



**A Year in Focus:
Impact Report**

2023

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Impact Report
2023**

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Minister of Climate Change and Environment of the UAE



H.E. Dr. Muhammad Sulaiman Al Jasser

President of the Islamic Development Bank and Group Chairman

Acknowledgement of Core Donors

We sincerely acknowledge the Ministry of Climate Change and Environment (MOCCAE), the Islamic Development Bank (IsDB), and the Environment Agency – Abu Dhabi (EAD) for their vital and continued support. Their contributions have been integral to advancing

ICBA's mission of addressing the critical challenges of climate change, water scarcity, and soil salinity in arid and saline regions. Their partnership strengthens our ability to implement impactful solutions, enhance food security, and build resilience for vulnerable

communities worldwide. We deeply value their trust and collaboration, which are pivotal in achieving ICBA's vision of sustainable and climate-resilient agriculture.



H.E. Razan Khalifa Al Mubarak
Managing Director,
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Abu Dhabi (Chair)



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Dr. Tarifa Alzaabi
Director General, ICBA
(Ex officio member)

Acknowledgement of the Board of Directors

We extend our deepest gratitude to the Board of Directors for their unwavering guidance, strategic vision, and commitment to ICBA's mission. Their leadership has

been instrumental in advancing our work to address critical agricultural and environmental challenges in arid and saline environments. The Board's dedication to ICBA's vision of

sustainable livelihoods and food security is a cornerstone of our progress and success, and we are profoundly thankful for their continued support and insightful governance.



Dr. Tarifa Alzaabi
Director General

Foreword from the Director General

The year 2023 was a defining one for the International Center for Biosaline Agriculture (ICBA). As the United Arab Emirates hosted the 28th UN Climate Change Conference (COP28), the world's attention turned to the very challenges that have shaped our center's mission for nearly a quarter of a century: climate change, water scarcity,

land degradation, and the pressing need to transform food systems in the world's most fragile environments. ICBA entered this moment with purpose, translating decades of science into action for the communities who need it most.

Across the year, our scientists and partners

delivered on 48 research and development projects, mobilizing USD 9.9 million to advance solutions for arid and saline landscapes. From the UAE and the wider Middle East to North Africa, Central Asia, South Asia, and sub-Saharan Africa, ICBA's work continued to focus on what matters on the ground — resilient crops, efficient use of

scarce water, healthier soils, and livelihoods that can withstand a changing climate.

Science remained at the heart of our progress. At the Desert Life Science Laboratory, our researchers completed the whole-genome sequencing and assembly of *Citrullus colocynthis* and *Salicornia bigelovii*, unlocking new possibilities for breeding crops suited to desert conditions. Our teams advanced climate-resilient cereals such as pearl millet, finger millet, foxtail millet, fonio, quinoa, and amaranth, while piloting controlled-environment agriculture, aquaponics, and solar-powered irrigation in countries as diverse as Morocco, Burkina Faso, Mali, and

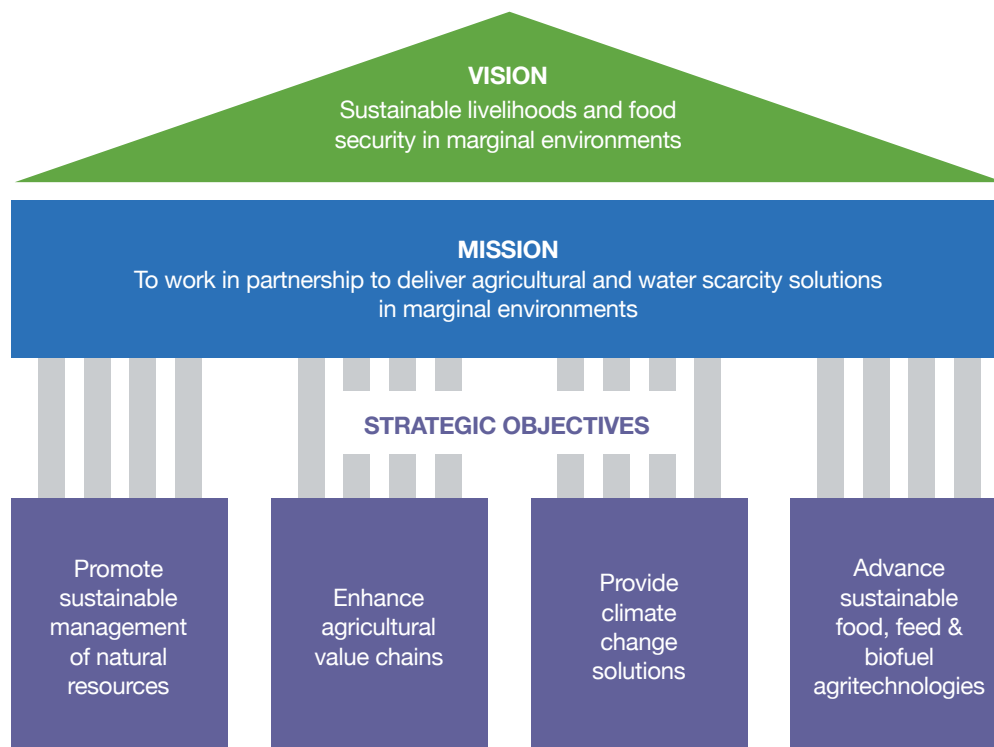
Niger. These efforts were complemented by 22 published peer-reviewed journal articles that bring our findings to the wider scientific community.

Capacity development remained a cornerstone of our mission. We trained 3,729 specialists through in-person and online courses, hosted 41 interns from eight countries, and launched three new CPD-certified e-learning courses with the Environment Agency - Abu Dhabi. We also welcomed the third cohort of the Arab Women Leaders in Agriculture fellowship, continuing to invest in the next generation of women scientists from the region.

I extend my sincere gratitude to our Board of Directors for their steady guidance, to our donors and partners for their continued trust, and to ICBA's staff for the dedication that makes our work possible. Together, we are building a more food-secure, climate-resilient future for the communities we serve.



ICBA at a glance



ICBA is an international not-for-profit applied agricultural research center with a unique focus on marginal environments where an estimated 1.7 billion people live. It identifies, tests, and introduces resource-efficient, climate-smart crops and technologies that are best suited to different regions affected by salinity water

scarcity, and drought, among other factors.

Since its formation in 1999, the center has implemented projects in some 40 countries in Central Asia, the Middle East, North Africa, South Asia, the South Caucasus, and sub-Saharan Africa.

ICBA has also expanded its network of partners around the world to increase the reach and impact of its work. It has partners in more than 50 countries, enabling it to leverage a vast and diverse pool of expertise to achieve lasting outcomes on the ground.

It is a founding member of the Association of International Research and Development Centers for Agriculture, a six-strong alliance focused on increasing global food security by supporting smallholder agriculture within healthy, sustainable, and climate-smart landscapes.



Through its work, ICBA helps to create jobs, and improve livelihoods, food security, and nutrition for some of the poorest rural communities around the world.

ICBA contributes to the achievement of seven Sustainable Development Goals:



2023 in numbers

12



48
projects



13
new collaborative
agreements



1,407
mentions in leading
news outlets



22
published peer-reviewed
journal articles



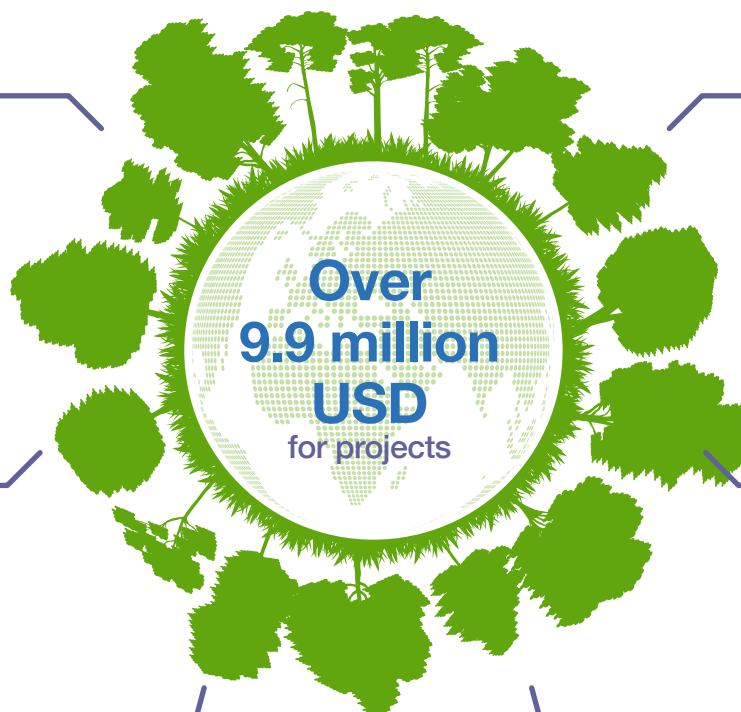
30,142
YouTube video
views



130,777
website
sessions



11
MoUs

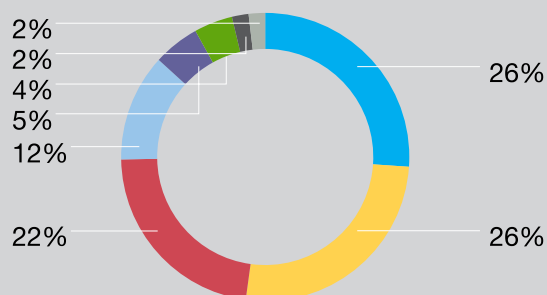


60 beneficiary countries*



* This also includes beneficiaries of capacity development programs.

Funding Sources



- Environment Agency - Abu Dhabi
- Ministry of Climate Change and Environment
- Islamic Development Bank
- Other External Donors
- International Fund for Agricultural Development
- Sergey Bin Family Foundation
- Food and Agriculture Organization of the United Nations (FAO)
- Emirates Nature - WWF

Highlights of 2023

ICBA earns Gold Impact Seal for sustainability leadership



In November 2023, ICBA received the Impact Seal “Gold Tier” from Majra, the National CSR Fund, at the World With Purpose Summit in Dubai — a federal recognition of ICBA’s record on environmental, social, and governance principles and the UN Sustainable Development Goals.

The Impact Seal is awarded by Majra to organizations that demonstrate outstanding commitment to sustainable impact, corporate social responsibility, and alignment with UAE

national priorities. It assesses performance across governance, environmental stewardship, and social impact. ICBA’s receipt of the Gold Tier — the highest level — reflects the breadth and depth of research and development work the center has sustained over more than two decades.

ICBA’s contributions to sustainability are wide-ranging. Its research addresses food and water security in some of the world’s most resource-constrained environments, working

across 40-plus countries in the Middle East, North Africa, Central Asia, South Asia, and sub-Saharan Africa. In the UAE specifically, ICBA runs long-term experiments on date palm management, tests resource-efficient agricultural technologies, manages one of the world’s most important collections of salt-tolerant plant genetic resources, and operates the Emirates Soil Museum — a public education and awareness hub that engaged more than 3,100 visitors in 2023.

Dr. Tarifa Alzaabi, Director General of ICBA, says: “With COP28 taking place in the UAE, we had a unique platform to demonstrate that climate-resilient crops like millets deserve a central place in the global food security conversation. The Millet Demo Farm brought that message to life.”

The award reinforces ICBA’s growing profile as a globally recognized center of agricultural research excellence, just as the UAE hosted COP28 — a moment that put the country’s leadership on climate and food systems in the international spotlight.

Millets take center stage at COP28



When COP28 convened in Dubai in late 2023, ICBA seized a once-in-a-generation opportunity: a global climate summit on its home turf, during the International Year of Millets.

