (MENA) region. Under the Collaborative Program Euphrates and Tigris (CPET), researchers continued to facilitate dialogue and cooperation among four riparian countries (Iran, Iraq, Syria, and Turkey). In 2015, the country partners agreed to work on six key task forces to increase the productivity, efficiency and resilience of water use and services, namely: (1) hydrology and climate change; (2) hydropower; (3) water quality; (4) agricultural water productivity; (5) marshlands; and (6) socio-economic and improving livelihood.

Researchers continued studies into soil improvement in marginal sandy lands. As part of a joint project with Tadweer, a waste treatment plant in the UAE, the researchers studied how organic (compost) and inorganic (*Zeolite*) amendments help to enhance water and nutrient retention capacity of sandy soils. They carried out a series of experiments to test how compost and *Zeolite* increased growth of barley under greenhouse conditions where the yields doubled and water use decreased when compost was used at the rate of 30 tonnes per ha.

In a separate series of experiments, scientists investigated how the use of microorganisms can boost the effect of organic amendments like compost in UAE soil conditions. Complementing organic amendments with effective microorganisms has been found to improve considerably soil quality, leading to increased organic matter and microbial activity. The research team found that using the *Bontera*^{TM} microbial soil enhancer to grow quinoa in greenhouse and field conditions helped to increase yields by as much as 30 percent and make a saving of 25 percent on chemical fertilizers.

Research on using biochar from date palm waste as a soil amendment showed that it has a positive impact on soil health by increasing soil carbon, nutrient and water-holding capacity. Our research showed that scaling up the application of biochar using date palm waste has high potential for increasing crop production in marginal environments, and reducing the date palm waste which can help protect the environment

ICBA launched two initiatives in 2015: a partnership with the Qatar National Research Fund to study the feasibility of nano-filtration for desalinization of seawater to irrigate vegetable crops in greenhouses, and a research project with the Arabian Gulf University that carried out a comprehensive review of salt-affected soils in Bahrain and the UAE. Later the results would be extrapolated for other GCC countries

Key achievements of the Integrated Crop and Seed Production Systems in Sub-Saharan Africa project:

- A comprehensive database was developed on water resources, irrigation technologies, crops and baseline socio-economic conditions of the farming communities for each country.
- Different irrigation technologies for water distribution (i.e. canals and pipes), and irrigation methods (i.e. furrow, basin, drip and sprinkler, Californian system) were demonstrated and tested for their efficacy under local conditions. The Californian system proved most successful.
- Demonstration fields were planted with Irish potatoes in Mali, Nigeria and Gambia instead of traditional onion and tomato.
- Two seed production units were established: one onion seed production unit in Nigeria and a potato seed production unit in Gambia.
- 240 farmers, extension workers and local irrigation technicians attended technical training sessions, and more than 800 participated in field days.

In a field experiment at ICBA, the scientists found that using biochar at the rate of 20 tonnes per ha in sandy soils irrigated with saline water increased fresh biomass of pearl millet by 60 percent. Additionally, the available water content increased by 16 percent, proving that water saving is possible.

Climate Change Impacts and Management

Climate change is increasingly affecting rainfall and temperatures, and hence poses more risk to populations in marginal environments than those in any other regions. With 2015 setting the record for the warmest year in over a century, arid and semi-arid regions such as the MENA region were hit the hardest as they were faced with the dilemma of having to feed more people under the least favorable conditions for agricultural production. There is clearly an urgent need for research to support water and food security adaptation strategies, especially in regions where water resources are already under great pressure.

In keeping with its mission on climate change adaptation and mitigation, ICBA continued to develop and test improved technologies and plant germplasms, and work out effective strategies for adaptation and mitigation. ICBA completed the Modeling and Monitoring Agriculture and Water Resources Development (MAWRED) project in 2015 that generated finer resolution climate change data for the MENA region. This data was used in the analysis of future conditions of climate, water resources availability and possible changes in crop production in the region as a means to direct new policies and investment frameworks.

Building on the success of MAWRED, with USAID support and in partnership with the University of Nebraska - Lincoln and various in-country stakeholder organizations, ICBA launched a program that will build drought management systems in Morocco, Tunisia, Jordan, and Lebanon over the next three years. Provided that there is additional support, this work is expected to pave the way for extending the program to other countries in the region.

Furthermore, ICBA scientists carried out studies to improve irrigation management at the agribusiness level under a project that engaged scientists, agribusinesses, farm operation managers, water user associations, and policy-makers from Jordan, Oman, Tunisia and the UAE. The project utilized state-of-the-art near real-time monitoring systems for irrigated agriculture on farms in over 11 agro-ecological zones. The scientists also deployed the technology in real production situations in 16 agribusinesses that represent 2,500 ha of annual and perennial staple and cash crops.

ICBA successfully completed the Adaptation to Climate Change in Marginal Environments in West Asia and North Africa project funded by the

A team of scientists from ICBA and partner organizations tested state-of-the-art sensory technology in real farming conditions under a project aimed at improving irrigation management. As part of this work, they, for example, installed soil moisture and salinity sensors in a citrus orchard.

Key achievements of the Adaptation to Climate Change in Marginal Environments in West Asia and North Africa project:

- Developed more resilient agricultural production systems in an integrated comprehensive approach that helped the participant farmers in marginal environments.
- Enhanced the productivity and income of more than 1,500 farms in addition to creating new income opportunities for rural women.
- Equipped more than 5,000 farmers with key skills for better management of their lands through extensive capacity-building program and hands-on training.
- The outcomes of the project were endorsed and adopted by agricultural authorities at the local and government levels.
- Agricultural authorities and extension agencies became part of the project implementation and scaling-up to wider farming communities in Sinai and other neighboring areas.

Several years of collaborative research has resulted in the release of the new high-yielding sorghum variety 'Keshen' at the National Center for Biotechnology of Kazakhstan.

International Fund for Agricultural Development (IFAD), the Arab Fund for Economic and Social Development (AFESD) and the Organization of the Petroleum Exporting Countries (OPEC). This project worked with more than 5,000 progressive farmers in Egypt, Jordan, Oman, Palestine, Syria, Tunisia and Yemen, to enhance their capacity in efficient on-farm seed production and delivery systems of selected stress-tolerant forages and to apply efficient packages of forage production technologies.

Crop Productivity and Diversification

ICBA works to help small-scale farmers to make better use of marginal lands and water resources by cultivating non-traditional crops. To adapt to problems of salinity and water shortage, made worse by climate change, farmers need to diversify crops and increase productivity of available land and water resources. During the year, ICBA scientists multiplied for conservation and further research a total of 65 accessions, including 52 accessions of wheat received from the International Maize and Wheat Improvement Center (CIMMYT), Mexico, and six accessions of quinoa from Peru. A total of 168 accessions were distributed, including ten accessions within ICBA, 51 accessions to partners in the UAE and 105 accessions to researchers and partners in 13 other countries.

As forage production is important for agro-pastoralist communities in Central Asia, ICBA worked to promote high-yielding forage crops in Kazakhstan in partnership with the country's Ministry of Agriculture. To this end, ICBA established an integrated agro-livestock and mixed farming system on a farm in southern Kazakhstan to test a number of high-yielding salt- and drought-tolerant sorghum and pearl millet varieties. In parallel, under a Russian government-funded program, we worked with national partners in the Aral Sea region to ensure that agro-pastoralists have year-round access to good quality forage. Since the field survey results showed that around 35-40 percent of irrigated agricultural lands have low or negative return on investment, ICBA scientists studied the benefits of integrating salt-tolerant crops and non-traditional forages into traditional farming in one of the villages. Experiments showed that the new mungbean variety 'Durdona', grown in fallow edges of rice fields, nearly doubled yields and incomes of 10 local farmers, while making soils healthier. As a result of this work, rural women formed a learning alliance in the village, the first of its kind to work with women farmers willing to diversify their household incomes.

