

# ANNUAL REPORT 2020



Science for resilient livelihoods in dry areas

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# ANNUAL REPORT 2020





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## Foreword: joint message from CGIAR Regional Director of CWANA and ICARDA Director General, Mr. Aly Abousabaa, and ICARDA Board Chair Mr. Michel Afram

### A unified approach

Any reflection on 2020 will likely dwell on the magnitude and impact of the COVID-19 pandemic. Yet, our enduring memory will be of the ICARDA family of staff, farmers, partners, and donors, among others, who came together to overcome the challenges of lockdowns, travel restrictions, labor shortages, and supply issues. Their commitment enabled ICARDA to remain on track with our objectives across the Central and West Asia and North Africa (CWANA) region.

We were also grateful for the exceptional flexibility and adaptability of donors, such as the Arab Fund for Economic and Social Development (AFESD) and the Secretariat General of the Gulf Cooperation Council (GCC) who were key to our ongoing capacity building activities, bestowing additional support and leadership during these challenging times. Furthermore, our strong networks with country stakeholders, including the National Agricultural Research System (NARS) partners, enabled swift action and contingencies to continue our work and keep our staff and family farming communities safe.

Our work on climate-smart crops, genebanks, and international nurseries continued largely unaffected due to the vital support of donors and partners. Research, delivery, and training packages meant new and past improved crops varieties continue to flourish under climate change to **boost yields and income** throughout the region.

Our sustainable crop and livestock programs, again with the support of our donors and partners, **gained strength across Ethiopia, Sudan, and beyond**. Our research delivered hardier, more productive community herds, the means to grow forage sustainably, and the social and economic insights needed to create more employment opportunities.

Our land, soils, and water teams continue to **restore soil quality and biodiversity** throughout the region by

upscale pioneering and innovative approaches that protect and sustainably manage valuable water sources.

More than anything, the pandemic made us determined to help drive CGIAR's ongoing transition to a streamlined, integrated, and dynamic One CGIAR that delivers a greater impact and more robust food systems efficiently – both across the dry areas where we work and globally. After officially joining the One CGIAR in late 2020, our restructured science teams were already in place for a much higher degree of integration. Across the CGIAR, and alongside our partners, donors, and other CGIAR Centers, we began developing the multi-stakeholder initiatives that will frame One CGIAR's future work. We are also reaching out to relative newcomers, non-CGIAR countries, and bilateral donors to ensure that ICARDA continues to serve them either bilaterally or within One CGIAR.

Above all, 2020 highlighted our long-term host country arrangements and the trust we have built with partners and donors over four decades in the Central and West Asia, and North Africa (CWANA) region and beyond. Under a united One CGIAR, we will be uniquely placed to improve food and water security for dryland family farmers and progress towards the Sustainable Development Goals. Regardless of the 2020 challenges, we see a bright and unified future.



Aly Abousabaa



Michel Afram



A photograph of three men in a field. On the left, a man in a blue plaid shirt and a blue baseball cap looks down at a smartphone. In the center, a man in a grey hoodie with 'NSC SPORT' on it also looks at the phone. On the right, a man in a dark jacket looks on. In the background, there is a tall metal structure, possibly a weather station or irrigation equipment, and a clear sky. An orange semi-transparent banner is overlaid at the bottom of the image, containing the title.

# Digitalizing research for a level playing field

Throughout 2020, we continued digitalizing our research to facilitate faster, better, and more accurate data collection, knowledge sharing, analysis, and decision-making. Global developments in technology, digital analytics, remote sensing, networks, and software, especially on now-ubiquitous smartphones, make data collection, analysis, reporting, and knowledge sharing easier and more efficient, even in the most isolated and fragile dry areas where we work.

Our unique and growing pool of big data – based on four decades of drylands research – helps to model and

analyze new approaches, climate variability, assessment of new crop varieties and livestock improvements, socioeconomics, and decision-making at all levels. When consolidated with other Centers under the ongoing One CGIAR reformulation, our data will constitute a formidable resource that will contribute significantly to the battle against global climate challenges.

In 2020, our Geoinformatics for sustainable Agro-Ecosystems ([GeoAgro](#)) Team led by [Dr. Chandra Shekhar Biradar](#) ramped up the digitalization of research through its [geo-big data-driven platform](#) to leverage the latest

cutting-edge technological innovations. Selected ICARDA projects contained GeoAgro pilot elements while staff and partners were trained on geotagging tools. The implementation of geo-referenced field data collection with geotagging tools led to collection of over 2,500 datasets for mapping farming systems across dry region in 2020.

We were also thrilled when 4 GeoAgro-related projects made it to the final 15 (out of 120 entries) of the CGIAR Big Data Inspire awards. **Two projects** went on to win – one helps farmers monitor locust activity, and the other, supported by the International Livestock Research Institute (ILRI) alongside ICARDA's **Dr. Mounir Louhaichi**, facilitates accurate decision-making in rangelands health by **pooling data and satellite imagery**.

**ICARDA's Monitoring, Evaluation, and Learning (MEL) Team**, led by **Dr. Enrico Bonaiuti**, developed tools such as the **WOCAT digital explorer** and the **Central Asia Climate Portal**. These tools pool valuable data and knowledge such as climate information and global agricultural innovations from official international sources to support organizations, policymakers, and researchers in decision-making, monitoring, and learning.

MEL also developed tools such as the **Monitoring, Evaluation, and Learning Quality Assurance Processor**, or 'M-QAP', which pools large data sets from mainstream research databases to simplify and support research and encourage standardization across global databases. These tools have been adopted by the **Partnership for Research and Innovation in the Mediterranean Area (PRIMA)** to strengthen the extent and complexity of their knowledge frameworks.

Also in 2020, the **Partnership for Research and Innovation in the Mediterranean Area (PRIMA)** began using ICARDA's **Monitoring, Evaluation, and Learning (MEL)** as its prime monitoring and evaluation tool, to

strengthen the extent and complexity of its intervention framework. PRIMA is a joint program undertaken by its **19 participating states** aimed at creating a competitive environment for solutions development in research and innovation across the Mediterranean area.

Through its Monitoring, Evaluation, and Learning (MEL) Team, ICARDA also became the official **AGROVOC** editor in Arabic, in addition to its contribution to the English AGROVOC version, vastly increasing the integration of online tools and systems, which are available in multiple languages. It also improves the discoverability of knowledge from the Central and West Asia and North Africa (CWANA) region in line with the recent **Findable, Accessible, Interoperable and Reusable (FAIR)** policy approved by CGIAR.

Another exciting, digital-focused initiative is ICARDA's involvement through **Dr. Filippo Bassi**, in the Activated Genebank Network (**AGENT**) project, funded by the European Union and launched in 2020. It standardizes and pools phenotype information from global genebank networks within a single database and revolutionizes plant genetic resource information sharing. Our Genetic Resources Team is also accelerating research digitalization through tools such as the CGIAR Breeding Program Assessment Tool, which aids design and analysis, and helps the breeding management system centralize breeding data.

Our **Query the Breeding Management System (QMBS)** initiative was developed and published in 2020 to offer scientists and researchers easy ways to access knowledge from a wide range of analytics, visualization, and data transformations from within the Breeding Management System – an established tool that helps breeders manage their processes.

Finally, ICARDA also embraces low-cost digitalization for services to stakeholders with a low technology, affordable approach. The **ICT2Scale project** uses cell phone-based services to offer e-learning and extension services for crop and small ruminant production, beekeeping, and conservation agriculture to farmers in Tunisia, and farmers in our community-based livestock projects in Ethiopia use the **DTREO app** to capture and share details about productive animals.

Read about **digitalization** in detail in the appendix.





# HIGHLIGHTS OF 2020

## Boosting wheat production in Sudan and Ethiopia through the TAAT wheat compact project

The ICARDA-coordinated [Technologies for African Agricultural Transformation \(TAAT\)](#) wheat compact project strengthens production capacity and seed systems across Africa, including Ethiopia and Sudan, where ICARDA leads the programs. It is funded by the African Development Bank (AfDB), International Institute of Tropical Agriculture (IITA), and Bill & Melinda Gates Foundation (BMGF) and led by ICARDA's [Dr. Zewdie Bishaw](#). In 2020, more basic seed, certified seed, and quality declared seeds were produced in six target countries where nearly 1 million ha were planted, benefiting smallholder wheat farmers. Sudan's bumper harvest produced 1.15 million tons of wheat and ICARDA and its partners are working to improve the sustainability of wheat production with proper input management and diversified rotations.

## Capitalizing on idle land for better food security in South Asia

The ICARDA-South Asia & China Regional Program led by [Dr. Ashutosh Sarker](#) implements a project across

**1,900** **TRAINEES**  
BENEFITTED FROM  
**TRAINING**  
**COURSES**



Bangladesh, India and Nepal with support of International Fund for Agricultural Development (IFAD), covering 24,873 smallholder farmers. Family farmers now harvest healthy yields of lentil, kabuli chickpea, and grass pea from lands that would have otherwise remained fallow. An additional 150,000 farmers indirectly benefitted through farmer-to-farmer seeds and knowledge sharing. The projects also established 97 Village Seed Hubs involving farmers' associations which produced 122 tons of seeds to support the coming years' cropping. Over 12,000 farmers are now trained on production technologies, and 7,355 women improved their skills in value addition, processing, and other skills.

## ICARDA scientists win Crop Science Society of America outstanding paper award

ICARDA was thrilled when the [2020 Outstanding Paper Award](#) of Crop Science Journal by the Crop Science Society of America (CSSA) went to a [paper](#) led by Dr. Khaoula El Hassouni, a former Ph.D. student of ICARDA, and the [Universite Mohammed V](#), collaborating with Prof. Hickey and Dr. Alhamad of the [Queensland Alliance for Agriculture and Food Innovation](#), and with senior author [Dr. Filippo Bassi](#) of ICARDA. Recognized as one of the premier showcases of agricultural scientific research, the Crop Science Journal is a bimonthly peer-reviewed scientific journal. The award-winning research was funded by the [Australian Grains Research and Development Corporation \(GRDC\)](#) and [CGIAR Research Program on Wheat \(WHEAT\)](#), and explores the genetic variability for mature root traits among 25 durum genotypes.

**172** **PARTNERSHIP**  
**AGREEMENTS**  
 **SIGNED OR**  
**RENEWED**

**134** **ISI JOURNAL**  
 **ARTICLES**  
**PUBLISHED**

## Water and soil management in Egypt

The iNASHR project is funded by the Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) and developed alongside Egypt's Agricultural Research Center (ARC) and Ministry of Agriculture and led by ICARDA's **Bezalet Dessalegn**. The project addresses Egypt's water scarcity and soil quality while improving food security for smallholder family farmers. In 2020, ICARDA established 420 demonstration sites, 16 percent of them women-owned. Planted with improved wheat and faba bean varieties, the demonstration sites benefit 400 individuals directly from capacity-building efforts, of which 21 percent are women.

## More productive livestock in Ethiopia through community-based breeding

ICARDA's **community-based breeding programs** (CBBP) supported by the CGIAR Research Program on Livestock (CRP Livestock), International Livestock Research Institute (ILRI), the World Bank, and the International Fund for Agricultural Development (IFAD) continued to increase the productivity and profitability of indigenous sheep and goat breeds across Ethiopia. Led by **Dr. Aynalem Haile**, the programs expanded to 3 major regions of Ethiopia and more than 60 legal breeders' cooperatives now

 **120 RESEARCH PROJECTS**  
IMPLEMENTED IN **66 COUNTRIES**

lead the breeding program. An upscaling process undertaken with financial support from The United States Department of Agriculture (USDA) involved more than 2,000 households, the purchasing and distributing of 479 goat bucks from existing Community-Based Breeding Programs (CBBPs), and mass synchronization and artificial insemination to distribute improved genetics. We also linked farmers to better market routes including through slaughterhouse companies, livestock cooperatives, and buyers in Dubai.

## Dr. Abdoul Aziz takes the helm to drive ICARDA's work in the Arab Peninsula

In 2020, **Dr. Abdoul Aziz** took over from **Dr. Azaiez Ouled Belgacem** as ICARDA's Regional Coordinator of the Arabian Peninsula Regional Program. Across the Arab Peninsula, ICARDA works in partnership with Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates. Financial support is provided by the Arab Fund for Economic and Social Development (AFESD), the Secretariat General of the Gulf Cooperation Council (GCC), and the Kuwait Fund for Arab Economic Development (KFAED). Projects improve agricultural productivity across the region without depleting water and soil resources while increasing the resilience of farmers and farming systems to climatic change. In 2020, 1,500 Arab nationals benefitted from group courses, individual degrees, and non-degree training. Regional projects focus on scaling out developed technology packages, adaptive research, improving date palm production, and capacity building.

## BBC 100 Women 2020

**Safaa Kumari**, a leading ICARDA plant virologist from Syria, was recognized as one of the world's '100 Inspiring Women 2020' by the BBC, the United Kingdom's national broadcasting corporation, for

**1,619**  
**BREEDING LINES**  
DISTRIBUTED TO PARTNERS IN  
**43 COUNTRIES**



**18**   
**ICARDA CROP VARIETIES**  
RELEASED BY NATIONAL PARTNERS

her work protecting globally important crops from destructive pests and viruses. Her plant epidemiology research focuses on the most damaging viruses affecting key dryland crops, such as barley, chickpea, faba bean, lentil, and wheat, crucial to local and global food security. In 2010, Dr. Kumari discovered a faba bean variety immune to the faba bean necrotic yellows virus, an insect-transmitted virus that, until her discovery, wiped out faba bean crops across the Middle East and North Africa (MENA) region.

