



TOWARDS
DYNAMIC DRYLANDS



2015
ANNUAL
REPORT

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2015 Annual Report Production

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JOINT MESSAGE FROM THE DIRECTOR GENERAL AND THE BOARD CHAIR



Mahmoud Solh
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The year 2015 will be remembered for the waves of refugees from the Middle East and North Africa (MENA) region looking for a safer future in other parts of the world. While millions of people crossed into Europe, the international community looked for the roots causes of the migration, recognizing that food insecurity, unemployment, drought and environmental degradation all play a role in the uprising and coalescing of conflict.

ICARDA's work in the severely food-and water-stressed MENA countries puts it in a strong position to contribute to stability in the region. The decades of research and the knowledge we have generated with our partners on drought management, agricultural productivity and natural resources will continue to bear fruit and build more resilient communities. In 2015, we have become more focused on consolidating our efforts with our stakeholders in the affected regions and beyond so we can scale out proven technologies for wider impact.

2015 made history when ICARDA became the first organization ever to withdraw its seed collection from the Svalbard Global Seed Vault, the world's backup facility for storing seeds. The mission, executed with support from the Global Crop Diversity Trust and CGIAR, drew tremendous international attention. The seed collection, originally housed in Aleppo, Syria, has been replicated amid the crisis and is now safely stored in our new state-of-the-art genebanks in Lebanon and Morocco. We extend deep gratitude to all our national partners, particularly in Egypt, Ethiopia, India, Jordan, Lebanon, Morocco and Turkey, for their extensive support in keeping the dryland's rich natural heritage alive and safe. Also, we applaud ICARDA's team of managers, researchers and technicians, and our colleagues in Syria, without whom our transition would not have been possible.

ICARDA's dynamic mix of strategies based on solid science addresses crop yields, water efficiency, the management of droughts and land degradation, livestock productivity, as well as socio-economics and policy. The strategies aim to respond to the enormous challenges in setting up efficient and effective agricultural and rural production systems in the dry areas.

Our outcomes in 2015 further add to the body of evidence that demonstrates a clear potential and path towards productive and climate-resilient livelihoods for smallholders and livestock producers – a road towards **'Dynamic Drylands'** – the theme of ICARDA's 2015 Annual Report, which we proudly present.

In Ethiopia, for example, the improved legume varieties developed as a result of our research partnership with the NARS are turning around the country's declining trend in food legumes production. Higher yields encourage farmers to plant more legumes for domestic consumption and exports to Sub-Saharan Africa and the Middle East. In addition, heat-tolerant wheat varieties continue to transform agrarian landscapes in hot countries, such as Sudan, Nigeria, Senegal and Mauritania, where wheat was never considered as a viable major crop.

And—in 2015—ICARDA took big strides in assisting women to become equal stakeholders in the burgeoning wheat value chains in these countries. Rural communities suffering from long periods of conflict is the tough reality in many places where ICARDA works. We made heartening progress in supporting rural women in Afghanistan through village-based seed enterprises – a model approach to facilitate women entrepreneurship and empowerment.

In Tunisia and Ethiopia, we started new meat value chain initiatives with communities in marginal areas, which are going to be key in building their resilience as climate change worsens the scenario for farming.

ICARDA's 2015 Annual Report, **'Towards Dynamic Drylands'** showcases some impacts and innovations achieved in 2015 with support from our donors, global collaborators and NARS partners in different countries. We invite you to browse through the stories and see how the efforts of ICARDA and its partners are paying off.



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TOWARDS DYNAMIC DRYLANDS: A HIGH-VALUE INVESTMENT

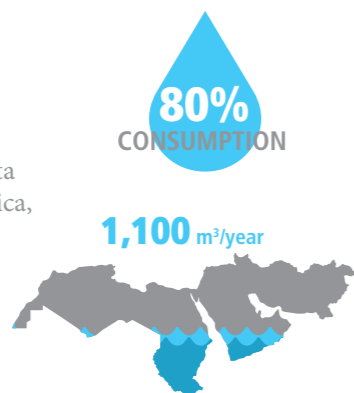
In the drylands of the developing world, smallholder livelihood challenges are huge. But so are the opportunities for impacts from agricultural research.

Severe water stress

About **80%** of total fresh water is consumed by agriculture, on average

Only **1,100** m³/year water per capita available in Middle East and North Africa, set to drop to **550** m³/year by 2050

Our basic well-being requires minimum **2,000** m³/year of water per capita



Degrading agricultural lands

52% of agricultural land world-wide moderately or severely affected by soil degradation

12 million ha of agricultural land lost each year from desertification and droughts

- A loss of 20 million tonnes of grain per year
- An income loss of US\$42 billion per year

Desertification will create **50 million** migrants over the next 50 years.

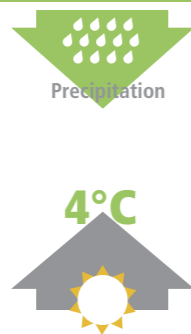


Debilitating climate change

More frequent and intense droughts, with drop in average precipitation

Rising temperatures, shrinking the growing period by more than **20%** for **4°C** rise

Rain-fed agricultural yields could be reduced by up to **50%** in Africa's drylands.