ICBA also implemented two projects to improve seed production of non-traditional, salt-tolerant crops (pearl millet, sorghum, barley, safflower, triticale and others)

Knowledge that empowers and changes lives

Amal and Wael run a family farm in a village in Port Saeed in Egypt. They make a living by selling dairy products. Like many other farmers in their area, they used to turn milk into yogurt and make cheese after storing yogurt for 3-4 days. But they were not happy about the final product.

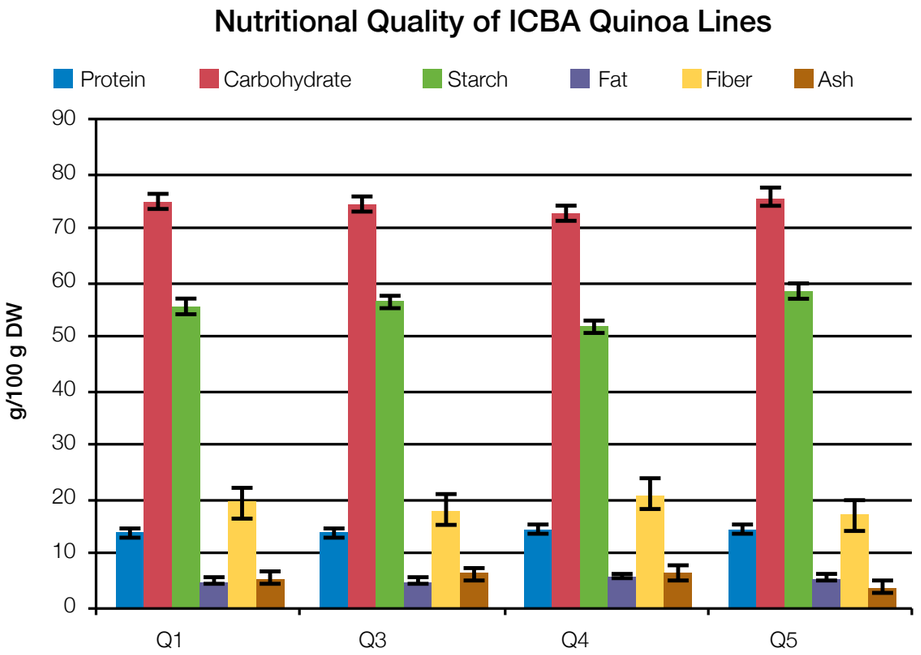
This completely changed when they learnt about a new technology from researchers working under the Adaptation to Climate Change in Marginal Environments in West Asia and North Africa project.

Initially, Amal and her husband used to process 20 kg of milk and make cheese. After they had been trained and received the new equipment, they started increasing their unit's processing capacity gradually to 100, 200, ultimately reaching 1,000 kg per production cycle.

"Now we are able to process cheese within a shorter period of time as we learnt that boiling milk at 90 ºC and then cooling it down to 40 ºC results in a good quality, ready-to-use product," says Amal.

More importantly, they started generating more revenue.

Wael started a pilot project with a fellow farmer to market cheese to nearby towns. They are now selling two kinds of cheese and yoghurt in three cities around the Suez Canal.



As part of research on quinoa, scientists analyzed the nutritional quality and chemical composition of the grains of four lines in collaboration with the Department of Food Science and Agricultural Chemistry of McGill University, Canada.

in Yemen, Egypt, Lebanon, Senegal and Mauritania. Scientists helped to establish seed production facilities and trained local experts to meet farmers' demand for seed. For example, two seed production and processing units established in Egypt produced more than 1,500 kg of seeds in the first season, which were distributed to 65 farmers.

ICBA also initiated a project in three countries of Central Asia – Kyrgyzstan, Tajikistan, and Uzbekistan – to introduce quinoa for improving food and nutrition security of the poor living in marginal areas. Seeds of five quinoa lines multiplied at ICBA were disseminated and trials for the evaluation of quinoa for human consumption and forage production were established under different eco-agroclimatic zones in the target countries that significantly differ in their soil characteristics and agricultural practices. Results from Uzbekistan show quinoa as a promising alternative crop. These quinoa lines produced about 30 percent more dry fodder and 25 percent more seeds than local annual chenopods.

Encouraged by the positive results of its research on quinoa, the Center in partnership with FAO launched a global program on collaborative research and extension on quinoa in drylands with the aim of testing an inclusive agribusiness model with quinoa to create more opportunities for smallholder farmers and agribusiness entrepreneurs. Since seed production is recognized as a major bottleneck for scaling up quinoa production, ICBA worked to build partnerships with private seed companies to overcome this problem. ICBA started negotiations with four seed companies (International Delta Center, Cairo, Egypt; Vibha Seeds Group, Hyderabad, India; Sub-e-Noor Pvt. Ltd, Karachi, Pakistan; and the Emirati/Egyptian company) on future collaboration. Each of these companies were provided with seeds of the elite quinoa lines that ICBA is recommending for large-scale multiplication and marketing.

ICBA continued studies on two long-term experiments on salt tolerance of 18 elite date palm varieties (ten from the UAE and eight from Saudi Arabia) at ICBA's research station in collaboration with the MoCCaE. Scientists collected data on growth and fruit yield and studied daily water uptake by the plants. Preliminary results showed that irrigation can be reduced by 30 to 50 percent to match better date palm's needs for water and yet maintain a leaching fraction to flush salts away.

ICBA joined forces with the King Abdullah University of Science and Technology (KAUST), Saudi Arabia, to study the impact of the rhizosphere microbiota on root system development and tolerance to environmental constraints in cereals. Testing nine bacterial strains, previously selected for their performance in promoting growth and enhancing salinity tolerance of

A series of experiments on elite date palm varieties have demonstrated that 'Barhi' and 'Lulu' are the most salt-tolerant varieties, withstanding a salinity level of 15 dS/m. They continued to produce fruits at this salinity level, yielding around 20-23 kg per tree.

Arabidopsis thaliana, the research team conducted field tests of three cereals irrigated with fresh or moderately saline water. Results showed that some strains enhanced plant growth by 20 to 30 percent under saline conditions.

In another project with KAUST, scientists continued genetic studies of salinity tolerance in barley in field conditions. They selected ten barley lines (5 tolerant and 5 sensitive) based on field trials which involved screening a global core collection of barley. They found that sodium accumulated in leaf sheaths in the tolerant varieties, while in the sensitive ones' sodium leaked to the upper shoots.

To enhance water use efficiency in marginal conditions, scientists also studied the effectiveness of soil amendments. As the soils of the Arabian Peninsula are predominantly sandy, with low nutrient and water retention capacity, as well as high infiltration rate, they continued identifying suitable soil amendments and assessing their efficiency through remote sensing techniques under a USAID-funded project. In particular, they cultivated several high value crops and tested the performance of selected amendments (zeolite and zeoplant) in improving soil properties in greenhouse and field conditions. In a separate experiment, scientists in collaboration with the private company Gulf Perlite also tested a soil amendment called perlite for its potential to save water in urban landscapes.

ICBA also continued research into different ways of increasing water productivity in water-scarce regions like the GCC. In particular, researchers worked on improved technologies for protected agriculture, which is common in the region due to harsh climate, scarce water and poor quality of land. Protected agriculture is practiced on more than 12,000 ha in the UAE, mainly in greenhouses where the fan and pad evaporative cooling system is used, leading to considerable energy and water consumption.