## Climate-smart wheat for fragile countries and territories

ICARDA's Dr. Nigamananda Swain and the Agricultural Research Institute of Afghanistan (ARIA), continued to support fragile countries and territories by **releasing three new drought-resistant wheat varieties in Afghanistan** to help overcome the increasing threat of recurring droughts in the country and help rehabilitate the agricultural sector. The new varieties were developed and field-tested through ICARDA's and ARIA's intensive research program under the **CLAP** (Community Livestock and Agriculture Project) of the Ministry of Agriculture in Afghanistan, supported by the International Fund for Agricultural Development (IFAD). New varieties produce optimum yields in water-scarce environments and show excellent performance under supplementary irrigation conditions. They are also resistant to yellow rust disease, which causes significant yield loss in the region. The Afghanistan Seed Production and Certification Directorate and National Seed Board will now oversee the seed multiplication and distribution to the farmers.

## Farming with Alternative Pollinators (FAP)

The International Climate Initiative (IKI)-FAP project funded by the German Federal Ministry for the

**1,146**  
PUBLICATIONS  
AND DATASETS



9 4 8 7 3 6 4 9 1 7 4 8  
2 5 1 5 3 0 6 2 8 3 7  
8 6 8 3 6 1 3 7 4 0

**27,013**  
PLANT ACCESSIONS  
REGENERATED



Environment, Nature Conservation, and Nuclear Safety (BMU) and led by **Dr. Stefanie Christmann**, increases yields by attracting higher diversity and abundance of pollinators and natural enemies through strips of marketable flowering plants like spices, oilseeds and vegetables. In 2020, the project presented results from Morocco and fine-tuned projects in the five participating countries. National Agricultural Research System (NARS) partners from Algeria, Egypt, Jordan, Palestine, and Turkey learned the FAP approach in an intensive 1-week training in Rabat before launching their own FAP projects, while FAP in the benchmark country Morocco is ongoing. The IKI project was also presented at the World Biodiversity Forum in Davos 2020, resulting in a well-received article in **Nature.com**. A 50-minute documentary on FAP was also created in **English** and **Arabic**.

## Mobile seed treatment units support Tunisian family farmers

In Tunisia, ICARDA and partners/funders, the CGIAR Research Program on Livestock (CRP Livestock), and the International Fund for Agricultural Development (IFAD) developed **innovative and locally produced seed cleaning and treatment units** to produce better quality seeds for crops and boost business for lead farmers and small- and medium-sized enterprises around forage seed production. A prototype was designed and developed by a local manufacturer in collaboration with ICARDA, led by Drs. **Udo Rudiger**, **Zied Idoudi**, and national partners in Tunisia. The unit was locally manufactured at a low cost and distributed to farmer cooperatives. In 2019 and 2020, the total quantity of cleaned and treated seeds increased from 240 tons to 691 tons, and the benefit for the cooperatives went from almost \$720USD to over \$6,000USD and the number of users from 138 to nearly 300.





# Climate-smart crops

ICARDA plays a critical role in developing and disseminating climate-resilient, market-driven crop varieties that provide a crucial defense against extreme temperatures, water scarcity, the emergence of new pests and diseases, and nutritional insecurity in dry regions.

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Our improved cereal and legume varieties have been tested and released over the past four decades by national partners across the Central and West Asia and North Africa (CWANA) region, South Asia, and sub-Saharan Africa, and beyond. Our new varieties have been

adopted by farmers worldwide, generating net benefits of approximately \$850USD million annually.

ICARDA's improved crops combat a range of challenges typical in dry regions. They can flourish in areas where rainfall is low and erratic, offer greater and more stable yields, and have a higher tolerance to stress factors such as diseases, pests, drought, and extreme temperatures. Many varieties are also biofortified with micronutrients, especially iron and zinc, offering better nutritional quality.

## ICARDA climate-smart crops and One CGIAR

ICARDA's Breeding, Seed Systems, and Genetic Resources Teams now work alongside other CGIAR centers to develop the One CGIAR Initiatives that seek to unify efforts in crop improvement globally and across Central and West Asia, and North Africa (CWANA) countries. The goals of the unified approach are improved crops and breeding methods, knowledge sharing, pooling of genetic resources, and creating excellence in breeding standards.

To find out about our 2020 work in climate-smart crops, click below:

- [WHEAT](#)
- [FOOD LEGUMES](#)
- [BARLEY](#)

## The DIIVA-PR Project

The ICARDA Dissemination of Interspecific ICARDA Varieties via Participatory Research (DIIVA-PR) project, supported by the [Global Crop Diversity Trust](#) crop wild

## KEY IMPACTS IN 2020

**80,191**

tons of cereal and legume seeds  
were disseminated to smallholder farmers

**1,619**

breeding lines distributed to partners  
in 43 countries

**18**

ICARDA crop varieties released by national partners

**~20,000**

seed samples were distributed to more than  
81 partners in 17 countries

relatives project, improved the stability and productivity of wheat, barley, and lentils in areas of Morocco, Lebanon, Senegal, and Ethiopia critically affected by climate change and climate variability.

The project's objective is to develop new varieties derived from crop wild relatives crosses, assess their response to climatic stresses across these locations, and introduce them to farmers through a participatory varietal selection strategy.

Over the 3 years of the project's duration, data from 15 environments were collected to guide the precise

Crops	Afghanistan	Ethiopia	Lebanon	Turkey	Grand Total
Barley				2	2
Bread wheat	3	1			4
Durum wheat			2		2
Winter wheat				8	8
Grand Total	3	1	2	10	16

identification of traits and best performing germplasm. At the same time, some 500 crop wild relative-derived elite lines were generated for durum wheat, barley, and lentil crops.

More importantly, 28 on-farm trials were conducted, and farmers' appreciation recorded. Despite the severe drought that affected Morocco in 2020, farmers growing Dissemination of Interspecific ICARDA Varieties (DIIVA) elites for the second season reported very good performances. This process resulted in the registration of two varieties in Lebanon, one in Senegal, and the expected registration in 2021 of one variety also in Morocco.

## Date palm

ICARDA also works across the Arabian Peninsula to improve date palm, an important crop for the region where 90 percent of global date production is concentrated. Funded by the Secretariat General of the Gulf Cooperation Council (GCC), the project improves date palm production systems in GCC countries, employing modern technology to increase crop management, post-harvest seed operation, and market and value chain development. Major project milestones in 2020 include applying drone technology to monitor pests, applying new liquid pollination techniques, and post-harvesting monitoring and control. Liquid pollination resulted in cost reductions of 80 percent, savings of 70 percent in pollen grains, and a profitability ratio of 1:9 when compared to conventional methods.

***New elite lines of our crops aligned to market-oriented product profiles can be found in [ICARDA's International Nurseries](#).***

ICARDA's International Nurseries Team implemented seed production and distribution for 1,295 sets of 28 International Nursery trials, covering 1,566 genotypes spread over the 7 ICARDA crops, to 114 cooperators in 43 countries.

From ICARDA-generated germplasm under development, distributed to national counterparts through the International Nursery system, we released 2 barley and 14 wheat varieties for crop production in 4 countries.

We also distributed three tons of quality seed of ICARDA-originated varieties of its six mandated crops to Syria and Lebanon for further multiplication and distribution. And we produced 160 kg of seed from 200 genotypes, selected from 1,300 accessions of dryland forages, for distribution to livestock-based livelihood communities in Lebanon, accompanied by a training video.

## WHEAT

As demand for wheat rapidly grows across Africa, Asia, and the Middle East, ICARDA is urgently addressing growing climatic challenges, pests, and diseases that hinder domestic production. We do this by generating an effective wheat-breeding strategy and new wheat varieties, alongside the training needed to help them flourish, and new technologies and tools. Our improved varieties deliver high-yield potential, resistance and tolerance to abiotic and biotic stresses, and acceptable end-use qualities. We also develop diversified wheat-pulse cropping systems that boost soil biodiversity while improving wheat's nutritional value.

## ICARDA wheat research in 2020

The African Development Bank (AfDB)-funded [Technologies for African Agricultural Transformation Wheat Compact](#) project expansion in Ethiopia and Sudan, the fantastic [Crop Science Society of America \(CSSA\) Award for outstanding paper](#), and our work on wheat in fragile states and territories, can all be found on our [highlights page](#).

Our Crop Breeding Teams are also working alongside other CGIAR Center Research Teams to develop the new initiatives that will define future approaches to wheat breeding across the globe under the One CGIAR reformulation.

Other 2020 developments in wheat include:

## Identifying disease and pests

Our disease and pests research in Turkey is supported by TAGEM (General Directorate of Agricultural Research and Policy, the Ministry of Agriculture and Forestry of Turkey) and the International Maize and Wheat





Improvement Center (CIMMYT) and is headed by Dr. Kumarse Nazari. In 2020, we helped the Regional Cereal Rust Research Center identify new stem and yellow rust races for the first time in some countries in the region. These rust races are resistant to current rust-resistant breeds in Central and West Asia, and North Africa (CWANA) countries, and research is underway to monitor their movement and find new rust-resistant traits to combat the ever-evolving threat.

### Better bread wheat for dry areas

Funded by the European Union and the International Fund for Agricultural Development (IFAD), and headed by [Dr. Tadesse Degu](#), our program in Morocco developed drought and heat-tolerant bread wheat with rust and Hessian fly-resistant traits. These varieties also demonstrated a 50 percent yield advantage over currently grown cultivars. We also developed yellow rust-resistant and high-yielding bread wheat varieties and distributed them to National Agricultural Research System (NARS) partners in Central and West Asia, and North Africa (CWANA) and sub-Saharan Africa. From this ICARDA-origin resource, more than 60 varieties have been released in the last 7 years alone.

### Durum wheat in Senegal

Funded by the Swedish Research Council and CIMMYT, and headed by ICARDA's [Dr. Filippo Bassi](#), the area along the Senegal River cultivated with new durum wheat varieties that can withstand up to 40°C heat exceeded 8,000 ha, benefitting some 50,000 farmers. Seeds of durum wheat varieties identified in Senegal were provided to farmers' associations and non-governmental organizations across Africa.

### Agricultural trainings and support in Central and West Asia, and North Africa

In addition to our Arab Peninsula Regional Program (see [highlights](#)), in 2020 we implemented over 1,100 demonstrations in farmers' fields in the region, led by Dr. Habib Halila and Dr. Nigamananda Swain with support from the Bill & Melinda Gates Foundation (BMGF), the Kuwait Fund for Agricultural Development (KFAED), the Organization of the Petroleum Exporting Countries Fund for International Development (OFID), and National Agricultural Research Systems (NARS). The demonstrations covered improved technologies for wheat and legume production in 28 target areas and, despite

COVID-related challenges, the outstanding efforts of NARS partners enabled over 5,800 farmers to benefit.

## ZAR3i – better wheat under harsh conditions in Morocco

A project led by ICARDA's [Dr. Rachid Moussadek](#), funded by one of the largest mills in Morocco and supported by CIMMYT, aims to improve cereal quality and productivity by offering farmers the right choice of varieties adapted to different production areas. In 2019, in collaboration with L'Institut National de la Recherche Agronomique du Maroc (INRA-M), local varieties were tested under different agroclimatic conditions including under drought, and local wheat germplasm was identified and multiplied in an irrigated area to secure the germplasm material to be tested next season with selected farmers.

Read about [wheat](#) in detail in the appendix.

## FOOD LEGUMES

ICARDA implemented numerous research projects in 2020 to deliver climate-smart food legumes for family farmers in dry areas to increase their income and household nutrition. ICARDA improves the productivity, nutritional quality, and yield stability of legume crops such as faba bean, grasspea, kabuli chickpea and lentil by developing elite germplasm, resistant to key diseases and insect pests and adaptive to rising temperatures, and water stress. We also look at ways to intercrop these varieties into staple crop systems such as wheat, barley and rice.

Our elite food legume lines are made available to the National Agricultural Research System (NARS) partners through [ICARDA's International Nurseries](#). ICARDA's Food Legumes Team is also working alongside other CGIAR Centers to develop the One CGIAR initiatives that seek to unify efforts in crop improvement globally and across Central and West Asia, and North Africa (CWANA) countries.

Our projects receive funding from the Indian Council of Agricultural Research (ICAR), the Government of Odisha, the International Fund for Agricultural Development (IFAD), the European Union, the





CGIAR Research Program on Grain Legumes and Dryland Cereals (CRP-GLDC), the Grains Research and Development Corporation (GRDC), the Global Crop Diversity Trust, the Arab Fund for Economic and Social Development (AFESD), Organization of the Petroleum Exporting Countries Fund for International Development (OFID) and Templeton World Charity Foundation, among others.

### Climate-smart food legumes

One such project, led by [Dr. Shiv Kumar](#), is the INCREASE project within the European Union-funded Horizon 2020 project, through which ICARDA and a consortium of 25 partners develop collections of chickpea and lentil to generate important genetic and genomic resources for accelerating the genetic gains in these crops. The European Union also funded research led by Dr. Fouad Maalouf which identified ideal ratios for faba bean/wheat intercropping systems. Through Global Crop Diversity Trust-funded research, Dr. Kumar also identified six high-yielding, nutritious lines of lentils. He was also elected Chair of the Scientific Program Committee of the International Food Legume Research Conference to be held in Kenya in 2022.

In Egypt in 2020, ICARDA, through [Dr. Aladdin Hamweih](#), led a global Ascochyta blight consortium to gain a better global understanding of Ascochyta blight diversity in chickpea, and develop ways to combat it. Dr. Hamweih also continued his food legume research focusing on disease resistance as well as climate-smart traits.

### Crop diversification for better soil and yields

Food legumes variety, technology, and seed systems strengthening project in Odisha (India) led by [Dr. Ashutosh Sarker](#) and Dr. Nigamananda Swain with fund support from the Government of Odisha's Department of Agriculture & Food Production, was implemented in the year with 1,115 farmers in 838.8 ha. The Village Seed Hubs produced 217.13 quintals of quality seed for outreach among farmers. Demonstration of good agriculture practices in pulses improved average productivity to 7.29-7.69 ton/ha in 2018-19 and 2019-20 respectively against the state average of 5.04 ton/ha.