DRYLANDS...

host **44%** of world's cultivated systems

support **50%** of world's livestock

are home to some of the world's poorest people, with about **336M** living in chronic poverty

have widespread malnourishment – **42%** of children less than 5 years of age in drylands of Asia and **27%** in drylands of Africa suffer from stunted growth

ICARDA'S RESEARCH FOR DEVELOPMENT AGENDA

A holistic approach to improving smallholder livelihoods in drylands

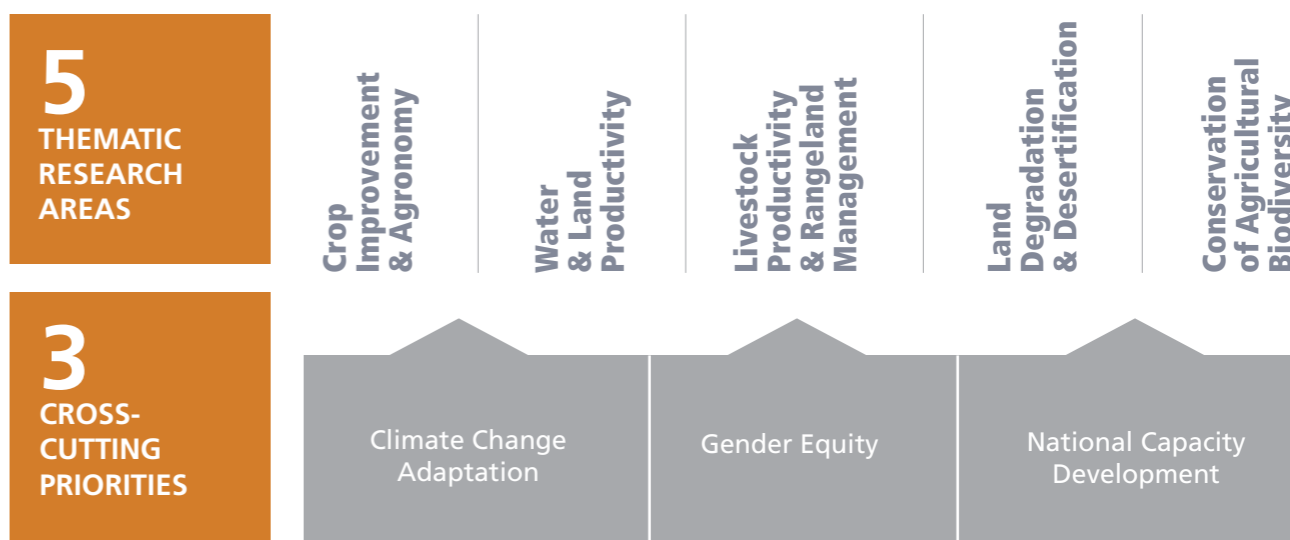
The International Center for Agricultural Research in the Dry Areas (ICARDA) delivers science-based solutions to improve the livelihoods of smallholder communities by addressing the potential of varied agroecosystems in drylands:

- ▶ In high potential areas, sustainably intensifying production systems
- ▶ In marginal areas, building resilience into production systems

OUR GOAL



OUR APPROACH



DELIVERING IMPACTS THROUGH DIVERSE PARTNERSHIPS

Partnerships are the cornerstone of all ICARDA's research for development activities. The approach has enabled ICARDA to successfully get research technologies into the hands of farmers and deliver impact on the ground – both at the farm and at the national level. The Center works closely with the national agricultural research systems, policymakers, local communities, private sector, international and regional organizations, UN entities, civil society organizations, and NGOs.

More than **920** varieties of wheat, barley, lentil, Kabuli chickpea, faba bean, peas and forage crops released by national partners that are tolerant to various stresses, e.g. drought, heat, cold, diseases and pests



About **\$850M** per year
Net estimated benefit from crop improvement (1977–2013)

CONTRIBUTING TO THE UN'S SUSTAINABLE DEVELOPMENT GOALS

ICARDA's holistic systems approach works towards the well-being of people and environment by bringing together crops, livestock, land, water, and soils in harmony with communities that interact with it and depend on it for their livelihoods.

ICARDA's strategies are directly linked to 8 of the 17 UN Sustainable Development Goals (SDGs)

Feed.
Nourish.
Thrive.
Sustain.

Challenges & ICARDA's Solutions



Smallholders and livestock producers in drylands live in a chronic cycle of poverty, challenged by poor productivity, scarce water, and degraded soils.

Sustainable intensification of production systems. Bridging the crop yield gaps and introducing legumes into cereal-based cropping systems to increase yields and incomes, and improve food and nutrition security



Small ruminant (goats and sheep) production and value chains. Improving livestock productivity, and meat and wool yarn value chains to build resilience against hardships and create new sources of income

Pulses (food legumes) production. Improved pulses technologies and micronutrient-dense lentil varieties for greater yields, incomes and rural nutrition



Women form 47% of the agrarian workforce in developing countries, yet the gender gap in agriculture is significant, with yields being about 35% lower on women's fields than on men's.

Gender-sensitized research and integrated women-focused activities. A cross-cutting gender focus to ensure equitable benefits from technologies and knowledge for all – both men and women.

Value chains and diversifying incomes. Innovative value-added crop and livestock product technologies along with capacity development for new sources of revenue and empowering women



Water is at a premium in drylands. Yet agriculture consumes about 80% of the fresh water resources in these areas. Poor farming practices are degrading soils and reducing productivity.

Water management and efficiency technologies. Innovative irrigation, water harvesting and gray water-reuse technologies, integrated with crop improvement, to save water and produce more crop per drop



Conservation agriculture. Scaling out the practice of minimum or zero till to conserve natural resources and reduce the use of fossil fuel needed for ploughing

Challenges & ICARDA's Solutions



Climate change is making drylands drier and hotter and leading to new crop diseases, heightening the risk and challenges for crop and livestock production.

Climate-resilient crop varieties. Improved wheat, pulses and barley varieties resistant to extreme heat and cold, droughts, salinity, and new diseases and pests emerging from climate variabilities and change

Integrated crop-livestock solutions. More productive barley-livestock systems and value-added products that build resilience and protect livelihoods from long drought spells in marginal areas

Empowering communities. Decision-making tools, climate-resilient technologies and knowledge dissemination to enable community-based management of natural resources in irrigated systems, rain-fed watersheds, and rangelands



Land degradation in drylands is a serious issue, leading to loss of fertile soils and desertification. In irrigated areas, soil salinity is a silent killer of productivity and is spreading fast.