To mark the occasion, ICBA launched a Millet Demo Farm on the sidelines of the conference in collaboration with SELCO Foundation. The farm showcased the complete millet value chain – from seed production through harvest, processing and consumption – in a

single, walkable site. More than 40 delegates attended the launch ceremony, including senior representatives from the Ministry of Climate Change and Environment of the UAE, the Food and Agriculture Organization of the United Nations (FAO) and the Islamic Development Bank (IsDB). Participants toured active millet research plots and post-harvest processing equipment, then sampled a range of millet-based dishes – a farm-to-fork experience that made the case for these ancient grains as both a food security tool

and a climate adaptation strategy.

ICBA's work on millets dates to 1999. In recent years the center has broadened its focus to include minor millet species such as finger millet, foxtail millet, proso millet and fonio, which trials at ICBA's research station have shown to be resilient under water stress and saline irrigation while delivering strong nutritional profiles. Their low input requirements give them a far smaller environmental footprint than conventional cereals.

Dr. Tarifa Alzaabi, Director General of ICBA, says: "With COP28 taking place in the UAE, we had a unique platform to demonstrate that climate-resilient crops like millets deserve a central place in the global food security conversation. The Millet Demo Farm brought that message to life."

With the demo farm now established at ICBA's Dubai headquarters and new partnerships in place, the center is well positioned to scale up millet value chains across the Middle East, North Africa and beyond.



An estimated
8.5%
of the global
population
lived in
extreme
poverty in
2023.





**End poverty in all its
forms everywhere**

About 682 million people suffered from extreme poverty, with sub-Saharan Africa accounting for the majority of the world's destitute*.

While the figure dropped a little as the global economy picked up after the pandemic, poverty rates returned to the levels in 2019.

The latest data shows that extreme poverty is more pronounced in such regions as sub-Saharan Africa, which is home to 66 percent of all people who subsist on less than 2 USD a day.

Most of the extremely poor in rural areas rely on smallholder or subsistence farming. And it is reckoned that there are more than 608 million smallholder farming households worldwide**.

Lacking adequate skills and resources to farm sustainably and profitably, these people are most vulnerable to climate change and other risks to agriculture.

To help them lift themselves out of poverty, it is important to equip them with necessary skills, crops, and technologies so that they can better manage risks and produce enough food to eat and sell.

* Christensen, Z. (2023, February 28). Economic poverty trends: global, regional and national. Development Initiatives. <https://devinit.org/resources/poverty-trends-global-regional-and-national/#note-LdT0zfnCI>

** Food and Agriculture Organization of the United Nations. (2021). Small family farmers produce a third of the world's food. <https://www.fao.org/news/story/en/item/1395127/icode/>



From mining pit to productive farmland in Morocco

When phosphate mining ends, it leaves behind a landscape stripped of topsoil, compacted and chemically altered – bearing little resemblance to the farmland that may once have surrounded it. For communities living near phosphate mines in Morocco’s Youssoufia region, reclaiming that land for productive agriculture represents both an environmental imperative and a chance to restore rural livelihoods.

Since 2018, ICBA has worked with the OCP Group – Morocco’s Office Chérifien des Phosphates and the world’s largest phosphate exporter – to establish a model experimental farm on reclaimed land at the Bouchane mine site in the Gantour mining basin near Youssoufia. The project set out to identify which crops and tree species could establish successfully on disturbed soils and to test organic amendments, irrigation systems and rainwater harvesting techniques to support them.

Over five years, ICBA researchers trialed four agricultural systems across the rehabilitated land, evaluating more than a dozen crops including olives, almonds, figs, pomegranates, capers, rosemary, carob, cactus, moringa and various cereals and forages. The results provided a clear picture of what thrives on reclaimed phosphate soils – and what does not. Quinoa, sorghum and millet struggled, with biomass yields roughly 70 percent lower than other tested crops. But several species performed strongly. Olive trees, particularly the Menara variety, showed a 15 percent average annual height increase. Almonds, figs, carob and jujube also established well.

Drip irrigation significantly outperformed other approaches, and organic amendments consistently boosted growth. Perhaps most practically, a semi-circular rainwater harvesting ridge design increased plant height by 12 percent compared to other techniques – a meaningful gain in a rainfed system where every drop counts.

Dr. Ahmed H. El-Naggar, Soil Management Scientist at ICBA, says: “Rehabilitating mined land is not just an environmental exercise – it is a food security opportunity. Our work in Youssoufia has shown that with the right species selection, the right agronomic practices and careful water management, disturbed soils can become productive again. That knowledge is transferable to mining communities well beyond Morocco.”

The project’s final report was delivered to OCP in 2023, giving the company and the communities near Youssoufia a science-based blueprint for transforming post-mining landscapes into functional, income-generating farms.

Reviving licorice as a livelihood crop in Uzbekistan

In Uzbekistan's arid lowlands, licorice (*Glycyrrhiza glabra*) has grown wild for centuries, prized for its medicinal properties and its remarkable tolerance of saline and drought-stressed soils. Yet despite global demand for licorice root in pharmaceutical, confectionery and cosmetic applications, systematic cultivation of the crop has been neglected. Most licorice harvested in Central Asia is still wild-sourced – an unsustainable practice that has seen natural habitat in Karakalpakstan shrink from 38,000 hectares in the 1960s to just 6,500 hectares by 2020.

ICBA, working with the German development agency GIZ and national partners in Uzbekistan, supported a project in 2023 to develop sustainable cultivation practices that could transform licorice from a wild-harvested resource into a reliably produced crop – and in doing so, create new income opportunities for rural communities.

The project combined research on best agronomic practices – covering water management, nutrient application and pest control in saline environments – with intensive on-farm training delivered primarily at a pilot plot at the International Innovation Center for the Aral Sea Basin experimental station in Karakalpakstan.

Farmers and agricultural professionals engaged in hands-on learning that covered the full production cycle, from soil preparation and planting to harvest and post-harvest handling. Participants also received training on the economic potential of sustainable licorice cultivation, the value of developing domestic processing capacity and the ecological benefits of managed cultivation over wild harvesting. A training manual is being finalized to codify these lessons for ongoing use.

Dr. Botir Khaitov, a plant scientist at ICBA, says: “Licorice tolerates conditions that would defeat most other commercially useful plants, and there is genuine international demand for quality-controlled root. The challenge has been bridging the gap between wild harvesting and sustainable managed cultivation. This project is showing that it can be done, and the results are encouraging.”

With training completed and the manual in development, the next phase will focus on policy briefs to guide government support for a sustainable national licorice industry – one that could generate rural employment, boost export revenue and demonstrate the value of treating traditional crops as economic assets.





Solar irrigation brings water security to West Africa's smallholders

Access to reliable water for irrigation is one of the most persistent constraints on agricultural productivity for smallholder farmers across sub-Saharan Africa. Without it, crops fail, incomes stagnate and communities remain caught in cycles of food insecurity and poverty. In the arid Sahel, where rainfall is erratic and groundwater often the only available source, the challenge is particularly acute.

As part of an IsDB-funded project to develop an investment plan for scaling up small-scale irrigation across the region, ICBA installed solar-powered Californian irrigation systems at sites in Burkina Faso, Mali and Niger in 2023. A project agreement with Senegal was also signed, and activities there began in April 2023. The low-cost Californian system draws water from boreholes equipped with solar pumps and delivers it to fields through a simple network of pipes – eliminating the cost and logistical burden of diesel fuel while producing no emissions.

Initial results from Mali and Burkina Faso are striking. By switching from manual watering to Californian irrigation with a constant water supply from a solar-powered borehole, combined with timely fertilizer application, farmers increased the

biomass yield of fodder crops from 47 to 65 tons per hectare – a gain of 39 percent. Water consumption for irrigation fell by 45 percent. In Mali alone, 175 smallholder farmers transformed previously low-yielding land into productive plots covering about 75 hectares in the areas of Koulikoro and Bougouni/Sikasso. Similar results were recorded in Burkina Faso and Niger.

Dr. Asad Sarwar Qureshi, a senior scientist in irrigation and water management at ICBA, says: “Over the past decade, we have worked with partners across the Sahel to identify cost-effective irrigation technologies suited to local conditions. The Californian system, powered by solar energy, is proving to be a practical and affordable solution that gives smallholder farmers control over their water supply and breaks their dependence on unpredictable rainfall.”

To guide future investment, the project team developed GIS maps to identify priority sites for small-scale irrigation expansion in Burkina Faso and Mali, with mapping work also under way in Niger. These tools will underpin an investment plan aimed at unlocking larger-scale financing for solar irrigation across the region.



**As many as
735
million
people faced
hunger in
the world in
2023.**



**End hunger, achieve food
security and improved
nutrition and promote
sustainable agriculture**

About 9.2 percent of the global population was affected by hunger in 2022, up from 7.9 percent in 2019*.

Some 122 million people joined the ranks of the world's hungry after the Covid-19 outbreak. Globally, almost one in three people suffered from moderate or severe food insecurity in 2022 due to the impacts of the pandemic, conflict, and climate change.

A much larger proportion of the population in Africa was undernourished compared to other regions of the world – nearly 20 percent as against 8.5 percent in Asia or 6.5 percent in Latin America**. South Asia, East Africa, and subSaharan Africa had the highest levels of undernourishment.

Climate change-induced drought, salinization, and other factors threaten food security in these and other regions where small-scale agriculture supplies most of the food. As staple crops produce little or fail, rural communities are faced with undernourishment and hunger.

* United Nations Statistics Division. (n.d.). Zero hunger. <https://unstats.un.org/sdgs/report/2023/Goal-02/>

** FAO, IFAD, UNICEF, WFP and WHO. 2023. In Brief to The State of Food Security and Nutrition in the World 2023. Urbanization, agrifood systems transformation and healthy diets across the rural–urban continuum. Rome, FAO. <https://doi.org/10.4060/cc6550en>



Saline-water aquaponics takes root on Morocco's Atlantic coast

In Morocco's Laayoune Province, where the Sahara meets the Atlantic Ocean, traditional agriculture is constrained by sandy soils, extreme aridity and water with very high salinity. Yet this apparent adversity holds the seeds of an unexpected solution: the same saline water that defeats conventional crops can power a new kind of farming system – one that produces both fish and food from salt-loving plants.

Working with the Mohammed VI Polytechnic University, ICBA advanced an integrated aquaponic farm in the province that brings together fish production and halophyte cultivation in a single closed-loop system. In a saline-water aquaponic system, nutrient-rich wastewater from the fish tanks is channeled into the halophyte growing beds, where the plants absorb the dissolved nutrients as fertilizer and filter the water, which can then be recirculated. The fish provide the fertility; the plants provide the filtration. Nothing is wasted.

The two target crops are *Salicornia bigelovii* – introduced to the region for the first time – and native *Sesuvium* spp. Both are halophytes: plants that thrive in conditions that would kill conventional crops. *Salicornia*, sometimes called sea asparagus, is rich in protein, minerals, vitamins and polyunsaturated fatty acids, and is valued as a gourmet vegetable, a source of edible oil and a natural salt substitute. *Sesuvium*, or sea purslane, is eaten as a leafy vegetable in coastal communities across the tropics and is a useful source of beta-carotene, minerals and bioactive compounds. Both plants also serve as nutritious livestock fodder. At the Asari coastal site, trials in 2023 confirmed that both species perform well under seawater irrigation.

At a second site at Boucraa, 2023 saw the near completion of the aquaponic farm facility itself, with a desalination unit installed and most equipment operational by October. Once fully commissioned, the Boucraa site will demonstrate the complete circular system at scale.

Dr. Dionysia-Angeliki Lyra, a halophyte agronomist at ICBA, says: “What we are building in Laayoune is a proof of concept for a whole new kind of farming system – one that generates protein from fish and nutritious food from halophytes using water that no conventional crop can tolerate. If it scales, it could change the food security equation for coastal arid regions across Africa and the Middle East.”

With construction substantially complete, 2024 will bring the first full operational season for the Boucraa aquaponic farm.

Millets gain ground in the International Year of Millets

They are among the most resilient crops on earth – able to produce grain under conditions of heat, drought and soil salinity that would devastate conventional cereals. Yet millets have been largely overlooked by mainstream agricultural research for decades, cultivated primarily by subsistence farmers in parts of Africa and Asia. The United Nations' declaration of 2023 as the International Year of Millets was a signal that the world is beginning to catch up with what ICBA has known for years.

