



# ANNUAL REPORT 2014

## International Center for Agricultural Research in the Dry Areas

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Women farmers in the Welmera district in the highlands of Ethiopia (read story on [page 23](#))

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## Foreword

2014 went on record as the hottest year ever measured, a telling sign that climate change is already here. The agriculture sector is predicted to take the heaviest toll, with the hardest hit being smallholder farmers in developing countries, particularly in dry areas. With rising temperatures and greater stress on water resources, agricultural productivity is set to experience a substantial decline. Yet against these odds, we need to produce progressively more to feed a rapidly growing world population.

The good news is that science and technology are increasingly and unambiguously showing us ways to overcome these hurdles, through cutting-edge approaches like genomics, biotechnology, geo-informatics, climate-smart agriculture and systems modeling tools.

We are pleased to share these select scientific innovations and impacts of our agricultural research on drylands in 2014, where the challenges with scarce natural resources are even starker. Implemented on the ground with national partners, many of these 2014 activities and their outcomes directly bolstered the systems research of Dryland Systems, the global research program of CGIAR that ICARDA is leading.

The success of heat-tolerant wheat varieties, capable of withstanding temperatures greater than 38°C, has proved to be a turning point for food security in Sudan and Nigeria. This wheat value chain initiative, reaping 4–6 t/ha in farmers' fields compared with the existing average of 1–2 t/ha, has convinced both governments to ramp up their domestic wheat production to cut down their growing dependence on wheat imports and vulnerability to global food prices.

In India, Bangladesh and Nepal, where malnutrition is at its worst, early-maturing, disease-resistant lentil varieties, with high iron and zinc are enabling rice growers to reap an additional crop of lentil using the short fallow period between the rice growing seasons. The practice is nourishing farmer families with healthy proteins and micro-nutrients, while at the same time replenishing their soils and creating an additional source of income. The newly established international Legumes Research Platform in India is now taking these gains forward to transform legumes production – the much needed next 'green revolution' for sustainability in the region.

We are particularly proud of our Genebank Team in Syria, whose unrelenting efforts helped us protect and duplicate 100% of the globally unique collection of crop genetic

resources stored in ICARDA's Genebank safely outside Syria. In addition to ensuring conservation of this unique agrobiodiversity, 2014 has opened new doors for crop breeders the world over who are looking to harness the genetic wealth to develop climate-change resilient crops. FIGS, a mathematical tool that can rapidly mine thousands of accession holdings in genebanks for desired genetic traits, showed a series of successes. It identified with accuracy accessions having traits for genetic resistance to notorious crop diseases and pests for wheat and legumes, such as rust and sunn pest, and dryland stresses such as drought and heat.

As part of our larger strategy to adapt smallholders in drylands to climate change, ICARDA's science has sharpened its focus on producing more with less in irrigated and agro-pastoral systems, and sustainably intensifying cereal-based rain-fed production systems through research platforms in Egypt, Ethiopia and Morocco.

These accomplishments of 2014 would not have been possible without ICARDA's high quality and committed scientists who work across 50 countries, often in complementary research partnerships with other institutions, including CGIAR centers. Our partnerships with national agricultural systems continue to be the bedrock of ICARDA's research programs. Finally, we are grateful to our donors for their continued support and to the new donors who have put their trust in us as we seek greater food and nutrition security, better smallholder livelihoods, and sustainable drylands through science and innovation.



**Mahmoud Solh**  
Director General



**Camilla Toulmin**  
Board Chair



# Why drylands matter



Marginal dry areas in Sidi Bouzid, Tunisia, a research site of the CGIAR Research Program on Dryland Systems

## Agricultural productivity in dryland regions is facing a multitude of challenges

Increasing water scarcity, land degradation including desertification, frequent droughts, high climatic variability, and loss of biodiversity

### Some facts about dry areas:

- Cover 41% of the world's land area
- Home to 2.1 billion people, with 16% living in chronic poverty
- Grow 44% of the world's food
- Agriculture uses up 80% of all water consumed, on average
- Water per capita is 1,100 m<sup>3</sup> per year in the Middle East and North Africa, compared with the global average of 8,900 m<sup>3</sup> per year, and is set to drop to 550 m<sup>3</sup> per year by 2050.

Source: FAO, IFAD, UNCCD

23 hectares per minute lost due to land degradation and desertification in dry areas

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a loss of 20 million tonnes of grain per year

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an income loss of US\$42 billion per year

# ICARDA at a glance

## Who we are

The International Center for Agricultural Research in the Dry Areas (ICARDA) is a global research-for-development non-profit organization with a vision of improved livelihoods of the resource-poor in the dry areas of the developing world.

ICARDA promotes sustainable agriculture development in dryland countries through collaborative and responsive research. The Center works closely with the national agricultural research systems, policymakers, local communities, and non-governmental organizations to bring its research outputs to field and deliver impact on the ground – our core strength.

### ICARDA in numbers

- Actively implemented over 180 projects in 2014
- Works in over 50 countries, with offices in 17 of them
- Employs around 450 skilled staff from over 44 countries

## Our focus in drylands

ICARDA strives for better livelihoods in drylands through a **strategic focus** on:

- food and nutrition security
- rural poverty
- water productivity
- land degradation
- sustainable management of natural resources

with **cross-cutting priorities** of:

- climate change adaptation
- gender equity
- capacity development.

## What we do

ICARDA delivers science-based systems solutions that help build resilience and sustainably intensify the productivity of dryland agroecosystems. Its integrated research outputs include new crop varieties; water productivity technologies; agronomic practices; natural resource management; rangeland and small ruminant production; and socioeconomic and policy analyses and options.

## ICARDA's research programs

**Biodiversity and Integrated Gene Management** conserves agricultural biodiversity of drylands and harnesses the genetic resources to develop improved, climate-resilient crop varieties.

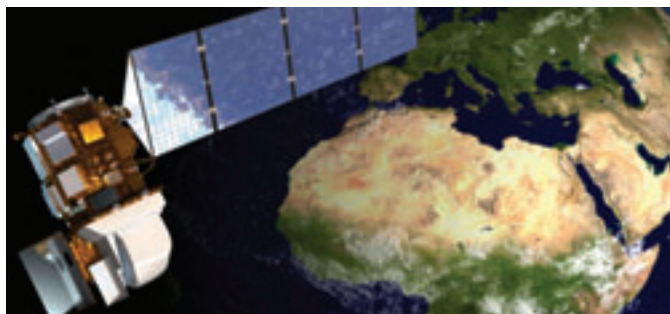
**Integrated Water and Land Management** develops technologies and practices to sustainably improve productivity of land and scarce water resources, and control and reverse land degradation.

**Diversification and Sustainable Intensification of Production Systems** works with agronomy, integrated crop–livestock–rangeland systems, crop diversification, small ruminant production, and value chains to create new income opportunities.

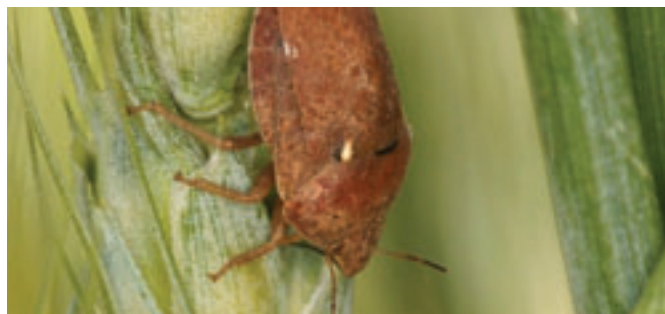
**Social, Economic and Policy Research** develops insights on rural poverty, livelihood strategies, gender and youth issues, and institutional frameworks to inform policy, guide research investment, and accelerate technology adoption.



## Leading the way in global research



**GeSTA – the new frontier in agroecosystems research** [Page 11](#)



**Award-winning discovery addresses damaging pests in wheat** [Page 14](#)



**Innovative legume varieties open new doors** [Page 18](#)



**Leveraging lentil to bridge micro-nutrient deficiencies** [Page 19](#)



**FIGS, a rapid gene mining tool, signifies next generation crop breeding** [Page 27](#)

### Joining hands against wheat stripe rust

ICARDA held the 2<sup>nd</sup> Stripe Rust Symposium in Izmir, Turkey, on 28 April–1 May 2014, attracting more than 200 participants – scientists, policymakers, extension workers and media representatives – from 44 countries to discuss how to tackle wheat stripe rust disease. The event laid the foundation for a regional initiative to combat this virulent disease that is spreading fast in Central and West Asia and North Africa, spurred on by the effects of climate change.



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# Science and impact highlights

## Connecting the dots to improve rural livelihoods in drylands



Potential beneficiaries of the Dryland Systems Program in East and Southern Africa

Environmental, social, economic and cultural factors all interact to affect communities living and farming in dryland areas. Incorporating 41% of the world's land area, and 16% of the world's poor, dryland areas are in urgent need of a new kind of approach that 'joins up these dots' in tackling problems of chronic poverty, food insecurity, population growth, water scarcity, land degradation and climate change.

This 'systems approach' is not easy, but the gains can be enormous. In a pioneering effort, the ICARDA-led **CGIAR Research Program on Dryland Systems**, is using systems research to sustainably increase productivity and build the resilience of dryland communities in Africa and Asia. The program is addressing agricultural livelihood systems as a whole – crop, water, soil, land, policy and institutions – to develop solutions by leveraging the expertise of its diverse agricultural research partners – eight CGIAR centers, regional organizations and national institutions.

**At program level**, in 2014, ICARDA worked with partner CGIAR centers to roll out a robust contextual framework of agricultural livelihoods systems and consolidated program implementation at 13 action sites. Primarily the program focuses on three agricultural livelihood systems: the (agro)-

### Incorporating systems modeling through knowledge partnerships

In November 2014, ICARDA, in partnership with Montpellier-SupAgro, the Montpellier institute of the International Centre for Advanced Mediterranean Agronomic Studies, Wageningen University, and the Technical University of Madrid, held a course in Tunisia to develop insights and refine the framework for integrated research aiming to build sustainable intensification and resilience in dryland agriculture – the goal of Dryland Systems.

The course built the capacity of researchers on the use of agro-ecological modeling and bio-economic modeling, which when coupled together can provide a consistent framework for assessing agricultural policy and development efforts – a valuable tool in keeping the systems research on track for intended outputs and outcomes.



pastoral, the cereal-based rain-fed and the irrigated systems. The sites selected are representative of these systems across five flagship regions – West African Sahel and the Dry Savannas; East and Southern Africa; North Africa and West Asia; Central Asia; and South Asia. Key challenges in each of the livelihood systems and possible entry points for change interventions were identified through in-depth analyses, along with investigation of synergies amongst different actors (individuals, households and community) as they interact with the farms. A number of integrated systems modeling approaches – such as crop sub-systems modeling, bio-economic modeling, agent-based modeling and participatory modeling – are in progress to take systems research to the next level.

On the implementation front, the program is using an innovation platforms approach to engage a diverse group of stakeholders in target regions – extension, NGOs, development agencies, local decision-makers, scientists and private sector – for participatory planning of research and testing of technologies and research methods with the end-users. The resulting research strategies and interdisciplinary research activities led to significant progress toward program goals in 2014.

## Research progress and successes in 2014

The following offers a sampling of research strategies being tested and results thus far at two of the five flagship regions targeted by Dryland Systems that are led by ICARDA – North Africa and West Asia; and Central Asia.

### In North Africa and West Asia

Farmers across **North Africa and West Asia** are largely agro-pastoralists, eking out a livelihood from the scarce water and highly vulnerable marginal lands of the region. More favorable agro-ecosystems exist, but suffer from poor yields. Rain is variable and where irrigation is prevalent, salinity and falling water tables are major concerns. Rangelands too are degraded with lack of water and overgrazing preventing regeneration.

The Dryland Systems Program is addressing the suite of challenges by integrating various strategies such as water management, conservation agriculture, value chains, community seed production, participatory improvement of local crop landraces, and livestock productivity.

#### Sustainable intensification in high potential areas

In Morocco where its rain-fed production system offers high potential, the program's strategy is to intensify and diversify crops for farmers.

A deficit supplemental irrigation package has been introduced into wheat production for farmers in the Tadla region. This boosted wheat grain yield by 20–25% and

allowed a saving of 1000–1200 m<sup>3</sup> of irrigation water per ha. Men and women farmers also participated in the evaluation of more than 70 advanced elite lines of cereals and food legumes introduced by ICARDA for greater productivity in cereal-legume systems.

In irrigated systems of the Nile Delta, the program is disseminating raised-bed technology. This has been showing encouraging results in increasing crop yields for wheat and faba bean by 15–28%, while saving on irrigation water by 20–25% (see [page 15](#)).

#### Rehabilitating degraded rangelands

For the marginal low-potential lands in Tunisia, scientists are working with pastoral communities in Tafilah and Salamyia to rehabilitate rangelands by setting up water harvesting and utilizing the water to plant shrubs, thus producing animal feed.

In Jordan, the Al-Majidiyya and Muhareb community schemes to manage rangelands resulted in **the revival of native species like *Atriplex halimus*, which is known to remediate degraded areas and fill the forage gap** in late summer when herbage drops. Also in 2014, ICARDA scientists modeled and monitored the Al-Majidiyya watershed to determine the best ways to conserve water. The University of Jordan is now using the results to monitor erosion and assess the impacts of the soil conservation measures and intercropping techniques introduced by the



Herder grazing sheep on salt bush growing in the micro-catchment water harvesting (using Vallerani) site



The **Climate Change And Drought Atlas for Jordan**, produced in 2014, provides a set of **339 maps** that comprehensively characterize past and expected climatic change in Jordan – a valuable resource for policymakers and communities in assessing promising agricultural technologies for adapting to climate change.

### Adapting dryland communities to climate change through conservation agriculture

North Africa and West Asia is estimated to be one of the worst hit regions by climate change. To address the challenge, a major focus of Dryland Systems in the region has been promoting the adoption of conservation agriculture practices of minimum or zero till and leaving behind the crop residue in the field – a proven cost-effective way of stabilizing yields, conserving resources, and increasing efficiency in drylands.

In 2014, nearly 5080 farmers across Jordan, Syria, Tunisia, Morocco and Iraq were engaged in applying the practice on over 39,000 ha. A key enabler in the success has been access for smallholders to locally fabricated low-cost zero till seeders. These machines have been innovated by a partnership of ICARDA with the Australian Center for International Agricultural Research, Iraqi researchers, and the private sector. On-farm demonstrations, training and workshops enabled significant uptake of the zero-till technology.