Cereal-legumes crop rotation. Establishing crop rotation of cereal crops such as rice and wheat with legumes to tap into their nitrogen fixation capability and to replenish degraded soils

Rangeland management. Technical interventions combined with socio-economic solutions for sustainable land management

Salinity reduction and management. An evidence-based framework offering solutions to countries to tackle salinity using a business model that reaps returns at farm, irrigation district and regional scales



Developing countries typically have weak national agriculture research institutions with a shortage in the number of qualified researchers.

National capacity development. Tailored training activities embedded across all research activities in the over 50 countries with which ICARDA partners

Research partnerships. Collaborating with national institutions, regional and international organizations, and academia to address complex challenges and leverage greater returns on research investments

IN 2015

100

NEW AND RENEWED PARTNERSHIP AGREEMENTS



105

RESEARCH PROJECTS IMPLEMENTED



106

ISI RESEARCH PUBLICATIONS PUBLISHED





**A | DYNAMIC
DRYLANDS**

ENABLING PRODUCTIVE
& CLIMATE RESILIENT
LIVELIHOODS

| Contributing to CGIAR Research Program on Grain Legumes

TURNING THE TIDE ON PULSES PRODUCTION IN ETHIOPIA FROM IMPORTS TO EXPORTS

Ethiopia is a major lentil producer in the sub-Saharan Africa region. However, the area under lentil cultivation and production has been declining in recent years. There are several reasons for this: use of low-yielding landraces, diseases, insect pests, frost, waterlogging and poor cultural practices including late planting. An ongoing long-term research partnership between ICARDA and the Ethiopian Institute of Agricultural Research (EIAR) has been reaping rewards over the past decade and enabling a brighter outlook for lentil farmers and the country. Yields have increased significantly, lentil production is climbing steadily, and the cultivated area is growing. (Figure 1)



Demekech Tekleyohannes, lentil farmer in Gimbichu, Ethiopia, sows and assists in the spread of improved varieties

Under the ICARDA-EIAR research partnership focusing on food legumes (pulses), ICARDA has been providing improved germplasm of lentil, chickpea and faba bean to EIAR, to test for adaptability to the local environment in farmers' fields and to crossbreed with local varieties. To date, about a dozen high-yielding, disease-resistant lentil varieties have been released, ten of which were selected from ICARDA's elite germplasm by Debre Zeit Agricultural Research Center (DZARC), located in the Oromia region. Research has also focused on developing beneficial agronomic practices, including optimal seeding rate, timely weeding and early planting using ridge and furrow, and broad-bed and furrow systems to tackle the excess water problem common to vertisols (soil with a high content of clay). The technology package has doubled lentil production from 54,227 tonnes in 2000-02 to 110,913 MT in 2012-14, stemming mainly from an increase in average yield from 707 kg/ha in 2000-02 to 1,286 kg/ha in 2012-14.

A key factor in the scale of research impact on lentil production in Ethiopia has been the strategy to disseminate improved varieties to farmers. Those participating in the program produced seeds under DZARC's supervision, which were then distributed from farmer to farmer and promoted through field days. Some farmers went on to become the nucleus of 'farmer research groups' in different districts, further scaling up the benefits of higher yields and incomes. Several extension experts and farmers were trained in seed production and

The popular 'Alemaya' variety of lentil has been central to the success of the technology package.

- Shiv Kumar Agrawal, Lead Lentil Breeder, ICARDA

A cost-benefit study estimated the returns from research investment in developing 'Alemaya' at a net benefit of about \$17 million and an internal rate of return of 44%

Funded by: International Fund for Agricultural Development (IFAD) and the Government of the Netherlands

Today, 20% of Ethiopian farmers grow improved lentil varieties from ICARDA's crop breeding program.

Improved lentil technologies have doubled lentil production from 54,227 metric tonnes (MT) in 2000-02 to 110,913 metric tonnes (MT) in 2012-14, with yield increase from 0.7 t/ha to 1.3 t/ha

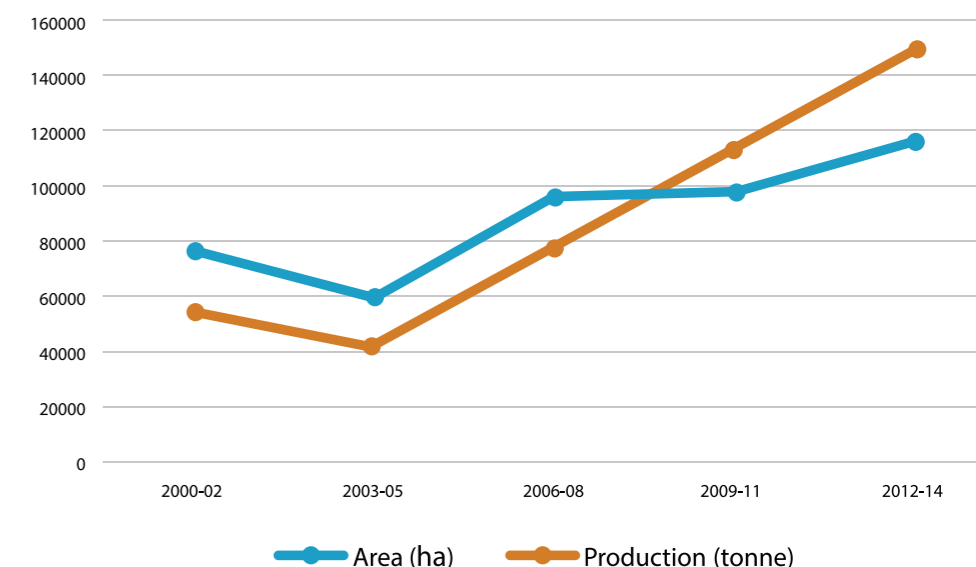


Figure 1: Total lentil area and production in Ethiopia during 2000-2014

processing to avoid a shortfall in improved seeds. Many farmers have now joined contract-based village seed-production schemes, generating extra income for themselves.