The research team tested two cucumber varieties under greenhouse and net-house conditions and found that the greenhouse consumed 49 times more energy and 1.5 times more water than the net-house. Additionally, several imported substrates (coco peat, perlite, peat) and local substrates (sand) were tested. Results indicated that the substrate based on local material is more productive and economical.

As part of the broader program on protected agriculture in partnership with the MoCCaE, FAO, ICARDA, ICBA since 2014 has been studying new technologies to reduce water and energy consumption by as much as 90 percent compared to the greenhouses currently used in the UAE. In 2015, the construction of a new generation greenhouse was completed at the Agricultural Innovation Centre of the MoCCaE in Al Dhaid, Sharjah, UAE.

Aquaculture and Bioenergy

As there are competing demands for fresh water in the Arabian Peninsula, it is important to consider alternative water resources for irrigation. Around 15 percent of the farmers in the peninsula install small-scale reverse osmosis (RO) units to desalinate groundwater for irrigation, producing highly concentrated brine. Given that conventional brine disposal systems are expensive and unproductive, ICBA has collaborated since 2014 with the International Water Management Institute(IWMI) to examine the costs and benefits of a freshwater- and brine-fed Integrated Aqua-Agriculture System (IAAS) to grow vegetables, forages, biofuel crops and aquatic species like *Sparidentex hasta* (sobaity seabream). In 2015, scientists looked at different integration patterns and analyzed protein, oil and saponin content of *Salicornia bigelovii* seeds.

ICBA also completed a three-year USAID-funded project to study the potential of halophytes as a good source of human food and animal feed, as well as renewable bioenergy. The project team assessed the biomass of 20 species and found that they are rich in protein, lipid, minerals, and hydrocarbon content and have potential as forages. They also found that these plants could uptake significant amounts of various salts from soils and water and accumulate them in their tissues. *Salicornia*, *Climacoptera* and *Halostachys* had the highest salt accumulation among these plants. The researchers also analyzed biogas potential of these halophytes under laboratory conditions.

As part of another project on the evaluation of Salicornia, launched in collaboration with KAUST in 2012, scientists continued assessment of the potential of growing Salicornia under different salinity levels and management practices in the UAE. In 2015, the scientists evaluated 15 Salicornia genotypes in pilot trials to examine the potential for large-scale production. Results showed seed yields ranged from 16 to 674 g/sq.m. with groundwater irrigation and from low to 150g/sq.m. under seawater irrigation, indicating high variation among Salicornia genotypes.

ICBA also continued four-year research into the benefits of integrating trees and shrubs into farming. In particular, the study, launched in 2012, looked at nutrient management using *Acacia ampliceps*, *Sporobolus arabicus* and *Paspalum vaginatum* at different salinity levels. Acacia is known to fix atmospheric nitrogen, provide forage for animals, and is also a source for bioenergy. The study showed the compatibility between Acacia and two salt-tolerant grasses like *Sporobolus* and *Paspalum* in response to different salinity and fertilization treatments.

Scientists also conducted research on desert gourd (*Citrullus colocynthis*) for its potential as a non-edible

An extrapolated annual oil yield in several accessions of desert gourd exceeded 1 t/ha, the highest being 3.4 t/ha (the average annual oil yields of the two main globally cultivated biodiesel feedstock crops - soybean and rapeseed -are 0.5-0.6 t/ha). Furthermore, the oil from most accessions had desirable physicochemical characteristics such as low free fatty acid content (<0.5 percent) for biodiesel production

biodiesel feedstock crop for cultivation in marginal lands. In the UAE, the plant often grows wild in sandy soils, covering large areas and surviving under hyper-arid desert conditions. Seeds of the plant have high oil content, placing it among potential candidates for bioenergy production in marginal lands. The research team collected 32 accessions in the UAE, which were then evaluated for two qualitative and 11 quantitative morpho-agronomic traits under the UAE conditions. Results showed that desert gourd is a promising candidate as a biodiesel feedstock crop.

Policies for Resilience

While ICBA's research produces new or improved technologies, plant varieties and practices, the Center also works with policy- and decision-makers to inform evidence-based policies. Through its research, ICBA aims to initiate more stimulating policies for adoption and scaling-up of solutions suited to marginal environments. The Center assisted a number of governments in developing agricultural and other strategies. In 2015, the Center completed an Investment Strategy for Food Security in Kuwait. The Strategy and Implementation Plan provide a road map for investing in key commodities for Kuwait, both under normal and crisis situations for 20 years.

ICBA's research also helped to shape some of the UAE national laws such as Draft Cabinet Resolution for the year 2015 concerning the regulation of the use of desalination units on wells; and Draft Cabinet Resolution for the year 2015 concerning the regulation of the management of the discharge water from desalination plants to the sea.

Enabling Innovations

Research on quinoa continued in 2015 at several experimental sites in the UAE, including the Agriculture Innovation Center in Al Dhaid.

Strategic Alliances

Strategic alliances and partnerships form the backbone of ICBA's sustainable operation and growth. The Center places special emphasis on partnership; it is a keyword in its mission.

In 2015, ICBA continued to enhance existing and build new relationships with partners at the international, regional and national levels to ensure the Center's research and knowledge are shared widely and benefit resource-poor smallholder farmers in marginal environments.

During the year, ICBA signed seven memorandums of understanding with FAO, Arabian Gulf University, the International Food Policy Research Institute (IFPRI), the International Atomic Energy Agency (IAEA), TECNOVA, University of Tehran, and Al Ain Municipality.

To promote ICBA as a Center of Excellence for knowledge and innovation in marginal environments, the Center hosted and organized 39 regional and international events, including a joint ICBA-IDB seminar on climate change adaptation in the context of the post-2015 Sustainable Development Agenda in Maputo, Mozambique. Furthermore, scientists presented their research work at 35 events organized by other organizations.

In 2015, ICBA completed an extensive stakeholder assessment that helped to identify ICBA's strategic stakeholders, and set the criteria for each group such as core donors; strategic funding partners; funding partners; potential funding partners; strategic research partners; research partners; potential partners; implementing partners; and potential implementing partners. Participants from 40 global funding, research and project implementation partners provided comprehensive feedback and information necessary to determine ICBA's baseline score on partnership success as measured by the defined Key Performance Indicators. The findings of ICBA's external stakeholder assessment conclude that the Center has a solid track-record in critical aspects of partnership management. According to the survey results, ICBA currently meets or exceeds the envisioned target of 75 percent partnership success on numerous partnership KPIs. They show that ICBA is particularly strong in terms of organizational adaptability, communication and information-sharing, as well as relationship management processes.

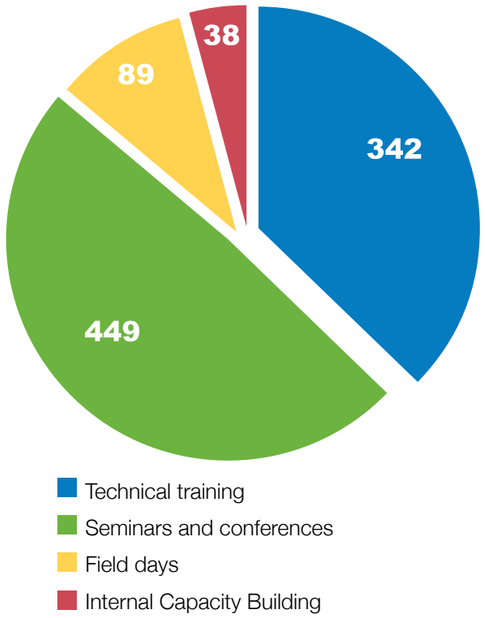
Capacity Building

Generating and spreading knowledge about ICBA's research and innovations is key to the Center's establishment as a global center of excellence.

