ICBA ANNUAL REPORT 2012

Innovating to make the most of marginal environments and contribute to food security

www.biosaline.org

Our mission

To demonstrate the value of marginal and saline water resources for the production of economically and environmentally useful plants, and to transfer the results of our research to national services and communities.

Our mandate

To help water-scarce countries improve the productivity, social equity, and environmental sustainability of water use through an integrated water resource systems approach, with special emphasis on the effective use of marginal quality water (saline and wastewater).

About ICBA

The International Center for Biosaline Agriculture (ICBA) is a vibrant international center of excellence for research and development in marginal environments.

Established in 1999 under the visionary leadership of the Islamic Development Bank and the United Arab Emirates, the Center has received generous core support from the United Arab Emirates, its host country, through the Ministry of Environment and Water and the Environment Agency, Abu Dhabi, and from the Islamic Development Bank. ICBA gratefully acknowledges the support provided through bi-lateral grants from other development and research organizations (see page 19).

ICBA's work addresses the closely linked challenges of water and food security. Our applied research for development is designed to improve soil and irrigation management, diversify and intensify crop production, and advance the use of conventional and non-conventional water, such as saline, treated wastewater, industrial water, and seawater. Building capacity and sharing knowledge is an important part of all we do.

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FOREWORD

We are pleased to present the 2012 Annual Report for the International Center for Biosaline Agriculture (ICBA). This report provides highlights of the Center's work in 2012 as well as summaries of the many activities carried out by the Center with its partners during the year. It also provides management information and acknowledges the generous support of our donors.

This year the Center has continued in its mandate to address the challenges in marginal environments. We have had some notable outcomes in identifying salt-tolerant crops and halophytes for biofuel and forage. New irrigation technologies, using sub-surface irrigation, investigated by ICBA have huge potential to decrease the need to use freshwater by using alternative sources of water, for example wastewater. Very promising also are the advances in diversifying and intensifying agriculture. Dual-purpose (food–feed) varieties of sorghum and pearl millet, Sesbania as an alternative to alfalfa, and naturally occurring soil rhizobia (nitrogen-fixing bacteria) improve productivity.

We are also pleased to continue the Center's work in helping governments to develop strategies, standards, and frameworks. The development of plans, such as the national salinity strategy for Oman, the water vision for the Organization of Islamic Cooperation, and the standards for brine disposal in the United Arab Emirates, will all have long-reaching effects in the region.

Although ICBA is proud of its achievements, there is still much to be done. To ensure food security, by 2050, the agricultural sector must produce enough food for a population of 9.1 billion, while providing employment and environmental services, and adapting to climate change. Studies have shown that to increase the world food production by 2050, we will have to increase agricultural production in marginal environments. Food security is closely linked to water security. Ensuring water security means using all water resources, not only freshwater, efficiently.

As ICBA reaches the end of its current strategic phase it has prepared a new strategy for the period 2013-2023. In November 2012 we held a foresight and strategic planning symposium where, with partners, the Center considered the dynamics of land and water resources, and the likely impacts of climate change and other challenges to agricultural production in the next decade and beyond. Insights from the symposium have guided our new strategy for 2013-2023.

The new strategy will take innovation as a core principle. Our applied research will be directed to innovative solutions to food and water security in marginal environments, applying new technologies, such as OMIC technologies – genomics, proteomics and metabolomics – developing multiple uses for wastewater and seawater, such as to produce biofuel crops, becoming a pioneering knowledge hub, and extending our partnerships. With the help of our partners we will innovate, build human capital, and encourage the learning that is fundamental for change.

Mr Fawzi Al Sultan, Chair, Board of Directors

Dr Ismahane Elouafi, Director General

HIGHLIGHTS 2012

Managing salinity

Salt-tolerant crops and halophytes (plants adapted to saline conditions) for biofuel and forage for grazing livestock are some of the solutions ICBA is exploring to manage salinity.

- Halophytes, low-cost biosaline technologies, and cropping systems, such as dual-purpose food-feed crops and shrub-tree crops adapted to poor quality water, are proven to enhance the productivity of saline soils and rangeland grazing. These could transform saline areas in Central Asia into multi-use crop-tree systems.
- ICBA has taken on the challenge of rehabilitating and reclaiming abandoned salt-affected farms in Abu Dhabi. Three model farms are being planted with perennial and annual forages irrigated with saline water. The improved modern irrigation systems that have been installed reduce water use by 20-30% and salt-tolerant grasses for animal feed provide alternatives to thirsty Rhodes grass.
- ICBA, in collaboration with the Masdar Institute of Science & Technology (UAE), took the initiative in partnering with Boeing and the University of Arizona (USA) to evaluate the potential use of seawater to grow Salicornia. Seed sourced by ICBA produced about four times more seed than other genetic material, up to 1.9 tonnes of seed per hectare. This shows that there is a potential for the use of seawater in certain types of production systems (seawater-based agriculture), to reduce demand for freshwater.

Managing water and irrigation

In 2012, ICBA continued to generate data, explore technologies, and capture information on water use and water management. Some key achievements include:

- A knowledge hub has been launched at ICBA on surface and groundwater water availability, water use, and crop production under different climatic scenarios. The knowledge will support water managers and decision makers in the Middle East and North Africa in planning for sustainable development and water security. Remote sensing was used to model land cover and irrigation requirements for the period 2006-2035 in Tunisia and to assess changes in water use associated with climate change.
- ICBA has explored innovative new irrigation technologies in Gulf Cooperation Council countries for the first time. Sub-surface drip irrigation has been tested and results show that the sub-surface technology can reduce water use by 20% compared to surface drip irrigation. The sub-surface technology has potential for treated wastewater irrigation as it will reduce the odor associated with wastewater surface irrigation systems.

Diversifying and intensifying agriculture

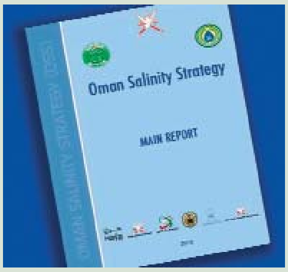
- In 2012, three new native rhizobia were isolated from the root nodules of cowpea and Sesbania at the ICBA research station. The strains are effective in forming nodules even at high salinity (12 dS m^{-1}). Tolerance to environmental stresses, especially high salinity and temperature, make these rhizobia highly valuable inoculums to improve the productivity of leguminous crops grown in marginal and salt-affected soils.
- ICBA's work with partners in Central Asia has identified promising dual-purpose sorghum and pearl millet varieties that can be sown as a second crop after wheat or rotated with rice. The dual-purpose varieties boost agricultural production and incomes in crop and crop-livestock systems in marginal areas. They can also diversify agricultural production in marginal environments.