#### Speed breeding

ICARDA can now produce up to five generations of barley, chickpea, grass pea, lentil and wheat crops per year through rapid generation advancement following speed breeding protocols that shorten the period for new variety releases from 10 to 6 years. The new screening and breeding infrastructure, which will be completed by the end of 2021, will increase capacity from 3,000 to 100,000 plants.

Dr. Habib Halila leads an Organization of the Petroleum Exporting Countries Fund for International Development (OFID)/Arab Fund for Economic and Social Development (AFESD)-funded crop diversification project across Middle East and North Africa (MENA) that examines the potential of intercropping food legumes with staple crops such as wheat. In 2020 it expanded to other agro-ecologies and supported national research institutions in scaling the innovations outwards. Projects led by Drs. Ashutosh Sarker and Nigamananda Swain also looked at intercropping faba bean, grass pea, Kabuli chickpea, and lentil into rice fallow, durum wheat, and barley systems and examined the use of remote sensing images to identify suitable fallows for such diversified crop systems.

We also develop early-maturing food legumes to fit within short maturing windows, and for a project in South Asia funded by the International Fund for Agricultural Development (IFAD) and led by [Ashutosh Sarker](#), our early-maturing lentils used between rice harvests increased system productivity by 25-30 percent where adopted, for over 23,845 farmers.

#### Safer grass pea

And with the support of the Global Crop Diversity Trust and the Templeton World Charity Foundation, and in partnership with the John Innes Center, we generated the genomic resources required to deliver varieties of grass pea with low ODAP (a natural toxin) accurately and efficiently, to make this hardy and nutritious crop safe









for human consumption. Research by [Dr. Zewdie Bishaw](#) also identified grass pea mutants with low ODAP that were suitable and safe options for farmers.

Read about [food legumes](#) in detail in the appendix.

## BARLEY

Barley is the ultimate multipurpose crop in the drylands of the Middle East and North Africa (MENA) region, covering 3.3 million ha, mainly in Morocco, Algeria, and Tunisia. Providing food, feed, forage and/or malt, barley increases food and feed security by intensifying animal and crop production per unit area. For many traditional subsistence farmers, barley is the only and often last option to feed their livestock, especially in drier years. Yet making a profit on produce is a challenge even when conditions are optimal. Climate change is expected to reduce rainfall by up to 50 percent and increase temperatures up to 4°C in the region by the end of the century. Therefore, new technologies need to be developed and deployed to increase the productivity per unit area in a scenario of worse climatic conditions.

The ICARDA Global Barley Breeding program has developed new barley genotypes, producing 10 percent more grain and straw under severe drought conditions than commercial checks (conventional varieties). New wild relative-derived genotypes with consistently higher B-glucan content for increased nutritional value have also been developed, together with new genotypes with 30 percent more forage production

than commercial checks. In total, 335 new elite barley genotypes have been distributed to 34 collaborators in 23 countries upon demand. The project has been funded by the CGIAR Research Program on Livestock (CRP Livestock), the Arab Fund for Economic and Social Development (AFESD), the Global Crop Diversity Trust, and the Chinese Academy of Agricultural Sciences.

## Global spring barley trials

In 2020, ICARDA's [Dr. Miguel Sanchez-Garcia](#) assembled [four Global Barley International Nurseries](#) and distributed new varieties to 23 countries.

## Low-input environments

These trials/nurseries are targeted to global low-input production conditions for rainfed agriculture, or in areas of drought and other challenges. The yield trial constitutes of 25 lines, including one local/national check, and with genotypes that have proven performance and adaptation from typical to severe dry regions of the world. These are coupled with disease resistance and they target different products and uses (especially food, feed, and fodder). The observation nursery has approximately 120 diverse, advanced barley lines, which combine climate smart, pest, disease, and yield traits, to deliver variability to national breeders for use in their own programs.

## High-input environments

The ICARDA barley nurseries for high-input environments provide materials targeted for areas where barley is grown under more favorable conditions and with the use of near-optimum level of inputs. The yield trial contains 25 lines including one local/national check and is constituted by elite barley genotypes with proven grain yield performance and adaptation across high-input testing sites around the world (India, Lebanon, Morocco, among others), coupled with disease resistance and targeting different products and uses (especially food, feed, malting, forage and fodder). The observation nursery has approximately 120 diverse, advanced barley lines, combining traits of interest to deliver variability to national breeders to make selections and use in their own program.



## Resilient crop-livestock systems

ICARDA's integrated approach towards more productive and sustainable crop-livestock systems focuses on farmer- and community-based solutions for improving sheep and goat production, sustainable management and restoration of rangelands, producing water-efficient dryland forages, and better integration of crop and livestock in mixed dryland systems.

Our innovations reduce the environmental footprint of dryland agriculture and aim for Land Degradation Neutrality through restoration measures that adapt to

climate change. We also deliver knowledge and skills to rural households to ensure product safety and maximum benefits from value addition. To ensure that CGIAR



harnesses our expertise now and in the future, our teams collaborate with other CGIAR Centers on new initiatives and frameworks that define future crop-livestock approaches under the One CGIAR reformulation.

In 2020 ICARDA's Community-Based Breeding Programs (CBBP) continued to ensure farmers' access to climate-resilient and productive breeding animals. Supported by the CGIAR Research Program on Livestock (CRP Livestock), and the Ministry of Agriculture in Ethiopia through the World Bank and led by [Dr. Aynalem Haile](#), ICARDA's CBBP's operate in three major regions of Ethiopia. Over 60 legal breeders' cooperatives now lead day-to-day operations and an upscaling operation funded by the United States Department of Agriculture (USDA) involved over 2,000 households, the purchasing and dissemination of 479 bucks from existing CBBPs, and mass synchronization and artificial insemination to disseminate improved genetics. We also linked farmers to better market routes through slaughterhouse companies, livestock cooperatives, and buyers in Dubai.

[Dr. Jane Wamatu's Sheep Fattening program in Ethiopia](#) funded in 2020 by CGIAR Research Program on Livestock (CRP Livestock) in collaboration with the Southern Agricultural Research Institute and the Amhara Regional Agricultural Research Institute, supported 44 youth groups and 44 champion farmers by improving feeding and management strategies, developing entrepreneurial skills, and facilitating the formation of seven officially registered cooperatives from the youth groups. Locally adapted forages that reduce feed costs were also researched, including sweet lupin, a forage with potential for feed, food, and soil fertility maintenance.

In collaboration with the Jordanian National Agricultural Research Center (NARC), CGIAR Research Program on Livestock (CRP Livestock), and with the financial support of the Arab Fund for Economic and Social Development (AFESD), [Dr. Mounir Louhaichi](#) and [Dr. Sawsan Hassan](#) duplicated the cactus nursery in Jordan to other research station, where over 100 different cactus pear accessions are now well established. Cactus pear, a dryland forage focus crop for ICARDA, was also selected as a [CGIAR@50 innovation](#) and added to the [WOCAT SLM database](#) as cactus fruit plantation in arid lands.

ICARDA also continued to research rangeland restoration and management throughout 2020. [Dr. Louhaichi's](#) team in collaboration with the [International Union for Conservation of Nature](#) are also developing a rangeland restoration toolkit, and in 2020 added several sustainable rangeland management practices including the [grazing management](#) to improve soil stability and enhances plant health and diversity. They also developed the [direct seeding](#) approach which is a set of rapid and cost-effective options that reduce time and labor over conventional shrub transplanting for large-scale restoration of degraded environments.

Meanwhile, in Jordan, research continued on watershed restoration to help restore degraded rangelands, with support from the United States Forest Service, the Jordanian National Agricultural Research Center (NARC), Utrecht University's Copernicus Institute of Sustainable Development, and WADI for Sustainable Ecosystems Development. Due to COVID restrictions, ICARDA's [Stefan Strohmeier](#) communicated with local communities through digital media and trained community members to take over vital field monitoring activities. The research team also joined with the Food and Agriculture Organization of the United Nations (FAO) to establish an inventory of sustainable land management practices with the potential to prevent sand and dust storms.

The [Crop Livestock Conservation Agriculture](#) (CLCA) project is led by [Mourad Rekik](#) funded by the International Fund for Agricultural Development (IFAD) in collaboration with the International Maize and Wheat Improvement Center (CIMMYT), the Institution of Agricultural Research and Higher Education in Tunisia, and the Technical Institute of Field Crops (ITGC) in Algeria. In 2020 the project promoted innovative livestock and crop management practices to optimize climate-resilient and integrated crop-livestock systems under conservation agriculture in Algeria and Tunisia. The project was implemented across 2,000 ha with 117 farmers, a 40 percent increase compared to 2019. In addition, CLCA activities in Algeria expanded to over five new districts, 430 farmers and 1,732 ha, compared to 982 ha and 241 farmers in 2019.

Read about [resilient crop-livestock systems](#) in detail in the appendix.



## Sustainable land, soils and water

The agricultural future of global dry areas is at grave risk from intensifying climate change, land degradation, and diminishing resources, especially water. To build livelihoods resilience and diversify cereal-based irrigated, rain-fed, and conservation agriculture food systems, ICARDA carries out sustainable land, soil, and water management research-for-development on diversified and sustainable practices for family and large-scale farming. We also develop sustainable desert agriculture and promote the safe use of treated wastewater to produce feed, forage, and trees.



In 2020, ICARDA's Soil, Water, and Agronomy Team collaborated with other CGIAR Centers on the new frameworks that will define CGIAR's future water management and soil health approaches across the globe under the One CGIAR reformulation.

Other 2020 highlights include:

ICARDA's [Dr. Vinay Nangia](#) completed successful [Ultra-Low-Energy \(ULE\) Drip Irrigation](#) trials on olive and citrus trees and fruits and vegetables. ICARDA conducted trials in collaboration with the Massachusetts Institute of Technology (MIT), the United States Agency for International Development (USAID), and L'Institut National de la Recherche Agronomique du Maroc (INRA-M). In six Gulf Cooperation Council (GCC) countries, a public-private research partnership with Jain Irrigation Systems Limited successfully tested ULE drippers for irrigating date palm plantations in six GCC countries.

The [ReWater MENA project](#), led by [Bezaïet Dessalegn](#), established a new site near the Serapeum Wastewater Treatment plant in Egypt, with Swedish International Development Cooperation Agency (SIDA) funds, under the management of the International Water Management Institute (IWMI) and in collaboration with the University of Florence. ICARDA is assessing potential water reuse options, successfully testing the production of wheat and barley crops using treated wastewater that complies with the Egypt National Reuse Code.

The [iNASHR project](#) is funded by The Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) and developed alongside Egypt's Agricultural Research Center (ARC) and Ministry of Agriculture and led by ICARDA's [Bezaïet Dessalegn](#). The project addresses Egypt's water scarcity and soil quality while improving food security for smallholder family farmers. In 2020 ICARDA established 420 demonstration sites, 16 percent of them women-owned. Planted with improved wheat and faba bean varieties, the demonstration sites benefit 400 individuals directly from capacity-building efforts, of which 21 percent are women. ICARDA also scaled up its raised bed (RB) wheat planting technology in Egypt. Results obtained in farmers' fields during 2020 showed a clear advantage of the RB technology with a 31 percent saving in irrigation

water, 32 percent increase in wheat grain yield and 98 percent increase in water use efficiency.

ICARDA, in collaboration with the United States Department of Agriculture (USDA) and various federal and provincial institutes, developed a model to transfer land and water management technologies to small farmers in Pakistan. The project trained agriculture service providers (ASPs) on technologies and business, disseminating 11 technologies to 1,266 farmers over an area of 12,474 acres (5,050 ha) generating income of up to 300,000 rupees (\$3,900USD) per season for trained ASPs. Some of the services introduced to the ASPs are installation and repairing drip systems, planting of crops on ridges and beds, and laser land leveling

At the end of 2020, we launched a new Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)-funded project led by [Dr. Aymen Fija](#) to develop soil and water conservation technologies tailored to specific and highly variable social and ecological contexts in Tunisia and upscale these across the relevant regions.

ICARDA also signed an agreement with the African Plant Nutrition Institute (APNI) to further research in nutrient management. The partnership has already led to joint research proposals to external donors, and APNI and ICARDA will collaborate under the One CGIAR initiatives targeting Africa.

Finally, we were thrilled when [Dr. Vinay Nangia](#) joined the Advisory Board of the Global Institute for Water, Environment and Health (a Geneva-based water think tank).

Read about [sustainable land, soils and water](#) in detail in the appendix.







# Genebanks

ICARDA's Genetic Resources (GRS) Team, led by Dr. Zakaria Kehel, works in Lebanon and Morocco, alongside global networks including the CGIAR Genebank Platform, the Global Crop Diversity Trust, GIZ-Germany, the European Union, and other development partners. Together, they collect, conserve, and develop the vital genetic resources needed to protect agrobiodiversity in dry regions.

Our genebanks currently contain over 143,806 accessions of major winter cereals, food legumes, forage, and rangeland species. This is in spite of the

upheaval encountered when the ICARDA genebank relocated from Aleppo in Syria in 2012, due to unrest in the country. Since then a tremendous effort to

safeguard and duplicate the precious collection means that to date, 83,702 accessions, out of the original 91,751 are available for distribution to global breeding programs. Efforts to regenerate the remaining accessions are ongoing.

In 2020 core activities included developing and applying best practices for acquisition, pre-breeding, regeneration, conservation, distribution, and documentation of genetic resources. The Genetic Resources (GRS) Team also continued reconstructing active base collections in Lebanon and Morocco, regenerating and characterizing accessions in 2020. Further collection missions were carried out in countries.

As well as this, to ensure that CGIAR harnesses ICARDA's expertise and genetic resources under the One CGIAR reformulation, the Genetic Resources (GRS) Team is also working with other CGIAR Centers on the new frameworks that will define CGIAR's future genebank approaches.

Efforts to improve performance in 2020 means that the ICARDA genebank system now responds faster to genetic resources research requests by intensifying the [Focused Identification of Germplasm Strategy](#) approach and ensuring safety duplications at two levels, as targeted by the CGIAR Genebank Platform. The Moroccan dryland agrobiodiversity genebank facility was also completed in November.