In 2015, ICBA continued to work on developing the knowledge and skills of its stakeholders in different countries and strengthening the capacities of institutions, researchers and students, and farmers through short- and medium-term training courses, workshops, field days, internships, master's, doctoral and post-doctoral research programs.

In particular, the Center organized a series of training courses funded by its partners on, among others, enhancing crop mapping and modeling capabilities; soil

2015 ICBA training and knowledge-sharing events



salinity management; water and irrigation management; and land degradation and soil management.

For example, scientists conducted a national training course on soil salinity management at Victoria, Seychelles, in July 2015 in partnership with IAEA and Seychelles Agricultural Agency (SAA). This course improved knowledge of participants in various aspects of soil salinity and sodicity from assessment to interpretation of results for sustainable management of saline farms.

The Center also worked closely with IDB to deliver a series of training courses in Africa. For example, ICBA organized a training course in Mauritania on managing water and irrigation systems in Sub-Saharan Africa (SSA). The knowledge participants gained is expected to help farmers to improve irrigation water conservation, control waterlogging and incipient soil salinization without compromising on crop yields. This is of particular importance to this region as it uses only 2 percent of its total renewable water resources due to lack of water infrastructure, although it has an abundant supply of water. Moreover, a major issue in increasing water use efficiency is lack of knowledge about water management and irrigation mechanisms.

Another training course on land degradation and soil management in Senegal brought together 19 participants from Burkina Faso, Ethiopia, Mali, Mauritania, Nigeria, Senegal, and Gambia. The course discussed issues related to soil salinity management in general and land degradation in Africa. Participants were briefed on sustainable land management through integrated approaches.

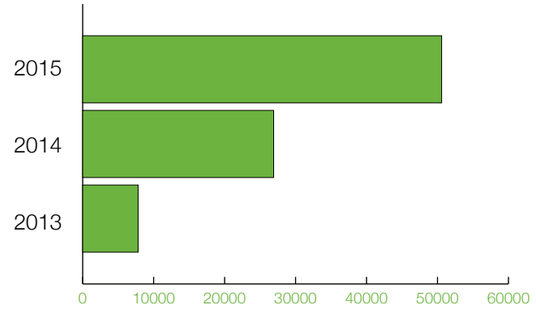
During a separate training course on soil salinity and soil fertility management, 13 participants from 10 African countries learnt about best management practices at the farm level to combat soil desertification and soil degradation. In particular, they improved skills in conservation agriculture, integrated soil fertility management and integrated soil reclamation.

Knowledge Hub

ICBA's communications efforts help to establish the Center as a global authority on agricultural production and food security in marginal environments. In 2015, ICBA launched its new website along with accounts on different social media platforms (Facebook, Twitter, LinkedIn, YouTube, SlideShare).

The website will serve as a repository of all publications, including scientific papers. Work is under way to upload all publications on the website and ensure free access to all previously published work. This work forms part of efforts to give open access to research output and knowledge generated at ICBA.

Website Users



The Center also developed a communications package in English, Arabic and French, which includes 23 project briefs for ongoing and past projects to capture ICBA's experience and knowledge, as well as a capacity-building brochure, a capability statement, and a fellowship brochure.

The efforts on social media platforms resulted in more visits to the Center's social media pages and website. More than 50,000 users visited ICBA's website in 2015. ICBA also has a growing list of followers on Facebook. The SlideShare account is also being updated as it will

A total of 25 participants from Seychelles Agricultural Agency and members of a local farmers' association attended a training course on soil salinity management in Seychelles. During the course, participants visited a farm to have hands-on training in soil and water salinity measurement.

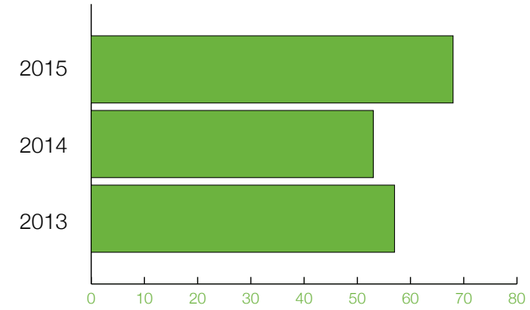
Publications

help to share presentations on ICBA's work with a large number of stakeholders.

In 2015, ICBA's scientists published 68 articles, including 25 in international peer-reviewed journals. Two papers on date palm genome sequencing and drought in the MENA region were published in *Nature Communications* (impact factor = 11.47) and *Bulletin of the American Meteorological Society* (impact factor = 11.5) respectively.

The quality and quantity of papers by ICBA researchers increased, contributing extensively to advancement of science in their respective fields.

Total Number of Publications



A. Peer-reviewed journals

1. Al-Dakheel, A.J., Hussain, M.I.& Al-Gailani, A. Q. M. (2015) Impact of irrigation water salinity on agronomical and quality attributes of *Cenchrusciliaris* L. accessions. *Agricultural Water Management*. 159: 148-154.

2. Al-Dakheel, A. J., Hussain, M. I. & Shabbir, G. (2015) Developing cropping sequence options for salt-affected rice-based production systems in Nile Delta and Iran. *Austin Journal of Plant Biology*. 1: 1009 -1019.

3. Al-Dakheel, A. J. & Hussain, M. I. (2015) Screening and selection of *Cenchrusciliaris* L. genotypes for salinity tolerant biomass production. *Journal of Plant Research*.

4. Bergaoui, K., Mitchell, D., Zaaboul, R., McDonnell, R., Otto, F.& Allen., M. (2015) Implications of the unprecedented drought of 2014 in the southern Levant region. *Bulletin of American Meteorological Society, Special Edition on Extreme Events* (Oxford University). doi:10.1175/BAMS-D-15-00129.1

5. Chamekh, Z., Karmous, C., Ayadi, S., Sahli, A., Hammami, Z., Fraj, M.B.& Slim-Amara, H. (2015) Stability analysis of yield component traits in 25 durum wheat (*Triticum durum Desf.*) genotypes under contrasting irrigation water salinity. *Agricultural Water Management*. 152:1–6

6. Choura, M., Rebai, A.& Masmoudi, K. (2015) Unraveling the WRKY transcription factors network in *Arabidopsis thaliana* integrative approach.

Network Biology, International Academy of Ecology and Environmental Sciences. 55-61.

7. Feki, K., Brini, F., Ben Amar, S., Saibi, W.& Masmoudi, K. (2015) Comparative functional analysis of two wheat Na+/H+ antiporter SOS1 promoters in *Arabidopsis thaliana* under various stress conditions. *Journal of Applied Genetics*. 56 (1): 15-26. doi: 1001007/s13353-014-0228-7

8. Gill, S.& Al-Shankiti, A. (2015) Priming of *Prosopis cineraria* (L.) *Druce* and *Acacia tortilis* (*Forssk.*) seeds with fulvic acid extracted from compost to improve germination and seedling vigor. *Global Journal of Environmental Science and Management*. 1(3): 225-232.