The improved lentil varieties are not only high yielding but also more rich in iron and zinc content than traditional varieties, which is contributing to alleviating micronutrient deficiency in rural populations – a severe and common malady in developing countries.

A new hope and healthier diets for smallholders in Ethiopia

Demekech Tekleyohannes, an Ethiopian farmer from Gimbichu, has seen her fair share of hard times. Ten years ago, a new strain of rust disease had infested and destroyed her lentil crops, her only source of livelihood. The local variety of lentil seeds used by the farmers had poor resistance to the new disease caused by unusual weather, an increasing problem with climate change in Ethiopia. Nearly 90% of the farmers lost their produce to the disease in 2005.

In response, the Ethiopian government with the help of ICARDA stepped up efforts to improve legume varieties using improved germplasm and varieties from ICARDA's breeding program. When the new varieties with the highest yield potential were released by the Ethiopian Institute of Agricultural Research (EIAR), most farmers were reluctant to sow them as they feared the crops would suffer the same fate.

Demekech was the first to step forward to sow improved varieties and managed to harvest nearly 1 tonne from just 30 kg of seeds. Her seed was bought by EIAR for multiplication and distribution to other farmers.

Legumes are now becoming popular with the smallholder farmers in Ethiopia as the new improved varieties of legumes are reaping three-fold higher yields for lentils, chickpeas and faba beans on farmers' fields. Apart from boosting yields, these crops are making soils healthier and reducing expenses on fertilizers, while enriching rural diets.

Watch Demekech's story on YouTube
<https://www.youtube.com/watch?v=9B7yNKOi4qI>



"We are using both formal and informal innovative approaches to ensure seed of improved varieties reach farmers and realize impact through creative partnerships."

- Zewdie Bishaw, Head of Seed Unit, ICARDA

| Contributing to CGIAR Research Program on Wheat

DELIVERING GENDER EQUITABLE BENEFITS IN SUB-SAHARAN AFRICA INCREASED WHEAT YIELDS AND INCOME FOR WOMEN AND YOUTH

Wheat is increasingly becoming a strategic crop grown as a subsistence and cash crop in many dryland communities in Africa. In most communities, socio-cultural and economic factors often put women and youth at a disadvantaged position in the rural households.

The ICARDA-led wheat component of the Support to Agricultural Research for the Development of Strategic Crops (SARD-SC) initiative, funded by the African Development Bank, is a multinational CGIAR project working in 12 countries across sub-Saharan Africa. The project is prioritizing the needs and interests of women and youth in the wheat value chain by focusing on their roles in wheat production, value addition and post-harvest activities, to both empower them and draw on their contributions in building prosperous communities. The initiative has set a goal to increase annual household incomes by two-thirds.

The SARD-SC wheat initiative is striving to ensure that newly generated transformational knowledge has a positive and equitable impact on women, men and youth. Women are growing seeds for income generation and solving seed availability issues in their communities as individuals and as groups in Sudan, Ethiopia and Nigeria – the three hub countries for the project. The project applies interventions specifically in value addition and training on reducing post-harvest losses from 30% to 15%.

SARD-SC's gender strategy factors in the economic, institutional and cultural realities of rural women and helps to gain the buy-in of male relatives and community leaders to increase participation of women.

- Dina Najjar, Social and Gender Scientist, ICARDA



Mama Muita, wheat farmer from Meru County, Kenya, participates in on-farm seed multiplication

According to project coordinator Solomon Assefa, the most notable feature of the project is its capitalizing on women's innovations for market development. The SARD-SC wheat initiative is increasing opportunities and capacities of women to participate in wheat value addition and processing through provision of market-driven technologies, such as baking bread and cakes, and making pasta, to increase incomes and create new jobs. For example,

Funded by: the African Development Bank

The project trained **4,783** women in 2015 in varied activities: seed multiplication, variety selection, post-harvest handling, and value addition activities such as baking, pasta-making and machine operation.

in Nigeria, women are processing wheat into pasta and the project is facilitating up-scaling of this innovation and creation of markets by providing machinery and training on pasta making.

Reversing gender imbalances requires interventions in the household, technical, services and marketing domains. As women are accessing services such as microcredit and technical training in seed production and value addition through the initiative, men need to be sensitized to the new understanding of gender roles in the household. Researchers and staff are trained by the SARD-SC gender focal points in order to adopt simple gender-sensitive research steps that include organizing focus group discussions for women and men, and comparing results to design gender- and youth-specific interventions and approaches. In Nigeria, for example, at the request of women, threshing and milling machines were introduced in project sites and women were trained in post-harvest activities.

The SARD-SC initiative is producing gender-disaggregated data and information related to participatory varietal selections, income generation and training, enabling gender-sensitive research, and a new and transformational understanding of women and youth in agriculture for all stakeholders involved.



"With the seeds and better farming practices that I learnt, I have now expanded my farm to two hectares so that I can get more money and take better care of my family."

- Halima Rabi Aliu, wheat farmer and member of innovation platform, Kadawa, Kano in Nigeria

Inclusive innovation platforms benefiting women and youth

"Previously, I used to get just 17 of the 100 kilogram bags per hectare from my one-hectare wheat farm," says Halima Rabi Aliu, a female wheat farmer from Kadawa, Kano in Nigeria. "However, since I started using seeds from the Kadawa Research Station, I am now harvesting 24 bags per hectare, and this is a good return," adds Halima.

Halima is one of the 750 farmers registered on SARD-SC wheat's innovation platform at Kadawa. The platform is managed by the Institute of Agricultural Research at the Ahmadu Bello University. Halima has been a wheat farmer for ten years and is presently registered for seed multiplication. She previously used seeds from the local market until she attended demonstrations at the research institute. Halima has attended four training sessions and two exchange visits to other farmers through the innovation platform.