ICBA has studied pearl millet and sorghum for over two decades. In 2020 the center broadened its focus, screening hundreds of genotypes of finger millet, foxtail millet, fonio and proso millet alongside pearl millet under varying salinity and irrigation regimes in the UAE.

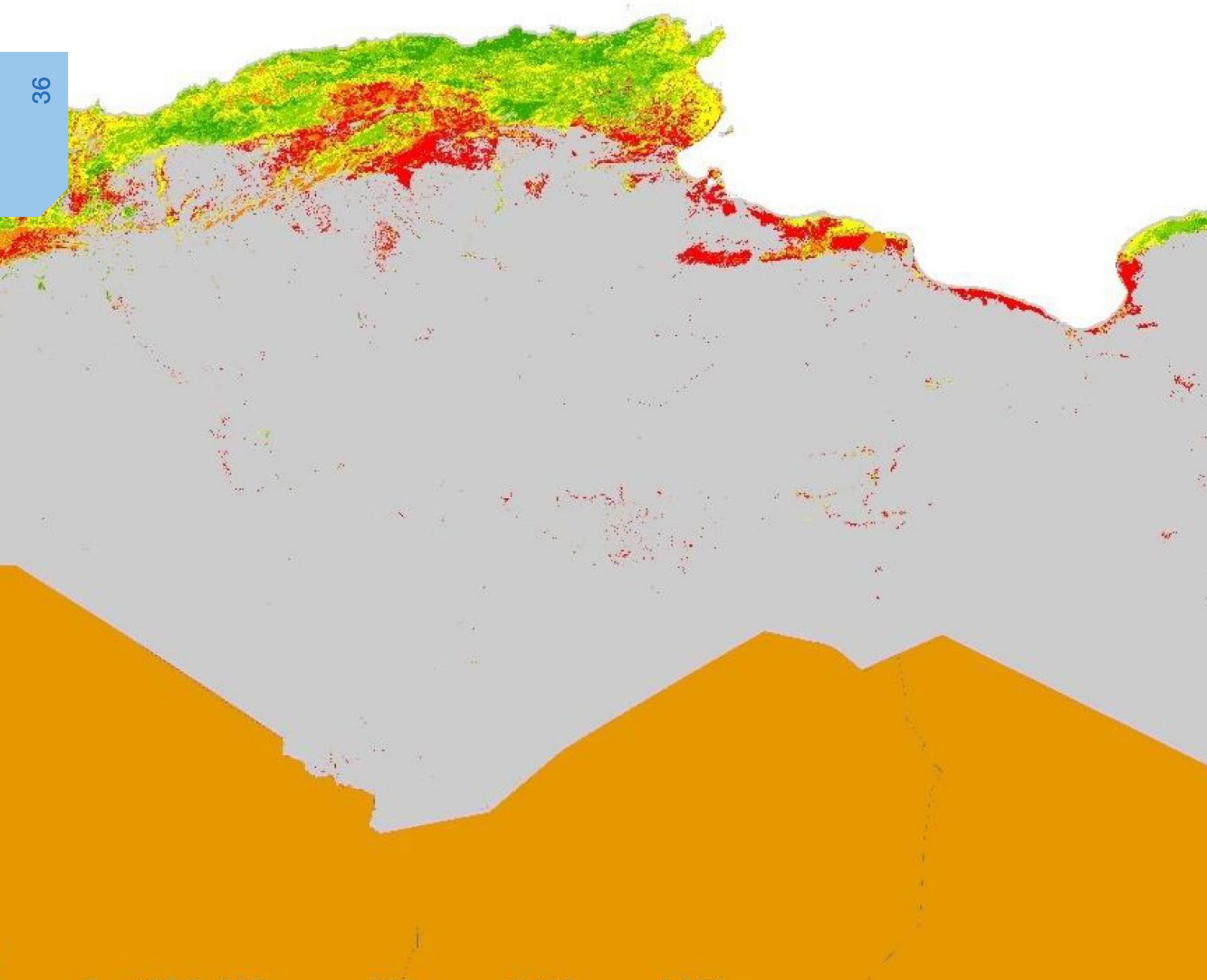
By 2023 the research had narrowed to the most promising performers. Under three complementary studies, scientists advanced their understanding of which genotypes perform best under the UAE's demanding conditions – high temperatures, sandy soils and irrigation water ranging from fresh to moderately saline – and how fertilization and other management practices affect yield.

In field trials evaluating foxtail millet accessions several promising candidates emerged. Accession ISe 1820 produced seed yields of 1.9 tonnes per hectare under freshwater conditions, while ISe 1269 and ISe 1687 held up best under salinity. Beyond grain, foxtail millet produced substantial biomass – up to 3.7 tonnes per hectare – making it an attractive dual-purpose crop for combined food and fodder production in arid farming systems.

Finger millet showed equally encouraging results. Four accessions showed no significant yield difference between freshwater and saline irrigation – a finding of considerable practical value for farmers who have no choice but to use brackish groundwater. And in a parallel study on crop management, grain yields increased significantly when finger millet was fertilized at rates of 50 to 75 kg of nitrogen per hectare and irrigated with moderately saline water, suggesting that simple, affordable inputs can help farmers overcome the yield drag imposed by salinity.

Dr. R.K. Singh, Head of Crop Diversification and Genetics at ICBA, says: “The International Year of Millets has drawn global attention to crops that ICBA has been studying for years. What makes millets so exciting is that they deliver where other crops fail. We now have the data to recommend specific varieties and practices with confidence to farmers and extension workers.”

With the top-performing accessions now identified, the next stage is seed multiplication and broader-scale validation trials. The goal is to have millet varieties and accompanying agronomic recommendations ready for farmers across the UAE and the wider MENA region.



A road map for biosaline agriculture across North Africa

The five countries of the Maghreb – Algeria, Libya, Mauritania, Morocco and Tunisia – share a common challenge: a long coastline on one side and vast expanses of arid, salt-affected land on the other. Water scarcity and soil salinity are intensifying under climate change, squeezing agricultural productivity precisely where population growth is driving food demand higher.

Yet the region possesses a significant, underutilized resource: brackish water. Groundwater with moderate to high salinity underlies large parts of the Maghreb, and halophytic plants – crops adapted to grow productively in saline soils and brackish water – offer a pathway to making use of it.

In 2023, ICBA completed a landmark baseline study commissioned by FAO and implemented in partnership with the Arab Maghreb Union (UMA). The study was the first systematic assessment of the opportunities and challenges for promoting biosaline agriculture across all five Maghreb countries, and it delivered a comprehensive report, a policy brief and a concept note endorsed by all five governments.

The study found that Algeria, Morocco and Tunisia had made the most progress in biosaline agriculture, with established experience in salt-tolerant crops and brackish water irrigation. Biosaline agriculture in Libya and Mauritania remains at an earlier stage, with activity so far limited to experimental research. Crucially, the study identified significant untapped potential across the region and proposed a clear vision, roadmap and action plan – including investment in research, policy development, value chain promotion and regional collaboration.

Dr. Henda Al-Mahmoudi, a plant physiologist at ICBA, says: “Biosaline agriculture can turn what many see as a liability – saline soils and brackish water – into a productive asset. This study gives the Maghreb governments a solid foundation for making that case and investing in the research and infrastructure needed to realize the potential.”

The report's endorsement by all five governments is a significant step toward translating knowledge into policy action – and potentially transforming how the Maghreb manages its marginal lands.

**Women
form the
backbone
of the rural
economy in
regions like
sub-Saharan
Africa and
North Africa.**







**Achieve gender equality
and empower all women
and girls**

Women make up an average of 43 percent of the agricultural labor force in developing countries. But only 10 to 20 percent of the farmland holders are women, and in some parts of the world, women still cannot legally own or control land*.

The majority of women farmers are either unpaid family workers or paid laborers. These women were hit hardest by the pandemic, with many being left indebted and hungry**.

If all women farmers had the same level of access to productive resources as men do, they could increase yields on their farms by 20-30 percent, lifting 100-150 million people out of hunger***.

Whether it is on the farm or in the lab, women's potential around the world remains largely untapped.

* Duckett, K.M. (n.d.). Empowering female farmers to feed the world. National Geographic. <https://www.nationalgeographic.com/culture/article/partner-content-empowering-female-farmers>

** ActionAid. (2020, October 16). World Food Day: Women farmers most at risk from Covid-19 food crisis. <https://actionaid.org/news/2020/world-food-day-women-farmers-most-risk-covid-19-food-crisis>

*** United Nations. (2011, March 7). Women could feed millions more people if given access to means of production – UN. <https://news.un.org/en/story/2011/03/368252-women-could-feed-millions-more-people-if-given-access-means-production-un#:~:text=Women%20in%20rural%20areas%20have,United%20Nations%20report%20released%20today>

Third cohort of Arab women agricultural leaders takes flight

In agriculture's marginal environments – where soils are salt-affected, water is scarce and climate change is sharpening these stresses – women form a critical part of the scientific and farming workforce. Yet women researchers in the Arab world continue to face structural barriers to leadership in agriculture: fewer opportunities, less visibility and working cultures that do not always support their advancement.

The Arab Women Leaders in Agriculture (AWLA) fellowship program, developed by ICBA with support from the Bill & Melinda Gates Foundation, is designed to change that. In 2023, the program launched its third edition, with a call for applications that drew candidates from across the Middle East and North Africa. Twenty fellows were selected – women from Algeria, Egypt, Jordan, Lebanon, Morocco, Oman, Tunisia and the UAE, representing a cross-section of scientific disciplines and career stages.

Delivered online over eight months starting in September 2023, the AWLA program combines scientific training with leadership development, mentoring and peer network building. Fellows engage with established researchers and institutional leaders, develop their skills in research communication, proposal writing and program management, and build connections with peers across the region that persist well beyond the program itself.

Two previous cohorts totaling 38 AWLA fellows have already gone on to take on more senior roles in national and international agricultural research and policy. The program has also won international recognition: AWLA received a gold award in the Women Empowerment category at the Global ESG Awards in October 2023.

Dr. Tarifa Alzaabi, Director General of ICBA, says: “The talent among women researchers in the Arab world is extraordinary. What has often been missing is not ability but opportunity – the chance to be seen, to be mentored and to build the networks that open doors to leadership. AWLA exists to create that opportunity, and the impact we see in our alumni gives us every reason to keep growing it.”

With three cohorts now underway and a growing alumni network, AWLA is building a platform for lasting change in agricultural science and leadership across the region.





ICBA launches global alliance to champion women in climate-smart agriculture

Women account for an average of 43 percent of the agricultural labor force in developing countries, yet they own only 15 percent of the farmland. They are also among the groups most vulnerable to the impacts of climate change. Against this backdrop, ICBA launched the Women Alliance for Climate Action in Agriculture (WACAA) at COP28 in Dubai on 4 December 2023.

The alliance aims to bring together women leaders, scientists, policymakers, farmers and organizations to mobilize support for women-led climate action in agriculture. It serves as a platform and voice for advocating gender equality in agricultural science and innovation, providing resources and opportunities for women, and promoting sustainable farming practices.

In the weeks before the COP28 launch, ICBA organized a regional strategic dialogue in Kampala, Uganda, on 20–21 November 2023 to set the agenda for the new initiative. Held with support from the Islamic Development Bank (IsDB), the dialogue brought together 31 participants – including 20 women –

from research and academic institutions, policymaking bodies and development organizations in Kenya, Tanzania and Uganda. Over two days of presentations, panel discussions and roundtable sessions, participants examined the role of women in sub-Saharan African agriculture and their potential as agents of change in climate adaptation and mitigation.

Among the dialogue's key recommendations were the need to strengthen capacity development programs tailored for women across the agricultural value chain, facilitate microfinancing initiatives targeted at women farmers and invest in research on climate-smart agriculture. Participants also called for improved access to land, credit and climate-resilient technologies and for more gender-disaggregated data to inform policies and programs.