9. Hazzouri, K. M., Flowers, J. M., Visser, H. J., Khierallah, H. S. M., Rosas, U., Pham, G. M., Meyer, R. S., Johansen, Caryn K., Patrick, Z. F., Masmoudi, K., Haider, N., Kadri, N., Idaghdour, Y., Malek, J. A., Thirkhill, D., Markhand, G. S., Krueger, R. R., Zaid, A.& Purugganan, M. D. (2015) Whole genome re-sequencing of date palms yield insights into diversification of a fruit tree crop. *Nature Communications*. 6:8824. doi: 10.1038/ncomms9824

10. Hussain, M. I.& Reigosa, M. J. (2015) Characterization of xanthophyll pigments, photosystem II photochemistry, heat energy dissipation, reactive oxygen species generation and carbon isotope discrimination during artemisinin-induced stress in *Arabidopsis thaliana*. *Plos One*. 10(1): e0114826. doi: 10.1371/journal.pone.0114826

11. Hussain, M. I., Reigosa, M. J.& Al-Dakheel, A. J. (2015) Biochemical, physiological and isotopic responses to natural product p-hydroxybenzoic acid in Cocksfoot (*Dactylis Glomerata* L.). *Plant Growth Regulation*. 75: 783-792. doi: 10.1007/s10725-014-9981-1

12. Hussain, M. I., Lyra, D. A., Nikos, Farooq, M. & Ahmad, N. (2015) Salt and drought stresses in safflower: a review. *Agronomy for Sustainable Development*. 36:1. doi: 10.1007/s13593-015-0344-8

13. Qureshi, A. S. (2015) Improving food security and livelihood resilience through groundwater management in Pakistan. *Global Advanced Research Journal of Agricultural Sciences*. 4 (10): 678-710.

14. Qureshi, A. S., Ahmed, Z. & Krupnik, T. J. (2015) Moving from resource development to resource management: problems, prospects and policy recommendations for sustainable groundwater management in Bangladesh. *Water Resources Management*. doi: 10.1007/s11269-015-1059-y (Online first: July 30, 2015)

15. Qureshi, A. S. & Al-Falahi, A. (2015) Extent, characterization and causes of soil salinity in central and southern Iraq and possible reclamation strategies. *International Journal of Engineering Research and Applications*. 5 (1): 1-11.

16. Qureshi, A. S.& Al-Falahi, A. (2015) Modeling the effects of different irrigation schedules and drain depths for salinity management: a case study from southern Iraq. *African Journal of Agricultural Research*. 10 (32): 3178-3188.

17. Safi, H., Saibi, W., Mrani-Alaoui, M., Hmyene, A., Masmoudi, K., Hanin, M. & Brini, F. A. (2015) Wheat lipid transfer protein (TdLTP4) promotes tolerance to abiotic and biotic stress in *Arabidopsis thaliana*. *Plant Physiology and Biochemistry*. 89: 64-75. doi: 10.1016/j.plaphy.2015.02.008

18. Shahid, M.& Rao, N.K. (2015) First record of the two *Asteraceae* species from the United Arab Emirates. *Journal on New Biological Reports*. 4(3): 215-218.

19. Shahid, M.& Rao, N.K. (2015) New records for the two *Fabaceae* species from the United Arab Emirates. *Journal on New Biological Reports*. 4(3): 207-210.

20. Shahzad, K., Rauf, M., Ahmed, M., Malik, Z. A., Habib, I., Ahmed, Z., Mahmood, K., Ali, R., Masmoudi, K., Lemtiri-Chlieh, F., Gehring, C., Berkowitz, G.A. & Saeed, N. A. (2015) Functional characterization of an intron retaining K+ transporter of barley reveals intron-mediated alternative splicing. *Plant Biology*. doi: 10.1111/plb.12290

21. Zhapayev, R., Iskandarova, K., Toderich, K., Paramonova, I., Al-Dakheel, A., Ismail, S., Rao, S., Omarova, A., Nekrasova, N., Balpanov, D., Ten, O., Ramanculov, E., Zelenskiy, Y., Akhmetova, A.& Karabayev, M. (2015) Sweet sorghum genotypes testing in the high latitude rain-fed steppes of northern Kazakhstan (for feed and biofuel). *Journal of Environmental Science and Engineering*. 4:25-30.

B. Accepted Peer Reviewed Journals

1. Aralova, D., Toderich, K.& Csaplovics, E. (2015) Spatial distribution patterns of vegetation cover in deserts of Central Kyzylkum with application of vegetation indices (VIs). *Journal of Arid Land Studies*.

2. Lyra, D., Kalivas, D.& Economou, G. (2015) A large-scale analysis of soil and bioclimatic factors affecting the infestation level of tobacco (*Nicotiana tabacum* L.) by *Phelipanche* species. *Crop Protection*.

3. Massino, A. I., Edenbaev, D., Khujanazarov, T. M., Azizov, K., Boboev, F., Shuyskaya, E. V., Massino, I. V. & Toderich, K. N. (2015) Comparative performance of corn, sorghum, and pearl millet growing under saline soil and water environments in Aral Sea Basin. *Journal for Arid Land Studies*.

4. Shahid, M. & Rao, N. K. (2015) New records of 8 plant species in the United Arab Emirates. *Tribulus*.

5. Zhapayev, R. K., Toderich, K., Tautenov, I.A., Umirzakov, S. I., Bekzhanov, S., Nurgaliev, N., Nurzhanova, Sh. J., Tajekeeva, A. K., Iskandarova, K. A.& Karabayev, M. K. (2015) Forage production and nutritional value of sorghum and pearl millet on marginal lands in Priaralie. *Journal of Arid Lands Studies*.

6. Touge, Y., Tanaka, K., Khujanazarov, T., Toderich, K., Kozan, O.& Nakakita, E. (2015) Developing a water circulation model in the Aral Sea Basin based on in-situ measurements on irrigated farms. *Journal of Arid Lands Studies*.

D. Published Books (Edited)

1. Burrough, P. A., McDonnell, R. A. & Lloyd, C. D. (2015) *Principles of Geographical Information Systems*. 3rd edition. Oxford: Oxford University Press. 352 p.

2. Toderich, K. N., Bobokulov, N. A., Shuyskaya, E. V., Rabbimov, A. R., Popova, V. V., Mukimov, T. Kh. & Khakimov, U. N. (2015) *Kochia prostrata* (L.) Shrad: a valuable fodder crop for improvement of rangeland productivity in arid and semi-arid zones of Central Asia. (eds: Shoaib Ismail & Tamara Matyunina). Tashkent: Fan va Texnologiya. 146 p.

E. Published Conference Proceedings/ Book Chapters

1. Al-Dakheel, A., Rao, N.& Richard, S. R. (2015) Biosaline agriculture as an approach for combating desertification. In: *Living Land, United Nations Convention to Combat Desertification (UNCCD)*, pp. 146-148.

2. Hirich, A., Choukr-Allah, R., Rami, A.& El-Otmani, M. Feasibility of using desalination for irrigation in the Souss Massa Region in the south of Morocco. (2015) In: Baawain, M., Choudri, B. S., Ahmed, M. & Purnama, A. (eds.). (2015) *Recent Progress in Desalination, Environmental and Marine Outfall Systems*. Springer International Publishing, pp.189-203. doi: 10.1007/978-3-319-19123-2_13

3. Qureshi, A. S., Yasmin, S., Howlader, N. C., Hossain, K.& Krupnik, T. J. (2015) Potential for expansion of surface water irrigation through axial flow pumps to increase cropping intensification in Southern Bangladesh. *Proceedings of the conference on "Revitalizing the Ganges Coastal Zone: turning science into policy and practice"*. October 20-22, 2014, Dhaka, Bangladesh. Humphreys, E., Tuong, T. P., Buisson, M. C., Pukinskis, I.& Phillips, M. (eds.). CGIAR Challenge Program on Water and Food. Dhaka, Bangladesh. pp. 553-565.

4. McDonnell, R. A. (2015). The growing thirst of the United Arab Emirates: water security stresses that challenge development. In: Bryde, D., Mouzughi, Y.& Al Rasheed, T. (eds.) *Development Challenges in the Arab States of the Gulf*. Berlin: Gerlach Press, pp..139-152.