High on our 2020 agenda was strengthening pre-breeding activities for ICARDA mandate crops such as grass pea and accelerating pre-breeding for drought, heat, and salt tolerance/resistance for barley.

## KEY IMPACTS IN 2020

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**~20,000**

seed samples were distributed to more than 81 partners in 17 countries

**27,013**

accessions were regenerated in the 2019/2020 cropping season

**>9,531**

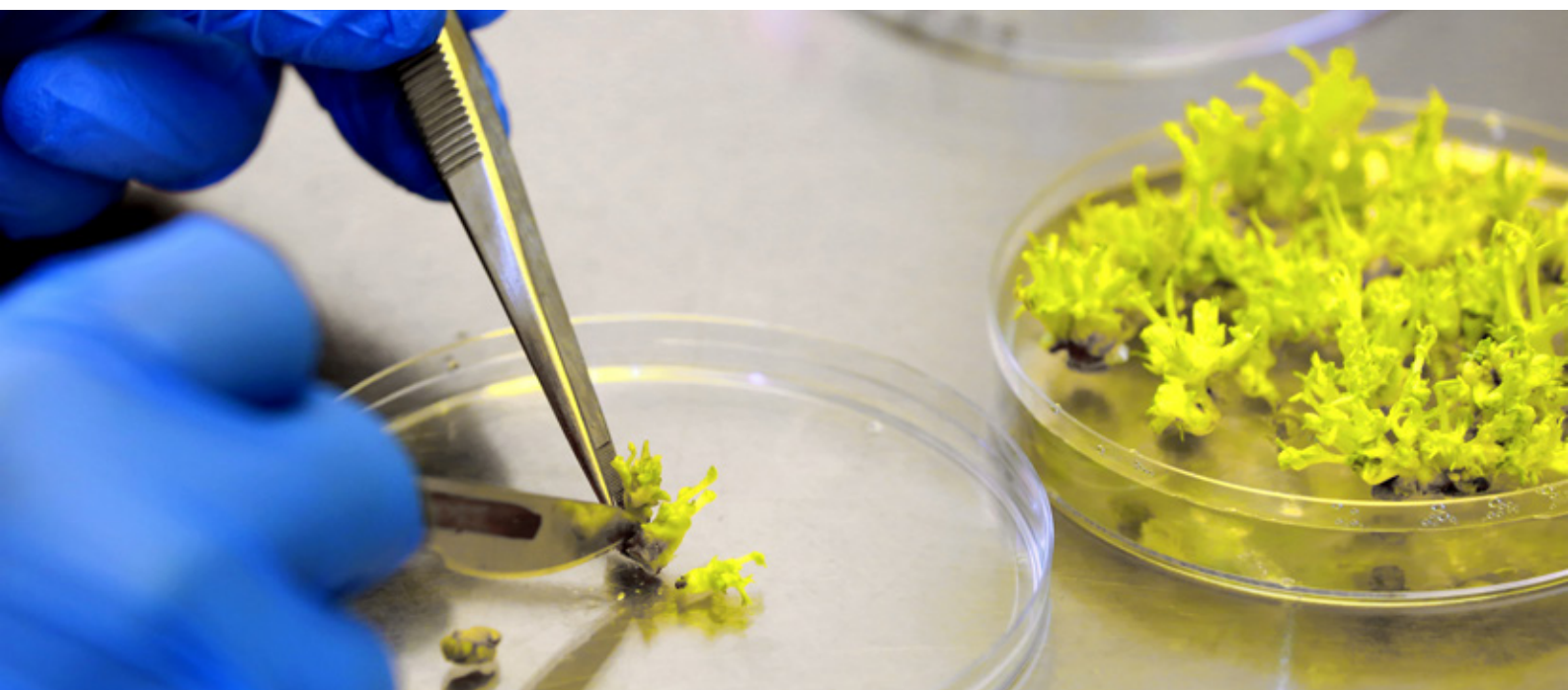
accessions were deposited in the Svalbard Global Seed Vault

**>1,156**

ICARDA's genebank holdings were assigned Digital Object Identifiers

ICARDA was also proud to lead a multi-nation project, funded by the Grains Research and Development Corporation, (GRDC), to develop sets of germplasm which allows characterization of virulences of the *Aschocyta* blight pathogen and identify good sources of resistance.

We also contributed to the Activated Genebank Network (AGENT) project funded by the European Union and launched in 2020. It standardizes and pools phenotype information from global gene bank networks within a single database and will revolutionize plant genetic resources information sharing.







## Improving rural livelihoods

ICARDA's Social, Economic, and Policy (SEP) Research Team plays a crucial role in analyzing our innovations' socioeconomic viability, adoption, scaling up, and impact on poverty alleviation, food security, systems resilience, and social inclusiveness. Our solutions aim for more inclusive markets and value chains, better natural resource management and governance, and optimization of sustainable land and livestock management options. Our approaches also include socioeconomic evaluation and gender transformative approaches, as well as context-sensitive targeting.



In 2020, the Social, Economic, and Policy (SEP) Team carried out several studies to analyze factors that can drive transformations in farmers' livelihoods and inform decision-makers and institutions on effective policies and strategies for improving agricultural productivity.

In Ethiopia, the CGIAR Research Program on Policies, Institutions, and Markets (CRP-PIM) and CGIAR Research Program on Livestock (CRP Livestock) fund important studies led by ICARDA's [Dr. Girma Kassie](#). These demonstrate how livestock market facilities could improve smallholder livestock keepers' market participation as well as the price of their livestock. Complementary studies highlight key livestock market facilities prioritized by the livestock keepers themselves, that they are willing to pay for.

In Syria, a study funded by the CGIAR Research Program on Wheat (CRP Wheat) and led by ICARDA's [Dr. Yigezu Atnafe Yigezu](#) and Dr. Amin Mugeru of the University of Western Australia showed how the use of zero tillage enhances technical efficiency and reduces the risk of poor wheat yields.

In Morocco, research funded by the CGIAR Research Program on Wheat (CRP Wheat) and led by ICARDA's [Drs Mina Devkota](#) and [Yigezu Atnafe Yigezu](#) identified agronomic factors such as tillage methods, seed quality, fertilizer application rates, and the type of preceding crop, that can reduce gaps in yield and profit margins in wheat production.

A study across 14 African countries funded by the CGIAR Research Program on Policies, Institutions, and Markets (CRP-PIM) and led by ICARDA's [Drs Aymen Frija](#) and [Boubkaer Dhehibi](#) showed how increased investments in agriculture could generate higher overall employment and reduce gender disparities in labor participation. It also demonstrated how women's employment rises over men's in response to agricultural investments and how infrastructure investments delivered a higher impact on female employment growth than productivity.

A study funded by the CGIAR Research Program on Dryland Systems (CRP Drylands) and the CGIAR Research Program on Policies, Institutions and Markets (CRP-PIM) demonstrated that public-private-civil society



partnerships are essential for developing technological and institutional innovations that involve more inclusive olive oil value chains. The research helps design initiatives that foster effective, inclusive, and contextually relevant processes for agricultural innovation.

And a [study in Egypt](#), led by [Dr. Boubkaer Dhehibi](#) and funded by the United States Department of Agriculture (USDA) through its Economic Research Service, showed that technological innovations and efficiency gains have historically contributed more to agricultural growth than did the expansion of irrigated areas or water use. The study is a clear argument for more investment in innovation.

As well as research studies, our [ICT2Scale project](#), funded by German development agency Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) and led by [Udo Rudiger](#) and [Dr. Boubaker Dhehibi](#), uses cell phone-based services to offer helpful information on crop and small ruminant production, beekeeping, and conservation agriculture for over 1,000 smallholder farmers in Tunisia. Current market prices for 10 common agricultural commodities are also shared. Eight [e-learning](#) modules were also developed to strengthen the capacities of trainers and extension workers.

Read about [improving rural livelihoods](#) in detail in the appendix.



## Capacity building

When delivering dryland farming system innovations, ICARDA includes a vital capacity-building component of trainings, technology, and support. Family farmers, scientists, governments, research institutions, and private sector actors, among others, can then take full advantage of our technologies and help them overcome critical issues they face, especially under a climate crisis

In addition to our Arab Peninsula Regional Program (see [highlights](#)), in 2020, we implemented over 1,100 demonstrations in farmers' fields in the region, led by Dr. Habib Halila and Dr. Nigamananda Swain with support from the Bill & Melinda Gates Foundation

(BMGF), the Kuwait Fund for Agricultural Development (KFAED), the Organization of the Petroleum Exporting Countries Fund for International Development (OFID), and National Agricultural Research Systems (NARS). The demonstrations covered improved technologies for

wheat and legume production in 28 target areas and, despite COVID restrictions, the outstanding efforts of National Agricultural Research Systems (NARS) partners enabled over 5,800 farmers to benefit.

Funded by the International Fund for Agricultural Development (IFAD) the Strengthening Agricultural Knowledge Management (SKIM) project, is led by ICARDA's **Dr. Akmal Akramkhanov**. As well as training sessions across the region, we supported the University of Khartoum in scientific poster development, and the Virtual Learning Route was created to build a framework of agricultural knowledge sharing to support stakeholders and entrepreneurs across Sudan.

### Training tomorrow's experts

In collaboration with the Center of Excellence project and funding from the Arab Fund for Economic and Social Development (AFESD), ICARDA's **Dr. Seid-Ahmed Kemal** held two in-country trainings for the Agricultural Research Centers of Egypt and Sudan. Fifteen young researchers in Egypt developed their knowledge in wheat and legume improvement through field and lab training. Across Sudan, 24 trainees (37 percent female) from 8 research stations learned contemporary agricultural approaches

As part of the SemiArid project, funded by ERANET, ArimNet 2 (an agri-research group from the Mediterranean region) with the support of ICARDA and the Faculty of Agriculture of the Lebanese University, held an international training course for 40 postgraduate students and young researchers dedicated to the design of sustainable and diverse farming systems in dry areas.

### Support for Uzbekistan

ICARDA together with Regional Environmental Center for Central Asia (CAREC) Uzbekistan and the European Union, became members of a consortium led by DT Global IDEV Europe, S.L. Spain. The project provides support to Uzbekistan to assist with the implementation of the government's Agri-Food Development Strategy 2019-2030, develops dialogue forums, and enhances sector statistics and monitoring and evaluation systems.

## KEY IMPACTS IN 2020

>600

members in ICARDA CAP DEV Alumni Network

90

online courses made available

13

students enrolled in MSC and PhD programs

>1,900

trainees benefitted from 25 online and offline courses

### Capacity building in fragile states and territories

Led by **Dr. Abdoul Aziz Niane**, ICARDA works with the Food and Agriculture Organization of the United Nations (FAO) in Syria to rehabilitate the country's seed sector by developing basic seed stocks for national farmers. Weekly field-based demonstrations and WhatsApp-facilitated COVID-19 question-and-answer sessions took place, and an illustrated training manual in Arabic was developed and distributed to pioneer farmers, the national seed support team, and other national agriculture extension experts. An FAO-funded water management training program also introduced modern irrigation techniques and rainwater harvesting to increase agricultural production.

Agricultural trainings funded by the United Nations Development Programme (UNDP) in Syria and led by ICARDA's **Majd Jamal** were carried out in farmers' fields rather than classrooms due to COVID restrictions. In 2020, 18 sessions were held and attended by more than 285 farmers, 53 extension agents, 50 researchers, and 12 policymakers.

Read about [capacity building](#) in detail in the appendix.





## Gender

Women living in the dry areas where we work continue to be overlooked regarding their rights, and as an important resource for labor and business enterprise. The Middle East and North Africa (MENA) region is one of the most gender-unequal regions in the world. The MENA's male labor force participation rate is comparable to other regions, at around 75 percent, but female labor force participation rates remain stubbornly low, at around 20 percent.

As more men migrate to urban areas and more research is carried out into gender inequalities and the potential of women in agriculture, CGIAR Centers such as ICARDA step up their support. We prioritize research that enhances access to land, water, seeds, credit, knowledge, and innovation, and we empower women through capacity development that facilitates their role as leaders and active agents of change. We also help them engage in more lucrative economic activities through agricultural diversification, intensification, and value addition.

In addition, we advocate for improvements in wages and working conditions and the eradication of gender-based inequality. We also investigate promising formal and informal institutional arrangements that enhance women's voice and power in dry area communities, and we promote proven technologies that reduce agriculture-related drudgery.

In 2020, we published several important studies and organized numerous workshops:

A workshop organized by the London School of Economics (LSE) in 2019 drew experts from all over the world, including LSE professor of Gender and Development, [Naila Kabeer](#), to discuss the continued limited access to labor market opportunities for women in South Asia and the Middle East and North Africa (MENA). The subsequent [report](#) published in 2020 featured recommendations and methodologies for greater recognition of women as workers rather than helpers, property ownership perceptions, pay equality, and the revitalization of agriculture as a valuable occupation in society.

Throughout much of 2020, ICARDA's Gender Scientist [Dina Najjar](#) carried out gender-focused studies such as one that [investigates the vital contribution women make to livelihood resilience](#). The study uncovered women's undervalued and hidden contributions to rural dryland farming practices and examined domestic issues. It suggests that building women's resilience to the impacts of COVID-19 and life afterward through better transport, digital access, consistent and affordable feedstock supplies, and other agricultural inputs will strengthen the resilience of households and whole communities.

## KEY IMPACTS IN 2020

7,355

South Asian women trained in value addition

68

women-owned demo sites in Egypt planted with improved wheat and faba bean

1

Safaa Kurari named as one of the BBC's '100 Inspiring Women 2020'

Dr. Najjar also published a critical study revealing, among other data, how women in Egypt, who are generally disadvantaged compared to men with regards to land management, are reluctant to pass land on to their daughters. This is most probably for fear of the daughters then being unable to protect ownership from extended family.