Dr. Tarifa Alzaabi, Director General of ICBA, says: “Women are not just affected by climate change – they are uniquely positioned to lead the response. WACAA gives them a seat at the table where decisions about agricultural adaptation and innovation are being made.”

A dedicated WACAA website was also developed and launched during 2023 to support the growing network of partners and stakeholders.





**Over
2 billion
people live in
water-stressed
countries.**

Globally, 72 percent of all water withdrawals are used for agriculture*. Yet 3.2 billion people live in agricultural areas with high to very high water shortages or scarcity**.

As climate change is shifting weather patterns, water supplies are set to decline and droughts to intensify. This poses a serious threat to rural populations who depend on farming for their food security and livelihood.

Against this backdrop, it is worrying that freshwater resources and aquifers are being depleted and degraded at an increasing rate.

* UN Water. (2021, February 24). Summary Progress Update 2021: SDG 6 — water and sanitation for all. <https://www.unwater.org/publications/summary-progress-update-2021-sdg-6-water-and-sanitation-all>

** FAO. (2020). The State of Food and Agriculture 2020. Overcoming water challenges in agriculture. Rome. <https://doi.org/10.4060/cb1447en>



Korean greenhouse technology put to the desert test

Greenhouses extend the growing season and protect crops from desert heat, but conventional designs were not built for arid conditions. Most greenhouses in the UAE are low-tech structures that rely on pad-and-fan cooling systems consuming 9–16 liters of freshwater per square meter each day. As controlled-environment agriculture expands – the area under production in the UAE grew by 7 percent between 2016 and 2019 – finding designs that use less water and energy is a priority.

With funding from South Korea's Rural Development Administration, ICBA evaluated Korean-designed greenhouse technologies at its research station in Dubai. In 2023, scientists conducted crop production trials in a ventilated net-house, growing 750 cucumber plants to assess how the system performed under local climatic conditions. The experiment tracked plant growth, flowering, fruit yield and the effects of Dubai's extreme daytime temperatures on the crop.

Results were promising. Cucumber yields reached 9.44 kg per square meter – more than double the world average of around 4 kg per square meter. Harvesting continued steadily over 54 days with no significant drop in output. However, the trial also revealed challenges: 137 of the 750 plants died during the experiment, possibly because of inadequate soil depth or contaminants in the concrete substrate. These findings will guide adjustments in future trials.

Dr. Hicham Fatnassi, a senior horticulture scientist at ICBA, says: *“Not every greenhouse technology transfers well to desert conditions. Temperature management, humidity control and water efficiency all behave differently when you are dealing with extreme heat and almost no rainfall. Our role is to give farmers the evidence they need to make sound investment decisions.”*

The project, which ran from 2020 to mid-2023, builds on a memorandum of understanding between ICBA and the Rural Development Administration signed in 2018. Results from the evaluation will feed into ICBA's broader advisory work on controlled-environment agriculture for governments and investors across the Gulf region.

2023

**set new
records for
several key
climate
change
indicators.**







**Take urgent action to
combat climate change
and its impacts**

Global climate data shows that 2015 to 2022 were the eight warmest years on record*. While 2020 was the hottest year in recorded history worldwide despite an abrupt decline in carbon dioxide emissions during the pandemic**, recordbreaking droughts, heatwaves, and rainfalls hit different parts of the world in 2022.

As the planet is heating up, the prospect of food insecurity looms large in many countries. Farmers the world over are already bearing the brunt of climatic extremes. The hotter and drier the weather becomes, the higher the chances are of crop yield reduction or failure and livestock loss. Extreme events such as droughts, heatwaves, and floods are becoming more frequent and intense in many Middle Eastern and African countries, causing immense social and economic damage.

* World Meteorological Organization. (2023, April 21). WMO annual report highlights continuous advance of climate change. <https://public.wmo.int/en/media/press-release/wmo-annual-report-highlightscontinuous-advance-of-climate-change>

** National Aeronautics and Space Administration. (2021, January 14). 2020 Tied for Warmest Year on Record, NASA Analysis Shows. <https://www.nasa.gov/press-release/2020-tied-for-warmest-year-on-record-nasa-analysis-shows>

Halophytes



النباتات الملحية

The UAE's Secret Ingredient
for Climate-Resilient Cuisine

Unlocking nature-based solutions for climate action

Coastal ecosystems such as mangroves, seagrasses and saltmarshes play a vital role in the fight against climate change. Known as blue carbon ecosystems, they sequester atmospheric carbon dioxide at rates far higher than terrestrial forests and serve as natural buffers against coastal erosion and storm surges. Yet these habitats are under growing threat from development, pollution and rising sea temperatures.

In the United Arab Emirates, where coastal and marine environments are economically and ecologically significant, the conservation and restoration of blue carbon ecosystems have become a national priority. Blue carbon ecosystems in Abu Dhabi alone store substantial amounts of carbon, suggesting their potential to offset a significant share of the emirate's greenhouse gas emissions.

This is the thinking behind a project on nature-based solutions for climate action, biodiversity and people in the UAE.

Funded by HSBC through Emirates Nature-WWF and implemented in partnership with federal and local government agencies, the project is investigating how coastal ecosystem management and restoration can deliver climate, biodiversity and socioeconomic benefits.

Over the past year, the project has made notable progress. Scientists completed a desktop review of 19 halophyte species found in the UAE, compiling data on their taxonomy, characteristics and potential applications. Detailed profiles were developed for five species, exploring their scientific and traditional uses.

Researchers also conducted a biochemical analysis of *Salicornia sinus-persica*, a native halophyte, collected from sites in Umm Al Quwain and Ras Al Khaimah. The analysis evaluated nutritional parameters including lipids, amino acids, beta-carotene, protein, dietary fiber and vitamins. Results revealed a rich nutritional profile, underscoring the species' potential as a valuable food resource for arid coastal environments.

Dr. Dionysia Angeliki Lyra, a halophyte agronomist at ICBA, says: "Coastal habitats in the UAE are uniquely positioned to contribute to climate mitigation, but we need robust scientific evidence to guide policy and investment decisions. By studying the ecology and nutritional potential of native halophyte species, we are building the case for nature-based solutions that work for both people and the planet."

The project also aims to assess the feasibility of a national blue carbon accounting mechanism and explore a blue financial instrument to mobilize private sector investment in nature-based solutions. By creating pathways for government and private sector collaboration, it seeks to remove barriers to scaling nature-based approaches for climate action in the UAE and beyond.





**Human
activity has
altered nearly
75%
of Earth's
surface.**



Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Today biodiversity is declining faster than at any other time in human history. It is under serious threat as a result of human activities. Alas, the world is falling short of meeting its targets to halt biodiversity loss. Around 1 million animal and plant species face the risk of extinction*.

So alarming is the current rate of biodiversity loss that some scientists suggest a sixth mass extinction in Earth's history is under way.

Agrobiodiversity, a vital sub-set of biodiversity, is also in decline. The diversity of crops present in farmers' fields has decreased and threats to crop diversity are growing. In view of climate change, this diversity is crucial for global food security and nutrition.

It is critically important to preserve biodiversity in general and agrobiodiversity in particular for a sustainable and food-secure future.

* United Nations. (n.d.). Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss. <https://www.un.org/sustainabledevelopment/biodiversity/>



Decoding the UAE's national tree

Every Ghaf tree in the UAE tells a story written in DNA – but until now, no one had read it. The Ghaf (*Prosopis cineraria*) is the nation's official tree, a drought-tolerant desert legume revered as a symbol of resilience. Its deep taproot draws water from far underground, its canopy shelters wildlife and livestock, and its roots fix nitrogen to enrich impoverished desert soils. Yet urbanization, overgrazing and climate change are fragmenting Ghaf populations across the country, and conservationists have had no way to know which populations are genetically distinct, how connected they remain or which carry traits critical for long-term survival.

In 2023, ICBA and the Environment Agency – Abu Dhabi (EAD) set out to close that knowledge gap with the UAE's first population-level genomic study of the Ghaf. Over the course of eight field expeditions spanning coastal lowlands, dune plains, gravel deserts and mountain foothills, researchers collected leaf tissue from more than 200 individual trees.

Sampling strategies were tailored to each site: widely distributed populations were sampled at random, while rare or isolated stands were sampled exhaustively to ensure no genetic lineage was overlooked.

Back in ICBA's Desert Life Science Laboratory, each sample underwent DNA extraction, quality assessment and fragmentation before being prepared for whole-genome sequencing. By the end of 2023, sequencing libraries for 120 individuals had been completed and sequenced, generating millions of data points for comparison across the species' geographic range. Library preparation for the remaining samples was underway, with full sequencing expected to complete in early 2024.

The ambitions behind the study go well beyond cataloguing diversity. Researchers aim to uncover the population structure of Ghaf across the UAE, map patterns of gene flow between regions, assess how habitat fragmentation has affected genetic health and identify populations that may warrant priority conservation because of their genetic uniqueness.

Dr. Mohammad Shahid, a geneticist at ICBA, says: “You can fence a tree and water it, but if you do not understand its genetic health – whether populations are becoming isolated, whether diversity is being lost – you cannot design conservation strategies that will endure. Genomics gives us the evidence to act with precision rather than guesswork.”

The project is laying the groundwork for the first science-based Ghaf conservation strategy built on genomic evidence – one that could guide seed sourcing, restoration planning and genetic monitoring for decades to come.

Mapping the DNA of desert-adapted crops

A reference genome is one of the most powerful tools in modern plant science. It provides a complete map of an organism's DNA – the location of every gene, its function and its relationship to observable traits such as salt tolerance, drought resistance, yield and nutritional content. With a reference genome in hand, breeders can identify the specific genes behind desirable characteristics, develop molecular markers to track those traits in breeding populations and accelerate the development of improved varieties.

In 2023, ICBA's Desert Life Science Laboratory achieved two landmark genome assemblies that will transform the center's crop improvement work. Researchers completed the whole-genome sequencing and chromosome-level assembly of *Citrullus colocynthis* – the wild desert colocynth, a close relative of watermelon – and advanced the genome assembly of *Salicornia bigelovii*, the salt-loving halophyte sometimes called sea asparagus.

Colocynth has evolved to survive extreme drought through mechanisms including a deep root system, and its seeds are rich in oil, protein and bioactive compounds with potential medicinal applications. Its genome spans approximately 366 million bases organized across 11 chromosomes. The assembly identified more than 23,000 gene models, many of which are linked to stress response mechanisms. Resequencing of 27 accessions collected from across the UAE also revealed genetic diversity that could serve as a foundation for future breeding programs.

Salicornia can grow in seawater, produce nutritious food and high-quality oil, provide fodder for livestock and potentially serve as a feedstock for biofuels – all on land and water that no conventional crop can use. Its genome assembly will enable researchers to understand the molecular basis of its extraordinary salt tolerance.

Dr. Hifzur Rahman, a plant molecular biologist at ICBA, says: “These genome assemblies give us a molecular roadmap for two crops that thrive where others fail. For colocynth, we can now begin to identify the genes underpinning its drought tolerance and transfer that knowledge to related crops like watermelon. For salicornia, we are unlocking the genetics of a plant that grows in seawater. This is the kind of foundational science that accelerates everything we do in breeding.”

Both genomes will be made available to the broader scientific community, amplifying their impact well beyond ICBA's own research program.



Recording Morocco's threatened desert flora



Morocco's Laayoune Sakia El Hamra region spans thousands of square kilometers of arid southwest desert, where native plants have adapted over millennia to harsh conditions of drought, heat and salinity. Yet despite its ecological importance, the region's flora had never been comprehensively cataloged. In areas where phosphate mining takes place and land is being restored, there is growing demand for reliable information about native plant communities – their biology, their seeds and their potential for medicinal, aromatic and forage uses.

To address this gap, ICBA and the Mohammed VI Polytechnic University (UM6P) set out to

develop the first comprehensive atlas of native plant species in the region, funded by the OCP Group.