5. Shahid, S.A. (2015) Healthy and productive soils are a pre-requisite for sustainable food security. Proceedings of "International Conference on Soil Sustainability for Food Security" Institute of Soil and Environmental Sciences, University of Agriculture Faisalabad, Pakistan, pp. 5-7.

6. Shahid, S. A., Al-Shankiti, A., Gill, S.& Mahmoudi, H. (2015) Innovative agricultural intensification of sandy desert soils using organic and inorganic amendments. In: *Living Land, United Nations Convention to Combat Desertification (UNCCD)*, p. 4.

7. Toderich, K., Khujanazarov, T., Ismail, S., Shuyskaya, E.& Rajabov, T. (2015) Improving the productive use of marginal lands in mixed farming and pastoral systems as part of climate change adaptation strategy. *Proceedings of the 5th Kubuki International Desert Forum 2015*. Kubuki, China. pp. 169-192.

8. Toderich, K. N., Ismail, S., Rabimov, A. R., Mukimov, T. Kh., Khujanazarov, T. M., Shuyskaya, E. V., Babokulov, N. A., Khamraeva, H. & Bekchanov, B. B. (2015). Biosaline low cost techniques to improve productivity of degraded rangelands and livestock feeding system under ongoing climate changes environments. *Proceedings International Conference dedicated to 85 Anniversary of the Institute of Karakul Sheep Breeding and Desert Ecology*, 13-15 August

2015, Samarkand, Uzbekistan, “Zarafshon’ Publisher: pp. 287-293.

F. Accepted Conference Proceedings/ Book Chapters

1. Hirich, A., Choukr-Allah, R. (2016) Water and energy use efficiency of greenhouse and net house under desert conditions of UAE. *International Water Conference on Water Resources in Arid Areas*. Oman, March 13-16, 2016
2. Pain, C. F., Abdelfattah, M. A., Shahid, S. A. & Ditzler, C. (2015) Soil-landform relationships in the arid northern United Arab Emirates. *In: Geopedology - an integration of geomorphology and pedology for soil and landscape studies* (Joseph Alfred Zinck, Graciela Matternicht, Gerardo Bocco and Hector Francisco Del Valle (eds). Springer.
3. Qureshi, A. S. (2015) Strategies for the bio-management of salt-affected and waterlogged soils: a perspective from Pakistan. *Agroforestry for The Management of Waterlogged Saline Soils and Poor-Quality Waters*. Dagar, J.C., Minhas, P. S. (eds). Springer.
4. Qureshi, A. S. & Ismail, S. (2015). Evaluating benefits and risks of using treated municipal wastewater for agricultural production under desert conditions. *Paper accepted for oral presentation in the 12th Desert Technology Conference* in Cairo, November 16-19, 2015.
5. Rahman, K., Mufti, K. A., Shahid, S. A. & Ismail. S. (2015) Soil characteristics mapping is pre-requisite to conduct applied agricultural research and transfer of technologies to farmers. *Proceedings of International Conference on Biotechnology and Bioengineering* - 014 BITS Pillani Dubai, UAE (October 29-30)

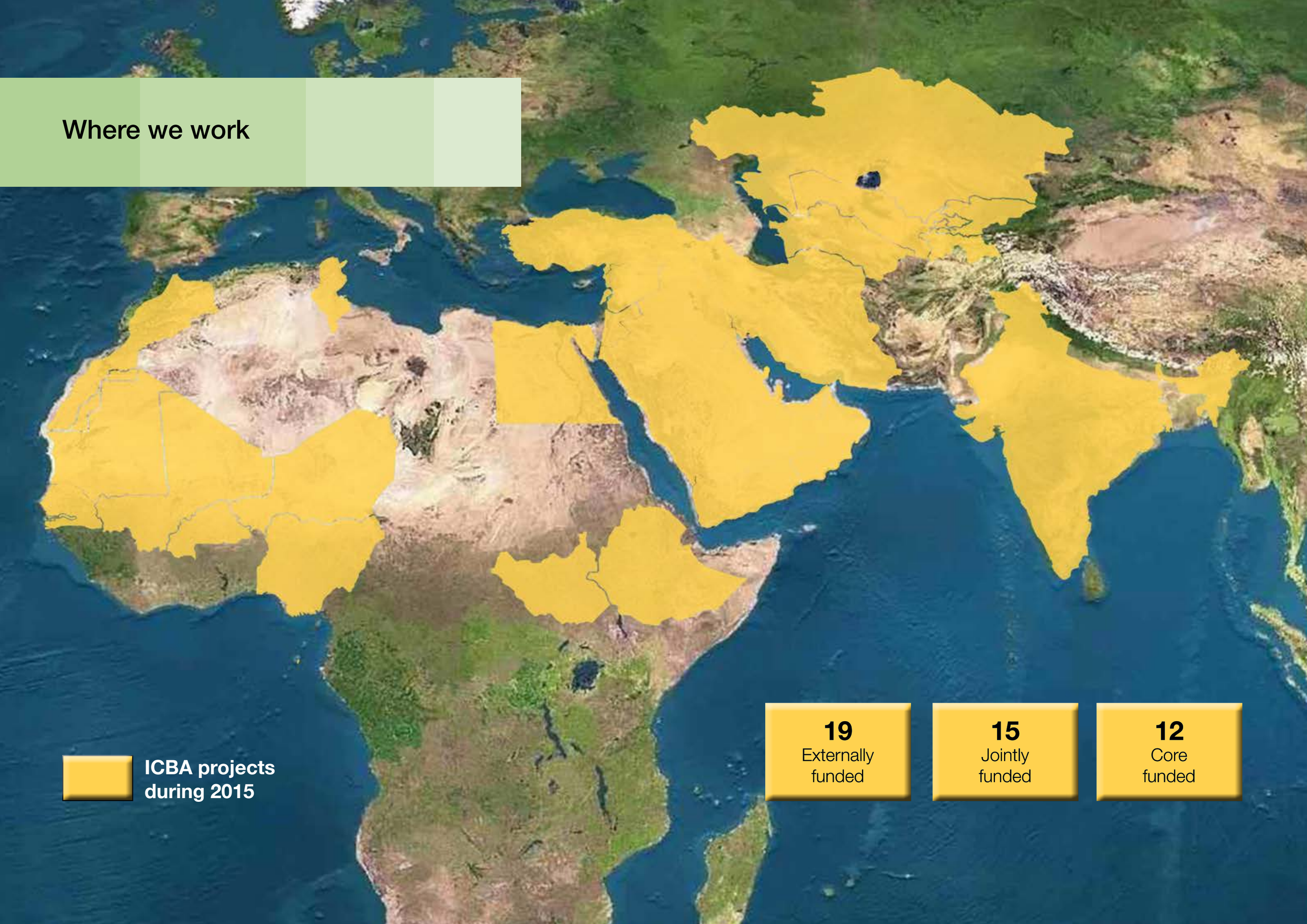
G. Published Scientific Newsletters and Magazines