By growing seeds, Halima is contributing to future increased wheat yields for other farmers in the community.

At the research station, farmers witness practical demonstrations of the various wheat varieties and different agronomic tests. The regionally based research stations are an important cog in the SARD-SC wheat program's information platform delivery approach. The station in Kadawa works in close collaboration with other local actors in the wheat value chain including the flour millers, association, market service providers and public decision-makers, in order to deliver agronomic packages and develop markets for the poor through capacity building of farmers, men, women and youth on wheat value addition.

| Contributing to CGIAR Research Program on Wheat and Grain Legumes

ENHANCING FOOD & NUTRITION SECURITY AGAINST CLIMATE CHANGE IN DRYLANDS STRONGER WHEAT-LEGUME SYSTEMS IN WEST ASIA AND NORTH AFRICA

Smallholder farmers in the West Asia and North Africa (WANA) region are severely afflicted by low crop yields, recording an average cereal yield of only 2 tonnes per hectare – almost half the world average, according to the UN's Food and Agriculture Organization (FAO). Virulent crop diseases/pests and weed infestations caused by changing climate patterns pose major challenges to food and nutrition security in the region. Furthermore, the increasing practice of cereal monocropping is depleting soil fertility. Sustainably intensifying cereal-based production systems using legumes is a strategic objective of ICARDA to harness the many benefits of legumes – boosting food and nutritional security, improving rural incomes, and replenishing nitrogen in soils to ensure sustainable cropping systems in drylands.

A project, conducted between 2012 and 2015 across eight WANA countries – Algeria, Egypt, Jordan, Lebanon, Morocco, Sudan, Tunisia and Turkey – demonstrated sustainable and profitable wheat-legume cropping systems over three planting seasons through improved crop technology packages. A team of ICARDA's scientists worked with the National Agricultural Research Systems (NARS) in project countries to introduce smallholder farmers to balanced technology packages tailored to different agroecologies in WANA so as to increase and stabilize the productivity of wheat and legume crops amid climate change.



Orobanche-resistant faba bean technology package revives faba bean production in Egypt

The project combined a suite of interventions using a systems approach: higher-yielding crop varieties resistant to stresses, seed systems, conservation agriculture, Integrated Pest Management (IPM) and water productivity technologies. The improved technologies were collaboratively tested and validated by the project scientists and smallholder farmers on their fields as part of on-farm participatory research.

Capacity building was a prominent feature of the project. Technology dissemination platforms were used in conjunction with farmer field days and schools to demonstrate and promote new technologies to large groups of farmers across neighboring communities. Further, leader farmers were invited to host these platforms and engage other farmers in the uptake and adoption of these technologies.

The project introduced improved technologies to over 19,000 farmers and extension workers, enabling higher crop yields and incomes while conserving natural resources crucial to the sustainability of food production systems in drylands.

Turning around faba bean production in Egypt hit by climate change

Faba bean production has been declining in Egypt because of Orobanche weed infestation spurred by climate change. Higher-yielding varieties with resistance to Orobanche and a low water requirement, combined with integrated pest management techniques, are turning around this trend. Farmers are seeing an average increase in yield of 22.5%, reaching 38% in demonstrations in Sharkia province. The results have encouraged the Egyptian Academy for Scientific Research and Technology to fund and initiate a national campaign for wider uptake of the improved faba bean technology package.



The effect of climate change on pests is already being seen in the region. Pests have become more frequent and have extended their range because of warmer winters

- Mustapha El Bouhssini, Principal Entomologist, ICARDA

Funded by: The European Union and International Fund for Agricultural Development

Improved incomes and food security

A total of 136 new improved varieties of bread and durum wheat, faba bean, chickpea and lentil were introduced and promoted to farmers along with their associated production technologies. The following are examples of impact in project countries:

- In Morocco, improved durum varieties of 'Louiza' and 'Faraj' almost doubled wheat yields, motivating farmers to establish village-based seed production and a women's association to produce value-added products like couscous and pasta.
- In Sudan, chickpea cultivation expanded from 4,000 ha in 2012 to approximately 23,000 ha in 2015 as 91% of farmers adopted an improved technology package, seeing an average net profit of US\$212 per hectare.
- In Lebanon, a winter chickpea variety resistant to Ascochyta blight, drought and cold, enabled farmers to profit from a yield increase of up to 25%.

In irrigated systems of Egypt and Sudan, a raised-bed planting package for faba bean that ICARDA's scientists developed with Egypt was widely adopted by farmers. The technology uses 20-25% less water while increasing yield by 22.7% as compared to flat planting.



Young women scientists in training through project activities, Tunisia

Promoting sustainable management of natural resources

Project scientists established Conservation Agriculture (CA) in cropping systems, the practice of zero or minimum till to improve soil fertility and water conservation, and promoted it through 106 technology dissemination platforms, mainly where direct drill planters were available (Algeria, Morocco, Lebanon, Jordan, Turkey and Tunisia). The project demonstrated yield increases from CA of up to 128% for wheat and 133% for chickpea.

The outcomes of the project continue to build on ICARDA's ongoing research in drylands to further enhance technology packages in response to new challenges emerging from climate change.

"Our government is committed to provide continued support to field crop production."

- Lassad Lachaal, then Minister of Agriculture, Tunisia, visiting project farmers in 2015, reaping two to three times higher yields of chickpea from improved variety packages.