In March 2023, joint botanical expeditions covered multiple areas of southwestern Morocco. Teams comprising researchers from ICBA and UM6P, accompanied by indigenous guides, documented plant species through field observations and hundreds of photographs.

In all, about 170 species were recorded across the study areas, representing 131 genera and 41 plant families – a remarkable level of diversity for a desert landscape.

Perhaps the most significant outcome was the discovery of 62 plant species not previously documented as growing in the region. These new records increased the total known flora from around 304 to 366 species – a jump of about 18 percent. The newly recorded species span a wide range of families, from grasses and legumes to members of the daisy and amaranth families.

Dr. Mohammad Shahid, a geneticist at ICBA, says: "What surprised us was the sheer diversity we found in what many would consider a barren landscape. These species are not just scientifically important – many have real potential as medicinal plants, forages or candidates for ecological restoration of degraded mining lands."

The atlas, combining botanical descriptions with seed-collection guidelines and detailed photographs, will serve as a practical reference for environmental consultants, land rehabilitation companies and government authorities working on ecological restoration. Given the vast extent of the study area, however, researchers note that documenting the region's full botanical diversity will require continued survey work over several years.

Red palm weevil meets its match



The red palm weevil (*Rhynchophorus ferrugineus*) is one of the most destructive agricultural pests in the world. A single infested tree can harbor more than 200 larvae, feeding unseen inside the trunk for months before symptoms become visible – by which point the tree is often beyond saving. The Food and Agriculture Organization of the United Nations estimates that pests and diseases cause losses of up to 30 percent of global date production annually, and red palm weevil is a primary culprit.

In the UAE, where date palm is a crop of profound cultural, economic and agricultural significance, the red palm weevil represents a

persistent threat that demands both vigilance and innovation. In 2023, ICBA advanced two complementary research programs targeting the pest from different angles.

Under the FAO-funded project on early detection systems, scientists continued developing, testing and validating a suite of detection tools – including pheromone traps, traditional traps, and an integrated platform combining Internet of Things sensors, drones and artificial intelligence.

The drone-mounted sensors can scan date palm canopies for signs of infestation that are invisible to the naked eye, while the IoT-

AI platform manages data from across a plantation to flag high-risk trees for targeted inspection. Results to date show that eco-friendly organic treatments are as effective as chemical pesticides in controlling the pest – a finding with significant implications for reducing chemical use in UAE date palm farming.

Under a parallel internally funded project, molecular biologists made progress in understanding the genetic basis of natural resistance to red palm weevil in date palm. Identifying the genes and molecular pathways associated with resistance opens the possibility of breeding for resistance rather than relying entirely on chemical or biological control.

Dr. Zied Hammami, an agronomist and date palm specialist at ICBA, says: “The red palm weevil is a formidable adversary. Our response needs to be as sophisticated as the pest itself – using the best of modern technology to detect infestations early, and molecular biology to understand how date palms resist attack naturally. Together, these two approaches give us a more complete toolkit than either could provide alone.”

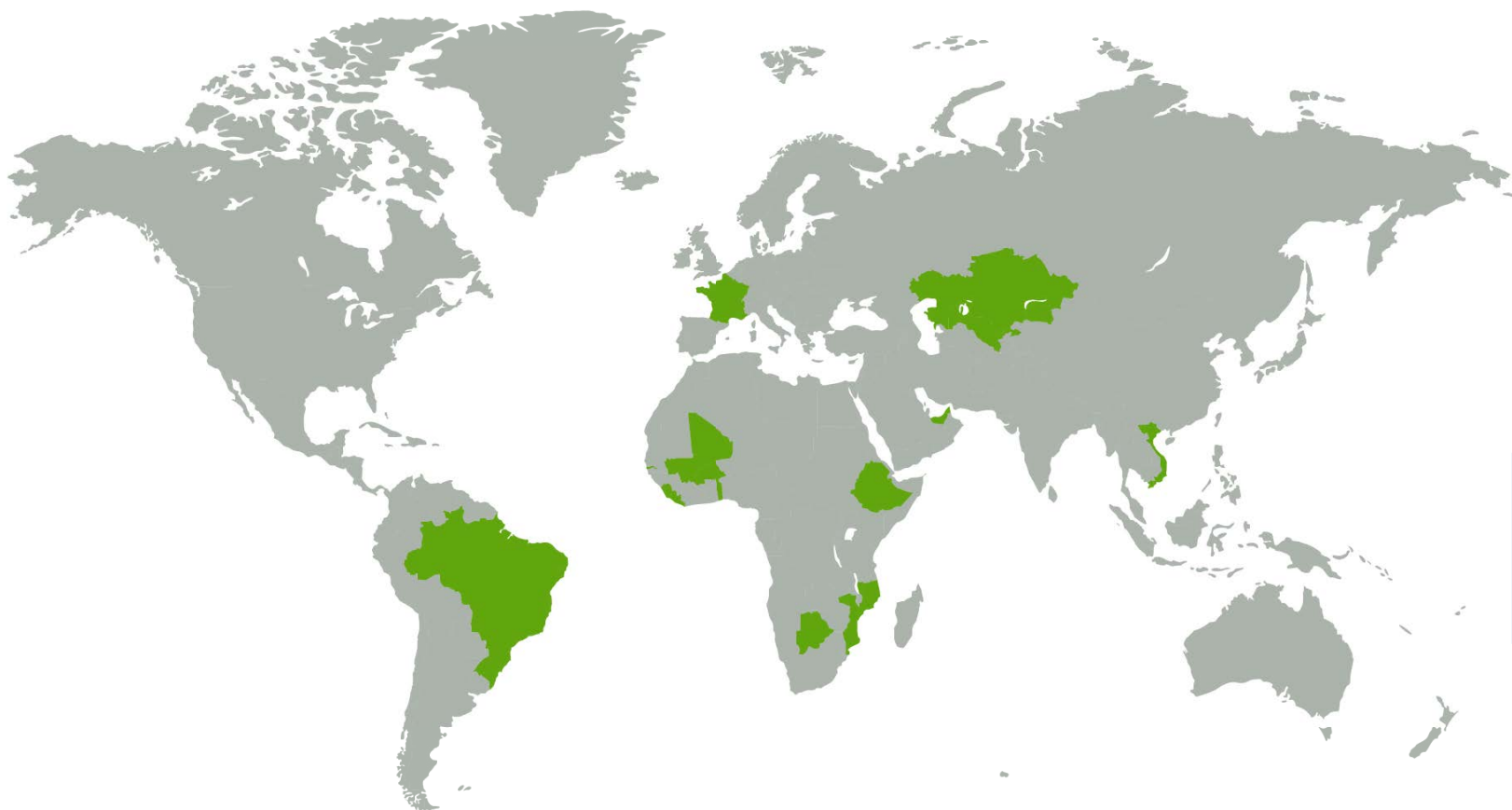


Sharing plant genetic resources

Under its mandate for marginal environments, ICBA collects, preserves, and shares germplasm of plant species with proven or potential salinity, heat, and drought tolerance.

ICBA provides seed samples to different institutions around the world for research, breeding, and introduction.

In 2023 the center provided around 840 samples of 25 different crops and plants to various stakeholders in 18 countries.



Partnerships of every kind must be at the heart of the Sustainable Development Goals.





Today's global problems call for global actions. All countries must come and work together to resolve the great challenges ranging from climate change to ecosystem degradation.

Goodwill and cooperation among nations is crucial for the fight against common threats. National, regional, and international organizations also must combine their efforts and support governments.

Collaboration at every level is key to achieving the Sustainable Development Goals.



Bringing life back to the Aral Sea basin

Few environmental disasters of the 20th century compare in scale and consequences to the shrinking of the Aral Sea. Once one of the world's four largest lakes, it has lost more than 90 percent of its volume since the 1960s, reduced by the diversion of its feeder rivers for Soviet-era irrigation. The consequences for the surrounding region – particularly Karakalpakstan, in the northwestern corner of Uzbekistan – have been catastrophic: desertification, salinized soils, destroyed fisheries and communities left stranded by a retreating shoreline.

Since June 2022, ICBA has been implementing a major project in Karakalpakstan funded by the Abu Dhabi Fund for Development (ADFD). The project's goal is to restore sustainable agricultural production in this ecologically devastated region – developing farming systems that can function on soils made hostile by decades of salinity and degradation, while building the knowledge and organizational capacity of local farming communities.

In 2023, field activities at three demonstration sites – Nukus, Chimbay and Muynak – generated the first systematic yield data for a portfolio of ICBA-recommended crops under Karakalpakstan conditions. Foxtail millet showed promise: highly drought- and heat-tolerant, it produced grain yields of up to 1.04 tonnes per hectare at Nukus and performed well across all three sites. Sorghum and pearl millet also demonstrated strong biomass production potential, opening options for combined food and fodder systems.

Work also began in 2023 on the design of integrated agri-aquaculture facilities and locally adapted greenhouses at the three sites – a diversification of the farming system model that will give communities additional income streams and nutritional resources. Researchers noted that two oilseed plants, safflower and castor, were growing naturally in different parts of the region, suggesting further potential for expanding agricultural production.

Dr. Kristina Toderich, a senior fellow at ICBA, says: “Karakalpakstan is one of the most challenging agricultural environments in the world – salt, heat and a history of ecological destruction have left the soils in a very difficult state. But our studies show that productive agriculture is possible here. Foxtail millet, sorghum and pearl millet are all yielding well on these soils. These results build confidence – both among scientists and among the farming communities we are working to support.”

The project is expected to directly benefit up to 15,000 farmers and agropastoralists and their households, with seed production units, cooperatives and extension programs building the institutional infrastructure for long-term agricultural revival in the Aral Sea basin.

Biochar and soil amendments improve crop yields in Uganda

Declining soil fertility is one of the most pressing constraints on agricultural productivity in sub-Saharan Africa. In eastern Uganda, where smallholder farming underpins food and income security, poor soils in districts such as Bugiri and Bugweri have long limited crop yields. Compounding the problem is limited access to improved agronomic practices and capacity-building opportunities for local farmers.

ICBA launched a pilot project in 2023 to test biochar and other soil amendments under real field conditions in eastern Uganda. Building on the success of biochar trials at ICBA's research station in the UAE, the project established demonstration and experimental plots in Bugiri and Bugweri districts in partnership with Uganda's National Agricultural Research Organization (NARO) and Makerere University.

Two demonstration plots were set up to test five rice varieties under different soil amendment treatments including biochar at a rate of 5 t/ha, biochar combined with rice-specific fertilizers, fertilizer alone, manure and an untreated control.

In parallel, two experimental farms tested a total of 10 treatments in a completely randomized design with five replicates, comparing biochar, manure, lime, NPK fertilizer and various combinations of these amendments.

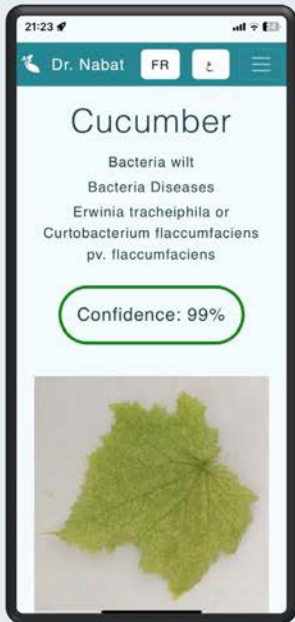
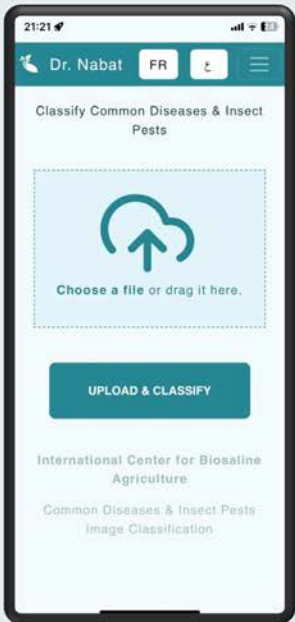
The results over two growing seasons revealed significant effects on rice yields. In the first season, biochar combined with NPK fertilizer had a pronounced positive impact on yields in Bugiri, while Bugweri soils responded most effectively to biochar combined with manure. Across all locations, the first season yielded better results regardless of soil type. In the second season, reduced rainfall underscored the importance of soil amendments for climate adaptation. Biochar and lime emerged as consistent factors in improving productivity in both districts.