1. Al-Dakheel, A. J. & Hussain, M. I. (2015) Saving freshwater resources through cultivation of salt-tolerant forage grasses: seasonal and genotypic variations. *Biosalinity News*, 16: 10-12.
2. Gill, S. & Al-Shankiti, A. (2015) Evaluating the efficiency of microbial soil enhancer in improving biomass yield for quinoa production in sandy soil. *Biosalinity News*, 16 (2): 8-9
3. Butnik, A. A., Toderich, K. N., Matyunina, T. E., Japakov, U. N. & Yusupova, D. M. (2015) Manual on fruit morphology and biology of seed germination of desert plants of Central Asia. *In*: Pechenitsin, V., Ismail, S.& Turok, J. (eds.) Tashkent: Yangi Nashr. 396 p. (in Russian with an English summary)
4. Shahid, M.& Rao, N. K. (2015) *Colocynth*: a potential oilseed crop for bio-fuel production. *Biosalinity News*, 16(1): 6-7
5. Shahid, S. A. (2015) No soil, no landscape – contribution to the International Year of Soils 2015. *Landscape Middle East*, August 2015, pp. 12-14.
6. Shahid, S. A. (2015) Soil education and sustainable development - contribution to the International Year of Soils 2015. *Landscape Middle East*, November 2015, pp. 16-18.
7. Shahid, S. A. (2015) The need for healthy soils for sustainable food security - where do we stand? *Farming Outlook*, 14 (3): 3-9.
8. Toderich, K. N., Bobokulov, N. A., Rabbimov, A. R., Shuyskaya, E. V., Mukimov, T. Kh., Popova, V. V. & Khakimov, U. N. (2015) *Kochia prostrata* (L.) Schrad – a valuable forage plant for improving the productivity of arid and semi-arid degraded rangelands in Central Asia (in Russian with an English summary). Tashkent: Fan va Texnologiya, 156p.
9. Zaaboul, R., Bergaoui, K., and McDonnell, R. (2015). New insight on climate change in MENA region. *Biosalinity News*, 16 (1): 9.
10. McDonnell, R., (2015). Citizen science sheds light on the role of climate change in the Levant drought of January/February 2014. *Biosalinity News*, 16 (2): 4.

H. Abstracts

1. Al-Shankiti, A. &Gill, S. (2015) Integrated plant nutrient management for sandy soil using chemical fertilizers, compost, biochar, and biofertilizers – a case study in the UAE. *Desert Technology, 12th International Conference (DT12)*, Cairo University, Egypt. November 16-19, 2015.
2. Gill, S., Al-Shankiti, A. & Shahid, S. A. (2015) Biochar intensifies agriculture in marginal environments. Soil organic matter balance methods as practice-applicable tools for environmental impact assessment and farm management support. *(SOMpatic) 2nd International Workshop*. December 8-10, 2015, Giessen, Germany.
3. Hussain, M. I. & Al-Dakheel, A. J. (2015) Using alternative water resources for cultivation of salt-tolerant perennial grasses under marginal environments. TROPENTAG 2015: *Management of Land Use Systems for Enhanced Food Security - Conflicts, Controversies and Resolutions*, Berlin, Germany; September 16-18, 2015.
4. Hussain, M. I., Hassan, M. & Maqsood, M. (2015) Evaluation of phosphorus nutrient management strategy in mashbean (*Vigna mungo* L. *Hepper*) genotypes: growth, grain yield and yield attribute. *Eucarpia International Symposium on Protein Crops –V Meeting AEL, Plant Proteins for The Future*, Pontevedra, Spain; May 4-7, 2015; p. 58.
5. Khujanazarov, T., Touge, Y., Tanaka, K., Toderich, K. & Tanaka, Sh. (2015) Strategies for water policy adaptation under climate change in the Aral Sea Basin. Abstracts Book. *Asia Oceania Geosciences Society (AOGS) Joint Assembly*, Singapore, August 2015. p. 136
6. Lyra, D., Bouaziz, M. & Ismail, S. (2015) Use of hyperspectral data for monitoring coastal areas for halophytes cultivation at commercial scale. [Accepted for publication in the Proceedings of 3rd Arab-American Frontiers of Science, Engineering, and Medicine symposium, hosted by the King Abdullah University of Science and Technology (KAUST) (5-7 December)]
7. Maqsood, M., Hussain, M. I., Iqbal, J. & Khan, M. K. (2015) Irrigation practices impact on growth and yield response of mungbean (*Vigna radiata* L.) under agro-ecological conditions of Faisalabad, Pakistan. *Eucarpia International Symposium on Protein Crops -V Meeting AEL, Plant Proteins for The Future*, Pontevedra, Spain, May 4-7, 2015.p. 126

Where we work



ICBA Projects in 2015

Externally funded

1. Rehabilitation and management of salt-affected soils to improve agricultural productivity (RAMSAP); Ethiopia, South Sudan (2015-2019)
2. Utilization of low quality water for halophytic forage and renewable energy production (PEER); Uzbekistan (2012-2015)
3. Collaborative Programme- Euphrates and Tigris; Turkey, Iran, Iraq, Syria (2013-2018)
4. Kuwait Food Security and Investment Strategy; Kuwait (2014-2015)
5. Groundwater Governance in the Arab World: Taking Stock and Addressing the Challenges; Egypt, Lebanon, Jordan, Tunisia, UAE, Oman, Yemen (2014-2016)
6. Mapping agricultural communities vulnerable to the impact of climate change and enhancing their livelihood in selected countries of MENA and SSA Region (with CDGI section) CODRA; Yemen, Egypt, Lebanon, Senegal, Mauritania (2014-2016)
7. Evaluation of the efficiency of BonteraTM microbial soil enhancer in improving soil quality for crop production; UAE (2014-2016)
8. Improving agricultural soil properties using soil amendments to enhance water and nutrient use efficiency for crop production in dry lands and assessing these efficiencies via remote sensing techniques; Arabian Peninsula (2014-2016)
9. Improving economics of using saline water in arid and semi-arid areas through integrated aqua-agriculture systems (IAAS); Arabian Peninsula (2014-2016)
10. Using reflectance sensing in precision irrigation management and scheduling under arid conditions; UAE (2015-2016)
11. A Drought monitoring for MENA: exploring and designing a regional system to support decision-makers better prepare for and be more resilient to future drought episodes; Jordan, Lebanon, Morocco, Tunisia (2015-2016)
12. CGIAR research program on integrated agricultural production systems for the poor and vulnerable in dry areas (CRP drylands Central Asia); Aral sea region (2015)
13. Establishment of Agricultural Technology Field-Testing Facility in KAUST's Research and Technology Park (KRTP); Saudi Arabia (2015-2016)
14. Promotion of high yield forage crops in short-farming rotation system under sprinkler irrigation on marginal lands (Kazakhstan); Kazakhstan (2015-2018)
15. Use of non-conventional agricultural water resources to strengthen water and food security in transboundary watersheds of the Amu Darya River Basin; Uzbekistan, Turkmenistan, Tajikistan (2015-2018)
16. Technical Assistance to PHOSBOUCRAA for Foum El Oued – Laayoune: Improvement of Forage Production System on Salt-Affected Farms; Laayoune- Morocco (2015-2018)
17. Evaluating Perlite to Save Water in Urban Landscapes; UAE (2015)
18. Feasibility of Nano Filtration for desalinization of saline/seawater used for irrigating vegetable crops in greenhouse under Qatar conditions; Qatar (2015-2018)
19. The impact of the rhizosphere microbiota on root system development and tolerance to environmental constraints in cereals; UAE (2014-2017)