The technology has increased cereal yields by 15–19% and net income of farmers by 29%. As a next step, scientists plan to factor in crop–livestock systems as part of conservation agriculture research to deliver integrated livelihood benefits.

project. A key aspect is the testing of the laser auto-guided Vallerani machine, adapted by ICARDA to time- and cost-effectively create micro-catchments for water harvesting over large areas (up to 30 ha/day). The technology could have huge potential for rehabilitating degraded rangelands.

### Developing value chains

Research along value chains particularly aims to benefit women in marginal areas. For example, the program is leveraging olive production in Jordan which offers a sizeable market opportunity. In 2014, a value chain analysis of olive oil production in Karak, Jordan, revealed a diminishing water supply, manual harvesting and poor post-harvesting processes as major constraints to productivity and profitability. Efficient water harvesting techniques and harvesting machines are being tested in four orchards. Researchers are also factoring in emerging markets for organic products where higher returns can be used to set up micro-finance schemes for start-up enterprises by women. As a demonstrated success, the enhanced sheep milk processing developed by ICARDA's team in Jordan for

production of the traditional cheese 'jameed' is now being out-scaled to 15 villages, with support from IFAD-funded development project.

### In Central Asia

Agriculture is a major source of livelihood for rural communities in the Aral Sea and Fergana Valley regions of Central Asia, but crop production remains poor given challenges such as salinity, frost, drought and diseases. The production system depends on irrigation, and given the scarce water resources, water use efficiency is a critical criterion for interventions.

### Multiple-stress-tolerant crops

One of the underlying Dryland Systems strategies to increase productivity in the region is to develop multiple-stress-tolerant crop varieties that can meet the future needs of food crops for human and fodder for animals. In 2014, more than 300 improved germplasm and varieties of wheat, chickpea, mung bean, potato, alfalfa and other crops were evaluated with some important successes. A major outcome was a new winter wheat variety called 'Davlatli', developed jointly by ICARDA and the University of Bonn. The variety is high yielding and offers resistance to all the main abiotic stresses typical for winter wheat in many parts of Central Asia, **making it a significant contribution to food security in the region.**

### Diversifying crop systems

To sustainably intensify and diversify productivity, the program introduced novel short-duration, erect and non-shattering mung bean varieties obtained from ICARDA's partner AVRDC (the World Vegetable Center). The mung beans were grown in rotation with winter wheat and cotton, during the short fallow period. A popular part of the diet, mung bean is a low water consuming crop with the additional benefits of fixing nitrogen in the soil. The strategy helped farmers **gain an additional 1.4–1.5 t/ha of crop that secures a price which is three to four times higher than that for wheat, while allowing greater overall water use efficiency.** The program has established a seed system and is field testing wheat-mung bean crop rotations in four provinces to assess the effect on soil nutrients and the economic profitability of the integrated wheat–mung crop system.



Introducing an additional crop of mung bean in rotation with winter wheat demonstrated additional income of **US\$1384 to US\$2907** from 0.5 ha land for participating farmers.

### Seed systems

Another strategy being developed is building the capacity of farmers in quality seed production for increased income generation, along with improved food productivity. Farmers

**www.cacilm.org**

CACILM, a web-based 'knowledge platform' for Central Asia, launched in 2014, has synthesized and consolidated proven best practices on sustainable land management, providing stakeholders with easy access to farmer innovations, examples of sustainable management of water, land and forest resources, sustainable farming methods, pasture use, improved livestock and crop production, and promising scientific developments for climate change.



Diversifying wheat-cotton crop system with mung bean in Fergana Valley, Uzbekistan

can fetch a US\$0.15/kg higher price for quality wheat seed compared to wheat grain, and a US\$0.50/kg higher price for mung bean seed over mung bean grain, by selling to seed processing plants. In 2014, 208 farmers received training from the program's "Seed systems" initiative and **produced 451 tonnes of improved wheat seed, earning US\$67000 and 80 tonnes of mung bean seed, earning US\$40,000**. The income received from certified seed grade could be much higher if the farmers produced higher quality grades, such as super elite and elite seed.



Healthy wheat harvest from raised-bed irrigation technology package, Egypt

## Research highlight

### GeSTA – the new frontier in agroecosystems research

The geospatial science, technology and application (GeSTA) research, led by ICARDA, is enabling scientists to effectively incorporate the constellation of biophysical, climatic, socioeconomic and institutional factors critical to supporting a 'systems' approach to drive sustainable agricultural development. GeSTA harnesses 'big data' from satellites down to drones observed at varied scales – farms, basins and landscapes – on a real-time basis to guide decisions. The information from GeSTA will be a key catalyst in integrating research across the various CGIAR research programs toward their unified goals of reduced poverty, food security, climate-smart agriculture, and sustainable natural resource management.

In 2014, 25 open access databases were established by the GeSTA team with CGIAR partners on its geo-informatics portal: [geoagro.icarda.org](http://geoagro.icarda.org). The Dryland Systems component of the portal is providing a comprehensive livelihoods database of more than 3000 household farms across program research sites for use by various stakeholders. As an example of its application, program scientists with their external partners used the database in conjunction with systems analyses of yield gaps to inform policy and management decisions for sustainable intensification in the Chinyanja Triangle in Africa.

*Supported by Australian Centre for International Agricultural Research; International Fund for Agricultural Development; United States Agency for International Development; and CGIAR Research Program on Dryland Systems*



# Building food security through systems solutions: a case study

*Several projects contributed to Dryland Systems research by testing and validating interventions that lie at the very heart of improving the integrity of agricultural production systems in drylands. The Arab Food Security Project was one such initiative that led to significant outcomes in 2014 that directly advance the goals of Dryland Systems.*

Arab countries are the largest importers of wheat in the world and are also its largest consumers. But with water in short supply and climate change impacts, growing more and stabilizing wheat production is a challenge for farmers in Arab countries. To help address this problem, ICARDA scientists worked with the national agricultural research systems (NARS) of 10 Arab countries from 2011 to 2014 to develop and disseminate wheat ‘packages’ tailored to supplemental irrigation, full-irrigation, and rain-fed agricultural livelihoods systems.

The project partnered with national agricultural research systems to deploy responsive dissemination strategies, combining ‘live’ tests in farmers’ fields with capacity development at all levels – farmers, technicians and extension, scientists, policymakers and development workers. Furthermore, the project facilitated a vigorous exchange of experiences amongst the countries, synergizing large-scale impacts. **More than 25,000 farmers were reached with improved technologies, reaping a 28% increase in wheat yield on average.**

Some innovations tested and validated were mechanized raised-bed technology, bringing ‘more crop per drop’ for smallholders in the Nile Delta. On average, it increased wheat yield by 28%, while reducing irrigation water use by 20–25% (see [page 15](#)). Also the no-till farming systems increased wheat yields by 16% in Syria, 20% in Jordan, and 50% in Morocco.

A major component of the project, the **Young agricultural scientists program, mentored and trained 34 young men and women as of 2014** – building national capacities for a food-secure future in the Arab region. These emerging scientists worked with ICARDA on various aspects of drylands agriculture such as plant breeding, plant protection, water and soil management, conservation agriculture, seed technology and socioeconomics.

Wheat technology ‘packages’ tailored to agroecosystems include:

- Improved wheat varieties
- Conservation agriculture
- Improved agronomic practices
- Greater water productivity technologies like supplemental, deficit and raised-bed irrigation.

Integrated solutions demonstrated an average wheat yield increase on farmers’ fields of about 31%, reaching a maximum yield increase of 82%.

The project is now progressing into a second phase for wider scaling, as agricultural ministers, heads of NARS and donors jointly endorsed the value of the research project for the region at a meeting held in Kuwait in November 2014.

“The technology packages demonstrated by this project are based on proven and confirmed research results, and thus we strongly and fully support this project.”

**Adel El-Beltagy, Minister of Agriculture and Land Reclamation, Egypt**

“The project results are important and calls us all to continue the project implementation into a second phase. The achieved yield increases in the country are supporting our strong political will and policy in providing food security in the Arab region through Sudan.”

**Engineer Ibrahim Mahmoud Hamid, Minister of Agriculture, Sudan**

*Supported by Arab Fund for Economic and Social Development; Islamic Development Bank; Kuwait Fund for Arab Economic Development; and Organization of Petroleum Exporting Countries Fund for International Development*

## Building wheat self-sufficiency in food insecure dryland countries



Heat-tolerant wheat varieties performing well in Kano, Nigeria

The West Asia and North Africa region is the largest food importer in the world, with self-sufficiency ratios for cereal averaging about 50%. The heavy and increasing dependence of the region on food imports pre-disposes it to instability with fluctuations in global food prices. To build self-sufficiency and reduce food import bills, ICARDA targets wheat production, a major staple of the region. Its work capitalizes on the wealth of genetic traits found in the region – the global center of crop diversity – to develop improved varieties, and its systems expertise to sustainably intensify wheat production.

### Integrated solutions to sustainably intensify wheat production

In Africa, ICARDA is strengthening the wheat value chain in 12 low-income countries through integrated solutions of improved wheat varieties, and soil, water and crop management technologies – tested and validated at research hubs in Ethiopia, Nigeria and Sudan. The activities are implemented under SARD-SC (Support to Agricultural Research for Development of Strategic Crops in Africa) – an initiative funded by the Africa Development Bank to strengthen strategic commodity crops on the continent. Its component on wheat commodity is led by ICARDA. On-farm trials identified 18 highly adapted, disease and stress tolerant varieties with yields of 5–8 t/ha, while current varieties were multiplied and promoted through demonstrations and farmer field days. Also in



17 new wheat varieties released across 12 countries, including Afghanistan, Iran, Ethiopia, Sudan and Nigeria, bringing higher yields and greater resistance to environmental challenges such as heat, drought and virulent pests and diseases, e.g. Ug99 and stripe rust.

2014, minimum tillage was introduced to promote soil conservation as part of the package.

In the Arab region, ICARDA successfully completed the first phase of the Arab Food Security Project in 2014, disseminating improved wheat technology packages in 10 countries. These packages combined improved wheat varieties with agronomy, no-till practices and improved water productivity (see page 12). The project is now in the second phase of scaling out.

### Big strides in Africa

ICARDA's activities under SARD-SC led to significant impacts in both Nigeria and Sudan, where the hot climate was a deterrent to wheat production. The newly introduced heat-tolerant wheat varieties, withstanding temperatures greater than 38°C, yielded 4–6 t/ha compared with an average of 1–2 t/ha for traditional varieties. The varieties



Heat-tolerant varieties like 'Goumria' and 'Reyna', ramp up yields from 1–2 t/ha to 4–6 t/ha, leading to a policy-shift in Nigeria and Sudan on wheat commodity.

are an outcome of the ongoing research partnership between ICARDA and the International Maize and Wheat Improvement Center (CIMMYT). The success of the SARD-SC project has led to a shift in policy and is beginning to transform commodity farming in both countries.

In Nigeria, the government has launched a national initiative to **expand the country's wheat-growing area from 70,000 ha to 340,000 ha**, and **reduce wheat imports by 45%** over the coming five years. Similarly in Sudan, the government plans to **expand the country's wheat area from 300,000 ha to 0.5 million ha** in 2015/16.

Further, the wheat project has established 'innovation platforms' at its research hubs in Ethiopia, Nigeria and Sudan, as a participatory technology development and dissemination strategy. These platforms bring together all stakeholder groups along the value chain – policymakers, scientists, extension, farmers and the private sector – to together identify challenges and share knowledge and information for sustained gains from science and innovations.

### Putting improved seed in the hands of farmers

Shortage of and poor access to improved seed for smallholders is a major cause for continued low wheat yields in developing countries. For example, in Morocco, farmers continue to use vulnerable varieties of wheat even though improved varieties have been available for many years. In 2014, ICARDA analyzed the bottleneck in the country's seed sector. It traced the low uptake of new varieties to private sector seed producers having limited adoption of the national varieties released. They find it easier and more profitable to import seed from Europe. However, foreign varieties put farmers at risk as they may not be best adapted to combat local environments, shifts in weather patterns from climate change, and emerging strains of diseases. Based on these findings, ICARDA has made a series of recommendations which it will discuss with policymakers in Morocco in 2015.

## Research highlight

### Award-winning discovery addresses damaging pests in wheat

Identifying genetic traits resistant to insect and diseases is a major challenge for crop breeders the world over. In 2014, entomology research at ICARDA won international recognition for its breakthrough research in identifying a subset of wheat lines resistant to sunn pest – a pest responsible for the most costly damage to wheat in North Africa and West Asia. The research identified 11 bread wheat and 13 durum wheat accessions in ICARDA's genebank with the help of its rapid genebank mining tool, FIGS (Focused Identification of Germplasm Strategy).

Another accomplishment in 2014 for which ICARDA's research leadership in the developing world was recognized was the development of Hessian fly-resistant wheat cultivars. The success was a culmination of almost 20 years of synergistic partnership of ICARDA with Morocco and Kansas State University, USA.

These findings promise to massively reduce pest control costs and allow for higher and more reliable crop yields for farmers in the drylands of the developing world.



"If there is the right science and technology, and the right policies to produce wheat economically and competitively, we would go after it."

**Dr. Akinwumi Adesina, Minister of Agriculture, Nigeria, announcing the government's full support for ICARDA's recommendations. Kano, Nigeria**

*Supported by African Development Bank; Cornell University; Grains Research and Development Corporation; Deutsche Gesellschaft für Internationale Zusammenarbeit (Germany); and CGIAR Research Program on Wheat*



## From farmlands to watersheds: producing more with less water in drylands



Flood irrigation practiced by farmers in Nile Delta in spite of water scarcity

In drylands where water is severely scarce, water productivity is the single most important performance criteria for agriculture. In West Asia and North Africa region, irrigation consumes 80–90% of all fresh water used. ICARDA's research targets developing and promoting technologies and policy recommendations to increase water productivity on farms and conserve natural resources within watersheds, while improving the livelihoods for dryland communities.

### Increasing water productivity in Nile Delta

#### Bringing a change: from technology demonstration to evidence-based policy-making

In the Nile Delta, several communities compete for its severely scarce water resources, including agriculture, aquaculture, tourism and livestock, with agriculture accounting for the lion's share. Mechanized raised-bed technology, a cost-friendly innovation integrating land and water management, is now making it possible to transform this water usage and the livelihoods of smallholders in the region. An outcome of a decade-long water benchmark research conducted by ICARDA with national partners in Egypt, the technology has **demonstrated an increase in water productivity for wheat of 65%, with average on-farm water savings of 20–25%**. The technology – combining raised-bed planting machines innovated for smaller-sized plots and the clayey soils of the Nile Delta; improved wheat varieties; and optimized seed and fertilizer application rates – was tested on farmers' fields in the Sharkia Governorate of

Egypt over three years. It now has the potential to scale out the benefits **across 1.2 million ha of wheat-growing land in the Nile Delta**.