PROJECT ACHIEVEMENTS

IN WEST ASIA & NORTH AFRICA

1,558

TECHNOLOGY
DISSEMINATION
PLATFORMS

FOR DEMONSTRATION,
PROMOTION AND
EVENTUAL SCALING-UP OF
IMPROVED TECHNOLOGIES

19,217

FARMERS
AND EXTENSION

INTRODUCED TO
IMPROVED
TECHNOLOGIES
THROUGH FARMER FIELD
SCHOOLS AND FIELD DAYS

136

IMPROVED
VARIETIES
WITH 23 NEW RELEASES

OF BREAD AND DURUM
WHEAT, FABA BEAN,
CHICKPEA AND LENTIL



| Contributing to CGIAR Research Program on Water, Land and Ecosystems

4 BUILDING RESILIENT & BETTER LIVELIHOODS FOR RAIN-FED COMMUNITIES

HOLISTIC RESEARCH AT WATERSHED LEVEL IN THE ETHIOPIAN HIGHLANDS

Rain water erosion of soil is a common problem in the Amhara region of Ethiopia. The resulting land degradation adversely impacts productivity and incomes of smallholder farmers in the region. The Gumara-Maksegnit rain-fed watershed near Gondar is the main research site for the ICARDA-ARARI (Amhara Regional Agricultural Research Institute) project aiming to reduce land degradation and farmers' vulnerability to climate change. The project operates on the premise that rural communities depend on a variety of livelihood strategies to meet their basic needs.

Integrated management to combat land degradation

The current level of land degradation is the result of deforestation, inappropriate farming practices, unsustainable grazing management and inefficient rainwater management. Extensive soil erosion is by far the greatest manifestation of land degradation. Even on moderate slopes, the annual soil loss during the rainy season easily exceeds 10 t/ha, and often reaches up to 20 t/ha or more.



Empowering the watershed communities to manage and use their resources more effectively and sustainably

The project engaged communities and farmers to participate in activities to mitigate soil erosion through building of stone bunds, constructing terracing, establishing permanent vegetation strips, and afforestation. Additionally, in partnership with the CGIAR Research Program on Water Land and Ecosystems, the project is currently assessing the impact of climate and land use change on watershed processes using hydrological and bio-economic models, while also developing strategies to improve livelihoods of women.

Scientists are harnessing the unique set of data generated by the project to develop and calibrate models which can analyze system dynamics, productivity and constraints at the watershed scale, and also simulate the hydrological and socio-economic impacts under varying climate and land use scenarios.

The final goal is to develop strategies that will reduce soil erosion and improve soil health across the watershed, improve crop and livestock productivity, increase vegetation cover, and reduce deforestation. These technology outputs from the project are directly improving the livelihoods of the over 4,000 people living in the watershed and when standardized and scaled out, benefit tens of thousands farmers across the Amhara region.

Funded by: The Austrian Development Agency

Farms in the Amhara region of Ethiopia lose 2 shovelfuls of fertile topsoil per square meter every year through soil erosion.

Measurement infrastructure to quantify and monitor the impact of soil conservation structures (stone bunds) on soil erosion

The use of clean burning, fuel-efficient stoves can be an important strategy in the 'toolbox' for soil management. They reduce the pressure of clearing vegetation and animal manure from the landscape, while reducing women's load for gathering fuel and their exposure to smoke.

- Debra Turner, Soil Scientist, ICARDA

| Contributing to CGIAR Research Program on Dryland Systems

5 SCALING OUT CONSERVATION AGRICULTURE THROUGH INNOVATION PLATFORMS

CROP-LIVESTOCK BENEFITS FOR DRYLAND COMMUNITIES IN NORTH AFRICA

The economic, agronomic, environmental and social benefits of Conservation Agriculture (CA) need to be understood by all the stakeholders before it can be widely adopted. A large project, Conservation Agriculture for North Africa (CANA), implemented by ICARDA with national partners, worked across three host countries, Algeria, Morocco and Tunisia, aiming to increase the understanding and uptake of CA.

CA involves reducing or eliminating tilling of the soil (zero tillage) and leaving behind the crop residue in the fields. This has been proven to conserve natural resources and cut production costs while reducing yield fluctuation and associated risks. Some of the key challenges in the CANA project were changing the mindset of farmers, extension workers and decision-makers toward zero tillage, making zero tillage machinery affordable and available, and integrating livestock into CA and the consequent trade-offs for residue management – a major concern for smallholders in the region. The project also identified and tested improvements in weed management, and enhanced the capacity of the national agricultural research and extension system and other stakeholders to practice and promote CA.



Forage crop growing under conservation agriculture in Fernana, Tunisia

Changing farmers' mindsets with evidence-based economic valuation

The project took a bottom-up approach with the close engagement of the farmers. Having farmers adopt CA depended heavily on their perception of the technology-specific characteristics of tillage. The high price of the seeders, the lack of drills and excessive drill-rental costs were other constraints. However, demonstrating economic benefits of the approach was a major factor in influencing the farmers. In Tunisia, the benefit to cost ratio was about 2.3 in the case of CA compared to 1.7 in the conventional system. In Morocco, the adoption of CA resulted in a 12% reduction in production costs for durum wheat. In terms of profitability, the CA system showed an increase of about 58% in farmers' net benefit. In Algeria, the ratio was 3.61 in a high rainfall system compared to 2.18 and 1.30 in the medium and low rainfall systems, respectively.

Funded by the: Australian Centre for International Agriculture Research

Zero tillage is one of the few technologies that can be justified on economic, food security, biophysical and environmental grounds, especially in dry areas where moisture is the major limiting factor.

- Yigezu A. Yigezu, Agricultural Economist, ICARDA

Locally manufactured affordable zero tillage seeding machinery

The project partnered with the private sector, engaging local manufacturers to develop, test and demonstrate machinery to make zero-till drills affordable and accessible to farmers. In Tunisia and Algeria, the prototypes are ready for testing for the coming cropping season. In Algeria, a 20% CA adoption rate in Setif Wilaya alone would require 330-350 seeder units, an opportunity large agricultural equipment manufacturers like CMA and PMAT are leveraging. In Morocco, the industrial partner ATMAR is working on developing and manufacturing an eco-seeder, looking to produce 30 units for the coming cropping season. Further, two major agricultural equipment importers (Gil and Sola) have imported no-tillage tine seeders and Gil has already sold eight machines.