- Sesbania is proving to be a promising forage crop for the Arabian Peninsula. ICBA's research demonstrates that 40% more forage can be produced using new cutting practices for Sesbania. Where water is slightly saline Sesbania can be a substitute for alfalfa.

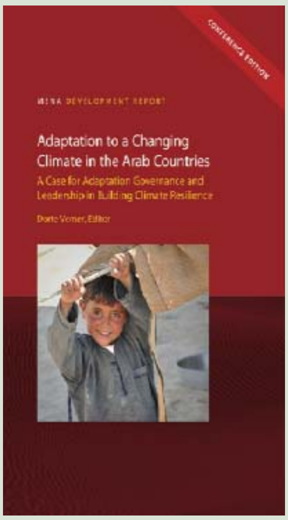
Informing strategy, policy, and governance

ICBA continues to address the needs of governments to develop strategies, standards, and frameworks. In 2012, ICBA contributed to and led a number of these initiatives.

- ICBA led the development of standards for brine disposal in the United Arab Emirates (UAE). On behalf of the UAE Ministry of Environment and Water, ICBA developed environmental guidelines and standards that will provide a framework for the UAE to better manage brine disposal from desalination plants while reducing the environmental impact on the marine ecosystem.



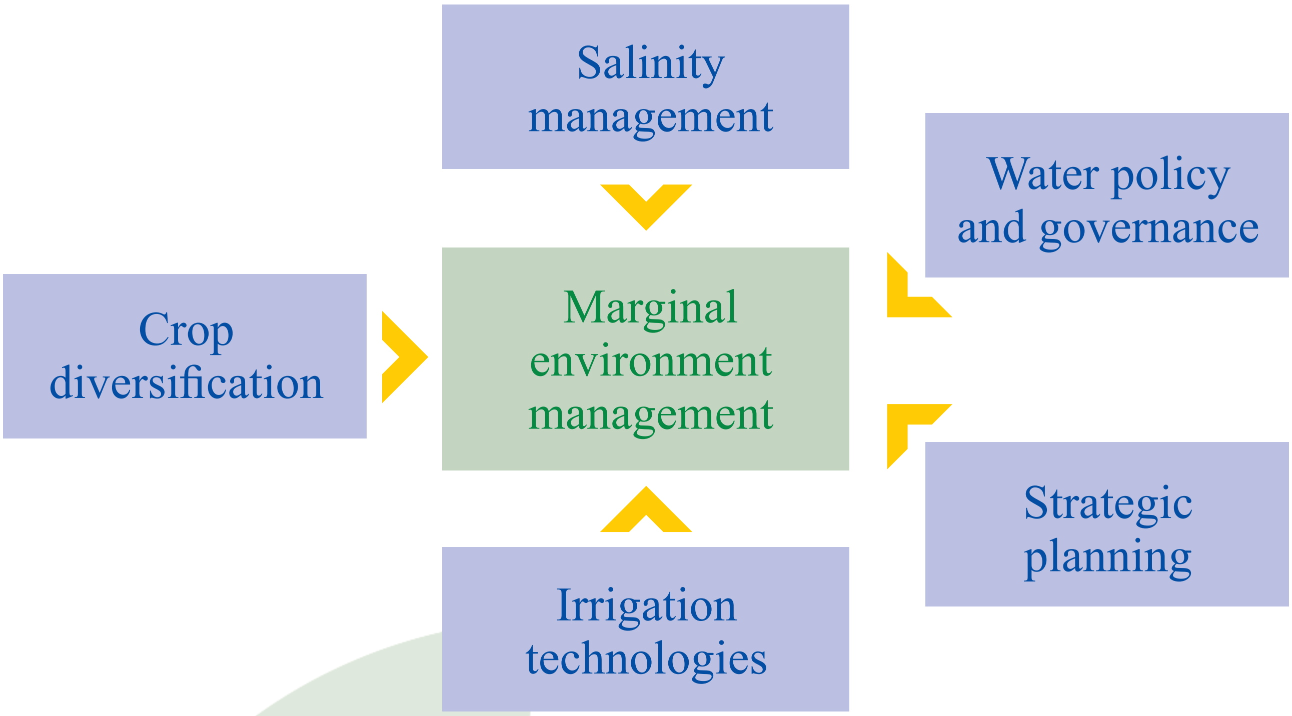
- ICBA helped to develop Oman's national plan to address salinity that was launched in 2012. The strategy sets out a framework for using saline water and managing saline land.
- ICBA finalized and presented the Organization of Islamic Cooperation's Water Vision to its 57 member countries. The vision promotes collaboration and cooperation in areas of water management.



- ICBA scientists contributed to three chapters in the World Bank report *Adaptation to a Changing Climate in the Arab Countries*. The report highlights the possibilities for adaptation in water, food security, and gender issues, and the policy options for adaptation.

OUR PROGRAM

Addressing the challenges that face marginal environments requires a holistic approach along the research-development-technology transfer continuum. With this in mind, ICBA organizes its program in five thematic areas (see below) to provide solutions for marginal areas that can be implemented at farm and policy levels.



PROVIDING FARMERS WITH BEST MANAGEMENT PRACTICES

Managing saline water is vital to sustaining the productivity of irrigated agriculture in marginal environments. Best management practices for using saline water provide farmers with opportunities to enhance crop production and improve their income.

Forages for dry saline environments in Central and West Asia and North Africa (CWANA)

Salt-tolerant annual and perennial forage crops can improve livestock productivity in dry saline environments. ICBA has developed crop management practices to maximize production of perennial buffel grass, and annual barley, triticale, pearl millet, and sorghum in saline conditions. *Cenchrus ciliaris* (buffel grass) is a perennial that can be grown in saline conditions to provide a continuous supply of forage for livestock. Short duration salt-tolerant annual forages with a low requirement for water are also important in these environments. More fodder on-farm allows farmers to keep more livestock, contributing to more intensive and remunerative livestock production.

Diversifying agriculture on marginal land in Kazakhstan, Tajikistan, and Uzbekistan

In salt-affected and degraded areas, diversifying crops and introducing sustainable land management practices can boost agricultural productivity and improve farmers' incomes. In the Central Asian countries of Kazakhstan, Tajikistan, and Uzbekistan, ICBA, in collaboration with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and local partners, has shown that sorghum and pearl millet can be grown as a second crop after wheat, as well as in rotation with rice.

Trials identified promising dual-purpose varieties that produce grain for food or feed for poultry, as well as feed for livestock. These dual-purpose varieties could fill gaps in the crop-livestock systems in the three countries. Seed of promising varieties is being produced and will be grown and evaluated under different management practices.