ICARDA scientists are directing research toward evidence-based policy-making to improve water use in Egypt using this technology. Socioeconomic surveys and a cost–benefit analysis were completed in 2014 to develop a robust rationale and mechanism for the Egyptian government's intervention. Preliminary analysis concluded that the raised-bed technology reduced the costs of inputs (such as seed, fertilizer, irrigation water and labor) and machinery use (such as pumps and tractors) and increased wheat yields, with **net financial benefits of US\$383/ha compared with conventional planting**.

In 2015, ICARDA aims to produce a policy brief for the Egyptian government and initiate dialogue with the stakeholders and policymakers on scaling out the raised-bed technology.

#### Developing a water productivity optimizer tool for Nile Delta

In 2014, ICARDA made important headway in developing a computer modeling tool to guide water engineers on optimizing water and land productivity across the Nile Delta while minimizing the environmental risk. The tool will reduce the inequity between the water users by using an algorithm that predicts the upstream and downstream outcomes for different water management scenarios, integrating water use data from farms, canals and the basin level.

To create the modeling tool, ICARDA scientists have adapted FAO's AquaCrop model and monitored water flow in and out of a sample 283 ha of irrigated Egyptian land to test and calibrate the model for different technology interventions. A beta version of the tool is now ready and enabling water engineers to examine scenarios for improving water and land productivity under the current and future climatic and environmental conditions.

### Mainstreaming women into community watershed management

In sub-Saharan Africa, 60% of the female workforce are employed in the agriculture sector, making women a vital interest group in improving land and water productivity. In 2014, ICARDA worked toward fully integrating community women into a project that links soil and water conservation with better livelihoods. The people of the rain-fed Gumara-Maksegnit watershed suffer from land degradation, poor productivity and vulnerability to climate change. The two-phase project has developed a soil and water assessment tool (SWAT) model for watershed management and empowered the community to sustainably manage their farming system resources (land, soil, water, crop and livestock).

In 2014, the project introduced 'mirt stoves' as a leverage to engage women. This clean cooking device reduces the use of firewood, while creating income generating opportunities for landless young women. The project trained women to make the stoves from locally available materials so they can earn money from selling them in the market. In exchange, the women helped with watershed management activities like terracing and making soil bunds. Initially a mirt stove was provided in exchange for 20 hours of watershed services, thus engaging 570 households.



Water from Chardara Dam on Syr Darya River irrigating farms at the border of Kazakhstan and Uzbekistan



A gender mainstreaming workshop, held in Addis Ababa, in March 2014, equipped 58 researchers with the necessary tools to incorporate gender into their research activities for the Rainfed Watershed Management project in Ethiopia. ([rainfedsystems.icarda.org](http://rainfedsystems.icarda.org))

### Research highlight

#### Turning salinity into a profit

A report published in 2014 could be a game-changer for farmers, governments and donors in dealing with saline water and salt-affected soil. The report, Potential business opportunities from saline water and salt-affected land resources, systematically documents the benefits of and impetus for investing in saline water recycling and reuse, as well as the restoration of salt-affected land in irrigated areas. A significant contribution to food, feed and renewable energy production can be achieved by recovering and reusing saline water, as demonstrated through four case studies. As an example of the business opportunities, an irrigation system in the Aral Sea Basin offers at least 10,000 sites that could be harnessed for micro-hydro-turbines to produce renewable energy.

#### Evaluating ecosystem services to promote improved water use

A new project initiated in 2014 in Kazakhstan is addressing the plight of downstream water users as they face poor productivity from high concentrations of pesticides, sediments and sewage carried in the Syr Darya River from upstream areas. Partnering with the Regional Environmental Center for Central Asia, ICARDA is building linkages between various stakeholders on the use of water. An open access database of biophysical, socioeconomic and geographic information system (GIS) datasets for the area was completed, mapping women-led water-related activities – a key focus being promoting the decision-making role of women in water resources management.



## Targeted legume research makes inroads with smallholders



Rice farmer in West Bengal, India, growing lentil crop in fallow season

Food legumes provide multiple benefits to poor people living in dryland areas. They are an important source of protein and micro-nutrients; add fertility to soils by fixing nitrogen from the air; and boost farm incomes and food security.

But despite these advantages, legumes are not as popular with smallholder farmers as rice and wheat. Legumes are considered more vulnerable to drought and disease and, overall, are deemed a risk crop. ICARDA has been working on several fronts to turn this around and make legumes an attractive crop for farmers. In 2014, these strategic activities led to impacts across South Asia and East Africa with the scaling out of technologies and stronger distribution systems for improved legume varieties.

### Mainstreaming lentil cultivation in South Asia's rice fallows

In 2014, ICARDA worked in India with national partners to scale out the practice of growing lentils on land left fallow in the winter season before and after rice crops. The initiative took forward results from previous years of successfully testing the innovation of short duration lentil varieties and related growing techniques in India, Bangladesh and Nepal. These projects had demonstrated that a winter lentil crop can enable farmers to obtain a second income from their smallholdings and produce more nutritious food for the local population.

Working with the Indian Council of Agricultural Research, ICARDA continued to promote production packages for lentil cultivation through a variety of channels, including local language leaflets and training sessions for farmers. The out-scaling received a boost from the National Food Security Mission of the Indian Government, which has prioritized lentil production to feed a growing population in the country.

During 2014, **the out-scaling project in India reached 3452 farmers in 175 villages**, providing information and training on how to store lentil seed, and when to sow seed and apply fertilizers and pesticides. Equipped with this knowledge, Indian farmers sowed lentil crops on 1067 ha of rice fallow land, **reaping yields of up to 1.8 t/ha, compared to average yields of 0.85 t/ha from traditional varieties.**

ICARDA's lentil varieties and techniques were also out-scaled in Bangladesh and Nepal with support from government



**13 new legume varieties released in 2014 (3 lentil, 4 faba bean and 6 chickpea) offer traits such as resistance to *Orobanche* parasite, heat and cold tolerance, early maturing, and being machine harvestable.**



“Thanks to the new variety of seeds and fertilizers, our lentil production has almost doubled.”

**Abur Ali Mandal, farmer in Nadia district, West Bengal (India)**

and national partners. Improved varieties **have now spread to 85% of lentil cropping in Bangladesh, bringing an additional annual income of US\$26.6 million. In Nepal, the value of the additional production is estimated at US\$180 million.**

### Bringing heat-tolerant faba bean to farmers in Sudan

In 2014, ICARDA continued its program of bringing heat-tolerant legumes to farmers in Sudan. Three varieties of higher yielding faba bean were released that **can tolerate temperatures up to 35°C**. As a result, the heat-tolerant cultivars are now dominating farmers’ fields in the country.



‘Hudeiba93’, ‘Basabeer’ and ‘Ed-Damer’ have increased faba bean yields in Sudan by 40% for 25,000 families, generating an additional average annual income of US\$4000.

### Seed for the farmer, by the farmer widens the reach

Access to quality seeds is a major bottleneck for smallholder farmers in developing countries. A key part of ICARDA’s work on grain legumes in 2014 was scaling out improved legume varieties through a farmer-centric approach in South Asia and Africa. These methods have successfully promoted and disseminated new legume varieties throughout the project areas.

In India, farmers participated in the screening of shortlisted lentil varieties in order to select the one most appropriate for their fields. This cultivar, developed using exotic germplasm, offers a 30% improvement in yield and resistance to disease caused by *Fusarium* fungi. Similar participatory approaches have improved yields for faba bean in Sudan.

In Ethiopia, ICARDA has been working with farmers in the central highlands and south-eastern parts of the country to establish village-based seed distribution systems for faba bean, chickpea and lentil. In 2014, efforts focused on

working with individual farmers and five seed producers’ associations to multiply improved varieties from ICARDA – four of faba bean, four of chickpea and two of lentil.



In Morocco, a farmer-based seed enterprise for faba beans has been successfully established.

In India, two seed hubs, established in Bihar state, enabled almost 600 farmers to produce and distribute 970 tonnes of lentil cultivar seed.

In Ethiopia, 1172 farmers (of which 154 were women) produced 755 tonnes of seed for improved varieties of faba bean, chickpea and lentil.

### Research highlight

#### Innovative legume varieties open new doors

ICARDA’s lentil breeding team has developed extra early maturing varieties of lentil, which mature in just 80–100 days, along with their attendant integrated crop management practices. This development will expand the uptake of growing lentil in rice–lentil–boro rice systems in India, Bangladesh and Nepal.

Another important crop breeding innovation for 2014 was ‘Sara’, a frost-resistant variety of chickpea, developed by ICARDA in partnership with the Dryland Agricultural Research Institute of Iran. The genotype developed by the team can survive temperatures as low as -24°C, an innovation that is set to transform production in the cold highlands of Iran and other locations with similar environmental conditions.

ICARDA’s newly established legume research platform in India and phenotyping facilities in Morocco and Sudan are poised to accelerate legume research in the developing world and deliver technologies that can expand legume cultivation and nourish both people and the soils throughout Asia and Africa.

*Supported by European Union–International Fund for Agricultural Development; Government of India’s National Food Security Mission; OCP Foundation; United States Agency for International Development; and CGIAR Research Program on Grain Legumes*

## Unleashing the nutrition potential of a legume diet



Detoxified grass pea adding nutrition and income for farmers in Sunderbans, West Bengal, India

In South Asia, malnutrition is among the worst in the world with a high incidence of severe poverty. Also acute in the region is micro-nutrient deficiency, a more widespread problem across the world that often goes unnoticed or unaddressed. More than two billion people worldwide suffer from this 'hidden hunger', causing health problems such as anemia and learning disabilities. To improve the health of rural communities in South Asia, ICARDA focuses on developing and promoting nutrient-rich legumes – a uniquely valuable crop for drylands that benefits soil health while also adding to incomes. These activities build and expand on the outcomes of CGIAR's research program on grain legumes.

### Bringing detoxified grass pea to nourish in tough conditions

Grass pea is a protein-rich hardy legume crop that can withstand even the harshest conditions of drought and salinity. This provides an important safety net for subsistence farmers and their families, but grass pea also contains harmful neurotoxins that can cause permanent paralysis when consumed in large amounts. ICARDA, in collaboration with partners in India, has been working to breed and promote new varieties of grass pea that are both safe to eat and high yielding.

In 2014, nearly 490 tonnes of seed of four new varieties of grass pea was produced. With the help of local development organizations, **these varieties reached some 2300 farmers, covering 815 ha of land, and bringing safe and higher yields of protein-rich grass pea.**

Building the capacity of the farming communities was a key focus of the grass pea project in 2014 to continue building on the successes and ensure sustained gains from research outcomes. The project helped establish 22 seed hubs, owned and managed by farmers in India, to supply seed of improved grass pea, and trained more than 6500 farmers (1200 female) on the safe handling and cooking of grass pea for food consumption. Targeting women for training is helping to ensure nutrition security for rural families even when times are tough.

### Research highlight

#### Leveraging lentil to bridge micro-nutrient deficiencies

In a project implemented across South Asia, ICARDA scientists with national partners have developed new varieties of lentil that provide higher levels of iron and zinc – more than 80 parts per million (ppm) of iron and more than 55 ppm of zinc, starting with a baseline of 40 ppm. Progress in 2014 focused on fast track seed multiplication along with large-scale promotion by national governments. **In Bangladesh, the fortified lentils reached 820,000 farmers, while in Nepal they reached 400,000 farmers.** Similarly in India, a lentil variety developed with 102 ppm of iron is bridging iron deficiency in three major states in the country. In South Asia, where populations are largely vegetarian, these lentil varieties have turned their staple rice–lentil dish into a powerhouse of both macro- and micro-nutrients.



Development of low neurotoxin grass pea is ensuring nutrition security for over 6700 farmer families across 517 villages in India, even under tough conditions of drought and high soil salinity.

*Supported by Government of India; OCP Foundation; and CGIAR's HarvestPlus*

## Increasing productivity and profitability of sheep and goats for dryland communities



Livestock producers targeted by value chain development in Ethiopia

Small ruminants play a critical role in increasing incomes and are vital sources of nutrition for many poor people in livestock-based and mixed systems in drylands. In 2014, ICARDA's research on small ruminants was largely focused in Ethiopia, building on its years of research in both improving livestock production systems and linking them to value chains sustainably.

### Developing sheep and goat value chain in Ethiopia

ICARDA has been working since 2012 in Ethiopia with national and regional research partners on the development of a new sheep and goat value chain to improve the livelihoods of animal producers. In 2014, a benchmarking survey was completed at six sheep and goat value chain sites to lay a robust framework for interventions and assessments. The survey interviewed sheep and goat producers and other value chain actors, like input suppliers, veterinarians and traders, to assess the current performance of the small ruminant meat value chains (full report available in August 2015).

The initiative, in partnership with the International Livestock Research Institute (ILRI), has designed six best-bet interventions along the value chain, which are being tested in a number of sheep and goat value chain sites. These include: community-based breeding programs, related establishment of farmer cooperatives, sheep fattening strategies, smart marketing, improved goat milk processing, and assessing meat microbial quality in slaughterhouses connected with the sites. The nine farmers' cooperatives established so far are



The animal feed analysis web application (AFAWA) – an online tool and database for managing laboratory analyses of feeds – went live in 2014. The open access database provides nutrient composition and nutritive values of feeds from diverse locations in dry areas of the world and related information. [afawa.icarda.org](http://afawa.icarda.org)  
Jointly developed by CGIAR Research Programs on Dryland Systems and Livestock and Fish



already working as the institutional set-ups for community-based breeding. Further, to systematically factor in gender aspects, a **gender capacity assessment tool** was developed that helps tailor capacity development of all partners engaged in value chains so as to bridge the gap between the abilities of men and women.

The initiative creates synergies through complementary research themes and tool development with several CGIAR Research Programs also active in Ethiopia. These include Dryland Systems, Agriculture for Health and Nutrition, and Policies, Institutions and Markets. The program is also leveraging partnerships with development projects in the region such as those funded by FAO, IFAD and USAID.

## Identifying the genetics of adaptation to hot arid environments

In 2014, ICARDA scientists investigated the genetic basis for adaptation to hot arid environments in sheep and goats from Egypt. Several candidate genomic regions spanning 29 genes in both sheep and goats were identified. These genes, directly or indirectly, play a role in adaptation to hot arid environments – offering useful insights that can be applied in the adaptation of small ruminants to arid environments in the face of climate change ([presented at the Plant & Animal Genomes XXII Conference, San Diego, CA](#)). Supported by the Agricultural Research Center, Egypt, and Iowa State University.