Another of Dr. Najjar's studies showed how [intensifying male outmigration in dryland areas affects women's roles in agriculture and related activities](#), with broader implications for productivity and gender equity. The findings reveal that women are performing more farm labor in agricultural communities due to the increasing outmigration of men. Furthermore, many socio-cultural and economic factors influence migration-related agricultural feminization in drylands, with ongoing negotiations of these happening at different societal levels.



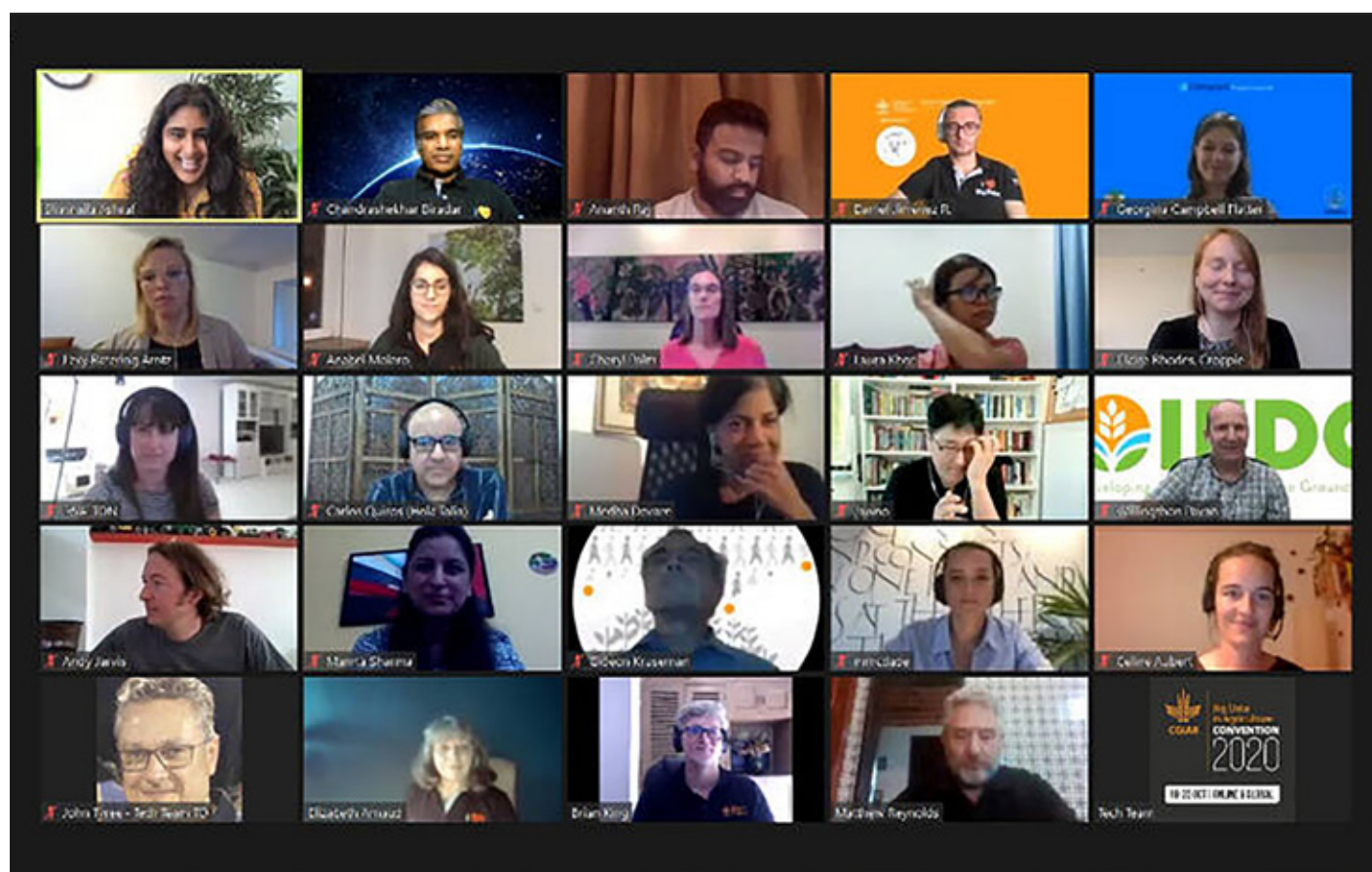




## Awards and recognition

In 2020, ICARDA was thrilled for our staff, partners, and students to win several prestigious awards for their research and fieldwork. Here is a list of our 2020 highlights.

- ICARDA projects **won two out of seven** CGIAR Big Data Inspire Challenge Awards.
- ICARDA scientist, **Safaa Kumari**, was recognized as one of the world's '100 inspiring women 2020' by the BBC for her work in protecting globally important crops from destructive pests and viruses.
- ICARDA's paper **received the 2020 Outstanding Paper Award** of Crop Science Journal by the Crop Science Society of America (CSSA).
- Dr. Badabate Diwediga, a former PhD student and early-career scientist supervised by ICARDA staff (Quang Bao Le), won the World Academy of Sciences for the Advancement of Sciences in Developing Countries – 2020 TWAS – Samira Omar Innovation for Sustainability Award.
- **Dr. Ashutosh Sarker** received the 'ISPRD Excellence Award' conferred by the Indian Society of Pulses Research and Development for his outstanding contribution in the field of 'Pulses Research and Development' during the International Conference in February 2020 in India.
- **Dr. Vinay Nangia** was selected to serve as an expert on the UN Commission to Combat Desertification Intergovernmental Working Group on Drought.
- ICARDA's **Dr. Shiv Kumar** was Elected Chair of the Scientific Program Committee of the International Food Legume Research Conference to be held in Kenya in 2022.
- **Dr. Vinay Nangia** was invited to join the Scientific Advisory Board of the Global Institute for Water, Environment, and Health (a Geneva-based water think tank).
- **Dr. Chandrashekhar Biradar** was selected as an expert member of EcoAgriculture, Indian Council of Food and Agriculture, an apex body of the Indian Chamber of Food and Agriculture serving the agriculture sector in India and the global platform for partnerships.





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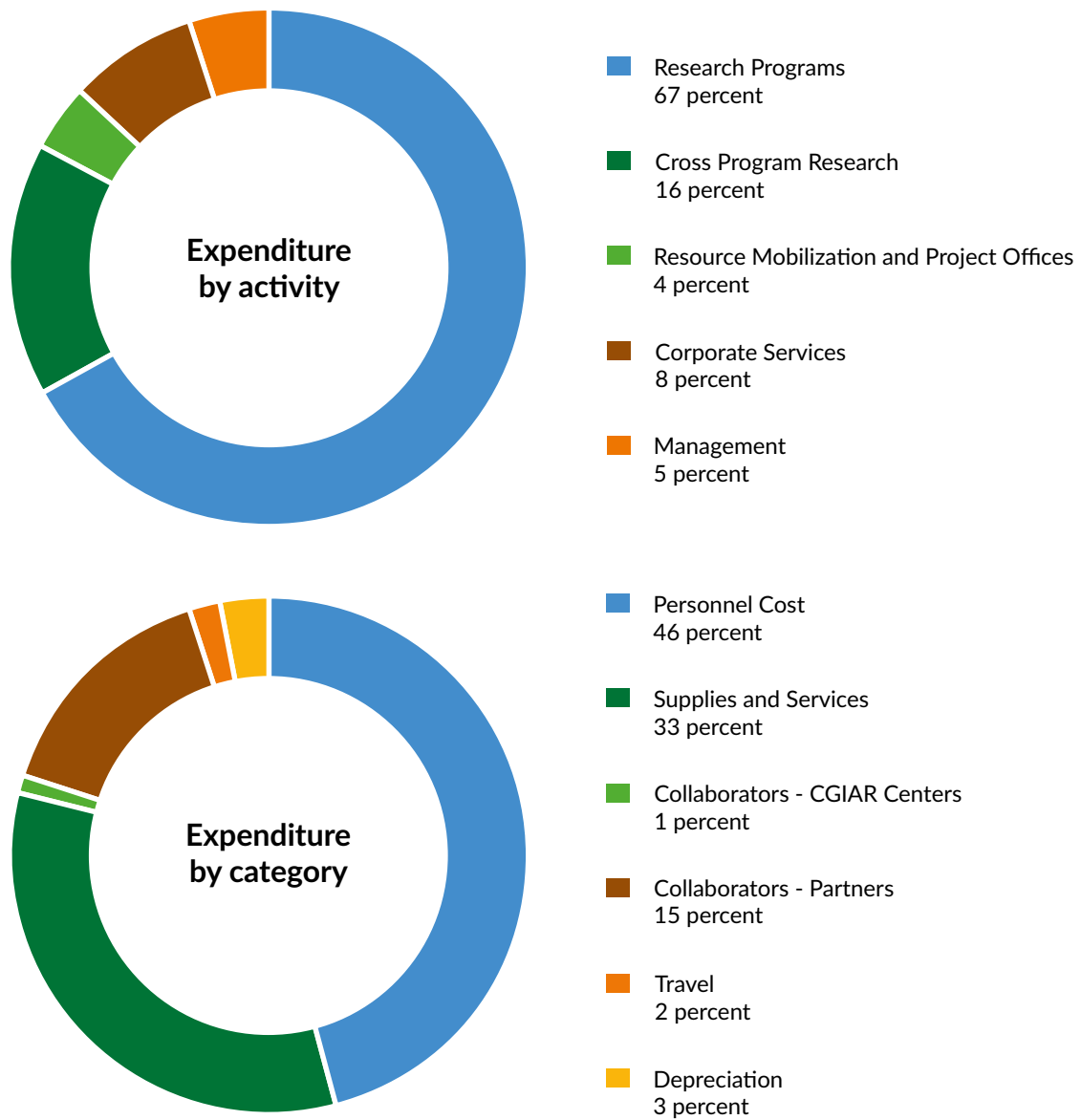
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For more detailed information, please see ICARDA's full [2020 financial statement](#).







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Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)

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Directorate of Soil Conservation and Watershed Development DSC-O, State Government of Odisha, India

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Regional Environmental Center for Central Asia  
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Société des Boissons du Maroc

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State Government of Maharashtra, India

Swedish International Development Cooperation  
Agency (SIDA)

Swedish University of Agricultural Science

The University of Western Australia

Tottori University

United Nations Development Programme (UNDP)

United Nations Environment Programme (UNEP)

United States Agency for International Development  
(USAID)

United States Department of Agriculture (USDA)

University of Sydney

World Agroforestry Centre (ICRAF)

World Bank







# Appendix

### DIGITALIZATION IN DETAIL

To ensure CGIAR can harness our unique knowledge assets for better decision-making and global knowledge sharing, we continued to digitalize our research across disciplines in 2020, in preparation for the One CGIAR reformulation. The future combined strength of this pooled data and tools from all CGIAR centers will constitute a formidable resource that will contribute significantly to the battle against global climate challenges.

#### Pooling global resources

ICARDA's Monitoring, Evaluation, and Learning (MEL) Team, led by Enrico Bonaiuti, developed the **WOCAT digital explorer** which enables development organizations to rapidly identify suitable and sustainable land management innovations for the countries in which they operate. The **Central Asia Climate Portal**, also developed by MEL alongside ICARDA's Geoinformatics for sustainable Agro-Ecosystems (GeoAgro) Team led by Dr. Chandra Shekhar Biradar and funded by the World Bank through the Regional Environmental Centre for Central Asia, pools climate data and satellite imaging from a range of official sources. The information is delivered to key policymakers and researchers to aid climate change decision processes and learning across Central Asia.

MEL's **Monitoring, Evaluation, and Learning Quality Assurance Processor**, or 'M-QAP', was launched in 2020 to source data from a range of mainstream research databases to simplify and support results reporting across the CGIAR. The project is funded by the CGIAR System Organization – and with intellectual contribution from the Alliance of Bioversity International, the CGIAR Research Programs on Grain Legumes and Dryland Cereals (CRP-GLDC), and on Roots, Tubers and Bananas (CRP-RTB), the International Center for Tropical Agriculture (CIAT), and ICARDA. M-QAP compliments MEL's development of the **CGIAR Intellectual Assets (IA) E-Reporting tool**, which aims to support all CGIAR Centers to standardize IA reporting. These different tools are developed within the overall MEL effort to improve data collection, processing, and reporting, as presented in the **ICARDA Indicators Reference Manual**.

Also in 2020, the **Partnership for Research and Innovation in the Mediterranean Area (PRIMA)** began

using MEL as its prime monitoring and evaluation tool, to strengthen the extent and complexity of its intervention framework. PRIMA is a joint program undertaken by its **19 participating states** aimed at creating a competitive environment for solutions development in research and innovation across the Mediterranean area.

Through its Monitoring, Evaluation, and Learning (MEL) Team, ICARDA became the official **AGROVOC Editors for Arabic** in addition to its contribution to the English language version, vastly increasing integration among ICARDA's online tools and systems. These are now accessible in multiple languages, which has helped to improve knowledge discoverability from the Central and West Asia, and North Africa region – in line with the recent **Findable, Accessible, Interoperable and Reusable (FAIR)** policy approved by CGIAR.

In 2020, our Geoinformatics for sustainable Agro-Ecosystems (**GeoAgro**) Team led by Dr. Chandra Shekhar Biradar ramped up the digitalization of research through its **geo-big data-driven platform** to leverage the latest cutting-edge technological innovations driven by geo big-data, earth observation, citizen science and ICTs. The GeoAgro Team also developed a number of Geotagging and Agrotagging tools to assist digitalization of research and outreach. Selected ICARDA projects contained GeoAgro pilot elements while staff and partners were trained on geotagging tools. The implementation of geo-referenced field data collection with geotagging tools led to the collection of over 2,500 datasets for mapping farming systems across dry regions in 2020.