Jointly funded

20. Modeling and Monitoring Agriculture and Water Resources for Development (MAWRED); Jordan, Tunisia, Palestine, Iraq, Morocco (2009-2015)
21. Adaptation to climate change in WANA marginal environments through sustainable crop and livestock diversification; Egypt, Jordan, Oman, Palestine, Syria, Tunisia, Yemen (2010-2015)
22. Application of near real-time monitoring systems for irrigated agriculture in MENA; Jordan, Oman, Tunisia, UAE (2014-2016)
23. Development of the MENA Regional Drought Management System; MENA - Jordan, Morocco, Lebanon, Tunisia (2015-2018)
24. Model for seed production of resilient salt-tolerant crop species for Climate Smart Agriculture in Egypt; Egypt (2015-2018)
25. Evaluating Green Compost and Zeolite to Enhance Soil Quality for Dubai Sustainable City; UAE (2014-2015)
26. Integrated crop and seed production systems under water/irrigation management in Sub-Saharan Africa; Burkina Faso, Senegal, Niger, Nigeria, Mauritania, Mali, Gambia (2011-2015)
27. Collaborative research and extension on Quinoa - a sustainable nutri-food project through dryland farming; India (2015-2018)
28. FAO "Support to the Water Scarcity Initiative workplan withi n the domains of Protected Agriculture in the GCC Countries and of Agricultural Drought Monitoring in the NENA Region", NENA region (2015-2016)
29. Soil salinity and properties mapping using remote sensing, geographical information system and field validation - Case study of Bahrain and United Arab Emirates; Bahrain, UAE (2015-2017)
30. Date palm water use monitoring project (Date palm sap flow): Estimation of water demands in three varieties under different salinity and irrigation levels; Arabian Peninsula (2015-2017)
31. Genetic studies of salinity tolerance in barley in field conditions; UAE, Saudi Arabia (2013-2016)
32. Cross-regional Partnerships for improving Food and Nutritional Security in Marginal Environments of Central Asia; Uzbekistan, Tajikistan, Kyrgyzstan (2015-2017)
33. Unlocking the potential of Protected Agriculture to improve nutrition, contribute to food security, and cut water consumption in the GCC countries; UAE (2014-2016)
34. Establishing of Salicornia pilot field trials at Marine Research Center (MRS) in Umm Al Quwain; UAE (2015-2016)

The Integrated Aqua-Agriculture System at ICBA is designed to maximize use of water for high-value and salt-tolerant crops, as well as fish species.

Core funded

35. Long-term evaluation of biochar application rate on field crop irrigated with saline water; UAE
36. Plant Generic Resources for marginal environments: Identification, multiplication & dissemination; UAE
37. Potential benefits and environmental risks associated with using treated municipal wastewater on vegetables, landscaping plants, forages and fruit trees in UAE; UAE
38. Protected agricultural production for maximum water and energy use efficiency in hot arid climates; UAE
39. On-farm demonstration of seed production and adaptation to Biosaline Agriculture production systems (aquaculture); UAE
40. Molecular mechanisms involved in toleance to salinity: Towards selection of candidate genes for plant breeding in two cereals; UAE
41. Evaluation of Elite Date Palm Varieties for Salt Tolerance at Various Salinity Levels at ICBA; UAE
42. Evaluation of Salicornia bigelovii under high salinity levels and management practices in the United Arab Emirates; UAE
43. Evaluation and development of quinoa as an alternative crop for marginal environments of the UAE; UAE
44. Automated sensor based control and monitoring of irrigation for research, demonstration and capacity building; UAE
45. Nutrient management trial using Acacia ampliceps, Sporobolous arabicus and Paspalum vaginatum at different salinity levels; UAE
46. Soil Museum; UAE

Sustainability

Non-conventional water resources can be used for forage production in marginal environments. For example, ICBA scientists demonstrated that forages can be successfully cultivated using treated wastewater in Jordan.

ICBA's work is supported by a variety of financial contributors and partners. This support helps ICBA to continue to generate and spread knowledge and technology needed for climate change adaptation and mitigation in marginal environments. The Center works closely with smallholder farmers and other land users in marginal environments, who are the ultimate beneficiaries of all ICBA's work. The Center also shares data and knowledge with policy-makers and researchers to support evidence-based policies and decisions.

To continue its mission of helping vulnerable farmers in marginal environments around the world, ICBA focuses efforts on diversifying sources of funding for agricultural research and innovation through different initiatives. Over the past several years, considerable efforts have been made in this direction and there has been a steady increase in external funding, especially for new projects. In parallel, the Center has been pursuing different mechanisms that will make it possible to cover operational costs through maximizing operational efficiency in addition to establishing a commercially feasible and sustainable waqf and an endowment fund. In 2015, ICBA's Board of Directors approved, in principle, establishing a waqf in ICBA's unused land in Dubai and agreed that the management goes ahead with officially communicating with the relevant authorities to pursue this initiative. Furthermore, the Board approved the concept of an endowment fund and assigned the Board Finance and Administration Committee the role of Endowment Investment Committee.

Much of the Center's work is funded by the three core partners: the UAE Government (through the Ministry of Climate Change and Environment and the Environment Agency – Abu Dhabi) and the Islamic Development Bank. We would like to thank them for their continued support. We also wish to thank the following organizations for their financial contributions to ICBA in 2015:

- Arab Fund for Economic and Social Development
- Development Alternatives, Inc.
- Flozyme Corporation
- Phosboucraa Foundation
- Gulf Perlite LLC
- International Atomic Energy Agency
- International Fund for Agricultural Development
- International Center for Agricultural Research in the Dry Areas
- International Water Management Institute
- Kazakh Research Institute of Water Management
- King Abdullah University of Science and Technology
- Kuwait Investment Authority
- National Academy of Sciences, USA
- Qatar Ministry of Environment
- Swedish International Development Cooperation, Sweden
- Tadweer Waste Treatment LLC
- United States Agency for International Development
- Zeoplant

Financial statement

Statement of activities (USD)	2015	2014
Grants and contributions		
Grants income	11,744,534	10,475,183
Other income	242,997	325,034
Total grants and contributions	**11,987,531**	**10,800,217**
Expenses		
Total expenses and losses	**(11,870,710)**	**(10,473,735)**
Surplus for the year	116,821	326,482

Statement of expenses by classification (USD)	2015	2014
Personnel	5,532,501	5,555,097
Collaboration	2,606,750	1,227,077
Supplies and Services	2,169,475	2,068,187
Depreciation	682,947	646,522
Capacity Building	516,142	673,777
Travel	362,895	303,075
Total operating expenses	(11,870,710)	(10,473,735)

Statement of financial position (USD)	2015	2014
Assets		
Cash and cash equivalents	9,698,972	3,783,237
Short-term deposits	7,608,696	10,597,826
Receivables	399,091	197,393
Pre-payments	300,469	799,701
Property and equipment	7,290,332	7,465,680
Total assets	**25,297,560**	**22,843,837**
Liabilities and net assets		
Accounts payables	1,662,252	1,413,343
Donors payables	2,759,352	3,008,168
Accruals for staff terminal benefits	919,913	904,360
Total liabilities	5,341,518	5,325,871
Net fixed assets	7,290,332	7,465,680
Net assets unrestricted-unappropriated	2,613,427	2,706,273
Net assets unrestricted-appropriated	10,052,283	7,346,013
Total net assets	**19,956,042**	**17,517,966**
Total liabilities and net assets	25,297,560	22,843,837

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ABOUT ICBA

International Center for Biosaline Agriculture - ICBA is an international, non-profit organization that aims to strengthen agricultural productivity in marginal and saline environments through identifying, testing and facilitating access to sustainable solutions for food, nutrition and income security.
ICBA's work reaches many countries around the world, including the Gulf Cooperation Council countries, the Middle East and North Africa, Central Asia and the Caucasus, South and South East Asia, and Sub-Saharan Africa.

Much of our innovative applied research work is sponsored by three core donors: the Ministry of Climate Change and Environment of the United Arab Emirates, the Environment Agency - Abu Dhabi, and the Islamic Development Bank. We gratefully acknowledge their support as well as the support of many other donor agencies that have sponsored components of our work over the years.

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