## Research highlight

### Community-based breeding, a promising approach to lifting animal productivity for the resource poor

Genetic improvement of livestock breeds in developing countries remains a challenge. In 2014, ICARDA's scientists further improved the design of a community-based breeding program for small ruminants and are now working on disseminating the improved genetics through reproductive technologies – an innovative approach that involves local institutions and communities and improves indigenous breeds. The strategy has demonstrated a successful model that empowers resource poor animal producers to improve the genetic quality and productivity of their herds – thus generating greater incomes ([dialogues.cgiar.org/blog/community-based-sheep-improvement-research-helps-breed-strong-rural-communities-in-ethiopia](http://dialogues.cgiar.org/blog/community-based-sheep-improvement-research-helps-breed-strong-rural-communities-in-ethiopia)).



A smallholder farmer in Yemen grazes his goats on Buffel grass, which saves on average 52% of irrigation water while providing higher quality fodder, as compared to traditional Rhodes grass (Arabian Peninsula Regional Program, funded by AFESD, IFAD)

*Supported by United States Agency for International Development; Oregon State University; and CGIAR Research Program on Livestock and Fish*

## Building climate change resilient livelihoods through barley



Women associations benefiting from targeted dissemination strategy, Ethiopia

In the dryland environments of Africa and Asia, small-scale farmers rely on resilient crops able to cope with water scarcity, drought, low and high temperatures, and soil salinity. One such crop is barley – part of ICARDA’s mandate – which can provide stable yields even when environmental conditions are exacerbated by climate change. In 2014, ICARDA and its national partners worked to improve barley varieties and build the capacity of dryland farmers for greater incomes and resilient livelihoods.

### Developing malt barley for value chain – a new revenue for smallholders

In 2014, ICARDA continued to develop and test improved varieties of barley suitable for malting, targeting the rapidly growing market for malted beverages in Ethiopia under a new value chain initiative. The country spends over US\$20 million annually on malt barley imports, offering a huge income opportunity for subsistence smallholder farmers.

ICARDA’s scientists are working with the Ethiopian Institute of Agricultural Research (EIAR) to screen barley varieties with traits such as high grain and malt quality, and tolerance to heat, drought, disease and insect pests. The team developed several barley varieties, of which ‘Miscal 21’ and ‘IBON174/03’ were successfully piloted by the industry and farmers for malt production in 2014. The improved varieties more than doubled farmer’s yields from 2 t/ha to 5 t/ha, boosting their incomes.



In 2014, four new barley varieties released with NARS partners are improving yields under both high input and low input conditions. ‘Ansar’ offers resistance to cold and drought in Iran and ‘BHS400’ to yellow rust and drought in the northern hills of India.



The malt barley research aims to connect resource-poor smallholders to a growing market for beverages brewed with malted barley in East Africa and South Asia countries – a new value chain opportunity targeting roughly 200,000 ha in each region.

## Creating barley livelihoods for women farmers

In Ethiopia, over 15 years of barley research collaboration is paying off by transforming the lives of women smallholders. The local variety of barley seed used was poor yielding and highly susceptible to disease. ICARDA worked with EIAR to overcome production constraints and introduce new improved barley varieties. Targeting a women's association, the project began with the provision of improved seed and training on crop management to 25 women smallholders.

From there, the success of the project snowballed. **The women's association grew ten-fold and barley yields increased from 1 to 6 t/ha.** Some 90% of these women are even reaping a surplus harvest to sell in markets and generate income, becoming role models in their community.



Crossing of barley as part of improved variety development process

## Research highlight

### Barley research to get impetus from R&D country hubs

In 2014, ICARDA kick-started R&D partnerships in six countries – Morocco, Ethiopia, India, Kazakhstan, Iran and Turkey – acting as focal points or hubs for barley research across the drylands. These partnerships, implemented under the CGIAR Research Program on Dryland Cereals, will synergize barley research outcomes and boost the capacity of dryland countries to adapt their smallholders to climate change and strengthen their food security.

“With new barley varieties and training, we have become self-sufficient and able to send our kids to schools.”

**Aselefech Telila, leader of the smallholder women farmers' association  
Welmera District, Ethiopia**

*Supported by Australia's Grains Research and Development Corporation; Impulsora Agrícola S.A. de C.V., Mexico; Indian Council of Agricultural Research; Chinese Academy of Agricultural Sciences; and CGIAR Research Program on Dryland Cereals*



## Getting the balance right: informing policy on groundwater extraction



Using liquefied petroleum gas cylinders to extract groundwater for irrigation, Morocco

Extracting groundwater to irrigate dry areas is a sensitive balancing act for the government. Policymakers need to provide enough water for farmers to get adequate yields from their crops and, at the same time, ensure that this limited resource is not overexploited or have any damaging fallouts, endangering sustainability.

To make sure this balance is achieved, ICARDA worked closely with two national governments to evaluate the potential impacts and efficacy of their proposed schemes – subsidizing solar power to pump groundwater in Morocco, and increasing groundwater tariffs in Jordan to limit extraction.

### Guiding solar initiative framework for groundwater pumping in Morocco

In Morocco, the majority of groundwater extraction is powered by liquefied petroleum gas (LPG) as it is subsidized by the government – a use the government didn't foresee when implementing an LPG subsidy for domestic use by poor households. Pumping groundwater using LPG is costly both economically – all LPG in Morocco is imported – and environmentally, through high carbon dioxide emissions.

To address these problems, Morocco's Ministry of Agriculture has been considering solar panels as an alternative power source for extracting groundwater. In order to build a firm case, the ministry worked with ICARDA to assess the returns and an effective regulatory framework to pre-empt any downside to its investment. ICARDA's socioeconomists conducted a cost-benefit analysis in 2014, based on surveys with 112 Moroccan farmers in a region with wide groundwater use for irrigation. The study found that **switching to solar power would reduce pumping costs by 33.3–60.6%** in the study area compared with continuing with LPG. However, the sensitivity analysis indicated that solar energy would entail a large upfront investment given the uncertainty and risk associated with it, and subsidies to purchase solar systems will be important in encouraging farmers to switch. The study determined that the solar initiative will benefit Morocco's public purse, potentially **saving between US\$9 and US\$39 million each year**. In environmental benefits, **solar power will reduce carbon dioxide emissions per farmer per year by roughly one-third, compared with LPG use.**

The study found that installation of water meters would be essential to control extraction with solar power, as once it is installed the cost of pumping to the farmers is virtually zero and thus is likely to lead to an increase in groundwater

extraction. Based on these findings, the Moroccan Ministry of Agriculture has agreed to use meters and subsidize the installation cost of solar power for pumping groundwater. In 2015, ICARDA aims to work with farmers and the Ministry to further the solar energy initiative for pumping groundwater for agriculture use.

**“It is the first time a study on solar energy and irrigation is conducted in Morocco. Its findings are useful for guiding policy decisions related to sustainable management of aquifers and energy.”**

**Hind Abdaoui, Renewable Energy Officer, Moroccan Ministry of Energy, Mining, Water and Environment**

### Projecting the impacts of extraction tariffs in Jordan

In Jordan, 10 out of 12 underground aquifers are overexploited. In order to conserve remaining groundwater resources, the Jordanian government recently decided to increase extraction tariffs. Starting in 2016, the Ministry of Water and Irrigation is considering reducing the free groundwater quota and charging higher tariffs to farmers abstracting more than the set quota. It plans to reduce the free groundwater quota from the current 150,000 to 75,000 m<sup>3</sup>/year/well and is considering a multi-tiered pricing

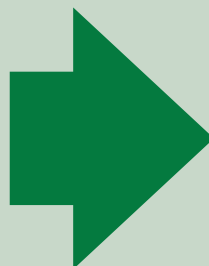
structure. Farmers exceeding the free quota would pay US\$0.014/m<sup>3</sup> for the first segment (from 75,000 to 200,000 m<sup>3</sup>/well/year), and US\$0.141/m<sup>3</sup> for the second segment (abstractions that go beyond 200,000 m<sup>3</sup>/well/year).

ICARDA, in partnership with the Jordanian Ministry of Water and Irrigation and the National Center for Agricultural Research and Extension, investigated how these charges might affect farmers’ incomes, both through increased pumping costs and through potential reductions in groundwater consumption. A total of 78 farming households provided production and cost data which was fed into a mathematical matrix for analysis.

The studies predicted farmers’ incomes would be reduced by 0.5–2.6% for the first tier increase in tariff, and from 4.1–16% for the second tier. Corresponding reductions in groundwater use were estimated at 1.6–4.2% for the first tier and 16.4–42.1% for the second tier. The study concluded that **Jordan’s new tariff scheme is not likely to hit farmers hard even if they go over the free quota by 125,000 m<sup>3</sup>/year/well; however, exceeding by more than this amount will impact them significantly.** The ‘inelasticity’ of farmers in their ability to respond to the higher cost for groundwater reflects their utter dependence on it, with no alternative such as rainfall or other water bodies in the country.

These findings have ensured that the Ministry will avoid implementing an ineffective policy. As a next step, alternative conservation measures are being investigated that can help the country design an effective policy with more acceptable trade-offs.

**Overall cost savings in areas equipped for irrigation when farmers start using solar panels instead of LPG and diesel = US\$1831 million/year**





## Building and using genetic diversity to improve crops



Collecting forage species on the slopes in Elbrus district, Northern Caucasus, Russia

Conserving the genetic diversity of crops is at the heart of efforts to build a food-secure world. Without such diversity, breeding high-yielding and disease-resistant crop varieties is severely limited, especially in the face of unpredictable conditions brought about by global climate change.

To make sure that crop-breeding programs fulfil their potential, plant scientists continued during 2014 to develop the ICARDA genebank, identifying, collecting, conserving, multiplying and distributing genetic material from plant samples (accessions) that display desirable traits.

### A stronger genetic resources program for a food-secure future

With decentralization of its genetic resources activities from Tel Hadya, Syria, ICARDA continued to focus on strengthening its genebank and germplasm distribution services. In 2014, **scientists collected more than 2000 new accessions, reaching 148,047 accessions** by the end of the year. These accessions are collected largely from the centers of origin of crop diversity with a wealth of unique landraces and wild varieties. To safeguard this invaluable collection, ICARDA has multiplied and duplicated its genebank holdings outside of Syria, with over 75% safely duplicated in Svalbard in the Arctic as of March 2014.

Another major achievement for 2014 has been the maintenance of ICARDA's genebank in Tel Hadya, given the difficult circumstances in Syria. The genebank still meets international standards for storage and is distributing plant material worldwide. At the same time, ICARDA's decentralization program is ensuring that genetic collections are safeguarded for the future at alternative holdings.

While continuing to maintain its genebank in Syria, ICARDA scientists aim to further develop the relocation sites in Lebanon and Morocco. Nearly 20,000 plant samples were multiplied in Morocco, Lebanon and Tunisia from 2013 to 2014 to reconstruct its active collection.

### Equipping plant breeders and farmers

During 2014, ICARDA **scientists distributed nearly 12,000 samples of genetic material** to plant breeders and farmers in 11 countries and to ICARDA's research programs. In addition, national teams in Jordan, Nigeria and Tunisia assessed the status and threats to agricultural biodiversity.

The lower germplasm distribution amount in 2014 compared with previous years is a reflection of the successful application of ICARDA's FIGS (Focused Identification of Germplasm Strategy) tool to rapidly screen out subsets of



accessions with desired traits. A user-friendly online version of FIGS is in progress which will allow plant breeders and scientists around the world to directly access this valuable tool for their crop improvement research.

## Bridging diversity gaps in the genebank

ICARDA is working on collecting novel diversity to enrich its genebank collection further. This is based on diversity gap analysis and the targeting of adaptive traits (like tolerance to drought, heat and salinity). Scientists conducted joint collecting missions in Cyprus, Greece, Jordan and Russia and collected landraces (locally adapted traditional varieties) and wild relatives of wheat, barley and legumes. In all, between 2012 and 2014, 4865 accessions have been collected thus far under this objective.



Wheat cultivars resistant to Hessian fly



Stunted wheat from infestation of Hessian fly

## Research highlight

### FIGS, a rapid gene mining tool, signifies next generation crop breeding

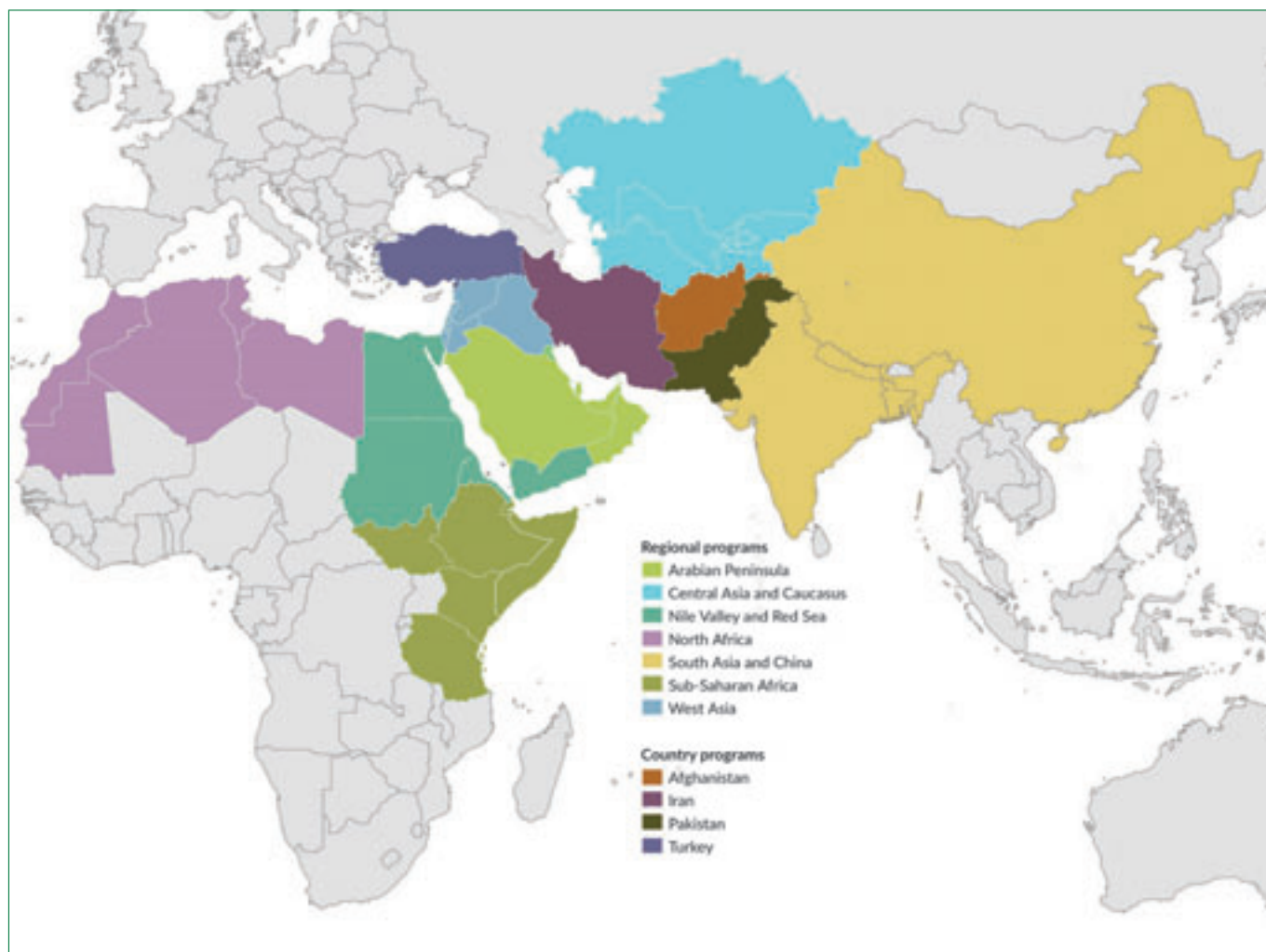
Agricultural genebanks hold the key to ensuring a food-secure future in the face of climate change and natural hazards. They provide crop breeders with access to genetic material from throughout the world with valuable traits, such as tolerance to disease, pests and drought. But with millions of accessions being held in genebanks, searching for the desired genetic trait is a near impossible task, which severely limits the utility of the biodiversity locked up in genebanks.