#### Award winners

We were also thrilled in October 2020, when 4 of our Geoinformatics for sustainable Agro-Ecosystems (GeoAgro)-related projects made it to the final 15 (out of 120 entries) in the CGIAR Big Data Inspire awards. (This, in addition to the ongoing development of ICARDA's GeoAgro portal, which is funded by the CGIAR Research Program on Big Data (CRP Big Data) and the International Center for Tropical Agriculture (CIAT) and functions as an institutional gateway for research and decision support based on geodata). **Two of the projects went on to win:**





The ClimaCell Locust Project led by ClimaCell and Geoinformatics for sustainable Agro-Ecosystems (GeoAgro), is a 360° digital tool that monitors locust activity and is accessible to farmers through smartphones, as well as authorities and public and private sector organizations.

The Big Data in Resilience of Rangeland Communities project, led by the International Livestock Research Institute (ILRI) alongside ICARDA's Dr. Mouinr Louhaichi and Geoinformatics for sustainable Agro-Ecosystems (GeoAgro), aims to establish the first-ever global data platform to pool rangeland data and satellite imagery from established and new sources. The platform facilitates accurate decision-making in rangeland health, risks, and opportunities for restoration.

## AGENT of change

Another exciting, digital-focused initiative is the [Activated Genebank Network](#) (AGENT) project funded by the European Union and launched in 2020. Working with ICARDA's [Dr. Filippo Bassi](#), AGENT standardizes and pools phenotype information from global gene bank networks, including those of CGIAR, within a single database. The project will revolutionize the sharing of plant genetic resource information and uncover a rich collection of genetic resources.

## Low cost, high impact digital approaches

Working in a different area is our ICT2Scale project. Funded by German development agency Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ), this project aims to enhance access to e-learning and cell phone-based services to strengthen extension for smallholder farmers in Tunisia. In 2020, ICT2Scale sent out technical SMS to 1,000 farmers concerning crop and small ruminant production, bee-keeping, and conservation agriculture. The market prices for 10 agricultural commodities were also made available to the beneficiary farmers via cell phones.

Led by ICARDA's [Khaled Al-Shamaa](#), and funded by the Breeding Modernization project, the [Query the Breeding Management System](#) (QBMS) enables scientists to retrieve their experiment data from the standard [Breeding Management System](#) (BMS) database for further use within the 'R' context. QBMS provides coverage of a wide range of analytics, visualization, data transformations, and manipulations that could not have been delivered within the BMS itself. The interface combining all the flexibility of an R environment with the referential integrity, persistence, and cohesion of a centralized database like the BMS. QBMS fits with the CGIAR strategy expectation set by the Excellence in the Breeding initiative.

### WHEAT IN DETAIL

ICARDA's durum and bread wheat breeding programs make extensive use of wild relatives to develop elite germplasm well adapted to the drastic and frequent droughts that affect the region in which ICARDA operates. In the last 10 years alone, more than 60 ICARDA-originated bread wheat varieties have been released across the Central and West Asia, and North Africa (CWANA) region, and sub-Saharan Africa by national programs in these regions.

Significant 2020 developments in our work on wheat were:

#### Improving food security in the Arab region

As well as our work on the Arab Peninsula Regional Program (see [highlights](#)), ICARDA works across Arab countries on the [Enhancing Food Security in Arab Countries](#) project to improve food security in the region. Headed by Dr. Habib Halila, phase III of the project is funded by the Arab Fund for Economic and Social Development (AFESD) and the Organization of the Petroleum Exporting Countries Fund for International Development (OFID). The project helps to improve food security and the growth of the agricultural sector by improving wheat production and training young scientists and national agricultural support staff.

As part of its third phase, the project continued to build on the results achieved during the previous phases, by verifying and fine-tuning recommended technology packages (wheat and food legume cultivars, agronomic and water management technologies). Working in Algeria, Egypt, Iraq, Jordan, Morocco, Palestine, Sudan, Syria, Tunisia, and Yemen, the project expanded the number of pilot sites to other agro-ecologies thereby out-scaling the technologies to more end-users and strengthening the capacity of national research and extension systems to promote the technologies for wider adoption.

In the 2020 season, the project implemented activities in 28 pilot areas distributed in the participating countries. These pilot sites represent the wheat-

based production systems followed by farmers in the concerned countries. The project implemented more than 1,100 demonstrations in farmers' fields covering various improved technologies for wheat and legumes production. The results of the demonstrations showed that improved production technologies can lead to an increase in wheat yield varying, from 15 to 97 percent depending on the country and the production systems. The average increase across all countries was 30 percent and the maximum average increase was 69 percent, indicating that higher potential and greater room exist for further improvement in wheat yield in all countries.

Concerning the project's capacity-building activities, these were affected during the 2020 season by COVID-19 due to confinement and shutdowns. However, the National Agricultural Research Systems' (NARS) partners stepped up their efforts in implementing the planned capacity-building activities, while taking obligatory safety measures into account. Due to these efforts, more than 5,800 farmers benefited from field days and farmers' field schools in the project countries.

#### Technologies for African Agricultural Transformation in Sudan and Ethiopia

The ICARDA-coordinated [Technologies for African Agricultural Transformation](#) (TAAT) wheat compact project, funded by the African Development Bank (AfDB), International Institute of Tropical Agriculture (IITA), and Bill & Melinda Gates Foundation (BMGF), continued to significantly strengthen production capacity and seed systems across Africa, including in ICARDA-led programs in Ethiopia and Sudan.

Led by ICARDA's [Dr. Zewdie Bishaw](#), collectively about 80,191 tons (670 t basic seed; 77,150 t certified seed, and 2,367 t of quality declared seed) were produced in 6 target countries, which is sufficient to plant around 1 million ha.

In 2020, Sudan's bumper harvest produced 1.15 million tons of wheat and ICARDA and its partners are working to improve the sustainability of wheat production with proper input management and diversified rotations. In 2020/21, Sudan reached 375,000 ha with expected productivity of 3.6 tons ha<sup>-1</sup> and production of 1.35 million tons – a wheat area expansion of





87 percent, productivity increase of 26 percent, and production increase of 135 percent, respectively, from a 2017/18 cropping season baseline. Similarly, Ethiopia continued expansion of irrigated wheat production (180,000 ha) in Amhara and Oromia States spearheaded by the government. The average productivity of irrigated wheat is 4.4 tons ha<sup>-1</sup>, 50 percent higher than rain-fed wheat. As a result of its irrigated wheat land area expansion, Ethiopia is now harvesting an additional 0.8 million tons of wheat, accounting for 52 percent of the imported wheat of 1.7 million tons.

## Disease identification in maize and wheat

Funded by the International Maize and Wheat Improvement Center (CIMMYT), ICARDA's team headed by Dr. Kumarse Nazari, supported identification for the first time in Turkey, and Tunisia, by the Regional Cereal Rust Research Center (RCRRC), of stem rust races TKTP and TTKTP that are virulent even on rust-resistant wheat cultivar Sr24. The stem rust Ug99 race TTKTT was

identified from Ethiopia and Iraq by RCRRC for the first time. This first report of TTKTT in Iraq represents only the third instance of a member of the Ug99 race group outside of Africa since the first detection of race TTKSK in Yemen in 2006, and Iran in 2007.

It is likely that most of the wheat cultivars and breeding germplasms in Central and West Asia, and North Africa (CWANA) countries are protected from wheat stem rust by the presence of stem rust genes SrTnp, Sr24 and Sr31. If the environmental conditions favor the spread of these races, they may cause a significant threat to wheat production. A new yellow rust race with a combination of virulence for Yr10 and Yr24 was also identified in Turkey, Egypt, Lebanon, Jordan, and Syria by the Regional Cereal Rust Research Center (RCRRC). Preliminary research shows that previously resistant durum wheat is particularly susceptible to this new variant. Resistant sources of durum germplasms within ICARDA's and CIMMYT's trials and durum wheat landraces from ICARDA genebank are available.

### Climate-smart wheat for fragile countries and territories

Funded by the International Fund for Agricultural Development (IFAD), ICARDA, led by Dr. Nigamananda Swain, and the Agricultural Research Institute of Afghanistan (ARIA) continued to support fragile countries and territories by **releasing three new drought-resistant wheat varieties in Afghanistan** to help overcome the increasing threat of recurring droughts in the country and help rehabilitate the agricultural sector. The new varieties were developed and field-tested through ICARDA's and ARIA's intensive research program under the **Community Livestock and Agriculture Project (CLAP)** of the Ministry of Agriculture in Afghanistan. These new varieties are producing optimum yields in water-scarce environments and showing excellent performance under supplementary irrigation conditions. The varieties are also resistant to yellow rust disease, which causes significant yield loss in the region.

### Durum wheat in Senegal

Funded by the Swedish Research Council and CIMMYT, and headed by **Dr. Filippo Bassi**, the **Senegal River Basin initiative** uses non-genetically modified molecular breeding techniques to develop a set of durum wheat varieties that can withstand up to 40°C heat along the Senegal River basin.

In 2020, the area cultivated with durum wheat along the Senegal River exceeded 8,000 ha benefitting some 50,000 farmers, and seeds of the varieties identified in Senegal were provided to farmers associations and non-governmental organizations in, Benin, Cameroon, Chad, Gambia, Ghana, Ivory Coast, Kenya Mali, Nigeria, Somalia, South Africa, Togo, and Zambia. In Ghana and Nigeria, local government support is quickly pushing durum cultivation, with several farmers already adopting the technology.

### ZAR3i

ZAR3i, a project led by ICARDA's **Dr. Rachid Moussadek**, funded by one of the largest mills in Morocco (Forafic) and supported by CIMMYT, aims to improve cereal quality and productivity by offering

farmers the right choice of varieties adapted to different production areas. The project improves the grain quality of 200,000 tons of bread and 50,000 tons of durum wheat being produced under rain-fed conditions in Morocco to reduce grain imports. The project will help in developing a digital platform, with the support of a private Portuguese and Moroccan company (named Deepface) for cereals that will help to set up incentives for grain quality in Morocco.

In 2020, in collaboration with L'Institut National de la Recherche Agronomique du Maroc (INRA-M), local varieties were tested under different agroclimatic conditions and with different management (conventional tillage and no-tillage). Quality analyses were carried out at INRA-M and ICARDA's technical laboratories.

Trials were increased at L'Institut National de la Recherche Agronomique du Maroc (INRA-M)/ICARDA experimental stations and farm sites in Meknes, Zaer, and Chaouia to assess drought-tolerant wheat varieties tested during this cropping season. The result of the effect of crop management, such as conservation agriculture, on yield was obtained, the preliminary study on the grain quality was implemented, and promising local wheat germplasm was identified and multiplied in an irrigated area to secure the germplasm material to be tested next season with selected farmers.

### Bread wheat in Morocco

The ICARDA bread wheat breeding program, headed by **Dr. Tadesse Degu**, applies classical and molecular breeding tools with a modified shuttle and speed breeding scheme, which enables the completion of the whole breeding cycle in an average of 4 years. In 2020, the elite high-yielding and drought tolerant wheat genotypes from ICARDA's bread wheat breeding program showed 50 percent yield levels higher than the commonly grown wheat cultivars in Morocco. Furthermore, using molecular markers and inter-country shuttle and hotspot screening, ICARDA developed yellow rust-resistant, high-yielding bread wheat genotypes distributed to National Agricultural Research Systems (NARS) in the Central and West Asia, and North Africa (CWANA) and sub-Saharan Africa regions from which, in the last 7 years alone, more than 60 varieties of ICARDA-origin have been released.



*New lines of all our wheat crops aligned to product lines can be found in ICARDA's International Nurseries.*

## FOOD LEGUMES IN DETAIL

### Diversified wheat-pulses cropping systems in Arab countries

Funded by the Arab Fund for Economic and Social Development (AFESD), and the Organization of the Petroleum Exporting Countries Fund for International Development (OFID), ICARDA, led by Dr. Habib Halila develops technology packages for wheat and food legume cultivars and management in agronomy and water. Working in the Middle East and North Africa (MENA), in 2020 the project out-scaled the technologies to more end-users, and we strengthened the capacity of national research and extension systems to encourage wider adoption.

### ICAR-ICARDA collaborative research program

Coordinated by Drs. [Ashutosh Sarker](#) and Nigamananda Swain, and in partnership with Indian Council of Agricultural Research (ICAR) funding and several India state agricultural universities, ICARDA targets the identification and deployment of climate-smart faba bean, grass pea, Kabuli chickpea, and lentil for intercropping with durum wheat and barley in different environmental settings. In 2020, 96 lentils, 102 Kabuli chickpea, 36 grass pea, 25 aba bean, 147 durum wheat, and 159 barley varieties were provided to partner institutions. In India, zero tillage approaches with rice-chickpea, millet-chickpea, and soybean-lentil were recommended as profitable technologies. Our 19 cactus nurseries were also expanded to agriculture science centers in 3 more states. Also in 2020, a salinity-tolerant lentil variety (PDL-1), and a Kabuli chickpea variety (PBG-8) with a 14.49 percent yield advantage were released in India. Upscaling chickpea, grass pea, and lentil technologies were also strengthened under various initiatives by the International Fund for Agricultural Development (IFAD), Phosphate Company Foundation, Morocco, Organization of the Petroleum Exporting Countries Fund for International Development, and the Odisha Pulse Mission.

### Capitalizing on idle land for better food security in South Asia

Under an International Fund for Agricultural Development (IFAD) grant, ICARDA, led by [Dr. Ashutosh Sarker](#), implements a project in 32 districts across Bangladesh, Nepal, and India involving 24,873 smallholder farmers, (5,284 in 2020) to introduce food legumes for use in fallow lands after the rice harvest. Over the last 4 years, these farmers have harvested average yields of 932 kg/ha of lentil, 1,048 kg/ha of chickpea, and 976 kg/ha of grass pea from lands that would have otherwise remained fallow. An additional 150,000 farmers indirectly benefit through farmer-to-farmer seeds and knowledge sharing. The projects established 97 (21 in 2020) Village Seed Hubs and produced 122 tons of seeds to support coming years' cropping. With the participation of 2,610 farmers in 2020, over the years, a total of 12,513 farmers were trained on production technologies, and 7,355 women improved their skills in processing and other value-adding activities.