Locally fabricated, low-cost zero-till seeders now on market

Costing only US\$8,000-11,000 compared to US\$50,000-60,000 for imported machines



Algeria Boudour ZT seeder



Moroccan Ecoseed ZT seeder



Tunisia SAJIR ZT seeder

Zero-till seeders developed by a research and private sector partnership of the University of Western Australia, ICARDA and the NARS with local manufacturers and farmers.

Planting faba bean and a triticale-vetch mixture after wheat increased the net return on lands under conservation agriculture by **312%** in Tunisia, demonstrating income potential from integrated crop-livestock systems in drylands.

Around five million farmers have been direct and indirect beneficiaries of the CANA project, with **22%** of them women.

Weed management

The project's strategy of growing a forage crop in rotation with other crops reduced weed populations and increased subsequent crop yields without the use of herbicides. In some cases, weed seed banks were reduced by almost 50% and weed management improved the productivity by 50-90%. Comprehensive weed management guides were produced for each platform.

Integrating crop with livestock benefits

The project introduced forage mixtures (cereals with feed legumes) that increased forage production (up to 8 t/ha of dry matter) and resulted in high quality hay, which in turn reduced animal production costs and labor inputs in feeding livestock. In Tunisia, with a forage mixture of vetch with triticale (a hybrid of wheat and rye), farmers obtained a 25% increase in milk yield from their cattle, which increased their incomes. Further, new crops tested after wheat (faba bean and triticale with vetch) increased the net return by 312% and the benefit to cost ratio by 89%.

Moving ahead

The involvement of a range of expertise and stakeholders in the project has led to the emergence of a North Africa Network on Conservation Agriculture, an informal coalition of partners from North Africa and Australia. Further, capacity building activities with the Australian expertise have brought together research centers and universities. CANA's innovative approach is now being used by other projects.

Mohamad El Mourid, ICARDA's Regional Coordinator for North Africa, sees the next step as consolidating CA innovation platforms and multi-stakeholder networks in North Africa to establish a sustainable CA hub in the region. The project is particularly focusing on expanding machinery development through public-private partnerships, and enhancing key indicators, e.g. value of forage crops, sowing times, seed rates and weed management.

Adding value for smallholders adopting conservation agriculture



"I can now feed the lambs well for selling during Aid-El-Idha."

- Taoufiq Ben Ammar (on left), farmer and livestock producer practicing conservation agriculture, Siliana district, Tunisia

Taoufiq Ben Ammar, a wheat farmer, lives in Chouarnia (Siliana district, Tunisia), where ICARDA and INRAT (Tunisia's national agricultural research institute) are collaborating on developing integrated crop-livestock solutions to promote conservation agriculture (CA), within the framework of the CGIAR Research Program on Dryland Systems. Taoufiq is progressively growing wheat under CA and saving fuel costs. With scanty rain, while most farmers worried about the expected wheat yield, Taoufiq had 300 well-stacked vetch hay bales inside his barn, a surprising amount for a dry year.

Although vetch is an ancient crop in North Tunisia, it was reintroduced as a substitute to cereal stubble grazing under a zero-till cropping package. Keeping soil cover is a key principle of CA, which takes away a common livestock feed option from smallholders.

Jamel Sahli, a neighboring farmer, is ready to buy the harvest of vetch hay. Last year, he observed that ewes grazing vetch showed a "burst" in the frequency of females displaying estrus, in contrast to when they were fed cereal stubble. Vetch grazing can provide a synchronous provision of energy and protein which is highly beneficial to ovarian follicular growth and oocyte quality.

"Next, we plan to set up flock monitoring and evaluation to quantify the effect of vetch grazing on sheep reproduction. The results will further enhance productivity of crop-livestock systems and increase the uptake of zero-tillage packages amongst farmers," says Mourad Rekik, small ruminant production scientist at ICARDA.

| Contributing to CGIAR Research Program on Dryland Systems

6 ENSURING SUSTAINABILITY OF RANGELANDS AND LIVELIHOODS OF PASTORALISTS INCLUSIVE LAND MANAGEMENT PRACTICES

Rangelands are often seen as grazing lands for animals only, but they play a far wider role. They provide vital ecosystem services such as mitigating climate change and conserving biodiversity in drylands with important consequences for livestock production, natural resources and socio-economic development. Managing them sustainably requires striking the right balance among their different functions, a complex challenge for communities that depend on rangelands for their livelihoods and local authorities and policymakers who regulate land use.

The case of Tunisia: on the road to science-based rangeland governance

About 34% of Tunisia's total landmass is rangeland. For centuries, sheep, goat and camel herders have relied on mobility and common use of rangelands for their livelihoods as an effective way to cope with droughts and conserve precious resources. However, Tunisia's current regulatory framework overlooks the needs of rangeland communities.



Rangelands of Beni Kheddache, Tunisia

Instead it responds to a sedentary agrarian land use based on rain-fed agriculture. Rain-fed farming is feasible on these lands but it is not sustainable. The situation has led to uncontrolled use of the rangelands, causing encroachment of cultivation. The resulting land degradation is made worse by recurrent droughts as the climate changes.

The decentralization in governance since 2011 has, however, opened the doors to new relationships – local communities are wielding greater influence over decision-making on land use issues, and the government has greater flexibility to amend the existing legislation. A team of rangeland scientists from ICARDA has leveraged this opportunity and is working closely with the Tunisian Ministry of Agriculture, researchers, development agencies and local partners to design a new science-based pastoral code that can ensure the viability of rangelands while addressing the needs of the various pastoral user groups that rely on them.

An in-depth analysis of existing laws and their applicability showed that the current Code on Forests – also applicable to rangelands – defined legal principles that deal with land ownership, an aspect not relevant to the traditional practice of land use by local people. The code's top-down approach focuses on the central state as main actor and has led to the dismantling of the traditional system of governance of common rangelands, which defined rangeland resting periods and regulated access for entitled user groups so that resources would be conserved. In addition to overgrazing, land users are planting olive trees in areas not suitable for orchards as a way of appropriating land.