In 2014, a series of successes with using the FIGS tool to find desired genetic traits is paving a new way forward for crop breeders. ICARDA's scientists used FIGS to find genetic traits in its genebank for abiotic stresses typical of dry areas, such as soil toxicity, heat and drought. They also identified new subsets for resistance to crop diseases such as stem rust and yellow rust in wheat and *Fusarium* wilt in legumes. Further, FIGS helped identify 14 new subsets of cereals and food legumes in response to germplasm requests by external researchers. Of particular note was use of the tool to discover resistance to sunn pest in wheat, an elusive task for crop breeders for many years (see page 14).

FIGS or the Focused Identification of Germplasm Strategy, developed by a team of scientists from ICARDA, the Vavilov Institute in Russia, and the Grains Research and Development Corporation in Australia, uses a 'learning algorithm' to harvest geoinformatic data and zone in on the desired plant traits, thus generating a small subset of likely accessions that can be easily screened for targeted genes.

*Supported by Australia's Grains Research and Development Corporation; Global Crop Diversity Trust; Federal Government of Germany; and CGIAR Research Program on Genebanks*

# Working with countries for a food-secure future



Partnering with countries through national research and extension systems (NARS), universities, policy-makers, and the private sector has been a cornerstone of ICARDA's research-for-development initiatives. The approach has been allowing us to shape agendas that are responsive to countries' needs, while advancing research to address the challenges shared by dryland communities across the developing world.

ICARDA's regional and country programs combine research with extensive capacity development to ensure a research-for-development continuum. They work through a core partnership of international scientists, NARS, local research institutions, and universities, with inputs from national policy- and other decision-makers.

With the center's decentralization, ICARDA's partnership programs – seven at the regional level and four at the country level – cover over 50 countries across Africa and Asia.

## ICARDA's agricultural research-for-development partnerships (arranged alphabetically)

### Regional programs

Arabian Peninsula  
Central Asia and Caucasus  
Nile Valley and Red Sea  
North Africa  
South Asia and China  
Sub-Saharan Africa  
West Asia

### Country programs

Afghanistan  
Iran  
Pakistan  
Turkey



## Highlights from regional and country partnerships



Scientists evaluating legumes performance on farmers' fields in West Bengal, India

In 2014, ICARDA's research partnership with the NARS developed and tested a wide range of innovative technologies on farmers' fields, with some demonstrating outstanding potential for increasing agricultural productivity in drylands. Representing a significant opportunity for countries, these technologies have attracted larger government support and are being promoted nationally for scaling out.

*\* Denotes program office location. For list of donors, see page 42.*

### Arabian Peninsula regional program

Activities in Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and United Arab Emirates (Dubai\*).

The program is continuing to develop and promote innovative and integrated technologies, enabling farmers to make the most of limited supplies of water and fertile land.

- In early 2014, ICARDA launched a new project to improve food security and the sustainable management of natural resources through integrated agriculture. As part of this, 54 pilot growers hosted a demonstration of technologies targeted to local conditions. These technologies, such as soilless systems (hydroponics), are being transferred within communities via farmer-to-farmer extension systems.

- The program has had sizable impacts for participating farmers. For example, soilless systems have doubled the net income of Yemeni farmers compared to that from conventional soil farming. Also, replacing commonly planted Rhodes grass with indigenous Buffel grass is bringing substantial water savings while producing more forage for farmers in Oman and the Emirates.

Also in 2014, Abu Dhabi became a member of CGIAR and its Food Control Authority signed a memorandum of understanding (MoU) with ICARDA, strengthening their agricultural research partnership for greater technology transfer and impacts for farmers in the region. A large project due for launch in 2015 will particularly target improving the production of date palm in Abu Dhabi.



A woman researcher receiving training on growing spineless cactus, Oman (ICARDA's Arabian Peninsula Regional Program)



### Central Asia and Caucasus regional program

Activities in Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan (Tashkent\*).

The program's range of activities are addressing land degradation and climate change, the biggest challenges to improving rural livelihoods in the region.

- A systems approach through innovative stakeholder partnerships is now in place at three action sites, implemented by the ICARDA-led CGIAR Research Program on Dryland Systems. Combating land degradation through conservation agriculture is gaining momentum, particularly in Kazakhstan and Uzbekistan. Developing new more resistant varieties, and promoting alternate crops, like mung bean and soy bean, are also helping farmers tackle soil degradation and salinization.
- A major collaborative action among regional research centers and international organizations present in the region got under way in 2014 to strengthen rural advisory services and develop coordinated approaches to facilitate farmers' access to innovations – a common hurdle in translating research to impacts.

In 2014, ICARDA also contributed to the design of the World Bank's new climate change adaptation and mitigation initiative in the region.



Barley selected from ICARDA's international nursery at a research plot in Dushanbe, Tajikistan

### Nile Valley and Red Sea regional program



Scientists with farmers in Sudan growing heat-tolerant wheat

Activities in Egypt (Cairo\*), Eritrea, Sudan and Yemen.

The program focuses on improving water productivity, water being the biggest bottleneck to farming in the region. The activities are implemented following an integrated approach of more efficient irrigation technologies, crop improvement, agronomy, and supportive policies and institutions.

- In Egypt, mechanized raised-bed technology, developed and validated by ICARDA with national partners over several years of research, is in the process of being scaled out through government support and innovative partnerships. In 2014, raised-bed application reached over 29,000 ha, reaping on average a 30% higher wheat yield and reducing irrigation water use in farmers' fields by 25%.
- A new MoU between ICARDA and the Food and Agriculture Organization of the United Nations, signed in 2014, is set to bring a concerted effort on the sustainable management of water and land resources to enhance food security and improve livelihoods in the Nile Valley and the Near East and North Africa region.
- In Sudan, a research project funded by the International Fund for Agricultural Development (IFAD) leveraged an IFAD investment project in the region to provide around 1000 smallholders with credit to invest in water conveyance technology – approximately US\$2 million in total. The technology is part of the project's systems approach and will help improve productivity for poor communities living in vulnerable conditions.
- A participatory barley breeding program is being implemented in four districts in Eritrea, jointly with the NARS and farming communities, to build resilience.

Also in 2014, Sudan became a member of CGIAR. In 2015, the Nile Valley program will continue to work toward improving productivity in high potential areas, while reducing risk in areas with low potential.

## North Africa regional program

Activities in Algeria, Libya, Mauritania, Morocco (Rabat\*) and Tunisia.

The program is responding to the challenges of climate change and the severely constrained production systems in the region by promoting conservation agriculture as a key strategy to help farmers build resilience and sustainably increase their crop yields. In a major step forward, a research platform was officially launched in Morocco, following an MoU with the Moroccan government. The platform will develop and validate technologies for the sustainable intensification of rain-fed production systems to improve the livelihoods of farming communities dependent on them across the drylands.

- In 2014, the program progressed significantly on promoting the uptake of conservation agriculture with ICARDA's no-till seeder, fabricated with local manufacturers, offering a cost-effective option to the farmers. The research outcomes persuaded the Moroccan government to subsidize the no-till drill by up to US\$9000. The program also worked with communities in Algeria, Morocco and Tunisia to replicate the development and manufacture of no-till drills locally. Another aspect has been incorporating conservation agriculture into the program's crop–livestock systems research in the region.
- An innovative south–south partnership of Morocco and India on food legumes research is sparking new learning and the transfer of technologies and practices across regions.
- The program is connecting research activities to local development projects, such as a World Bank project helping communities adapt to climate change in Morocco, and development projects in Tatouine and Medenine, Tunisia.

In 2015, the program will continue working toward bridging the yield gap in the region, while increasing the uptake of conservation agriculture.



Forage grown with conservation agriculture in Setif region, Algeria (travelling workshop)

## South Asia and China regional program



Legumes research fields at newly established platform in Madhya Pradesh, India

Activities in Bangladesh, Bhutan, China, India (New Delhi\*) and Nepal.

The program is generating technologies to raise incomes and improve nutrition for the millions of subsistence farmers, malnutrition being a severe problem in the region.

- In 2014, ICARDA worked through partnerships to out-scale food legume technology to rice fallow lands in Bangladesh, India and Nepal, enhancing farmers' incomes, household nutritional security and the sustainability of rice-based production systems. In India, lentil in rice fallow is covering some 1067 ha as of 2014 and has reached over 3500 farmers. The program also worked with the Government of India under its National Food Security Mission, to demonstrate the effectiveness of improved legume technologies for uptake by state extension agencies.
- High iron and zinc lentil varieties developed were demonstrated on farms and fast-tracked to increase their uptake in India, Nepal and Bangladesh.
- A new project is introducing and promoting spineless cacti in the marginal drylands of India as a way to build resilience and generate income through the many uses of cacti – as forage and in medicinal and cosmetic products for niche markets.

In 2014, ICARDA also put into operation a research platform in Bhopal, India, to generate technologies that will increase legume productivity both in the South Asia region and globally. India's south–south collaboration with Morocco on legumes research is further synergizing learning.



### Sub-Saharan Africa regional program

Activities in Ethiopia (Addis Ababa\*), Djibouti, Kenya, Somalia, South Sudan and Tanzania.

The program was formally launched in May 2014, consolidating and broadening ICARDA's activities to include six countries in the region (listed above). The program's research agenda, developed in partnership with the NARS, has prioritized integrated crop-livestock systems, small ruminant husbandry, natural resource management, water harvesting, and cereal and legume production for the region.

- In 2014, safeguarding the wheat crops of smallholders in Ethiopia against rust disease continued, producing and disseminating resistant seed to more than 10,000 households. Two new rust-resistant wheat varieties were also released, ensuring healthy wheat yields and food security in sub-Saharan Africa.
- Two new initiatives were launched in Ethiopia to improve legume production and create new income for barley farmers through the malted beverages value chain.
- Bilateral initiatives are under way in partnership with regional research and development organizations, like the Centre for Coordination of Agricultural Research and Development for Southern Africa. These planned projects will leverage ICARDA's niche expertise, for example small ruminants, to complement ongoing research projects in the region.

The program is also fully aligned with the CGIAR Research Program on Dryland Systems led by ICARDA.



Research strategy meeting of NARS heads at Sub-Saharan Africa Program launch in Addis Ababa, Ethiopia

### West Asia regional program



Conservation agriculture demonstration in Jordan

Activities in Iraq, Jordan (Amman\*), Lebanon, Palestine, Syria and lowland Turkey.

The program helps vulnerable farming communities, many in conflict-stricken countries, to overcome the multiple challenges of scarce natural resources, food insecurity, climate change and limited agricultural research infrastructure.

- In 2014, the program produced 'climate change atlases' for Jordan and Iraq as part of a food security initiative. With their comprehensive characterization, these maps will serve as baseline documents that can help assess future changes and provide guidance to the agricultural sector in adapting to climate change.
- In Iraq, the Ministry of Agriculture adopted research results on integrated pest management for protecting date palm plantations from notorious pests like the Dubas bug.
- A landmark project was launched to improve the livelihoods of sheep and goat farmers in the West Bank, Palestine. The project particularly focuses on benefiting women and the indigenous community of Bedouins and is implemented in partnership with the Cooperative for Assistance and Relief Everywhere (CARE) in the West Bank.
- Technologies developed by ICARDA to help livestock producers in Iraq and Jordan cope with climate change, such as conservation agriculture and milk processing innovative processes, are being out-scaled by an IFAD-funded development project in Jordan. Enhanced dairy processing reached 15 villages in 2014.

In 2015, the program will continue to strengthen the resilience of resource-poor rangeland farmers, and build the capacities of scientists working in post-conflict countries.



## Afghanistan country program

The program is working with a range of partners to help farmers increase productivity, diversify their crops, and strengthen their animal husbandry in Takhar, Nangarhar, Baghlan and Mazar provinces.

- In 2014, three high-yielding crop varieties resistant to drought and disease were released – the result of collaborative research between ICARDA and the Agricultural Research Institute of Afghanistan. The new varieties – one chickpea and two lentil – have the potential to raise farmer incomes by US\$60–100 per ha and will be supplied via a seed production program taken up by Afghanistan's Ministry of Agriculture, Irrigation and Livestock.
- Focus on livestock livelihoods in villages continued through the development of new fodder banks and veterinary field units, along with cross-cutting capacity building on farming, dairy and watershed management.
- The program expanded its partnerships to include working with other CGIAR centers on rice and potato crop improvement – bringing more comprehensive solutions to improve the livelihoods of smallholders in the country.
- Working along the research-to-development continuum, ICARDA collaborated with NGOs to provide technical support, such as with ActionAid for enhancing food security, and the United Nations Environment Programme for developing watershed-based activities.