Providing solutions for cropping on saline land in Iraq

In certain parts of central and southern Iraq, soil salinity is so high that salt-tolerant varieties are the only answer. Work by ICBA, the International Center for Agricultural Research in the Dry Areas (ICARDA), and the International Water Management Institute (IWMI) has shown that salt-tolerant varieties of wheat and barley, and salt-tolerant grasses, can make productive agriculture possible across a wide range of salt-affected land. On moderately saline land, salt-tolerant wheat produced 3-5 tonnes of grain per hectare and salt-tolerant summer forage crops produced 5-12 tonnes of dry biomass per hectare. On more saline land, salt-tolerant barley produced 0.8-1.3 tonnes of grain per hectare and salt-tolerant grasses produced 7-12 tonnes of dry biomass per hectare.

This multi-partner research project is helping to address one of the biggest threats to food security in Iraq and will provide policy makers with the information they need to develop long-term plans for managing agricultural production on saline lands.

Building capacity in technologies for sorghum and pearl millet, and seed production
A training workshop on technology packages for sorghum and pearl millet and seed production in Central Asia was held in October, in Uzbekistan.

Low-cost biosaline technologies for the Aral Sea basin, Turkmenistan

Scarce freshwater in the Aral Sea basin means that communities have difficulties growing enough food and animal feed, and so are vulnerable to climate change. To turn this situation around, ICBA is introducing low-cost technologies in saline desert environments in Turkmenistan. These technologies will help farmers grow a wider range of crops, use poor quality water efficiently, produce more feed for livestock, and improve rangeland grazing.

The work has taken place on rangelands in Dashaouz, in northern Turkmenistan, and in the Central Korakum sandy desert environments in Karakuli, in southeast Turkmenistan. Early results indicate that by inter-planting salt-tolerant crops and trees, and growing dual-purpose salt-tolerant food-feed crops, communities could grow enough food for themselves and enough feed for their livestock. Dual-purpose food-feed crops, and shrubs and trees that use poor quality water efficiently, can improve the productivity of saline soils and rangeland grazing. By growing a variety of salt-tolerant crops and adopting practices to manage saline water sustainably, communities will be better prepared for changes in climate.

Salt-tolerant sorghum and pearl millet for saline land in Egypt, Jordan, Oman, Syria, Tunisia, and Yemen

Introducing salt-tolerant varieties of crops, such as sorghum and millet, to feed livestock can intensify and diversify production on saline land and boost farm incomes. ICBA and partners involved farmers in Egypt, Jordan, Oman, Syria, Tunisia, and Yemen in identifying sorghum and pearl millet varieties that grow well in saline environments and produce good feed for livestock.

More than 50 farmers grew the salt-tolerant pearl millet and sorghum varieties that had been selected and found them more profitable. The results of trials over 343 hectares spanning 40 environments in the six countries showed that the return on pearl millet grown under management practices developed by ICBA and national agricultural research system (NARS) partners was 43-62% higher than for millet grown in the traditional way, and 33-48% higher for sorghum. Farmers are now asking for seed of the best performing pearl millet and sorghum, and seed production is underway.

Building capacity in using marginal water

Twenty-one field days and training courses on producing feed for livestock with marginal water resources were held in November, in Egypt. Over 400 farmers were involved.

In Jordan, a workshop on screening salt-tolerant genotypes and production under saline conditions was held in December.

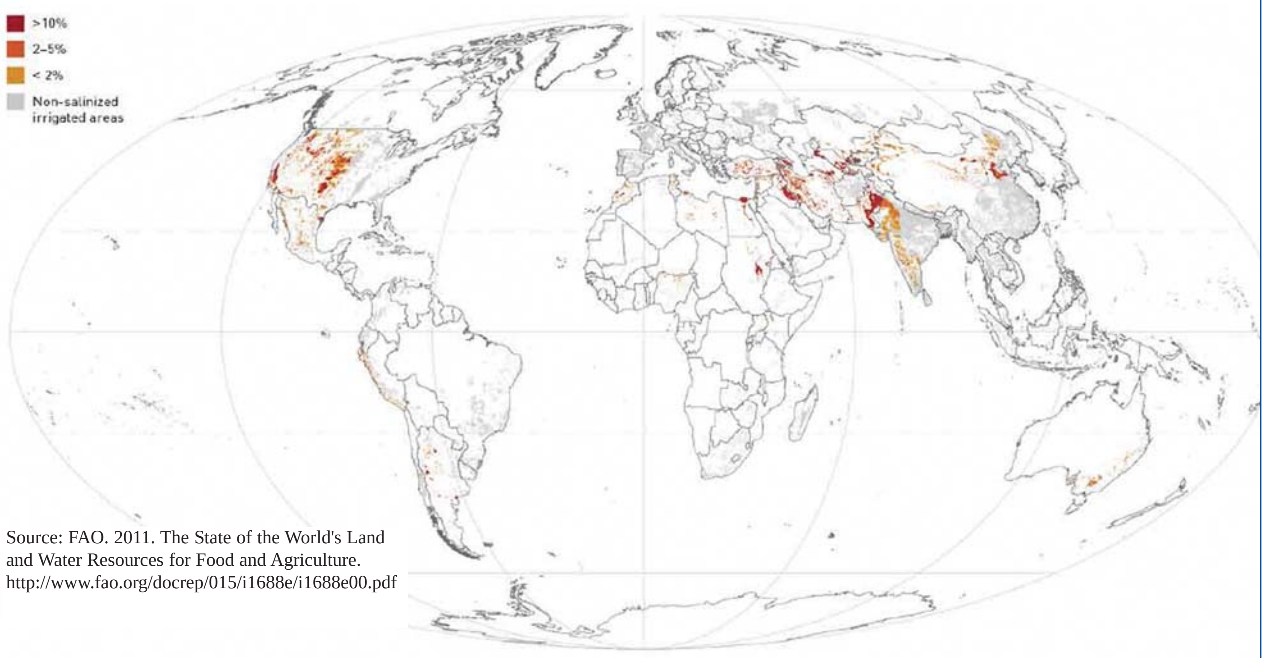
Rehabilitation of abandoned farms in Abu Dhabi

After dates, forages are the main crop in Abu Dhabi. Rhodes grass, a major forage crop, used to be grown on many farms in the northern and western regions. However, Rhodes grass is thirsty, requiring a considerable amount of freshwater and, because of this, has been withdrawn from the western region and will soon be banned in the northern region. This means an alternative is urgently needed.