The data point to tailored strategies for each location. In Bugiri, where moisture stress is a concern, combining biochar with manure and NPK is recommended. In Bugweri, where soils have higher organic matter but low phosphorus and potassium, lime combined with NPK proved most beneficial.

Dr. Nhamo Nhamo, a senior agronomist at ICBA, says: "What excites us about this work is its practical relevance. Biochar is not a silver bullet, but when combined with the right amendments for local soil conditions, it can make a real difference to smallholder farmers who depend on every harvest."

The project is also equipping farmers with decision-support tools and access to e-knowledge platforms dedicated to sustainable soil management. NARO and ICBA are preparing field days and farmer training sessions to disseminate the findings and build local capacity for long-term soil health.





AI-powered app puts crop diagnosis in farmers' hands

Crop losses due to pests, diseases and nutritional disorders cost the global economy an estimated 220 billion USD each year.* For smallholder farmers in the Middle East and North Africa, who often lack access to extension services and laboratory diagnostics, even a single misidentified disorder can mean a lost harvest and a season's income wiped out.

To address this gap, ICBA and the University of Barcelona developed Dr. Nabat – an AI-powered mobile application that enables farmers to diagnose crop diseases and nutritional deficiencies using only a smartphone camera. The project, which ran from 2019 to March 2023, was trialed in Egypt, Tunisia and the UAE.

The research team collected more than 50,000 images of diseased and healthy leaves using Open Data Kit, a field data collection system. These images were used to train deep learning models built on open-source architectures. The resulting AI can classify 21 different leaf disorders – including diseases, pests and nutritional deficiencies – affecting tomato, capsicum and cucumber, with an overall accuracy of 94 percent.

Available as both a web application and an Android app, Dr. Nabat goes beyond diagnosis. It includes a built-in decision support system that provides symptom confirmation, ecological and integrated pest management guidance, and conventional treatment options in Arabic, English and French. Farmers can identify the problem, understand it and act on it – all from the field.

During an internal evaluation conducted in Tunisia and Egypt in 2023, farmers expressed strong interest in the tool and recommended expanding it to cover fruit trees, cereals, date palm, olive and other locally important crops.

Dr. Henda Mahmoudi, a plant physiologist and project lead at ICBA, says: “Smallholder farmers in our target regions often spend significant sums on fertilizers and pest control without knowing exactly what is wrong with their crops. Dr. Nabat puts reliable diagnostic capability directly into their hands and helps them make better decisions faster.”

With mobile phone ownership rising rapidly even in remote rural areas, tools like Dr. Nabat also have the potential to attract younger people to agriculture by demonstrating that farming can be modern and technology driven. ICBA is considering the suggestions gathered during the evaluation as it plans the next phase of the app's development.

* FAO. 2019. New standards to curb the global spread of plant pests and diseases. <https://www.fao.org/news/story/en/item/1187738/icode/>

Training reaches thousands of farmers in sub-Saharan Africa through RESADE

More than 19 million hectares of land in sub-Saharan Africa are affected by soil salinity – a problem compounded by sea level rise, overuse of groundwater and decades of irrigation without adequate drainage. For the smallholder farmers who depend on this land, salinity means lower yields, higher food insecurity and deepening poverty.

Since 2019, ICBA has been working with national research partners across seven countries – The Gambia, Togo, Liberia, Sierra Leone, Mozambique, Botswana and Namibia – under a project called RESADE (Improving Agricultural Resilience to Salinity through Development and Promotion of Pro-Poor Technologies). Funded by the International Fund for Agricultural Development with a budget of USD 3.5 million, RESADE is one of ICBA's largest multi-country technology transfer programs. In 2023, following successful field trials in earlier seasons, the project shifted its emphasis from research to an intensive phase of farmer training and capacity development.

The results were striking. Over the course of the year, 53 training events were held across six countries, reaching 5,123 farmers and extension officers – 3,549 of them women. Topics ranged from biochar production and

quality seed management to food processing and the establishment of community seed banks. Training materials were developed in local languages, including six instructional videos and seven technical flyers produced in Togo, Botswana and Mozambique to extend the program's reach beyond direct participants.

The training went hand in hand with the scaling out of technologies proven in earlier trial seasons, including salt-tolerant varieties of sorghum, cowpea, pearl millet and rice, as well as California irrigation systems and biochar soil amendments. Farmers received seed of promoted varieties for self-multiplication, laying the foundation for continued adoption beyond the project's lifespan. Three new farmers' cooperatives were established in Togo and 34 cooperatives in total were strengthened in crop value addition and mechanization.

The human impact of the training was already becoming visible by the end of the year. In Togo, a woman who participated in food processing workshops was making couscous from sorghum instead of maize. In Botswana, another woman had established a small enterprise producing a sorghum-based drink – both drawing directly on skills acquired through RESADE.

Dr. R.K. Singh, Head of Crop Diversification and Genetics at ICBA, says: "Training is the thread that ties all our work together. We can develop the best salt-tolerant varieties in the world, but they will not make a difference unless farmers have the knowledge and confidence to grow them. What we saw in 2023 was more than 5,000 people gaining practical skills they can pass on to their neighbors and their children. That is how lasting change happens."



ICBA and G20 Global Land Initiative train restoration leaders worldwide

Land degradation threatens the livelihoods and food security of millions of people around the world. It is accelerated by climate change, unsustainable farming practices and water scarcity, particularly in arid and semi-arid regions. Restoring degraded lands requires not only innovative technologies and approaches but also skilled professionals who can apply them in the field.

Recognizing this need, ICBA joined forces with the G20 Global Land Initiative of the United Nations Convention to Combat Desertification (UNCCD) in 2023 to develop national capacities for land restoration. Together, they delivered the first international training course Biosaline Agriculture as an Approach to Land Restoration for 22 decision-makers, researchers and experts from 19 countries.

Held at ICBA's headquarters in Dubai on 6–9 November 2023, the CPD-certified program drew on more than two decades of the center's research and development work in sustainable natural resources management and land rehabilitation. It covered a range of nature-based technologies and approaches for managing and restoring degraded soils and mitigating and adapting to the effects of climate change on agriculture.

Topics included global and local climate change impacts, crop biodiversity, integrated cropping systems and sustainable land and water resources management. Participants also gained insights into the use of salt-tolerant food and feed crops and agroforestry systems for soil rehabilitation, salinity mitigation and freshwater conservation.

Ghazi Al-Jabri, a capacity development specialist at ICBA says: “Biosaline agriculture offers practical, nature-based solutions for restoring degraded lands. This training course is about putting those solutions into the hands of the people who can apply them on the ground in their own countries.”







**ICBA creates
and shares
knowledge
that
empowers
smallholder
farmers.**

Knowledge sharing

One of the main outputs of ICBA's work is knowledge. The center is committed to generating and sharing this knowledge with all stakeholders from smallholder farmers to policymakers. ICBA disseminates sciencebased knowledge by means of capacity development, knowledge hubs, and communications.



Local conference of youth puts young people at the heart of COP28



Young people are increasingly taking center stage in climate action and sustainable development. But they need more opportunities and platforms to express their views and make meaningful contributions. With this in mind, ICBA organized and hosted the Local Conference of Youth in the UAE (LCOY UAE) on 25–26 October 2023 at its headquarters in Dubai and at the Dubai campus of Zayed University.

Held under the theme “Putting youth at the heart of climate action,” the event was a local version of the global Conference of Youth organized under YOUNGO, the official youth constituency of the United Nations Framework

Convention on Climate Change (UNFCCC). It brought together some 200 participants for interactive sessions and discussions with experts on topics ranging from climate adaptation and food security to circular economy and energy transition.

The program also featured hands-on activities including Ghaf tree planting, Biodiversity Collage and Climate Fresk workshops.

The Climate Fresk session, held at Zayed University, helped students understand the causes and implications of climate change using data from the IPCC reports.

The event produced a Statement of the Youth, reflecting the collective voice of young people in the UAE on issues including climate finance, biodiversity conservation, gender-inclusive climate action and waste management. The statement served as a call to action ahead of COP28 and provided inputs into the Regional Conference of Youth, COY18 and COP28.

Dr. Tarifa Alzaabi, Director General of ICBA, says: “As the UAE marked the Year of Sustainability and prepared to host COP28, this forum gave young people a unique opportunity to discover, discuss and innovate solutions for climate change and bridge the gap between science and practice. We are grateful to all our partners for making it possible.”

LCOY UAE was co-hosted by Zayed University and sponsored by Schneider Electric, Siemens Middle East and Accuracy. Other organizing partners included the United Nations Global Compact UAE, the Global Shapers Dubai Hub, the United Nations Resident Coordinator Office in the UAE, the Arab Youth Council for Climate Change and the Arabian Youth Environment Programme.

ICBA hosts open day to showcase research on millets



Climate change threatens to reduce yields of staple crops such as wheat, rice and maize. But agrobiodiversity offers a way forward. Many neglected and underutilized crops are more tolerant of drought, heat and salinity and have better nutritional profiles than conventional staples. Millets are a case in point. Not only are they nutrient-dense and versatile, but they are also climate-smart crops whose cultivation helps to reduce agriculture's environmental footprint.

ICBA recognized the importance of these crops early on and has conducted research on them since 1999. In late 2020, ICBA scientists began studies on minor millets – including

finger millet, foxtail millet and proso millet – because of their adaptability to arid and saline conditions.

To present some of its latest findings and raise awareness about the significance of millets for food security and climate change adaptation, ICBA organized an open day on 21 March 2023 in line with the International Year of Millets declared by the United Nations.

The event was the first of a series of scientific talks and activities planned for 2023 under the theme of “Climate-resilient Crops of Tomorrow.” It brought together senior representatives from the Food and Agriculture

Organization of the United Nations, the International Center for Agricultural Research in the Dry Areas and Zayed University. Participants had a chance to experience a farm-to-fork approach as they harvested millets in the field and later tasted different millet-based dishes.

Dr. R. K. Singh, Program Leader on Crop Diversification and Genetics at ICBA, says: “While our previous research focused primarily on pearl millet, we have since expanded our work to include minor millets because they are better adapted to arid and saline conditions. They have a double advantage as they are more stress-resistant and nutrient-dense. Events like this open day help us demonstrate the potential of these crops and build momentum for their wider adoption.”

The open day was held in the UAE's Year of Sustainability and on the road to COP28, underscoring the role of climate-resilient crops in building more sustainable agrifood systems.



Emirates Soil Museum finds new audiences

The Emirates Soil Museum is a unique facility in the Gulf region. Established at ICBA in 2016, it serves as a knowledge hub for anyone interested in soil conservation in the UAE and the wider region and is specially designed to raise awareness – particularly among young people – about the threats to soils and the role healthy soils play in meeting current and future food needs.

In 2023 the museum reached 3,105 people, including professionals and students, through a range of educational programs and activities both on site and at other venues across the UAE. Participants attended sessions on drought and desertification, climate change, biodiversity loss and soil hazards, among other topics, and explored ways to mitigate and adapt to climate change through sustainable agriculture and the circular economy.

The museum also expanded its offerings by introducing three new interactive workshop formats: the Biodiversity Collage, the Climate Fresk and the Living Soils Workshop. In total, four Living Soils, three Biodiversity Collage and seven Climate Fresk sessions were conducted during the year.

As part of an awareness campaign for the International Year of Millets, the museum held three major talks for schools, attended by a total of 1,230 students.

Among highlights of the year, the museum ran hands-on workshops for some 200 students at the Beyond COP21 Symposium in Dubai, partnered with Eedama and Zayed University for an interactive millet cooking session on World Food Day, and organized a Living Soils Workshop at Expo City Farm during COP28.