In 2015, the program's agenda will focus on watershed management, conservation agriculture systems, and a seed certification system based on public-private-producer partnerships. Remote sensing and GIS-based studies will be emphasized, as permitted by the country's security situation.



Building capacity of extension and farmers on crop management

## Iran country program



On-farm trials of new winter wheat variety released from ICARDA nursery by NARS

The program is bringing research-based solutions for smallholders facing tough conditions in the highlands of Iran, such as frequent droughts and cold temperatures. The research agenda is using a systems approach to bring suitable crop varieties, natural resource management, capacity building, and policy recommendations, all informed and guided by stakeholder partnerships.

- In 2014, the program, with national partners in Iran, released high-yielding varieties of barley and winter bread wheat, developed from ICARDA germplasm and suited to the cold drylands of Iran. The new barley and wheat cultivars also offer resistance to water logging and disease, and promise to substantially increase yields for farmers.
- New systems research got under way at four sites in the Karkeh River Basin, selected as part of CGIAR's Dryland Systems research program, led by ICARDA. Using a participatory approach, the project worked with farmers to formulate a project plan and tested technologies for best-bet interventions, such as drip irrigation systems using marginal water and conservation agriculture.

Also in 2014, a new ICARDA regional program, the 'Highlands regional program', got the go-ahead from Iran's Ministry of Agriculture. The program will address challenges faced by farmers living in highlands across dry areas of the developing world. A new research and technology transfer initiative is scheduled for launch in 2015, targeted at increasing the production of wheat, barley and chickpea by 25% over the next five years in three provinces of Iran.

### Pakistan country program

The program focuses on fostering natural resource management, rehabilitating degraded lands, and increasing productivity and incomes for smallholder farmers.

- In 2014, ICARDA collaborated with the NARS to demonstrate a solar-powered irrigation system at three pilot sites on vegetable tunnels, orchards and cereal crops. It was hugely successful and has been adopted already by progressive farmers and NGOs. In addition, loans to install the solar system for irrigation have been proposed as part of the government budget.
- A wheat productivity enhancement project demonstrated ridge sowing to farmers in Punjab and Sindh provinces in collaboration with local institutes. The technology showed an average irrigation water saving of 30% compared with the usual farmer practice.
- A new systems research initiative was started by Dryland Systems, the CGIAR global research program that ICARDA leads, at Chakwal, in agreement with the NARS.

The main focus for 2015 will be to promote efficient use of irrigation water and natural resources.



Ridge-making in wheat to save irrigation water and increase yield

### Turkey country program

The program is continuing to deliver improvements in wheat varieties – a strategic focus of ICARDA's research in the country, suited to its cooler agro-ecosystem.

- The program released two winter wheat varieties in 2014 through the International Winter Wheat Improvement Program (IWWIP) – a joint initiative of ICARDA with the Government of Turkey and the International Maize and Wheat Improvement Center (CIMMYT). Also a seed health laboratory was set up and is now serving IWWIP.

- Collaborative research continued to make progress at the Regional Cereal Rust Research Center in Izmir, Turkey, to combat rust diseases in cereals, another initiative of ICARDA and Turkey. The center is emerging as a central hub for combating the disease, particularly wheat stripe rust – a major threat in the Central and West Asia and North Africa regions.

In 2015, the Rust Research Center will start supporting the region with monitoring, research and response measures to protect nations against cereal rusts, mainly in wheat.



Research fields for testing of stripe rust resistance in wheat at Izmir, Turkey



# Building national capacities and fostering women scientists



Young Agricultural Scientists Program trained 34 young men and women as part of the Arab Food Security Project

ICARDA's capacity development activities in 2014 transferred knowledge and skills to national scientists, agricultural extension workers, farmers and research students. Activities included farmer field schools, field trials, workshops, training courses, degree and non-degree research awards, and study tours tailored to the focus areas.

In 2014, 18,215 participants – 29% of these being women – benefited from ICARDA's capacity development activities. Women also made up the majority of ICARDA interns and represented nearly half the number of new students registered for master's and doctoral degree programs in 2014.

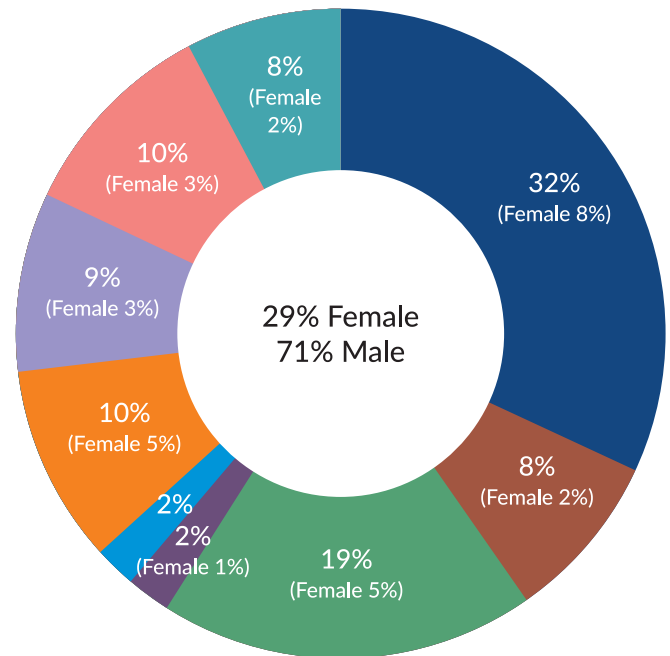
Participants in long-term courses, degree and non-degree programs: **1,386**

Participants in short-term training (workshops, farmer field schools, and field days): **16,829**

Total number of participants trained: **18,215**

Women accounted for 29% of scientists trained in 2014.

Capacity development activities by theme & gender 2014



- Crop genetic improvement & seed systems
- Livestock production
- Water/Natural resources management
- Multimedia information tools
- Protected agriculture
- GIS & other analytical tools
- Innovative systems
- Socioeconomics
- Agronomy & crop management

## Building new skill sets for greater research impacts

In 2014, ICARDA introduced a range of new training courses to enable more effective and efficient implementation of the research-for-development agenda. A particular focus was on building capacity to think beyond traditional approaches and pursue systems research – the cornerstone of Dryland Systems, the ICARDA-led CGIAR global research program. New course titles included 'Innovation systems approach'; 'Innovation platforms for improved impact'; and 'Sustainable intensification and resilience of agricultural systems: an integrated assessment and modeling of agricultural systems'.



To develop the capacity of scientists and other partners in gender research, a course was introduced on 'Gender mainstreaming in agricultural research'. Several new courses on modeling were also developed by ICARDA, including 'Policy-oriented economic modeling', 'Modeling of agricultural drainage management', 'Watershed modeling', and 'Modeling of ecosystem services'. For Central Asia, a special course was designed on 'Development of similarity maps to promote selected sustainable land management packages in Central Asia.'

Of special interest was a new development-oriented research course, 'Integrated agricultural research-for-development', which drew a number of participants from ICARDA's target regions, as well as from sub-Saharan countries such as Benin, Ghana, Kenya, Mali and Zimbabwe. The course was evaluated as highly relevant and applicable for their home countries.

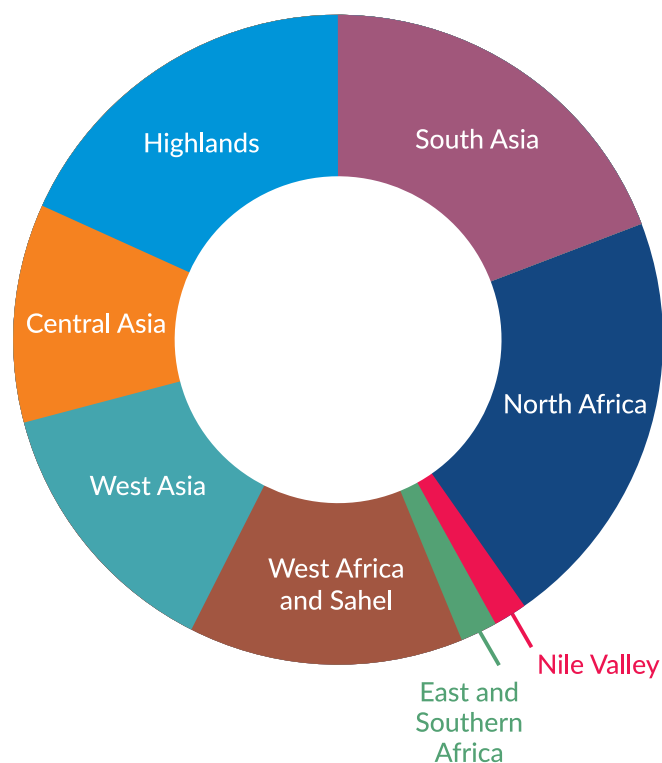
### Developing capacity to manage climate change

ICARDA delivered many courses and activities during the year to address the emerging and urgent need for developing the capacity of farmers and researchers in mitigating the impacts of and adapting to climate change. For example, in Iraq, ICARDA delivered training on the efficient use of irrigation pumps. Participants from across West Asia and North Africa learnt to assess forage resources and plan how to use these sustainably in the future, while in Tunisia, a course taught participants how to model agricultural systems for sustainably intensifying and building their resilience.

### Hands-on training for farmers and extension staff

ICARDA's research platforms and NARS partners arranged many farmer field days and farmer field schools during the year to demonstrate and promote technology uptake. For example, in Afghanistan, farmer field days dealt with techniques for saving and processing seed – a major bottleneck for smallholders. Other courses in Afghanistan focused on enhancing women's role in caring for small ruminants, ensuring animals stay healthy, and producing milk products efficiently and hygienically.

### Regional participation in ICARDA farmer field schools and field days 2014



### Maximizing technology dissemination through train-the-trainer activities

In Iraq, ICARDA and the Japan International Cooperation Agency worked with the Ministry of Agriculture and Water Resources of the Kurdistan Regional Governorate to maximize the uptake of technologies for improving wheat production and promoting greater self-sufficiency in the region. To achieve this community-wide goal, the program engaged government staff, extension workers and progressive farmers in a train-the-trainer activity, imparting knowledge and demonstration skills through on-farm trials to 188 participants. Further, study visits gave 35 trainers the opportunity to learn from the experience of Morocco and Turkey.

*Supported by Arab Fund for Economic and Social Development and Japan International Cooperation Agency  
Other donors: Austrian Development Cooperation; Australian Centre for International Agricultural Research; African Development Bank; European Union; Food and Agriculture Organization of the United Nations; International Fund for Agricultural Development; OPC Foundation; Organization of the Petroleum Exporting Countries Fund for International Development; United States Agency for International Development*

# Audited financial summary

## Statement of activity (US\$**x1000**)

	2014	2013
<b>REVENUES</b>		
Grants (core and restricted)	68,358	61,045
Other revenues and gains	614	1,939
<b>Total revenues and gains</b>	<b>68,972</b>	<b>62,984</b>
<b>EXPENSES AND LOSSES</b>		
Program related expenses	70,375	61,887
Management and general expenses	6,815	6,417
Other losses and expenses	-	-
Total expenses and losses	77,190	68,304
Indirect costs recovery	(6,423)	(6,574)
<b>Net expenses and losses</b>	<b>70,767</b>	<b>61,730</b>
<b>Net surplus from ordinary activities</b>	<b>(1,795)</b>	<b>1,254</b>
Extra-ordinary expenses	-	-
<b>Overall surplus (deficit)</b>	<b>(1,795)</b>	<b>1,254</b>

## Statement of financial position (US\$**x1000**)

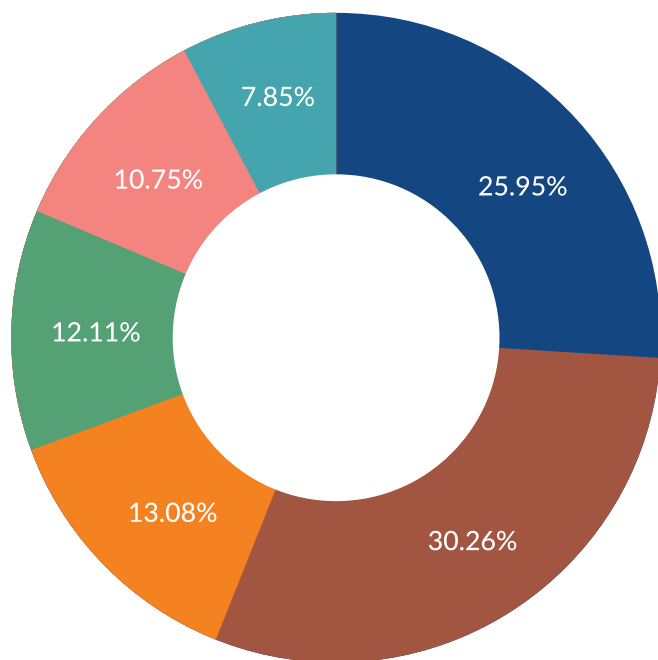
	2014	2013
<b>ASSETS</b>		
Current assets	36,458	44,210
Property and equipment	2,913	2,499
Other assets	-	-
<b>Total assets</b>	<b>39,371</b>	<b>46,709</b>
<b>LIABILITIES AND ASSETS</b>		
Current liabilities	30,213	35,691
Long term liabilities	-	65
Total liabilities	30,213	35,756
Net assets = Reserves	9,158	10,953
<b>Total liabilities and net assets</b>	<b>39,371</b>	<b>46,709</b>

## Statement of grant revenues, 2014 (US\$**x1000**)

DONORS	Amount
Afghanistan Ministry of Agriculture, Irrigation, and Livestock (MAIL)	324
Arab Fund for Economic and Social Development (AFESD)	2,673
Australian Centre for International Agricultural Research (ACIAR)	4,308
Austria	420
CGIAR Fund	18,047
Cornell University	501
European Commission	1,453
Germany	906
Global Crop Diversity Trust (GCDDT)	1,740
Grains Research and Development Corporation (GRDC)	771
Gulf Cooperation Council (GCC)	432
Impulsora Agricola, S.A. de C.V. (IASA)	420
India	944
International Center for Tropical Agriculture (CIAT)	884
International Crops Research Institute for Semi-Arid Tropics (ICRISAT)	4,568
International Food Policy Research Institute (IFPRI)	381
International Fund for Agricultural Development (IFAD)	2,776
International Institute of Tropical Agriculture (IITA)	4,054
International Livestock Research Institute (ILRI)	1,054
International Maize and Wheat Improvement Center (CIMMYT)	3,145
International Water Management Institute (IWMI)	1,338
Japan	436
Kuwait Fund for Arab Economic Development (Kuwait Fund)	1,187
Libya – Agricultural Research Center	2,354
OCP Foundation	694
<b>Syrian Arab Republic *</b>	<b>919</b>
United States Agency for International Development (USAID)	5,329
United States Department of Agriculture (USDA)	3,450
Miscellaneous	2,850
<b>TOTAL</b>	<b>68,358</b>