ICBA and the Farmers' Services Centre, based in Abu Dhabi, are testing salt-tolerant annual and perennial grasses to substitute for Rhodes grass on three model farms in salt-affected areas – Madinat Zayed, Mezaira'a, and Ghayathi – in the western region. Farmers are helping select varieties that produce good quality feed for livestock, but need less water and are salt-tolerant. The farm at Madinat Zayed has been planted with the salt-tolerant grasses Distichlis, Sporobolus, and Paspalum. At Mezaira'a, in addition to the grasses, the salt-tolerant forage shrubs Acacia and Atriplex have been planted. The farm in Ghayathi has been equipped with a fully automated irrigation system and salinity sensors to monitor field salinity in real time. The Abu Dhabi Farmers' Services Centre and farming communities are finding the model farms very useful in identifying productive substitutes for Rhodes grass.

INTRODUCING NEW CROPS TO ENHANCE SALINE WATER PRODUCTIVITY

Proportion of land salinized due to irrigation



Source: FAO. 2011. The State of the World's Land and Water Resources for Food and Agriculture. http://www.fao.org/docrep/015/i1688e/i1688e00.pdf

Sustaining agricultural production in marginal environments means continuously searching for new crops that are tolerant to stresses, such as salinity and high temperatures. Farmers in marginal environments need a range of crops to widen their options and minimize their risks. Seed production of species adapted to marginal environments at ICBA ensures they are available to development projects and plant scientists worldwide.

Salt-tolerant native grasses and shrubs for animal feed

An important part of ICBA's work is to investigate forage grasses and trees that can be grown with saline water in conditions such as those found in the United Arab Emirates (UAE). Long-term studies at ICBA of a combination of *Sporobolus arbicus* and Paspalam with *Acacia ampliceps* and two grasses – a local variety of *Lasiurus scindicus*, and *Cenchrus ciliaris*, a variety introduced from Africa – show that such agroforestry systems can be productive. Cenchrus fixes atmospheric nitrogen through root nodules, adding fertility, and the agroforestry system makes efficient use of nutrients, both significant factors in the economics of farming in marginal conditions.

Halophytes for saline land in Uzbekistan

Some parts of the Aral Sea basin in Central Asia are naturally saline. Other parts have become saline because of poor irrigation management. ICBA is investigating the benefits of growing halophytes to make such areas productive and improve food security. Two research and demonstration sites have been set up in Uzbekistan. One is in Central Kyzylkum, an area of natural inland salinity, and the other is in Khorezm, on salinized old irrigated agricultural land near Shurkul Koshkupur Lake.

ICBA and Khorezm Rural Advisory Support Services surveyed 50 farms to provide baseline data and assess the feasibility of using halophytes for forage or producing biofuel. Scientists from ICBA and the Institute of Botany also collected seed of native halophytes. Some will be multiplied and grown to investigate their potential for biofuel feedstock. Others will be grown for livestock feed. The next step will be to provide seed and run training courses through women's groups on growing halophytes. In the years to come, barren land may be gradually transformed into crop-tree systems with many different productive species.

Building capacity in monitoring soil and water quality, and collecting wild seed

ICBA and Khorezm Rural Advisory Support Services organized a training workshop on 'Evaluation criteria for soil and water quality monitoring of Shurkul Koshkupur Lake environment' at Urgench State University, Uzbekistan.

Masters students and communities received training on how to collect seed of wild halophytes, raise plants from seed, and domesticate seed production.

Sesbania as an alternative to alfalfa

Sesbania, a legume grown for feeding livestock, could be a viable alternative to alfalfa in areas prone to salinity. Cutting Sesbania at regular intervals improves yields by 40% compared to when it is left uncut. Three cuts a year produced 44.6 tonnes per hectare of dry matter. This means that Sesbania has excellent potential as an alternative legume to replace alfalfa in low-salinity forage production systems.

Salicornia for green fuel

One potentially profitable crop that can be grown with seawater is Salicornia, also known as sea asparagus. Seeds of Salicornia can be used to produce biofuel. Researchers at the Masdar Institute (MI), along with companies such as Boeing, Etihad Airways, and UOP Honeywell, are looking at the potential of growing Salicornia and native halophytes with seawater for use as biofuel feedstock.

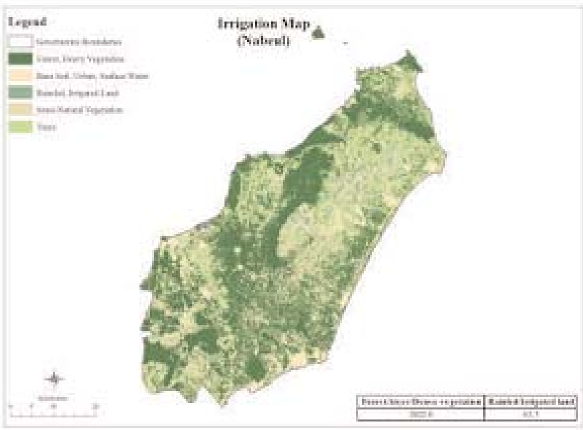
In 2012, ICBA and MI studied the growth of Salicornia irrigated with seawater under conditions in the United Arab Emirates (UAE). The results were encouraging. ICBA and MI will now evaluate genotypes of *S. bigelovii* and native UAE halophytes for their oil potential. The next step is to grow Salicornia for seed and to determine whether or not the seed produced is viable.

Seawater irrigation for livestock feed

Another crop that can be irrigated with seawater is NyPa grass. Over the last four years, ICBA and NyPa International have tested NyPa grass (*Distichlis spicata* var. Yensen 4a) in the arid conditions of the UAE. The results showed that the grass grew well when irrigated with seawater and grew again strongly after severe cutting. This means that, with proper management, NyPa grass irrigated with seawater can be grown to feed livestock in coastal areas.

PROVIDING INNOVATIVE SOLUTIONS TO MAKE THE MOST OF MARGINAL ENVIRONMENTS

Developing land cover and irrigation maps



Land cover and irrigation maps have been produced for Tunisia using NASA remotely sensed data. This map, for the Governorate of Nabeul, is being used as a basis for water use assessment using a biophysical crop model.

Sustainable intensification of agricultural production in less-favored, fragile, and marginal environments means finding innovative solutions that do not degrade the resource base. ICBA takes an integrated approach that considers water, crop, soil, climatic, and socioeconomic factors.