Mrs. Ryma Affani, Curator of Emirates Soil Museum, says: “In 2023 we were able to reach more people than ever before through new workshop formats and partnerships. The Climate Fresk and Living Soils sessions in particular have proved to be powerful tools for engaging audiences of all ages with the most pressing environmental challenges of our time.”

The museum further enhanced its facilities in 2023 by adding a new workstation and library for visitors and researchers and creating a Soil Archive to display samples from the National Soil Survey. The Desert Farm, previously showcased at Expo 2020 Dubai, was also relocated to the museum park as an external exhibit to support education and awareness programs.



Three new e-learning courses expand ICBA's digital reach

As demand for flexible, accessible training in agriculture continues to grow, e-learning has become a vital channel for reaching stakeholders across borders and time zones. For ICBA digital education is a natural extension of its mission.

Building on the success of its e-learning platform launched in 2022, the center added three new courses in 2023, all certified by the Continuing Professional Development Certification Service in the UK. The new offerings – “Integrated Agri-Aquaculture Systems in Marginal Environments,” “Alternative Crops for Degraded Lands in the UAE” and “Agricultural Value Chain” – brought the total number of courses on the platform to seven.

The courses are self-paced and include presentations, videos, quizzes and reading materials. They cover topics closely aligned with ICBA's core research areas, from sustainable food production using saline water and aquaculture to the cultivation of underutilized crops suited to harsh growing conditions and the development of agricultural value chains that link smallholder farmers to markets.

By the end of 2023, a total of 472 learners – 331 men and 141 women – from 49 countries had completed one or more of the seven courses to date available on ICBA's e-learning portal.

Dr. Charbel Tarraf, Chief Operations and Development at ICBA, says: “The growing uptake of our e-learning courses shows there is a real appetite for specialized agricultural knowledge that people can access at their own pace, wherever they are. By expanding our course offerings, we are making ICBA's expertise available to a much wider audience and helping to build the skills needed for sustainable agriculture in marginal environments.”

Also in 2023, an Arabic version of the guide “E-learning methodologies and good practices” was published on the FAO elearning Academy's portal as a result of a collaboration between ICBA, the FAO elearning Academy and Mutah University in Jordan. The guide is expected to support the development of high-quality e-learning content across the Arabic-speaking world.

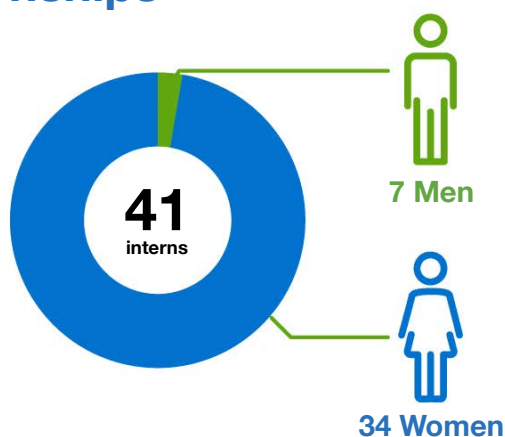
ICBA plans to continue developing new courses and diversifying topics to meet the needs of stakeholders working in challenging agricultural environments.

Developing capacities

Capacity development is an integral part of ICBA's work. In 2023 the center focused considerable efforts and resources on catering to the capacity development needs of different stakeholders.

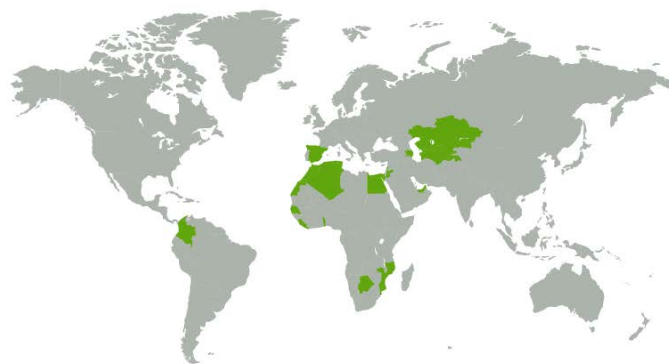
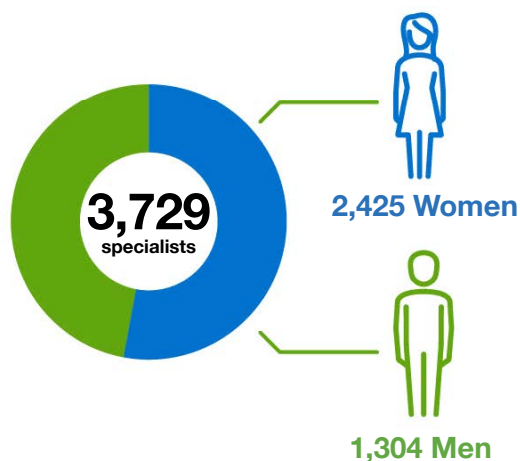
ICBA continued to work on enhancing the capacities of institutions, researchers, students, and farmers through shortand medium-term training courses, workshops, farmer field schools, internships, master's, doctoral, and post-doctoral

Internships



University students from eight countries

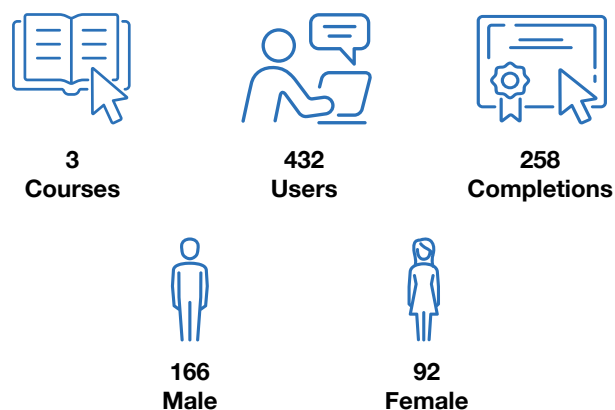
Technical training courses



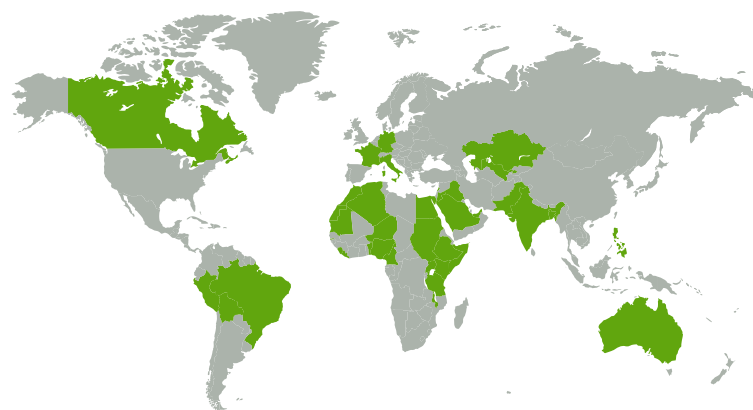
43 special technical training courses, online and in-person, for participants from 38 countries

E-learning courses

ICBA's e-learning statistics for 2023



Beneficiaries of ICBA's e-learning courses from 49 countries to date



Communicating science-based knowledge

ICBA continued to communicate its science-based knowledge and research and development work to different audiences through the news media, its website, and social media channels.



Knowledge products





Developments in Soil Classification, Land Use Planning and Policy Implications

THE UNITED ARAB EMIRATES

FAWZI M KARIM & ABDULLAH J DAKHEEL

WATER CONSERVATION STRATEGY

2010



Science, Policy and Politics of Modern Agricultural System



United Arab Emirates Keys to Soil Taxonomy

Science-based publications form the core of ICBA's knowledge output. They are part of the center's contribution to the advancement of agricultural science. In 2023 our scientists produced a total of 22 published peer-reviewed journal articles.

Peer-reviewed journals

Published

1. Ali, S., Mir, R.A., Tyagi, A., Manzar, N., Kashyap, A.Sh., Mushtaq, M., Raina, A., Park, S., Sharma, S., Mir, A.A., Lone, Sh.A., Bhat, A.A., Baba, U., **Mahmoudi, H.** & Bae, H. 2023. Chromium toxicity in plants: signaling, mitigation, and future perspectives. *Plants* 12(7): 1502. <https://doi.org/10.3390/plants12071502>
2. Ali, S., Tyagi, A., Mir, R.A., Rather, I.A., Anwar, Y. & **Mahmoudi, H.** 2023. Plant beneficial microbiome a boon for improving multiple stress tolerance in plants. *Frontiers in Plant Science* 14: 1266182. <https://doi.org/10.3389/fpls.2023.1266182>
3. Al-Tamimi, M., Green, S., Abou Dahr, W., Al-Muaini, A., **Lyra, D., Ammar, K.**, Dawoud, M., Kenyon, P., Kemp, P., Kennedy, L. & McLachlan, A. 2023. Drainage, salt-leaching impacts, and the growth of *Salicornia bigelovii* irrigated with different saline waters. *Agricultural Water Management* 289: 108512. <https://doi.org/10.1016/j.agwat.2023.108512>
4. Al-Tamimi, M., Green, S., Abou Dahr, W., Al-Muaini, A., **Lyra, D., Ammar, K.**, Dawoud, M., Kenyon, P., Kemp, P., Kennedy, L. & Clothier, B. 2023. Salt dynamics, leaching requirements, and leaching fractions during irrigation of a halophyte with different saline waters. *Soil Research* 62(1). <https://doi.org/10.1071/SR23116>
5. **Ammar, K.A., Kheir, A.M.S.**, Ali, B.M., Sundarakani, B. & Manikas, I. 2023. Developing an analytical framework for estimating food security indicators in the United Arab Emirates: a review. *Environment, Development and Sustainability*. <https://doi.org/10.1007/s10668-023-03032-3>
6. Badran, A., Eid, N.A., Hassan, A.R. & **Mahmoudi, H.** 2023. Differential responses in some quinoa genotypes of beneficial endophytic bacteria against bacterial leaf spot disease. *Frontiers in Microbiology* 14: 1167250. <https://doi.org/10.3389/fmicb.2023.1167250>
7. Bazgaou, A., **Fatnassi, H.**, Bouharroud, R., Tiskatine, R., Wifaya, A., Demrati, H., Bammou, L., Aharoune, A. & Bouirden, L. 2023. CFD modeling of the microclimate in a greenhouse using a rock bed thermal storage heating system. *Horticulturae* 9(2): 183. <https://doi.org/10.3390/horticulturae9020183>
8. **Fatnassi, H.**, Bournet, P.E., Boulard, T., Roy, C., Molina-Aiz, F.D. & **Zaaboul, R.** 2023. Use of computational fluid dynamic tools to model the coupling of plant canopy activity and climate in greenhouses and closed plant growth systems: a review. *Biosystems Engineering* 230: 388–408. <https://doi.org/10.1016/j.biosystemseng.2023.04.016>
9. **Fatnassi, H., Zaaboul, R.**, Elbattay, A., Molina-Aiz, F.D. & Valera, D.L. 2023. Protected agriculture systems in the UAE: challenges and opportunities. *Acta Horticulturae* (ISHS).

10. Garg, V., Chitikineni, A., Sharma, M., Ghosh, R., **Samineni, S.**, Varshney, R.K. & Kudapa, H. 2023. Transcriptome profiling reveals the expression and regulation of genes associated with Fusarium wilt resistance in chickpea (*Cicer arietinum* L.). *The Plant Genome*: e20340. <https://doi.org/10.1002/tpg2.20340>
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16. Kota, S., Vispo, N.A., Quintana, M.R., Cabral, C.L.U., Centeno, C.A., Egdane, J., Maathuis, F.J.M., Kohli, A., Henry, A. & **Singh, R.K.** 2023. Development of a phenotyping protocol for combined drought and salinity stress at seedling stage in rice. *Frontiers in Plant Science* 14: 1173012. <https://doi.org/10.3389/fpls.2023.1173012>
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18. Ram, H., Laxuman, Kenganal, M., Muniswamy, S., Lokesh, G.Y. & **Samineni, S.** 2023. Genetic diversity studies and Fusarium wilt screening in chickpea (*Cicer arietinum* L.) germplasm. *Legume Research*. <https://doi.org/10.18805/LR5078>

19. Rustamova, I., Primov, A., **Karimov, A., Khaitov, B.** & Karimov, A. 2023. Crop diversification in the Aral Sea region: long-term situation analysis. *Sustainability* 15(13): 10221. <https://doi.org/10.3390/su151310221>

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1. **Abd El Baki, H.M.**, Fujimaki, H., Tokumoto, I. & Saito, T. 2023. Optimization of irrigation scheduling using crop-water simulation, water pricing and quantitative weather forecast. *Water*.