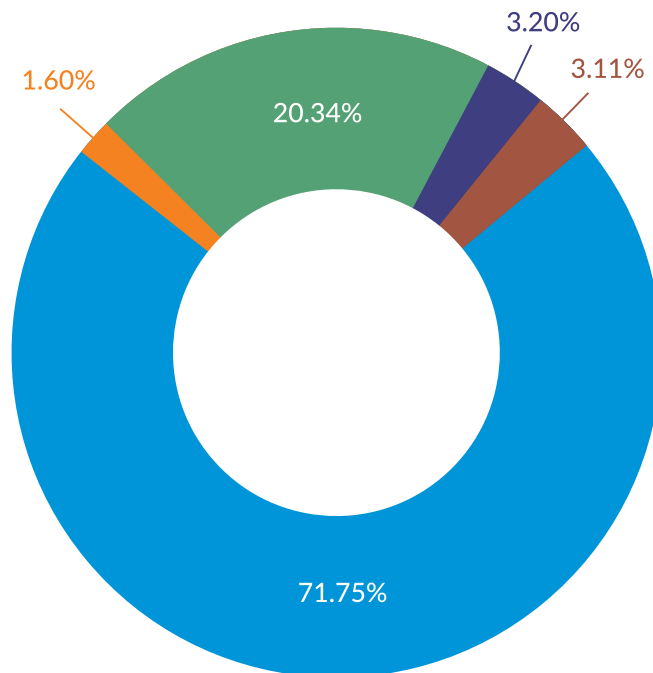
\* Donor that provided core funds

**Expenditure by category**



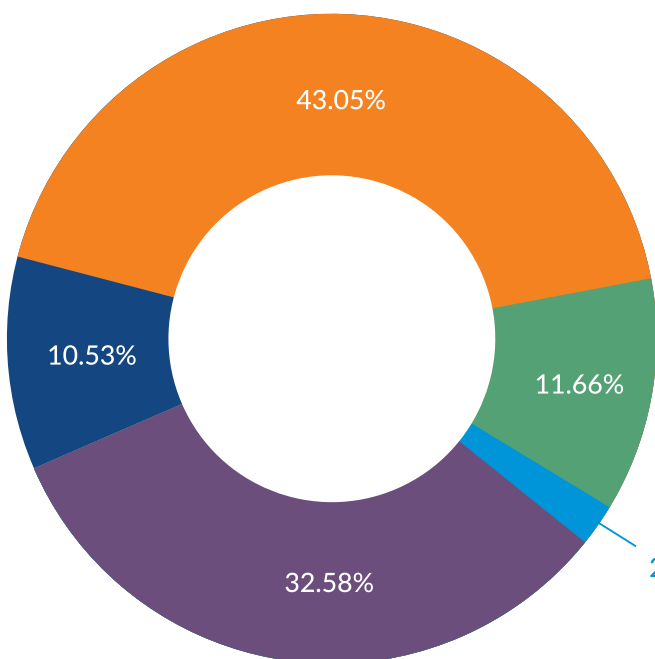
- Personnel costs
- Supplies and services
- Collaborators - CGIAR Centers
- Collaborators - Partners
- Travel
- Depreciation

**Expenditure by program and activity**



- Research programs
- Research support
- International cooperation and communication
- Corporate services
- Management

**Expenditure by research program**



- Integrated Water and Land Management Program
- Biodiversity and Integrated Gene Management Program
- Diversification and Sustainable Intensification of Production Systems Program
- Social, Economic and Policy Research Program
- CGIAR Research Programs 1.1 Dryland Systems



# Honors and awards in 2014



Ahmed Amri



Miloudi Nachit



Osman Abdalla

Ahmed Amri, Miloudi Nachit, Mustapha El Bouhssini, and Osman Abdalla

*Biodiversity and Integrated Gene Management Program Award of Merit* from the International Plant Resistance to Insects Working Group for research on Hessian fly resistance in wheat in Morocco (award for INRA<sup>1</sup>, ICARDA, and USDA-ARS<sup>2</sup> team).



Ashutosh Sarker

*South Asia and China Regional Program Coordinator and Food Legume Breeder*

**Awarded** by the Indian Society of Genetics & Plant Breeding for “Contribution to Lentil Genetic Enhancement for Nutritional Security”.



Mesut Keser

*Turkey Country Program Manager*

**Honored** for his contribution to wheat breeding in Turkey by naming a winter wheat variety released in 2014 as ‘MESUT’. The seed distribution will be started by farmers from 2015.



Mustapha El Bouhssini

*Entomologist, Biodiversity and Integrated Gene Management Program*

**Distinguished Scientist Award** from the International Branch of the Entomological Society of America; **Distinguished Alumnus Award** from the Entomology Department, Kansas State University.



Ramesh Pal Singh Verma

*Barley Breeder, Biodiversity and Integrated Gene Management Program*

**Honored** with plaque at the 53rd Annual Meeting of All India Wheat & Barley Workers Meet for development and release of new two-row malt barley varieties.



Vinay Nangia

*Agricultural Hydrologist, Integrated Water and Land Management Program*

**Outstanding Young Scientist Award** from the Association of Agricultural Scientists of Indian Origin affiliated with the American Society of Agronomy.

## Recognition of students



Ahmed Ekzayez

*Virology Lab member and PhD student*

**Congress award** for one of the three best oral presentations of graduate students at the 11<sup>th</sup> Arab Congress of Plant Protection held at Al-Balqa’ Applied University, Al Salt, Jordan.

## Of special mention

ICARDA especially acknowledges the contribution of two globally renowned agricultural scientists who received prestigious awards in 2014 and have been associated with the center in varying roles.



Prof. Paul Vlek

*Interim Deputy Director General – Research (since April 2015) and Special Advisor to ICARDA’s Director General on Integrated Systems Research (since February 2015)*

*Independent Science Advisory Committee of the CRP Drylands System (June 2014)*

*(Home organization: University of Bonn)*

**Awarded 2014 World Agriculture Prize.**



Dr. Sanjaya Rajaram

*Senior Scientific Advisor/Consultant at ICARDA (2008–2014)*

*Director of Integrated Gene Management Program, ICARDA (2005–2008)*

**Awarded 2014 World Food Prize.**

<sup>1</sup> Morocco’s National Agronomic Research Institute

<sup>2</sup> USDA Agricultural Research Service

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Ministry of Agriculture and Agrarian Reform, Syria  
*Expertise: Agriculture, Plant Breeding*  
Syria

**Dr. Masum Burak**

Director General of Agricultural Research  
Ministry of Food, Agriculture and Livestock, Turkey  
*Expertise: Horticulture*  
Turkey

**Dr. Susan Schram**

Independent Consultant, USA  
*Expertise: International Agriculture, Rural Development*  
USA



# Donors and investors

## Donors in 2014

- Afghanistan
- African Development Bank (AfDB)
- Arab Fund for Economic & Social Development (AFESD)
- Asian Development Bank (ADB)
- Australia (incl. ACIAR, GRDC, CSIRO, Curtin University, DPI)
- Austria
- Brazil (incl. EMBRAPA)
- CGIAR Consortium
- China
- Common Fund for Commodities (CFC)
- Cooperative for Assistance and Relief Everywhere, Inc. (CARE)
- Cornell University
- Egypt
- European Union (EU)
- Food and Agriculture Organization (FAO)
- France (incl. CIRAD)
- Germany (incl. GIZ, ZEF)
- Global Crop Diversity Trust (GCDDT)
- Gulf Cooperation Council (GCC)
- Impulsora Agrícola, S.A. de C.V. (IASA)
- India
- International Center for Biosaline Agriculture (ICBA)
- International Fund for Agricultural Development (IFAD)
- Iran
- Japan (incl. JICA)
- Kuwait Fund for Arab Economic Development (KFAED)
- Libya
- Morocco (incl. INRA)
- OCP Foundation
- OPEC Fund for International Development (OFID)
- Russia
- Stockholm International Water Institute (SIWI)
- Swedish University of Agricultural Sciences
- Syria
- Turkey
- United Nations Development Programme (UNDP)
- USA (incl. USAID, USDA)
- United Kingdom
- Arab Fund for Economic and Social Development (AFESD)
- Australia (incl. ACIAR, AusAid, GRDC)
- European Union (EU)
- Italy
- Canada (incl. IDRC)
- Sweden
- Norway
- CGIAR (incl. Consortium and Challenge Programs)
- Desertification Trust Fund
- Iran
- Japan (incl. JICA, JIRCAS)
- Libya ARC
- United Nations Development Programme (UNDP)
- Denmark
- OPEC Fund for International Development (OFID)
- Egypt
- France
- Syria
- Ford Foundation
- Switzerland
- Belgium
- Austria
- Food and Agriculture Organization of the United Nations (FAO)
- Asian Development Bank (ADB)
- Gulf Cooperation Council (GCC)
- India
- Cornell University
- Yemen
- Saudi Arabia
- Morocco
- Spain
- Turkey
- Global Crop Diversity Trust (GCDDT)
- Tottori University
- China
- United Nations Environment Programme (UNEP)
- United Nations Convention to Combat Desertification (UNCCD)
- Kuwait Fund for Arab Economic Development (KFAED)
- Islamic Development Bank (IsDB)
- Ethiopia
- Finland
- South Africa
- Mexico
- Peru
- OCP Foundation
- Russia

## Major donors, cumulative 1977 to 2014

- USA (incl. USAID, USDA)
- World Bank
- Germany
- International Fund for Agricultural Development (IFAD)
- Netherlands

# Donors by regional and country programs

## Regional programs

### Arabian Peninsula

- Abu Dhabi Food Control Authority/Government of Abu Dhabi
- Arab Fund for Economic and Social Development (AFESD)
- Gulf Cooperation Council (GCC)
- International Fund for Agricultural Development (IFAD)

### Central Asia and Caucasus

- Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Germany
- Government of Russia
- International Fund for Agricultural Development (IFAD)

### Nile Valley and Red Sea

- African Development Bank (AfDB)
- Arab Fund for Economic and Social Development (AFESD)
- Australian Centre for International Agricultural Research (ACIAR)
- CGIAR
- European Union (EU)
- Government of Egypt
- Government of Sudan
- Grains Research and Development Corporation (GRDC)
- International Fund for Agricultural Development (IFAD)
- Kuwait Fund for Arab Economic Development (KFAED)
- United States Agency for International Development (USAID)

### North Africa

- African Development Bank (AfDB)
- Arab Fund for Economic and Social Development (AFESD)
- Australian Centre for International Agricultural Research (ACIAR)
- Common Fund for Commodities (CFC)
- European Union (EU)
- Grains Research and Development Corporation (GRDC)
- International Fund for Agricultural Development (IFAD)
- Kuwait Fund for Arab Economic Development (KFAED)
- Ministry of Agriculture, Libya
- Ministry of Agriculture, Morocco
- OCP Foundation Morocco

### South Asia and China

- CGIAR
- Government of China
- Indian Council of Agricultural Research (ICAR), Ministry of Agriculture, Government of India

- National Food Security Mission (NFSM), Department of Agriculture & Cooperation, Government of India
- OCP Foundation, Morocco
- OPEC Fund for International Development (OFID)
- State Government of Karnataka, Government of India

### Sub-Saharan Africa

- African Development Bank (AfDB)
- Austria Development Agency
- Embrapa-Brazil
- Government of the Netherlands
- Grains Research and Development Corporation (GRDC)
- International Fund for Agricultural Development (IFAD)
- UK Department for International Development (DFID)
- United States Agency for International Development (USAID)

### West Asia

- Arab Fund for Economic and Social Development (AFESD)
- Australian Centre for International Agricultural Research (ACIAR)
- European Union (EU)
- Grains Research and Development Corporation (GRDC)
- International Fund for Agricultural Development (IFAD)
- Japan International Cooperation Agency (JICA)
- United States Agency for International Development (USAID)

## Country programs

### Afghanistan

- Australian Centre for International Agricultural Research (ACIAR)
- European Union (EU)
- International Fund for Agricultural Development (IFAD)
- Ministry of Agriculture, Irrigation and Livestock, Afghanistan

### Iran

- Government of the Islamic Republic of Iran

### Pakistan

- Australian Centre for International Agricultural Research (ACIAR)
- United States Department of Agriculture (USDA)

### Turkey

- Government of Turkey

# Appendix 1: ICARDA Genebank's global services and achievements

Table 1. List of varieties released by NARS partners in the 2014 crop season

Crop	Variety	Country	Adaptation and key traits
Bread wheat	Honqolo	Ethiopia	Highlands and mid-highlands; moderately resistant to rusts (Sr, Yr and Lr) and <i>Septoria</i>
	Reyna	Nigeria	Irrigated wheat; good bread-making quality; early maturing; heat tolerant
Durum wheat	Icarasha1	Iran	Early flowering; early maturity; resistant to Lr, Yr, Sr (Ug99 races), PM, and HF; strong gluten; high protein
Winter wheat	Gizil Bugda	Azerbaijan	High yield potential; stripe rust, leaf rust, smuts resistant; winter hardy; drought tolerant
	Baran	Iran	High yield potential; early maturity; cold and drought tolerant; moderately resistant to yellow rust
Barley	Yundamai7	China	High yield; drought tolerant
	Yundamai8	China	High yield
	Ansar	Iran	Winter type; cold tolerant; drought resistant; lodging and shattering resistant
	BHS400	India	Rain-fed areas in northern hills; drought tolerant; yellow rust resistant
Faba bean	Didea (EH01048-1)	Ethiopia	Large seed size; botrytis and root rot diseases resistant; suitable for mechanical harvesting
	Santa Elena (HBPCT-08-19)	Mexico	Chocolate spot tolerant; suitable for mechanical harvesting
	Hama2	Syria	High yield; large seed size; suitable for mechanical harvesting
	Hama3	Syria	High yield; medium seed size
Chickpea	TBA	Afghanistan	Spring type; irrigated areas; high yield
	Garaja	Azerbaijan	High yield; <i>Ascochyta</i> blight resistant
	Saral	Iran	High yield; cold tolerant; <i>Ascochyta</i> blight resistant
	Vostok	Kazakhstan	Early maturity; moderately resistant to <i>Ascochyta</i> blight; upright and compact plant; lodging resistant
	Baraev	Russia	High yield; <i>Ascochyta</i> blight resistant
Lentil	FLIP2011-33L	Afghanistan	Spring type; irrigated; high yield; <i>Fusarium</i> wilt resistant
	FLIP2010-27L	Afghanistan	Spring type; high yield; <i>Fusarium</i> wilt resistant
	IPL526	India	Wilt and rust resistant; late sowing
	Bilehsevar (ILL6037)	Iran	<i>Fusarium</i> wilt resistant; large yellow seeds