Rhizobia for improving productivity

Inoculums of the soil bacteria rhizobia are an easy and inexpensive way to enhance soil nitrogen and agricultural productivity. But the tolerance of rhizobia to environmental stress varies. The naturally occurring soil rhizobia in root nodules of cowpea and Sesbania in the UAE are, however, adapted to salinity and heat. ICBA scientists used sequencing technologies to isolate *Sinorhizobium meliloti* and *S. kostiense*, and three other species reported for the first time in the Arabian Peninsula, *S. terangae* and *S. arboris* (biovars 1 & 2). As these particular rhizobia are tolerant to high salinity and temperatures they could be very valuable as inoculums to improve the productivity of leguminous crops grown in other regions with similar conditions.

Treated wastewater – an alternative source of water

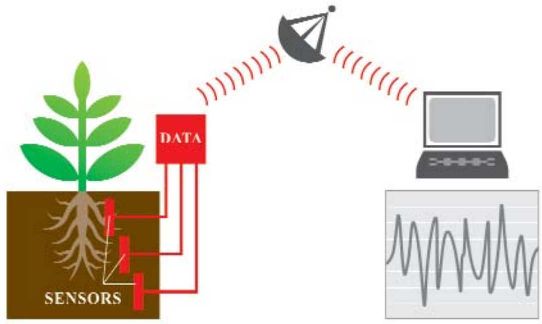
In water-scarce areas, treated wastewater (TWW) is a resource that can be used sustainably under certain conditions. Aspects that must be considered when using TWW are contamination by heavy metals and pathogens, the effects on plants, and the long-term effects on the environment. Agreed standards and guidelines for using TWW and building the capacity of extension services and farmers are important if TWW is to be used productively.

ICBA and partners made inventories of 426 wastewater treatment plants in Arab countries. Only half of the 388 million cubic meters of wastewater treated in a year is used for agriculture. Researchers at nine research stations then evaluated the risks associated with using TWW to irrigate forage crops, olive, citrus, and pomegranate. They found TWW had high concentrations of nickel and lead, and that irrigating with TWW led to significant accumulation of salt in the soil. ICBA and partners are exploring ways to overcome these problems as TWW may be important in augmenting agricultural water supplies in the future.

Investigations also involved farmers on 169 farms. The farmers helped evaluate forage crops suitable for irrigation with TWW – salt-tolerant beet, barley, sorghum, triticale, and pearl millet – and tillage and soil management practices. Part of the investigations is a survey of consumers regarding their attitudes towards produce grown with TWW.

INTRODUCING IRRIGATION TECHNOLOGIES FOR BETTER PRODUCTION SYSTEMS

Developing sensor technology for efficient irrigation management



Instruments to measure soil water content have been available for many years. However, only in recent years has sensor technology developed sufficiently to enable cost effective near-continuous monitoring of water content and movement in the soil as a tool in irrigation management.

As well as extensive first-hand knowledge and experience of farming systems in the Middle East, North Africa, the Arabian Gulf, and West and Central Asia, ICBA has considerable experience in irrigation technology and managing irrigation systems. Encouraging the use of more efficient irrigation technology is an effective, feasible way of reducing and making better use of water in agricultural production.

Moisture and salinity sensors for managing irrigation

Under arid and saline conditions, good irrigation management means supplying the right amount of water at the right time, and no more. Sensors to measure soil-water content and salinity near-continuously and in near-real time are powerful tools for improving irrigation management. Advances in instrumentation and communication can now provide agricultural producers with the information they need when they need it, and also enable automatic monitoring and feedback control of irrigation.

ICBA is developing a pilot system based on supervisory control and data acquisition (SCADA) to demonstrate the technical feasibility of using real-time measurements of soil moisture and salinity to manage irrigation in sandy soils. The sensors provide information on soil-water content, conductivity, temperature, crop water use, and the movement of water within and below the root zone. Control systems that combine up-to-date weather information and data from moisture and salinity sensors can improve irrigation management and conserve water.

Building capacity in the use of marginal water in agriculture

Two workshops were held at ICBA. One covered assessing the environmental impact and managing soil and water associated with using marginal water for agriculture. The other, in collaboration with the Ministry of Environment and Water, dealt with integrated management technologies for saline water.

Sub-surface drip irrigation, a first in the Gulf Cooperation Council region

In 2012, ICBA introduced sub-surface drip irrigation to the Gulf Cooperation Council region for the first time, testing the system at the ICBA research facilities. The results showed that the sub-surface drip system reduces water use by 20% compared to surface drip irrigation. The sub-surface technology has potential for use with treated wastewater as it will reduce the odors usually associated with wastewater irrigation.

Towards productive irrigated agriculture in Sub-Saharan Africa

In Sub-Saharan Africa, irrigated agriculture needs to become more productive and market-oriented in order to create jobs and stem migration from rural areas. ICBA is taking a multi-pronged approach to improving irrigated agriculture in seven countries – Burkina Faso, Gambia, Mauritania, Mali, Niger, Nigeria, and Senegal. The multi-pronged approach considers water, soils, irrigation, crop varieties, seed production, commercialization, diversification, socio-economics, markets, and value chains.

The first step has been to develop reliable data on water for each country, and in 2012 work began with a workshop to standardize methods of data collection.

Partners then made inventories of irrigation technologies, surveyed cropping patterns, and collected data on water resources. Some countries then moved on to start testing and demonstrating irrigation technologies and evaluating crops, cropping patterns, and crop production.

EXPLORING WAYS TO ADAPT TO CLIMATE CHANGE – A NECESSARY PATHWAY

ICBA looks at the nexus between water and agricultural production with particular emphasis on adaptation to climate change. The ultimate objective is to develop strategies and management practices for adapting to climate change in marginal environments.

Preparing farmers in the marginal environments of West Asia and North Africa (WANA) to adapt to climate change

Farmers who grow a wide range of crops lessen their risks, especially as climate change advances. If one crop fails all is not lost because they can still harvest others. But many farmers in marginal environments have difficulties finding varieties adapted to their particular farming conditions and getting hold of seed.

To address these issues and widen the range of crops available to farmers, ICBA and partners tested varieties of pearl millet and sorghum under different management practices on 50 field stations and 80 farms in six countries in West Asia and North Africa (WANA). Trials involved 400 farmers across 40 marginal environments. Revenues from pearl millet plots under best management practices were 43-62% more than from plots under traditional management practices, and for sorghum they were 33-48% more.

To meet demand from farmers for seed, ICBA and ICRISAT supplied pure seed of the most widely adapted pearl millet and sorghum to national agricultural research systems (NARS) for multiplying. Farmers were also trained to produce seed as farmer-managed seed production is low-cost and has long-term benefits.