2. **Alikhanov, B., Qureshi, A.**, Attia, A. & **Boboev, H.** 2023. Selection of potential sites for small-scale irrigation in Burkina Faso using geospatial techniques and analytical hierarchy process. *Sustainability*.

3. **El-Naggar, A.** et al. 2023. Biochar amendment under deficit irrigation and salinity stress: a comprehensive study on soil chemical properties, CO₂ emissions, and nutrient and water use efficiency in alfalfa and Rhodes grass. *Soil Systems*.

4. **Hammami, Z., Nhamo, N.**, Tounsi-Hammami, S., Rezgui, S. & Trifa, Y. 2023. The efficiency of chlorophyll fluorescence as a selection criterion for salinity and climate aridity tolerance in barley genotypes. *Frontiers in Plant Science*.

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9. Nune, R., Western, A.W., George, B.A., **Gummadi, S.**, Pasupuleti, S., Ragab, R. & Dixit, S. 2023. Predicting hydrological changes in semi-arid catchments due to climate change and anthropogenic changes. *Irrigation and Drainage*.
10. Prasoon, R., Maryam, A., Francois, F., Nemeer, P., Nawah, E.R.L. & **El-Naggar, A.H.** 2023. Field sampling radioecological experiments for vegetables and ghaf leaves in Abu Dhabi. *Journal of Environmental Radioactivity*.

Accepted

1. Buck-Sorlin, G., Molina-Aiz, F.D., Marcelis, L. & **Fatnassi, H.** 2023. How can plant modelling be a leverage for cropping system improvement by integrating plant physiology and smart horticulture? *Acta Horticulturae*.
2. Molina-Aiz, F.D., Honore, M., **Fatnassi, H.**, Valera, D.L., López-Martínez, A. & Moreno-Teruel, M.A. 2023. Experimental and numerical assessment of carbon sequestration in horticultural crops inside Mediterranean naturally ventilated greenhouses. *Acta Horticulturae* (ISHS).

Book chapters

Published

1. Aggarwal, P., Ambasta, A., Castellanos, A., **Gummadi, S.**, Højte, S., Martínez-Barón, D., Mwongera, C., Ouédraogo, M., Radeny, M., Rusdal, T., Sander, B.O., Sebastian, L. & Wassmann, R. 2023. Working across scales and actors for transforming food systems. In: Campbell, B., Thornton, P., Loboguerrero, A., Dinesh, D. & Nowak, A. (Eds.), *Transforming food systems under climate change through innovation*, pp. 197–208. Cambridge University Press. <https://doi.org/10.1017/9781009227216.017>
2. Azam-Ali, S., Ahmadzai, H., Choudhury, D., Von Goh, E.V., Jahanshiri, E., Mabhaudhi, T., Meschinelli, A., Modi, A.T., **Nhamo, N.** & Talabi, O.A. 2023. Marginal areas and indigenous people priorities for research and action. In: von Braun, J., Afsana, K., Fresco, L.O. & Hassan, M.H.A. (Eds.), *Science and innovations for food systems transformation*, pp. 261–280. Springer Nature.
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4. Läderach, P., Schapendonk, F., Shirsath, P., Amarnath, G., Prager, S., **Gummadi, S.**, Kramer, B., Govind, A. & Pacillo, G. 2023. The climate-security nexus: securing resilient livelihoods through early warning systems and adaptive safety nets. In: Campbell, B., Thornton, P., Loboguerrero, A., Dinesh, D. & Nowak, A. (Eds.), *Transforming food systems under climate change through innovation*, pp. 63–74. Cambridge University Press. <https://doi.org/10.1017/9781009227216.007>
5. López-Martínez, A., Molina-Aiz, F.D., Valera, D.L. & **Fatnassi, H.** 2023. Geometric and aerodynamic characterization of insect-proof screens used in greenhouses: aerodynamic models. In: Singh & Sharma (Eds.), *Protected cultivation, modeling and automation*. Apple Academic Press, Taylor & Francis Group.
6. Molina-Aiz, F.D., Valera, D.L., López-Martínez, A. & **Fatnassi, H.** 2023. Ventilation models in greenhouses. In: Singh & Sharma (Eds.), *Protected cultivation, modeling and automation*. Apple Academic Press, Taylor & Francis Group.
7. **Nhamo, N.** & Talabi, A.O. 2023. Field management practices for pseudocereals: yield gains and health benefits. In: Rakszegi, M., Papageorgiou, M. & Rocha, J.M. (Eds.), *Developing sustainable and health promoting cereals and pseudocereals: conventional and molecular breeding*, pp. 189–201. Elsevier.



Supporters and contributors

ICBA's progress on improving food security and nutrition and creating employment opportunities for vulnerable rural communities in different countries is possible thanks to unwavering support of the many donor and development agencies and partner organizations we work with.

Most of the funding comes from ICBA's founders: the Government of the UAE (through the Ministry of Climate Change and Environment and the Environment Agency - Abu Dhabi) and the Islamic Development Bank. This funding helps ICBA continue to deliver on its mission and vision.

In 2023 our research and development work was also funded by other supporters and contributors. We would like to thank all of them for their generous contributions.

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- Abu Dhabi Fund for Development
- Accuracy
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- Sergey Brin Family Foundation
- Siemens Middle East
- Silal Food and Technology LLC
- UAE Prime Minister's Office
- University of Wollongong in Dubai

Financials





Statement of financial position

	As of 31 December	
	2023	2022
Assets	USD'000	USD'000
Non-current assets		
Property and equipment	3,075	2,939
Right-of-use assets	132	17
	3,207	2,956
Current assets		
Inventories	41	40
Accounts and other receivables	881	619
Deposits	10,896	19,068
Cash and bank balances	17,772	6,803
	29,590	26,530
Total Assets	32,797	29,486
Equity and Liabilities		
Equity		
Reserves – Designated	15,397	15,397
Reserves – Undesignated	6,300	5,382
Total Equity	21,697	20,779
Non-current liabilities		
Provision for employees' end of service benefits	974	768
Deferred income	1,335	2,160
Lease liabilities	100	-
	2,409	2,928
Current liabilities		
Accounts and other payables	3,121	2,829
Deferred income	5,537	2,931
Lease liabilities	33	19
	8,691	5,779
Total Liabilities	11,100	8,707
Total Equity and Liabilities	32,797	29,486

Statement of activities and other comprehensive income

	Year ended 31 December	
	2023	2022
	USD'000	USD'000
Grants income	9,916	9,584
Other income	143	57
Operating expenses		
Research and collaborator expenses	(7,558)	(7,147)
Administrative and general expenses	(2,323)	(2,188)
Operating surplus for the year	178	306
Finance income – net	740	236
Surplus for the year	918	542
Other comprehensive income	-	-
Total comprehensive income for the year	918	542

Board of directors



H.E. Razan Khalifa Al Mubarak
Managing Director,
Environment Agency -
Abu Dhabi (Chair)



Mr. Mohammad Jamal Alsaati
Special Advisor, Office
of the President of the
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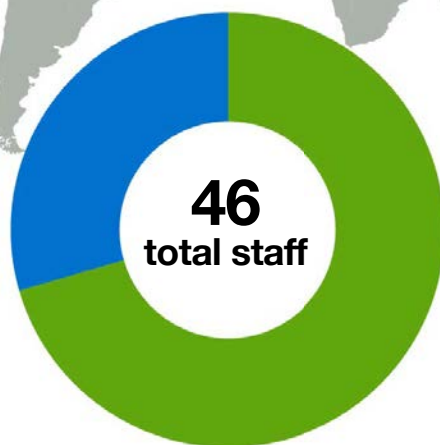
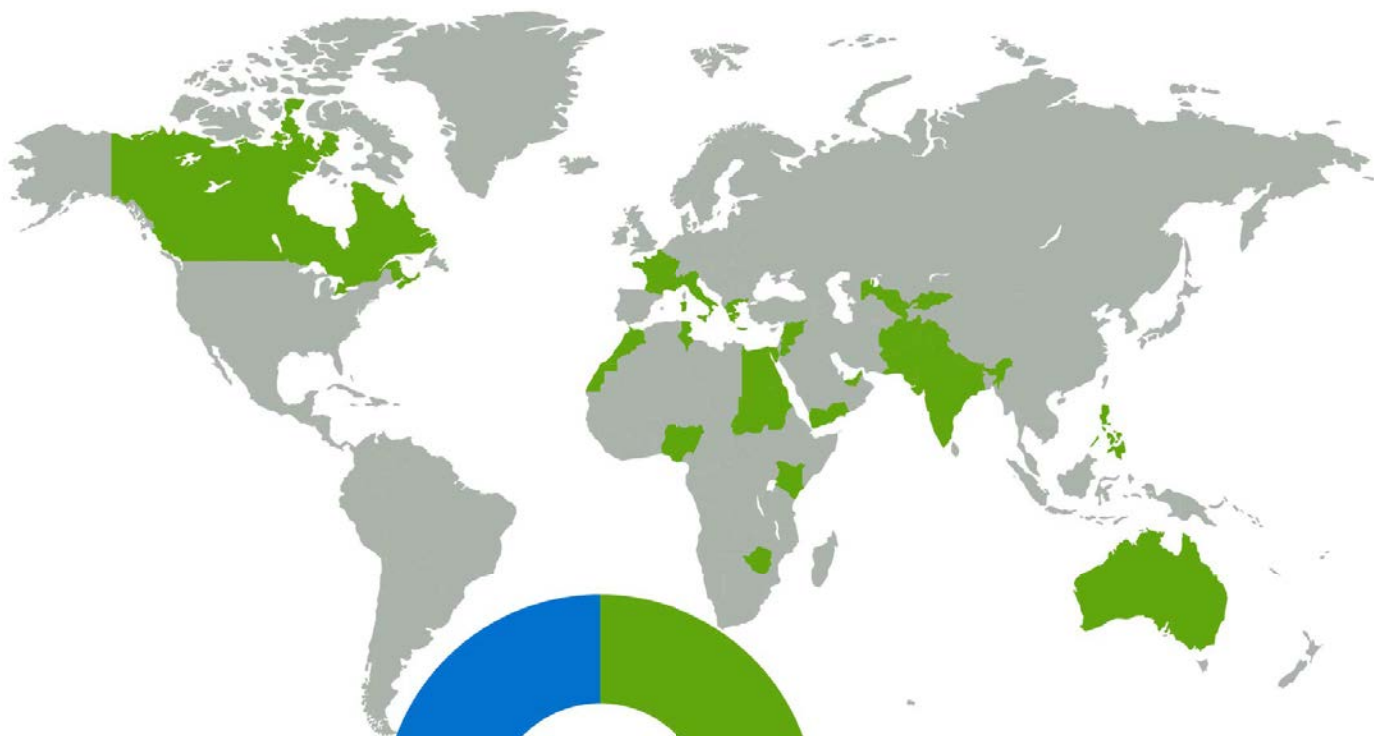


Dato' Dr. Mohamad Zabawi bin Abdul Ghani
Director General,
Malaysian Agricultural
Research and
Development Institute



Dr. Tarifa Alzaabi
Director General, ICBA
(Ex officio member)

Staff



13
Women



33
Men

ICBA staff are based in
2
Countries



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