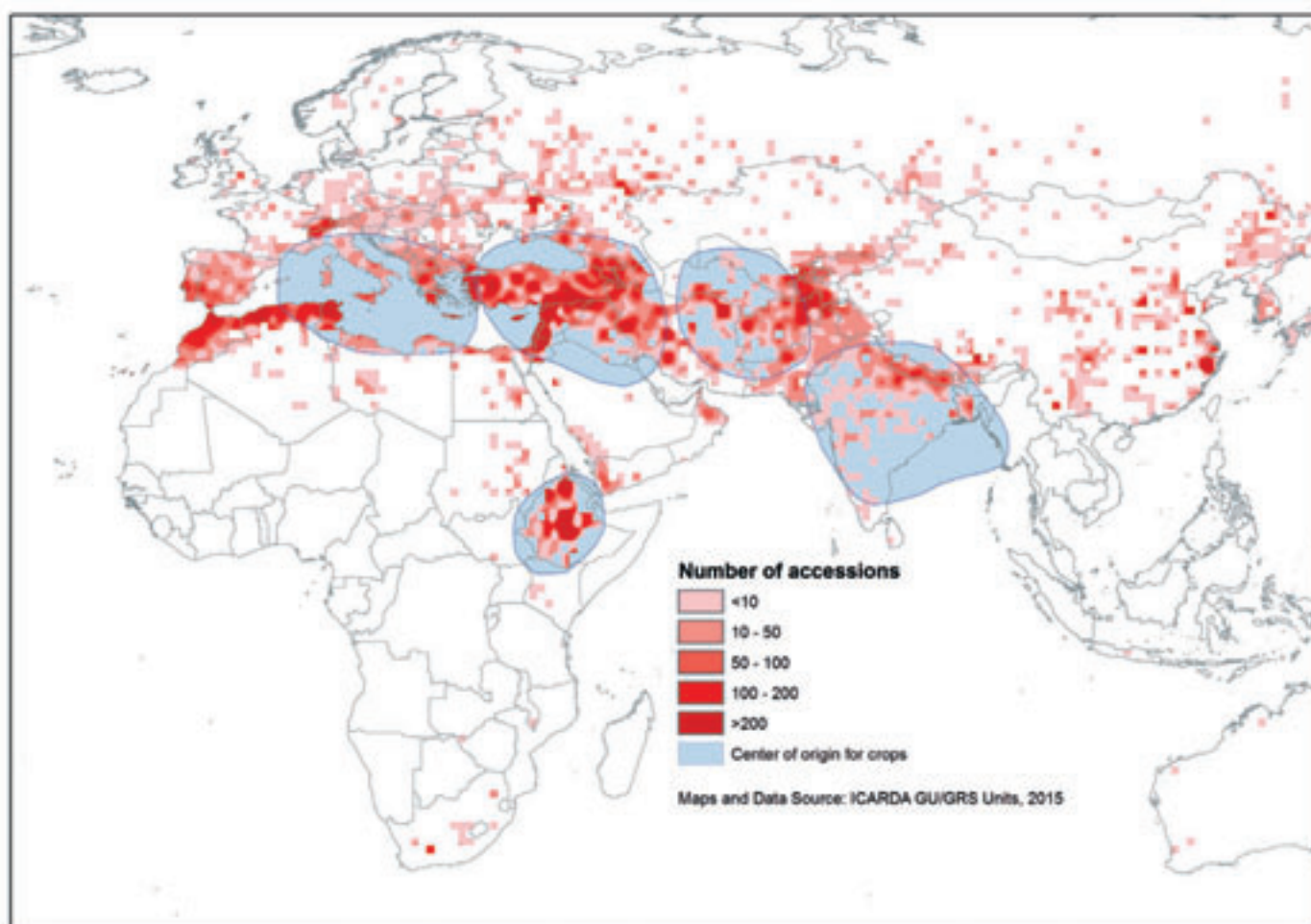
## Appendix 1: ICARDA Genebank's global services and achievements

Table 2. Distribution of international nurseries in the 2014–15 crop season

Crop	Sets available	Sets distributed	No of collaborators	No of countries
Bread wheat	5	221	40	19
Durum wheat	3	122	50	31
Barley	8	341	64	37
Faba bean	11	177	42	29
Chickpea	10	349	60	30
Lentil	14	313	52	30
Grass pea	4	69	28	23
<b>Total</b>	<b>55</b>	<b>1592</b>		

Total number of collaborators: 145

Total number of countries: 50



ICARDA's Genebank holdings

Source: ICARDA Geoinformatics Unit, 2015

## Appendix 2: Scientific publications

### Papers in ISI journals

- Abi Saab, M.T., R. Albrizio, V. Nangia, F. Karam, and Y. Rouphael. 2014. Developing scenarios to assess sunflower and soybean yield under different sowing dates and water regimes in the Bekaa valley (Lebanon): simulations with Aquacrop. *International Journal of Plant Production* 8(4): 457–482.
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- Rathanayaka, K., S. Maheepala, B. Nawarathna, B.A. George, H. Malano, and M. Arora. 2014. Factors affecting variability of household water use in Melbourne. *Resources, Conservation and Recycling* 92(2014): 85–94.
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## Appendix 2: Scientific publications

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- Yigezu, Y.A., A. Aw-Hassan, K. Shideed, and T. Al-Shatter. 2014. A policy option for valuing irrigation water in the dry areas. *Water Policy* 16(3): 520–535.
- ### Books/book chapters
- Akramkhanov, A., B. Tischbein, and U.K. Awan. 2014. *Effective Management of Soil Salinity – Revising Leaching Norms*, Chapter: Effective management of soil salinity – revising leaching norms (Lamers, J.P.A., A. Khamzina, I. Rudenko, P.L.G. Vlek, ed.). Bonn University Press, Göttingen, Germany. PP 121–134.
- Ates, S., I. Casasús, and M. Louhaichi. 2014. *Forage Resources and Ecosystem Services Provided by Mountain and Mediterranean Grasslands and Rangelands*, Chapter: Diverse and resilient agro-pastoral systems: a common goal for the Mediterranean regions. *Sciences Animales, Production et Protection Animales*. PP 545–557.
- Aye, L., B. Nawarathna, B. George, H. Malano, S.N.S. Puthrivilakom, and H. Malano. 2014. *The Security of Water, Food, Energy and Liveability of Cities: Challenges and Opportunities for Peri-Urban Futures*, Chapter 27: Greenhouse gas emissions of decentralised water supply strategies in peri-urban areas of Sydney. Springer Netherlands, Dordrecht, The Netherlands. PP 355–362.
- Davidson, A., H. Malano, P. Hellegers, B. George, and B. Nawarathna. 2014. *The Security of Water, Food, Energy and Liveability of Cities: Challenges and Opportunities for Peri-Urban Futures*, Chapter 35: Valuing the water used in peri-urban regions of Hyderabad, India and in western Sydney, Australia. Springer Netherlands, Dordrecht, The Netherlands. PP 465–474.
- Kumar, A., F. Bassi, M. Michalak de Jimenez, F. Ghavami, M. Mazaheri, K. Simons, M.J. Iqbal, M. Mergoum, S.F. Kianian, and P.M.A. Kianian. 2014. *Genomics of Plant Genetic Resources*, Chapter 12: Radiation hybrids: a valuable tool for genetic, genomic and functional analysis of plant genomes. Springer Netherlands, Dordrecht, The Netherlands. PP 285–318.
- Kumar, J., E. Srivastava, M. Singh, D. Mahto, A. Pratap, and S. Kumar. 2014. *Alien Gene Transfer in Crop Plants Vol. 2*, Chapter 9: Lentil. SpringerLink. PP 1–18.
- Kumar, S., A. Hamwih, A. Manickavelu, J. Kumar, T.R. Sharma, and M. Baum. 2014. *Legumes in Omics Era*, Chapter 6: Advances in lentil genomics. Springer New York, NY, USA. PP 111–130.
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- Shideed, K., A. Mazid, T. Oweis, and M. van Ginkel. 2014. *Arab Environment. 7 Food Security: Challenges and Prospects*, Chapter 3: Potential of rainfed agriculture and smallholder farmers in food self-sufficiency. Arab Forum for Environment and Development, Beirut, Lebanon. PP 74–101.
- Shobharani, N., S. Srikanth, V.P. Bhadana, J. Badri, R.M. Sundaram, P. Senguttuvel, G.S.V. Prasad, T. Shaw, P.V.N.S. Prasad, A.S. Hariprasad, L.V. Subbarao, S.K. Agrawal, and B.C. Viraktimath. 2014. *Genetic Diversity and Genealogy of Rice Varieties of India*. Directorate of Rice Research.
- Solh, M. 2014. *Arab Environment. 7 Food Security: Challenges and Prospects*, Chapter 2: The role of science and technology in enhancing food security. Arab Forum for Environment and Development, Beirut, Lebanon. PP 44–73.

## Appendix 3: Senior staff at ICARDA

Note: List is correct as of 31 December 2014

Bold: Staff who left ICARDA during 2014

### OFFICE OF THE DIRECTOR GENERAL

Dr. Mahmoud Solh, Director General  
 Dr. Elizabeth Bailey, Executive Assistant to the Director General and Board Secretary  
 Dr. Lamya El-Fattal Masadiah, Executive Assistant to the Director General  
**Mr. Raymond Melbourne Davies, Consultant – Internal Auditor**  
 Mr. Antonio Villamor, Internal Auditor  
**Ms. Houda Nourallah, Administrative Officer – DG**  
 Ms. Houda Nourallah, Consultant – Administrative Officer – DG  
 Ms. Dalia Nemer Kan'an, Executive Secretary – DG  
 Mr. Wael Tabbarah, Consultant – Legal

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## Acronyms and abbreviations

ACIAR	Australian Centre for International Agricultural Research	IFPRI	International Food Policy Research Institute
ADB	Asian Development Bank	IITA	International Institute of Tropical Agriculture
AfDB	African Development Bank	ILRI	International Livestock Research Institute
AFESD	Arab Fund for Economic and Social Development	IsDB	Islamic Development Bank
APRP	Arabian Peninsula Regional Program	IWMI	International Water Management Institute
AusAID	Australian Agency for International Development	IWWIP	International Winter Wheat Improvement Program
AVRDC	World Vegetable Center (previously Asian Vegetable Research and Development Center)	JICA	Japan International Cooperation Agency
CAC	Central Asia and Caucasus	JIRCAS	Japan International Research Center for Agricultural Sciences
CARE	Cooperative for Assistance and Relief Everywhere	KFAED	Kuwait Fund for Arab Economic Development
CFC	Common Fund for Commodities	LPG	Liquefied petroleum gas
CIAT	International Center for Tropical Agriculture	MAIL	Ministry of Agriculture, Irrigation, and Livestock (Afghanistan)
CIMMYT	International Maize and Wheat Improvement Center	MoU	Memorandum of understanding
CIRAD	Centre de coopération internationale en recherche agronomique pour le développement (France)	NARS	National agricultural research systems
CRP	CGIAR Research Program	NCARE	National Center for Agricultural Research and Extension (Jordan)
EIAR	Ethiopian Institute of Agricultural Research	NFSM	National Food Security Mission
EU	European Union	OFID	OPEC Fund for International Development
FAO	Food and Agriculture Organization of the United Nations	OPEC	Organization of the Petroleum Exporting Countries
FIGS	Focused Identification of Germplasm Strategy	R&D	Research and development
GCC	Gulf Cooperation Council	SARD-SC	Support to Agricultural Research for Development of Strategic Crops in Africa
GCDT	Global Crop Diversity Trust	SWAT	Soil and water assessment tool
GeSTA	Geospatial science, technology and application	UNCCD	United Nations Convention to Combat Desertification
GIS	Geographic information system	UNDP	United Nations Development Programme
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (Germany)	UNEP	United Nations Environment Programme
GRDC	Grains Research and Development Corporation	USAID	United States Agency for International Development
IASA	Impulsora Agrícola S.A. de C.V.	USDA	United States Department of Agriculture
ICARDA	International Center for Agricultural Research in the Dry Areas		
ICBA	International Center for Biosaline Agriculture		
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics		
IDRC	International Development Research Centre (Canada)		
IFAD	International Fund for Agricultural Development		

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**The International Center for Agricultural Research in the Dry Areas (ICARDA)** is the global agricultural research organization working with countries in the world's dry and marginal areas to deliver sustainable systems solutions that increase productivity, improve rural nutrition, and strengthen national food security. ICARDA's integrated approach includes new crop varieties; agronomy; on-farm water productivity; natural resources management; rangeland and small ruminant production; and socioeconomic and policy research to better target poverty issues and accelerate technology adoption. A member of the CGIAR Consortium, ICARDA leads its global research program, Dryland Systems. To achieve its goals, the Center works closely with national agricultural research programs and other partners in more than 50 countries across North and Sub-Saharan Africa, and Central, South and West Asia.

[www.icarda.org](http://www.icarda.org)



RESEARCH  
PROGRAM ON  
**Dryland Systems**

The **CGIAR Research Program on Dryland Systems** brings together a wide range of partners, including countries, research and development organizations, and private sector to bring rural communities living in the world's dry and marginal areas practical solutions for better livelihoods and food security. The goal of Dryland Systems is to identify and develop resilient, diversified and more productive combinations of crop, livestock, rangeland, aquatic and agroforestry systems that increase productivity, reduce hunger and malnutrition, and improve quality of life among the rural poor. Systems research teams – in partnership with rural communities and countries – are working to validate technology and policy “packages” targeted to agroecosystems in drylands, and promote their scaling-out in five flagship regions: West Africa Sahel and the Dry Savannas; East and Southern Africa; North Africa and West Asia; Central Asia and the Caucasus; and South Asia.

[drylandsystems.cgiar.org](http://drylandsystems.cgiar.org)



CGIAR is a global research partnership for a food-secure future. CGIAR research is dedicated to reducing rural poverty, increasing food security, improving human health and nutrition, and ensuring sustainable management of natural resources. It is carried out by the 15 Centers that are members of the CGIAR Consortium 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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