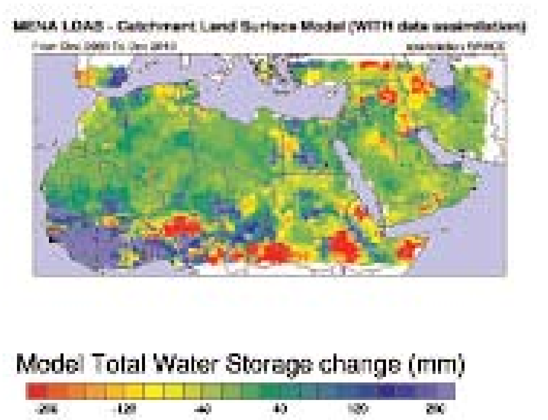
Building capacity for adapting to climate change

Training courses on production, management, genetic improvement, and seed were organized for staff of national agricultural research systems (NARS), and both men and women farmers.

The NARS organized 21 field days, training courses, and workshops involving more than 670 farmers.

GENERATING KNOWLEDGE TO SUPPORT ADAPTATION TO CLIMATE CHANGE

Developing regional models of groundwater and surface water resources in the Middle East and North Africa (MENA)



ICBA is helping develop regional models of groundwater and surface water resources in MENA. This harnesses cutting edge space-based earth observations and hydrological modeling and represents a new era in water resources assessment in the region. The model, the MENA Land Data Assimilation System (LDAS), produces not only current observations of water amounts, but also expected future amounts according to the latest climate change projections.

Up-to-date information on water use in different sectors and the likely effects of changes in climate on water resources and agriculture are essential in managing water for sustainable development. To provide governments with comprehensive information, ICBA and partners are collecting and processing data and new information from geographic information systems (GIS), remote sensing, and modeling to model future scenarios and perform risk analyses. Governments can use the scenarios and analyses to assess opportunities and constraints imposed by regional climate conditions on sustainable development and food security.

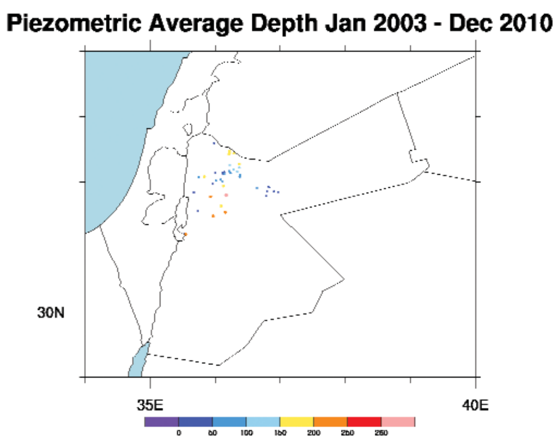
A knowledge hub for water information and knowledge

As part of the Modeling and Monitoring Agriculture and Water Resources Development (MAWRED) program, ICBA, in collaboration with the US National Aeronautics and Space Administration (NASA) Goddard Space Flight Center (GSFC), has developed regional and country-scale monitoring and modeling of groundwater, soil moisture, and surface resources, as well as land cover and irrigation water use. The MAWRED program harnesses cutting edge space-based earth observations and land surface modeling to bring new insight to water and agriculture resource assessment in the Middle East and North Africa. In 2012, through remote sensing and classification techniques, vegetation cover maps for Tunisia were produced. The model is now being calibrated and verified.

Building capacity in analyzing water data and modeling

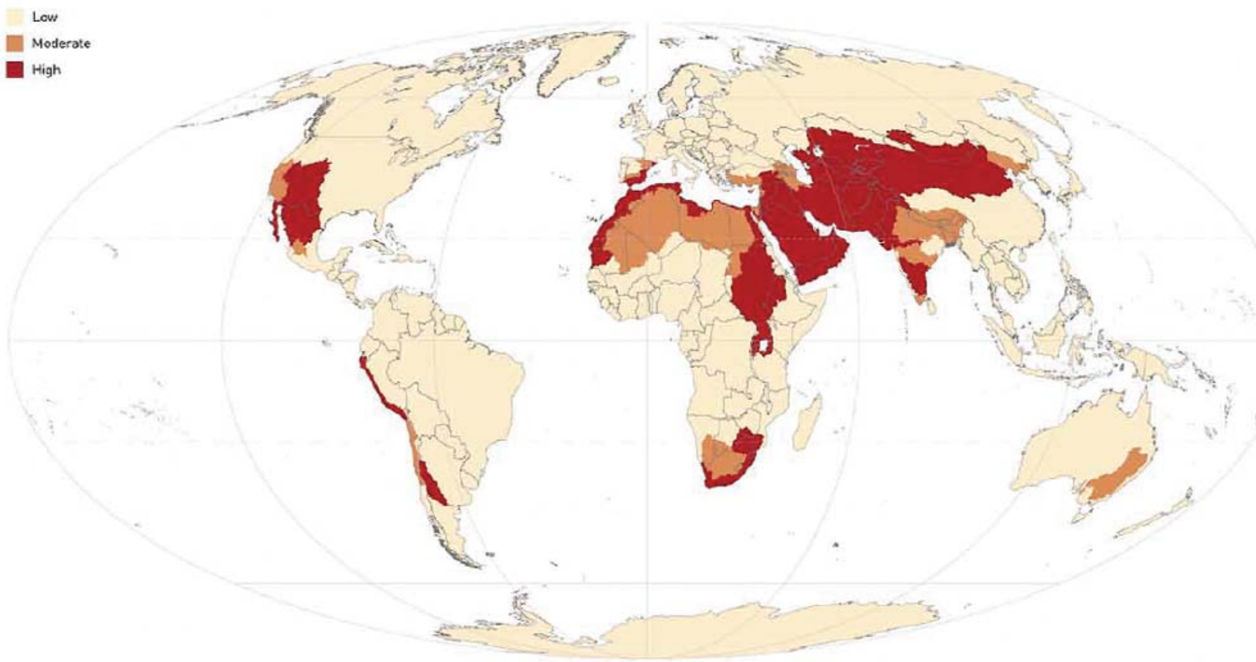
An important part of the MAWRED program is developing communities of practice. Researchers and policy developers spend time at the ICBA knowledge hub to learn new data and modeling techniques that they can apply to problems in their countries.

The North-South Research Center for Social Sciences (NRCS), Morocco, the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Germany, the National Council for Climate Change, Sustainable Development and Leadership (NCCSD), India, and ICBA held an international conference in Marrakech, in November. The conference addressed the need for a new vision for science, policy, and leadership, and to view climate change as opportunity. A workshop, held in conjunction with the conference, looked at key concepts, tools, and successful practices for environmental mainstreaming in development planning with a focus on climate change.