### The Odisha Pulse Mission

In collaboration with the Odisha Government's State Department of Agriculture, ICARDA, led by Drs Swain and Sarker has promoted black gram, chickpea, grass pea, lentil, and mung bean in fallow lands in 14 districts. Under [The Odisha Pulse Mission](#), the rice fallow area decreased by 20 percent. As well as these, 4,095 tons of pulses were produced from 4,338 ha of rice fallow lands, with an average yield of 940 kg/ha – a 50 percent plus productivity increase on the state average. The value of total produce is worth \$3.3USD million, and 126 Village Seed Hubs and 127 Custom Hiring Centers were established in 18 districts, covering 11,131 farmers. Under a seed self-sufficiency initiative, 272.7 tons of quality pulses seeds were produced, and the installation of mini dal mills has led to the uptake of value addition initiatives by women. Farmer committees were developed and engaged with new farmers across 18 districts.

### INCREASE project

The European Union-funded INCREASE project was launched in 2020 with [Dr. Shiv Kumar](#) heading the

ICARDA team. The project is under the European Union's Horizon 2020, a consortium of 25 partners that develops collections of chickpea, common bean, lentil, and lupin to generate a pool of genetic and genomic resources for accelerated improvement of the crops. In 2020, we multiplied genetically pure chickpea seed and lentil germplasm through the single seed descent method for multilocation phenotyping in the next crop season.

### Grasspea project

Under the Global Crop Diversity Trust and the Templeton World Charity Foundation-funded project on grass pea, the Japan International Cooperation Agency (JICA) and ICARDA (led by [Dr. Shiv Kumar](#)), are researching 384 grass pea genotypes, while developing a speed-breeding protocol and interspecific hybridization with crop wild relatives, to widen the genetic base and optimize useful traits in cultivated species. In 2020, 27 7 introgressed lines were advanced using the speed breeding protocol and the diversity panel of 384 grass pea germplasm was phenotyped and genotyped for establishing marker-trait association.

### Genomics-enabled legume improvement

In 2020, the CGIAR Research Program on Grain Legumes and Dryland Cereals (CRP-GLDC) and Grains Research

and Development Corporation (GRDC)-funded research optimized the protocol of genome editing in chickpea, intending to apply this technology to improve chickpea production. The research also optimized the genomic selection method for improving chickpea improvement accuracy by developing an efficient single nucleotide polymorphism (SNP) genotyping for genome-wide association study, to associate specific genetic variations with biotic and abiotic stresses. We also evaluated MAGIC (an innovative technique to increase the speed and efficiency of breeding) population in chickpea for Ascochyta blight and drought tolerance using field screening and multilocation testing.

### Legumes research under the CRP-GLDC

At Egypt's ICARDA/Agricultural Genetic Engineering Research Institute research center led by ICARDA's [Dr. Aladdin Hamwieh](#), research is carried out on chickpea, faba bean, and lentils focusing on disease resistance as well as climate-smart traits. This research is funded by the Grains Research and Development Corporation (GRDC), the CGIAR Research Program on Grain Legumes and Dryland Cereals (CRP-GLDC), and Egypt's Agricultural Research Center (ARC). In 2020 working in close collaboration with legume pathologists and partners in the Central and West Asia, and North Africa (CWANA) region, ICARDA led a global Ascochyta blight consortium to gain a better global understanding





of Ascochyta blight diversity in chickpea, and develop ways to combat it.

During the last 6 years, the Grains Research and Development Corporation (GRDC) also invested in chickpea research at ICARDA's chickpea breeding program. A number of chickpea varieties were evaluated in multi-locations in Egypt, Ethiopia, India, Lebanon, Morocco and Tunisia. The results demonstrated their varying resistance to various common plant diseases as well as cold, drought, and salinity. Over 125 crosses have been developed between Australian genotypes and the new resources between 2014 and 2020 through the ICARDA chickpea breeding program and thousands of recombinant lines have been developed. It is expected that the outputs obtained from this project will enable dryland farmers, including in Australia, to receive more developed breeding lines resistant to biotic and abiotic stresses. This should result in higher and stable grain yield and reduce the cost of inputs and improve profitability for growers, and the results will contribute significantly to the new breeding approaches such as genomic selection.

Led by [Dr. Shiv Kumar](#) in Morocco under the CGIAR Research Program on Grain Legumes and Dryland Cereals (CRP-GLDC) funding, we also studied the impact of heat and drought stresses on the nutritional quality of lentil and found that iron, zinc, and crude protein content were significantly reduced under heat and drought stress conditions. We also found that heat priming of lentil seeds and foliar treatment with  $\gamma$ -aminobutyric acid (GABA) confers protection to reproductive function and yield traits under high-temperature stress environments.

## European Union-funded DIVERSify project

In the European Union-funded DIVERSify project, led by ICARDA's [Dr. Fouad Maalouf](#) in Morocco and Lebanon, three faba bean lines combined well with wheat at Marchouch, Morocco and Kfardan in Lebanon, two at Marchouch and four at Tal Amara, Lebanon. Overall, promising combinations were identified for high rainfall vs low rainfall environments. Further, a 50 percent wheat + 100 percent faba bean combination was identified as appropriate for intercropping wheat with faba bean in dryland agriculture.

## Pre-breeding project on lentil

As part of the Global Crop Diversity Trust-funded Dissemination of Interspecific ICARDA Varieties (DIIVA) project, ICARDA's Legume Team, led by [Dr. Shiv Kumar](#), six high-yielding, biofortified pre-bred lines of lentil showed high yields across the test locations and contain high iron and zinc content in their large yellow grains. Ten accessions that originated from *Lens orientalis* were superior to the check for protein content, 5 for zinc and 10 for iron concentration.

## UPGRADE project on grass pea

As part of ICARDA's UPGRADE project with funding from the John Innes Centre, the Legume Team screened grass pea germplasm against major abiotic stresses, including drought, heat, waterlogging and salinity. ICARDA's [Dr. Zewdie Bishaw](#) headed the research to assess the effects of drought and heat on the concentration of the grass pea natural toxin ODAP. In 2020, the research identified grass pea mutants with low ODAP (a natural toxin) that were suitable and safe options for farmers.

## LIVESTOCK IN DETAIL

### Tougher, more productive livestock in Ethiopia through community-based breeding

ICARDA's [Community-Based Breeding Programs \(CBBP\)](#) supported by the CGIAR Research Program on Livestock (CRP Livestock), International Livestock Research Institute (ILRI), the World Bank, and the International Fund for Agricultural Development (IFAD), continued in 2020 to increase the productivity and profitability of indigenous breeds across Ethiopia. Led by [Dr. Aynalem Haile](#), CBBP were established through community flocks to enlarge the genepool and identify prime rams and ewes for selective breeding.

In 2020, the program expanded to 3 major regions of Ethiopia (Amhara, Oromia, and South) with a total of more than 60 legal breeders' cooperatives now leading day-to-day operations. An upscaling operation, undertaken with financial support from the United



States Department of Agriculture (USDA) in Konso, Ethiopia, involved more than 2,000 households, the purchasing and dissemination of 479 goat bucks from existing Community-Based Breeding Programs (CBBPs), and mass synchronization and artificial insemination to disseminate improved genetics.

Farmers were also linked with one of the biggest export slaughterhouses in Ethiopia (Allana), and the purchase of 100 goats was facilitated, which were slaughtered and exported to Dubai. Results on meat quality and consumer evaluations were very positive. The program is now being replicated in Burkina Faso, Iran, Liberia, Malawi, South Africa, Sudan, Tanzania, and Uganda.

### Cactus pear – nutritious and income-generating food for humans and livestock

As well as being an income-generating fodder for livestock, which requires minimal agronomic inputs, cactus pear is also packed with nutrition and ideal for human consumption. In 2020 ICARDA, in collaboration with the Food and Agriculture Organization of the United Nations (FAO), CactusNet, the Jordanian National Agricultural Research Center (NARC), the CGIAR Research Program on Livestock (CRP Livestock), and with the financial support of the Arab Fund for Economic and Social Development (AFESD), and led

by [Dr. Mounir Louhaichi](#), facilitated the foundation of a [cactus nursery](#) at the Mushaqqar research station in Jordan. Over 100 different cactus pear accessions are now well established.

### Silvopastoral/Tunisa rangelands project

Funded by the CGIAR Research Program on Livestock (CRP Livestock), and led by [Dr. Mounir Louhaichi](#) and [Dr. Mouldi Gamoun](#), the indigenous rangelands plants research in Tataouine, Tunisia investigates indigenous rangelands plants in Tataouine, Tunisia for their human health benefits and their attributes as feed for livestock and wildlife. Tataouine rangelands accommodate 27 percent of the country's total rangelands, making it the top region for pastureland for an estimated 1.3 million head of sheep, goats, and camels. Despite all the restoration and protective efforts, overgrazing, overharvesting, and recurrent droughts continue to degrade these rangelands. In addition to their pastoral value, Tataouine's rangelands are home to countless valuable medicinal and aromatic plants.

### Sheep Fattening Project

In Ethiopia, a team led by ICARDA's [Dr. Jane Wamatu](#), under the [Sheep Fattening Project](#), and with the support of the CGIAR Research Program on Livestock (CRP Livestock), the Southern Agricultural Research



Institute, and the Amhara Regional Agricultural Research Institute in Ethiopia, has been expanding opportunities in agribusiness to youth as a means to advance rural livelihoods and economic development across three regional states in Ethiopia.

In 2020, a survey on forage options and perceptions of forage utilization revealed that farmers select forages based on biomass yield and acceptability by animals. ICARDA also researched sweet lupin, a multi-purpose forage with immense potential for feed, food, and soil fertility maintenance. The study revealed varying effects of different processing procedures of the alkaloid-laden sweet lupin grain on ram fattening. Participant farmers were later champions in the demonstration and promotion of processing techniques of sweet lupin grain before supplementation. The demonstration aimed to enhance the performance of Doyogena rams, in a farmer exposure and learning field day.

Meanwhile, youth members continue to undertake sheep fattening, with Doyogena and Bonga successfully registering five youth cooperatives; each cooperative is an amalgamation of several youth groups. An entrepreneurial skills development training manual was also translated into Amharic and Keficho for use across rural areas.

## Watershed restoration in Jordan

ICARDA's [Stefan Strohmeier](#), alongside the United States Forest Service, the Jordanian National Agricultural Research Center (NARC), Utrecht University's Copernicus Institute of Sustainable Development, and WADI for Sustainable Ecosystems Development (local Jordanian non-governmental organization) developed a community-based watershed rehabilitation approach that effectively restores degraded rangelands in Badia, Jordan. This approach will decrease the fodder shortage of local livestock keepers who will, in turn, rely less on external aid to feed their animals. In 2020, despite COVID-19 restricted access to the Badia Research Site watershed, the local community kept close communication with the scientists through digital media and took over some of the field monitoring works.

In addition, ICARDA joined an inter-regional Food and Agriculture Organization of the United Nations (FAO)-Technical Cooperation Program project on combatting

sand and dust storms. Moreover, the research investigated considerable on-site benefits (less soil and carbon loss) and off-site impacts (less dust transported to urban areas) through mechanized micro-water harvesting and plantation of native shrubs in Badia.

## An integrated for crop-livestock conservation agriculture in North Africa

ICARDA's Crop Livestock Conservation Agriculture (CLCA) Initiative in North Africa (Algeria and Tunisia), led by Drs. [Mourad Rekik](#) and [Aymen Frija](#), promoted innovative practices to optimize climate resilience and integrated CLCA in the fragile livestock-cereal belt of semi-arid Algeria and Tunisia. The project is supported by the International Fund for Agricultural Development (IFAD) in collaboration with the International Maize and Wheat Improvement Center (CIMMYT), the Institution of Agricultural Research and Higher Education in Tunisia, and the Technical Institute of Field Crops (ITGC) in Algeria.

Key to the project is the development of Crop-Livestock Integration Options (CLIO) that encompass forage inclusion, such as stubble management for mulching, feed, and soil cover crops, and herd health management, among others, in dryland crop and livestock farming approaches. Another important aspect of the project has been the introduction of community 'knowledge hubs' which, in 2020, led to [self-sustained scaling of CLIOs](#) in Tunisia and Algeria.

During Phase III of the project in Tunisia in October-December 2020, Crop Livestock Conservation Agriculture (CLCA) was implemented across 2,000 ha with 117 farmers, a 40 percent increase compared to the year before. A total of 57 pioneering women farmers were involved in the CLCA on-farm trials and demonstration plots. Further, in addition to the districts of Beja, Jendouba, Kef, Kasserine, Siliana, and Zaghuan (the focus of Year II), the project activities were extended to the districts of Bizerte and Gafsa.

In Algeria, Phase III Crop Livestock Conservation Agriculture (CLCA) project activities expanded from 6 to 11 target districts, and during the third cropping season, directly facilitated the establishment of 1,732 ha by almost 430 smallholder farmers (compared to 982 ha

and 241 farmers in Year II). This was possible by involving five additional Technical Institute of Field Crops (ITGC) regional stations and two new ITELV regional stations.

## SUSTAINABLE LAND, SOIL, AND WATER IN DETAIL

### Drip irrigation in Morocco

ICARDA, led by [Dr. Vinay Nangia](#), and in collaboration with the Massachusetts Institute of Technology (MIT), L'Institut National de la Recherche Agronomique du Maroc (INRA-M), and the United States Agency for International Development (USAID), conducts irrigation research within ICARDA's Ultra-Low-Energy (ULE) Drip Irrigation Project. The project introduced a drip irrigation system that demands much less energy than a conventional system. 2020 marked the successful completion of online dripper trials on olive and citrus trees, as well as the initiation of inline dripper trials on fruit and vegetable crops. Furthermore, ICARDA entered a public-private research partnership with Jain Irrigation Systems Limited to test and demonstrate ULE drippers for irrigating date palm plantations in six Gulf Cooperation Council (GCC) countries to save water and energy.