HELPING COUNTRIES DEVELOP POLICIES, STRATEGIES, AND FRAMEWORKS

Global distribution of water scarcity by major river basin



Governments take the lead in scaling up technical innovations, and applying new knowledge to water and land use. But to inform policy and decide on appropriate strategies for water, agriculture, and the environment they need reliable information on water resources, cropping systems, and soil salinity. ICBA has compiled comprehensive information from the Middle East and North Africa (MENA), Gulf Cooperation Council (GCC) region, and Sub-Saharan Africa (SSA) to help prepare strategies and plans for water and agriculture.

A national salinity strategy for Oman

In Oman, the expansion of agriculture in the 1990s had a negative effect on agricultural productivity. The 'Oman Salinity Strategy', developed collaboratively by ICBA and the Omani Ministry of Agriculture and Fisheries, is a framework for preventing salinity and pollution, and for using water resources sustainably and economically.

The strategy is based on a scientific assessment of salinity problems in Oman. Consultations with key ministries, government agencies, and local and international specialists ensured that recommendations were based on up-to-date information and current thinking. The strategy assesses current water resources and future demand, water use in agriculture and the impact of salinity, socioeconomic issues, governance, legal and regulatory frameworks and policies, and developing capacity for managing salinity.

Oman Salinity Strategy

The main recommendation in the Oman Salinity Strategy is that seawater intrusion and the salinization of agricultural land in Oman cannot be solved without introducing measures to reduce and eventually eliminate groundwater overdraft. This will require the following actions:

- National coordination of major water users and planning, monitoring, and regulatory agencies.
- Improving agricultural extension services, as this will eventually deliver a high return to the economy. This should be given a high priority in the implementation of the Salinity Strategy.
- Capacity development is a key, but often neglected, area. Capacity building will need to involve stakeholders at all levels – individual, organizational, and institutional.
- Reducing the use of groundwater will add significant value to the economy and enable sustainable agriculture.
- Continuing to invest in upgrading on-farm irrigation efficiency, new recharge dams, and reuse of treated wastewater will not be sufficient to slow down the rate of seawater intrusion. There has to be a cut in overall groundwater use.
- Agricultural water demand for different crops is poorly defined. Extensive on-farm research and monitoring is required to refine knowledge on actual water use in order to reduce the uncertainty in predicting changes in groundwater availability and seawater intrusion.
- The economic efficacy of, and water conservation gains from, irrigation efficiency improvements to date is unknown. More research is required to establish the nature of the gains.
- Continued use of salt-affected lands must be judged objectively given that the volume of good quality groundwater is a bigger constraint than the availability of cultivable land. Water should be used where it adds the greatest value to the economy.

A water vision for the Organization of Islamic Cooperation

In 2012, two years of consultations culminated in the adoption by the 57 countries of the Organization of Islamic Cooperation (OIC) of a vision to foster collaboration and cooperation on water. The OIC Water Vision responds to the challenge of securing reliable access to water for health, livelihoods, and production and managing the risks related to water associated with population growth, depletion of resources, environmental degradation, and climate change.

Close collaboration with major stakeholders, ministries responsible for water in OIC member countries, and key Islamic organizations has ensured that the vision is culturally and politically appropriate as a framework for developing water policy and management in all 57 countries. The UAE has nominated ICBA to support translating the vision into action.

Standards for brine disposal in the United Arab Emirates

In the Arabian Gulf, desalinated seawater is important in meeting a significant proportion of freshwater needs. Seawater is a shared resource and must be protected from pollution, including from brine produced by the desalination itself. Environmental standards for desalination plants and guidelines for monitoring discharge will help prevent pollution and minimize environmental impacts.

In 2012, on behalf of the United Arab Emirates Ministry of Environment and Water, ICBA developed standards for managing and monitoring brine disposal from desalination plants. In developing the standards, ICBA reviewed existing environmental guidelines and standards in each emirate, took into account international best practice, and consulted widely with stakeholders.

A strategy for sustainable agriculture in the United Arab Emirates

The United Arab Emirates (UAE) has limited renewable freshwater resources and limited land suitable for agriculture. Groundwater resources are dwindling and the quality is deteriorating. The UAE used to produce all types of agricultural produce, mainly fruit, dates, vegetables, and animal feed. However, few farms are now productive because land has become salinized and water has been over-exploited.

In 2012, ICBA and the Ministry of Environment and Water began developing a national strategic plan for improving plant and animal production in the UAE. The plan will consider water productivity, water efficient crops, and best management practices, and provide a framework for developing the agricultural sector while sustainably using natural resources. Work began on assessing land, water, agricultural systems, and production through a socioeconomic survey of crop, livestock and crop-livestock systems, and a survey of abandoned farms.

Contribution of ICBA to the World Bank study *Adaptation to a Changing Climate in the Arab Countries*

While the Arab region has been adapting to changes in rainfall and temperature for thousands of years, the speed with which the climate is now changing has, in many cases, outstripped traditional coping mechanisms. The World Bank study *Adaptation to a Changing Climate in the Arab Countries* draws on extensive regional knowledge and expertise for a comprehensive analysis of the potential impact of climate change in the Arab region. ICBA scientists contributed to this study by drafting three chapters.

BUILDING CAPACITY

A core component of ICBA's applied research and development programs is developing capacity and organizing training.

Capacity building in 2012

In 2012, capacity building activities included:

- Environmental impact assessment and soil and irrigation management associated with the use of marginal water in agricultural production. Organized at ICBA, the 18 participants came from Egypt, Jordan, Oman, Palestine, Tunisia, the UAE, and Yemen.
- Integrated management technologies of saline water. Organized at ICBA, 15 participants from the UAE took part.
- Integrated management technologies of marginal water (treated wastewater). Organized at ICBA, 16 participants from the UAE took part.
- Farmers' schools for forage production and utilization techniques under the use of marginal water resources were organized in Egypt. There were 70 participants from Egypt, Jordan, Oman, Tunisia, the UAE, and Yemen.
- Seed production and maintenance of technology packages for sorghum and pearl millet in Central Asia, Tashkent, and Uzbekistan. Organized in Uzbekistan by ICBA in collaboration with the CGIAR Program Facilitation Unit for Central Asia and the Caucasus (ICARDA and ICRISAT), 20 participants from Uzbekistan, Kazakhstan, and Tajikistan took part.
- Environmental cost and changing face of agriculture in the Gulf States held at Cambridge University. ICBA has taken the lead in editing a book arising from the workshop, which is being published by the Gulf Research Council.