### Wastewater management in Egypt

Wastewater treatment and reuse have great potential to contribute towards addressing the Middle East and North Africa (MENA) water crisis. ICARDA's ReWater MENA project covering Egypt, Jordan, and Lebanon is funded by the Swedish International Development Cooperation Agency (SIDA) and managed by the International Water Management Institute (IWMI). Led by [Dr. Bezaïet Dessalegn](#), ICARDA manages the Egypt component of the project, focusing on the direct and indirect management and reuse of treated wastewater in agriculture. In 2020, the project established a new site in Ismailia, near the Serapeum Wastewater Treatment plant, to assess potential direct reuse options. The production of wheat and barley crops using treated wastewater of permissible water quality – as per the National Reuse Code – was successfully tested.

### Supplementary irrigation in dry areas

The [supplementary irrigation innovation](#), developed by ICARDA scientists under the leadership of [Dr. Vinay Nangia](#), is a customizable complementary water management system that enables farmers to





control the amount and timing of irrigation in rainfed agricultural areas. The innovation removes the need for large-scale irrigation infrastructure, and diversifies crop management options by enabling individual control in water use, and reducing crop failure risk due to drought. Now used across Africa, China, and India the system improves the resilience of farmers to water-related shocks. The Food and Agriculture Organization of the United Nations (FAO), the World Bank, and the Global Alliance on Climate-Smart Agriculture promote the system as a climate-smart practice. In 2020, the innovation was selected as one of the top 50 CGIAR innovations in the field of irrigation for smallholder farmers and was also included in the International Fund for Agricultural Development's (IFAD) [Panorama Rural Solutions Portal](#).

## iNASHR – water management in Egypt

ICARDA's [iNASHR project](#) is funded by the German development agency Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) and implemented in partnership with Egypt's Agricultural Research Center (ARC) and Access Agriculture. Led by [Dr. Bezalet Dessalegn](#), the project helps to address Egypt's water scarcity and soil quality to improve food security for smallholder farming families by promoting sustainable intensification of wheat-based systems by facilitating adoption and multiplication of ICARDA-improved seed varieties, modernizing traditional raised bed (RB) farming methods, and reintroducing a cereal/legume crop rotation on-field, through mechanization. In 2020, 420 demonstration sites were established, of which 16 percent are owned by women. These were planted with improved varieties of wheat and faba bean using good agricultural practices. Moreover, about 400 individuals, of which 21 percent were women, directly benefited from capacity-building efforts including farmer field schools and training of trainers. A total of 2,495 direct and 14,525 indirect beneficiaries were reached during the reporting period. ICARDA also scaled up its RB wheat planting technology in Egypt. Results obtained in farmers' fields during 2020 showed a clear advantage of the RB technology with a 31 percent saving in irrigation water, 32 percent increase in wheat grain yield, and 98 percent increase in water use efficiency.

## Soil protection and rehabilitation of degraded soil for food security

At the end of 2020, ICARDA, led by [Dr. Aymen Frijia](#), launched a new Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)-funded project in line with the Tunisian 2050 soil and water protection strategy to develop soil and water conservation technologies tailored to specific, and highly variable, social and ecological contexts. These technologies have been upscaled across the relevant regions. A key component of the initiative is in establishing appropriate indicators and tools for monitoring the impact of scaling investments.

## Agriculture service providers model on land and water technologies transfer in Pakistan

ICARDA, in collaboration with the United States Department of Agriculture (USDA) and various federal and provincial institutes, developed a business model to transfer land and water management technologies to smallholder farmers in Pakistan. The project trained agriculture service providers (ASPs) on technologies and business, disseminating 11 technologies to 1,266 farmers over an area of 12,474 acres (5,050 ha).

These services included the installation and repair of drip systems, the sale of Biozote (biofertilizer) and gypsum, planting of crops on ridges and beds, laser land levelling, soil testing for accurate and balanced use of fertilizers, and wheat planting with zero till drill. The Happy Seeder (a tractor-mounted machine that cuts and lifts rice straw) and a banana residue chopper, reduced residue burning to prepare land after crops.

Our scientists conducted 45 surveys with the agriculture service providers (ASPs) to document the impact of the technologies through assessing income generation rates and sustainability. All the ASPs reported that they are satisfied with their business and that they would continue it after the end of the project. The study showed almost 50 percent of the ASPs earned between 100,000 rupees (\$1,300USD) to 300,000 rupees (\$3,900USD) in one season.

## IMPROVING RURAL LIVELIHOODS IN DETAIL

### Factors to boost incomes of Ethiopian livestock farmers

In Ethiopia, ICARDA researchers, led by [Dr. Girma Kassie](#), study factors that impact market access for livestock farmers and inform the government's investments in the sector to improve smallholders' market participation and performance to boost livestock production and productivity. The project is funded by the CGIAR Research Program on Policies, Institutions and Markets (CRP-PIM), and the CGIAR Research Program on Livestock (CRP Livestock). One study revealed that [introducing animal sheds](#) for animals to rest and refresh can significantly improve the market price of stock and consequently smallholder farmers' market participation. A related study investigated [what market facilities farmers are most willing to pay for](#), whereby animals' sheds, veterinary service posts, holding barns, water troughs, and feed selling facilities were the most valued by the farmers.

### Impact of zero tillage on production in dry areas

Using a sample of 621 farmers in Syria, the study ([El-Shater, Mugeru and Yigezu, 2020](#)) assessed the impacts of the adoption of zero tillage (ZT) technology on productive efficiency, input-specific resource use efficiency, and production risk. Model results showed that adoption of ZT proved to be an effective risk management strategy in dryland production systems, where it led to 95 percent and 33.3 percent reductions in the risk of obtaining wheat yield levels below 1,000 kg/ha and 1,500 kg/ha, respectively. A clear indication that using ZT leads to improvements in productive efficiency is a 93 percent reduction in the risk of obtaining efficiency levels below 40 percent among users of ZT. Future research will be needed to clarify whether coupling ZT with the other components of conservation agriculture will reverse some of these effects.

## Explaining yield and gross margin gaps in wheat-based dryland systems

Another [study](#) by Drs. [Mina Devkota](#) and [Yigezu Atnafe Yigezu](#), funded by the CGIAR Research Program on Wheat (CRP Wheat), showed how substantial scope exists for improved agronomic practices that increase wheat yields and gross margins for farmers in Morocco. It identified tillage methods and fertilizer rates as important causal factors of the yield gap in rainfed systems, followed by the quantity of phosphorus and nitrogen fertilizer, seed quality, and the type of preceding crop. In the irrigated environment, the preceding crop was the most important variable in explaining the yield gap, followed by variety, seed quality, and quantities of nitrogen and phosphorus fertilizers. Grain yield and grain price were the most important variables explaining gross margins.

### Agricultural growth and sex- disaggregated employment in Africa

A research team that included ICARDA Drs. [Aymen Frija](#) and [Boubkaer Dhehibi](#) studied the [impact of investment in alternative agricultural research and development investment across 14 African countries](#). The aim was to investigate how these investments can mitigate future challenges like climate change and population pressure on national economies. Results showed increased investments in agriculture could generate higher overall employment and reduce gender disparities in labor participation. Further, in 8 out of the 14 countries, female employment increased more than male employment in response to agricultural investments, and infrastructure investments had a higher impact on female employment growth than productivity scenarios.

### Towards an innovative olive oil value chain

Another [study](#) from the Social, Economic, and Policy (SEP) Team, funded by the CGIAR Research Program on Dryland Systems (CRP Drylands) and the CGIAR Research Program on Policies, Institutions, and Markets (CRP-PIM), analyzes relationships between the olive oil value chain leading operators in Tunisia and how they can be improved for better performance and





resilience of the olive oil sector. Findings suggest that public-private-civil society partnerships are essential for developing technological and institutional innovations that involve more inclusive olive oil value chains. The research can help development practitioners, the research community, and the broader region design initiatives to foster practical, inclusive, and contextually relevant processes for agricultural innovation.

## Water, policy, and productivity in Egyptian agriculture

Dr. Boubaker was also involved in another study funded by the United States Department of Agriculture (USDA) through its Economic Research Service on how along with improving water resources, investments in research can also raise productivity and release constraints on growth. The results showed that technological innovations and efficiency gains contributed significantly more to agricultural growth in Egypt than the expansion of irrigated areas or water use, and how the historical rise in total resource productivity significantly increased the value of natural resource rents in Egyptian agriculture.

## CAPACITY BUILDING IN DETAIL

### Strengthening agricultural knowledge management

The Strengthening Agricultural Knowledge Management (SKIM) project, led by Dr. Akmal Akramkhanov and funded by the International Fund for Agricultural Development (IFAD), facilitates the growth of knowledge

management and capacity development operations across the Near East and North Africa and Central-Eastern Europe and Central Asia regions, and in Europe. In 2020, SKIM supported the University of Khartoum in scientific poster development; created the Virtual Learning Route, which aims to build a framework of agricultural knowledge sharing in Sudan; and supported entrepreneurs in Moldova with knowledge transfer training. The project also carried out countless training sessions across the Central and West Asia, and North Africa (CWANA) region to improve sharing knowledge and research among organizations.

### Supporting fragile countries and territories

In Syria, led by Dr. Abdoul Aziz Niane, ICARDA works with the Food and Agriculture Organization of the United Nations (FAO) to rehabilitate the country's seed sector by producing basic seed stocks of barley, chickpeas, lentil, and wheat, towards the multiplication of certified seed and eventual dissemination to national farmers. ICARDA also implements FAO-funded water management training programs to introduce modern irrigation techniques and rainwater harvesting to increase agricultural production. Field-based demonstrations were organized every week during the vegetative, flowering, fruiting, and maturity phases of the crop, and question-and-answer sessions were organized on WhatsApp with ICARDA seed experts. A total of 1,000 copies of a 19-page illustrated training manual in Arabic were distributed to the pioneer farmers, as well as the supporting team of seed experts and other national agriculture extension experts.

Continuing our capacity development support of fragile countries and territories, in 2020, with funding from the United Nations Development Programme (UNDP), ICARDA carried out a series of training in Syria through projects led by [Dr. Majd Jamal](#). Due to COVID-19 social distancing, on-the-job training and business development support was provided in farmers' fields instead of in the classroom with the ICARDA and UNDP team members and local extension specialists.

Also in 2020, led by [Dr. Abdoul Aziz Niane](#), ICARDA delivered quality legume seeds from advanced varieties bred by its scientists to Lebanon as part of an ICARDA-Lebanese Agricultural Research Institute (LARI) joint capacity development project. With funding from the Arab Fund for Economic and Social Development (AFESD), ICARDA provided LARI with 722 kg of breeder seeds that included 450 kg of chickpeas (from seven advanced varieties), 155 kg of faba bean seeds (from six varieties), and 117 kg of lentil seeds (from five advanced varieties).

### Center of Excellence technology training in Egypt and Sudan

The Center of Excellence project, funded by the Arab Fund for Economic and Social Development (AFESD), and led by [Dr. Seid Kamal](#), strengthens technology innovation and scaling by improving the skills and knowledge of researchers. In 2020, two in-country trainings were organized for the Agricultural Research Centers of Egypt and Sudan to improve the skills and knowledge of young researchers in classical and modern crop breeding tools and methods. The aim was to enable the researchers to modernize their breeding programs to increase genetic gains in wheat and food legume breeding, for wheat-based irrigated cropping systems.

In Egypt, 15 young researchers working in wheat and legume improvement participated in field and lab training covering major crop breeding topics; methods, and strategies; breeding tools (speed breeding, genomic selection, marker-assisted selection); breeding for quality; genotype x environment interactions, and statistical analysis and seed systems.

A similar module was carried out in Sudan for accelerated genetic gains in wheat and food legumes

in irrigated wheat-based production systems. A total of 24 trainees (37 percent female) from 8 research stations across Sudan were trained in experimental designs and data analysis using Genstat; breeding methodologies and genetic gain; genetic resource utilization; biotechnology and speed breeding; product profile; mainstreaming nutritional quality in breeding, and variety maintenance. All trainees completed the course and received certificates from ICARDA.

### International training on the design of sustainable dry region farming

As part of the SemiArid project funded by ERANET ArimNet 2 (an agri-research group from the Mediterranean region), with the support of ICARDA and the Faculty of Agriculture of the Lebanese University, a group of lecturer-researchers from Mediterranean institutions held an international training course dedicated to the design of sustainable farming systems in dry areas. Around 40 students were trained on integrated analysis methods to explore the role that diversity can play (i.e., crop variety and cropping systems, access to resources, etc.) to design more efficient agricultural systems. The course also taught students how to guide and help farmers and local decision-makers to reflect on strategic production choices concerning climatic, technical, or socioeconomic constraints.

### Online learning

In the framework of the ICT2Scale project in Tunisia, ICARDA and its national partners – the Agricultural Training and Extension Agency and the National Institute of Agricultural Research of Tunisia – have developed eight [e-learning modules](#). Three modules are in French or Arabic and strengthen the capacity of agricultural trainers and extension workers to support local farmers. The modules cover: i) cactus production, ii) andragogy, iii) project development, iv) beekeeping, v) complementary irrigation, vi) 'Innovation Platform', vii) cattle and dairy, and viii) medical plants. So far, over 200 online participants have completed the courses and received an online certificate.





ICARDA is a non-profit international organization undertaking research-for-development for innovative, science-based solutions that improve livelihoods in rural communities across dry regions. ICARDA's long history as the only CGIAR center headquartered in the non-tropical drylands means we possess a unique understanding of regional critical issues, and the scientific knowledge, country agreements, and research networks required to deliver resilient livelihoods to rural dryland farmers.

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CGIAR is a global research partnership for a food-secure future. CGIAR science is dedicated to reducing poverty, enhancing food and nutrition security, and improving natural resources and ecosystem services. Its research is carried out in close collaboration with hundreds of partners, including national and regional research institutes, civil society organizations, academia, development organizations and the private sector.

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