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ICBA DONORS AND PARTNERS

Core donors

- Ministry of Environment and Water, UAE
- Environmental Agency, Abu Dhabi, UAE
- Islamic Development Bank

Grant donors

- Arab Bank for Economic Development in Africa (BADEA)
- Arab Fund for Economic and Social Development (AFESD)
- Australian Agency for International Development (AusAID)
- Australian Center for International Agricultural Research (ACIAR)
- European Union
- International Fund for Agricultural Development (IFAD)
- OPEC Foundation for International Development
- United States Agency for International Development (USAID)
- The World Bank

Partners

- Abu Dhabi Farmers' Services Centre, UAE
- Abu Dhabi Food Control Authority (ADFCA)
- Arab Water Council (AWC)
- Arab League
- Du Pont
- International Center for Agriculture Research in the Dry Areas (ICARDA)
- International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
- International Water Management Institute (IWMI)
- Masdar/Boeing, UAE
- Ministry of Agriculture and Fisheries, Oman
- NARS of Partner Countries
- Organization for Agriculture in Saline Environments (OASE)
- United Nations Development Programme (UNDP)
- UAE University
- UAE Municipalities
- Universities

FINANCIAL SUMMARY

Statement of activities

GRANTS AND CONTRIBUTIONS	2012 USD	2011 USD
Grants unrestricted	7,000,000	7,000,000
Grants restricted	1,828,715	2,110,361
Interest income	151,879	54,635
Other income	6,220	62,271
Total grants and contributions	8,986,814	9,227,267

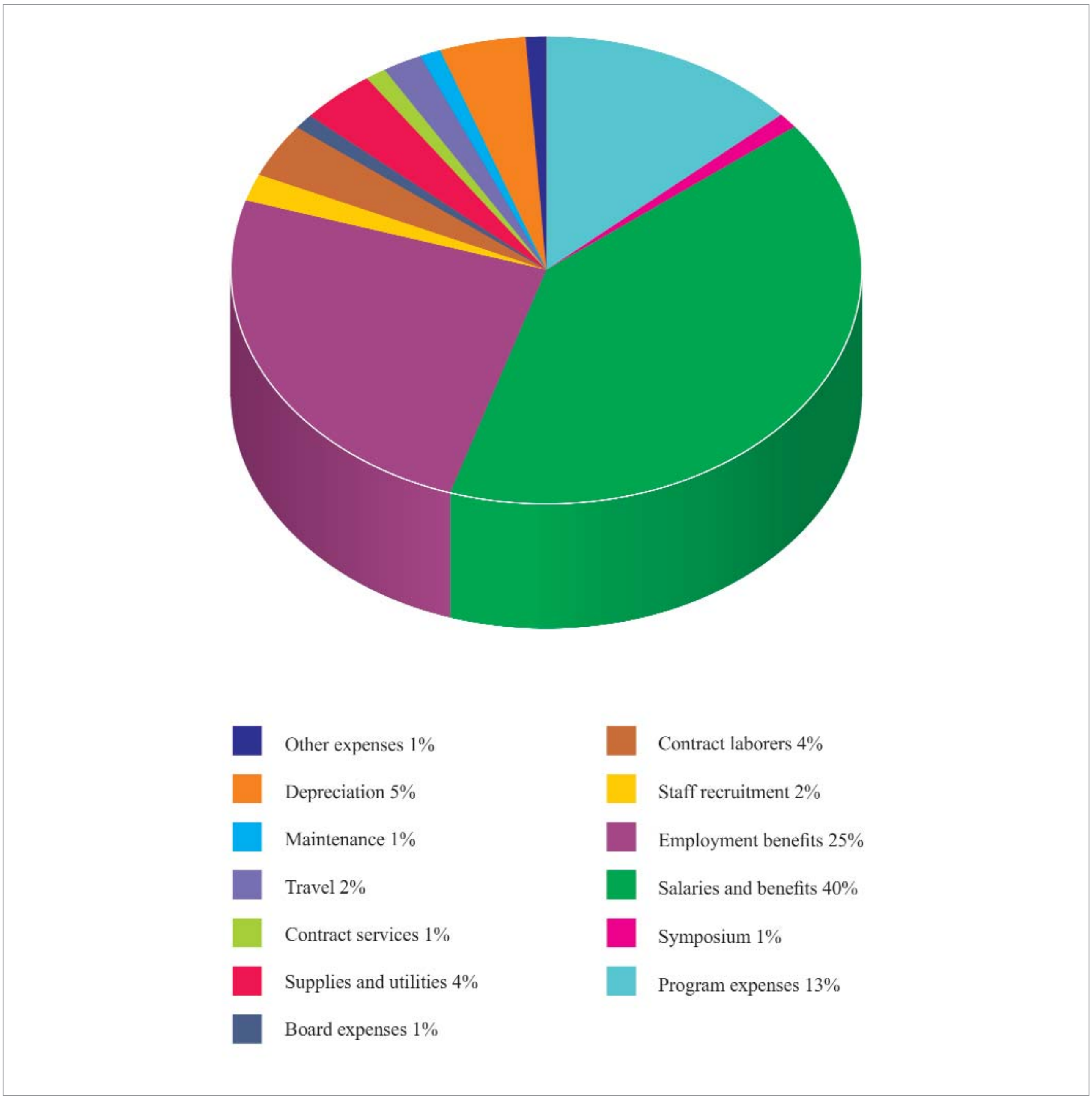
PROGRAMS AND LOSSES	2012 USD	2011 USD
Program expenses	(1,016,551)	(1,564,295)
Symposium	(107,330)	-
Management and general expenses	(6,410,281)	(5,560,174)
Total expenses and losses	(7,534,162)	(7,124,469)
SURPLUS FOR THE YEAR	**1,452,652**	**2,102,798**

Statement of financial position

ASSETS	2012 USD	2011 USD
Current assets		
Cash and cash equivalents	2,885,345	11,936,860
Short-term deposits	9,918,478	-
Receivables from donors	292,203	-
Other receivables	111,250	-
Due from employees	43,067	11,644
Prepayments	125,037	39,880
Inventory	17,825	-
Non-current assets		
Property and equipment	6,006,155	5,767,229
Total assets	19,399,360	17,755,613

LIABILITIES AND NET ASSETS	2012 USD	2011 USD
Current liabilities	688,895	576,264
Non-current liabilities	497,530	354,338
Total liabilities	1,186,425	930,602
Net assets unrestricted, unappropriated – property and equipment	6,006,155	5,767,229
Net assets unrestricted, unappropriated – other	2,950,872	2,469,436
Net assets unrestricted, appropriated	7,495,443	5,760,687
Net assets temporarily restricted	1,760,465	2,827,659
Total net assets	18,212,935	16,825,011
TOTAL LIABILITIES AND NET ASSETS	**19,399,360**	**17,755,613**

Expenditure by category



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