Rangeland tenure and governance are the biggest challenges we are facing in development-oriented research on rangelands. It is our role as scientists to offer evidence-based policy advice for these processes.

- Jutta Werner, Scientist - Rangeland Management and Rangeland Ecosystem Services, ICARDA

Rangeland degradation is costing the country over **US\$32 million** annually. Adding the cost of degradation from transforming rangelands to cropped land affecting **31,500 ha**, at a cost of **US\$115/ha** over a 30-year period, the total value of the loss amounts to around **US\$100 million**.

(Source: Tunisian Ministry of Agriculture)

The new pastoral regulatory and governance framework proposed by the scientific team, led by Mounir Louhaichi, ICARDA's lead rangeland scientist, places the governance of the land in the hands of pastoral users. It lays down principles that are key to the viability of the pastoralists and the rangelands, such as:

- The rules and laws well adapted to the local conditions, and surveyed and monitored by the local pastoral communities;
- The responsibility for pasture management resting at the local level through an inclusive decision-making process involving all pastoral user groups;
- Conflict-resolving mechanisms operating at the local level with the involvement of governmental stakeholders; and
- The new local governance of the pastoral resources accepted at the local, regional and national levels.

The outlook for the proposed pastoral code in Tunisia is promising, as the project's inclusive approach is securing support from Tunisia's policymakers and local communities alike. In June 2015, ICARDA organized a high-level meeting with the Tunisian Ministry of Agriculture (General Directorate of Forestry) and advised and facilitated the creation of a shared vision with the relevant Tunisian ministries, research institutes and IFAD for reforming current pastoral law. At a follow-up national seminar, held in December 2015, ICARDA led problem analysis and formulation of new institutional options with various stakeholders (ministries, research institutions, extension agencies and FAO) for a new and more appropriate pastoral law. A working group with representation from the relevant ministries is being established to promote closer coordination and ensure outcomes that safeguard both the livelihoods of pastoralists and the future of rangelands.

The case of Uzbekistan: inequitable grazing land access causing land degradation

Changes in land use and land tenure practices after the Soviet era are causing a dramatic decline in the natural resources of the rangelands in Central Asia, the largest contiguous block of grazing lands in the world, spread over 260 million ha. As a first step toward more suitable policies in Central Asia, ICARDA scientists, in collaboration with local research partners, conducted a rangeland tenure study in August 2015 in the Aral Sea region of Karakalpakstan to analyze the issues faced by pastoral communities. The study revealed that the current framework is concentrating land use around rural community areas while remote rangelands are lying underutilized.

The problem is caused by a mix of factors. Officially, the smallholder livestock owners (with up to 20 animals) are only allowed to graze their animals freely around villages, while the vast rangelands are reserved for state-owned sheep cooperatives known as 'shirkats' with as many as 10,000 animals. Large livestock owners (with 600 sheep or more) can also access pastures under shirkats through contractual arrangements with the state and the shirkat itself. However, lands under shirkats lie underused mainly because their water wells are in disrepair as shirkats lack funds and maintenance costs are high.

Access to the more productive pastoral lands of the shirkats is beyond the reach of smallholders as the state imposes a land tax to lease them. As a way out, smallholders either lend their animals to the shirkat herders or work as shirkat herders themselves, which also allows them to graze their own animals. They also often enter into unofficial arrangements with shirkats in return for well-maintenance services – a risky proposition as shirkats are known to renege on the arrangement once wells are repaired, causing losses to livestock owners. In one example, as much as US\$11,500 was lost on well repairs.

Land degradation – largely in grasslands – is estimated to have a 3% share of the national GDP in Uzbekistan, estimated at US\$62.6 billion according to the World Bank. A solution could be an inclusive and locally adapted rangeland tenure system that enables balanced access to larger pasture areas by smallholders and large agro-pastoralists. Developing such a responsive tenure system requires bringing all stakeholders together for collective decision-making – rural communities, local administration, cooperatives and policymakers – a continued goal for ICARDA in the region.

Funded by: The CGIAR Research Program on Dryland Systems and the Russian Federation



**B | DYNAMIC
DRYLANDS**

INNOVATIONS & NOVEL
SCIENCE



Growing 10 to 12 crops can provide a 'buffet' for pollinators to feed on and gain nectar and pollen for three seasons.

- Stefanie Christmann, Environmental Governance Expert, ICARDA

The value of pollinators is estimated at **US\$220 billion** each year, representing **9.5%** of the world's agricultural food production

(Ecological Economics, 2009).

Funded by: The German Ministry for the Environment, Nature Conservation, Building and Nuclear Safety and GIZ (Germany)

1 FARMING WITH ALTERNATIVE POLLINATORS: A LOW-COST BOOST TO YIELDS AND INCOMES

Wild pollinators (such as wild bees, bumblebees, flies, butterflies, midges and wasps) are known to increase agricultural yields, but their diversity is declining rapidly with climate change, monocultures and excessive use of pesticides (FAO). This situation is threatening the production of the foods we take for granted.



In a first-of-its kind scientific approach, ICARDA scientists developed and introduced 'Farming with Alternative Pollinators' (FAP) in Uzbekistan, and subsequently introduced it into Morocco in 2015 with replicable results. FAP is a self-supporting way to proactively conserve pollinators' diversity. To attract many different pollinators, 25% of each plot is used to grow a variety of crops such as coriander, sunflower and pumpkin, along with locally made nesting support, while the main crop is grown on the remaining three-quarters of the plot. Control fields grow the main crop in the entire area. FAP doubled the harvest of sour cherry in Uzbekistan and, in both Uzbekistan and Morocco, at least doubled the yield for cucumber with the potential for even greater increase. Since Morocco hosts vastly different species to Uzbekistan, these results demonstrate the replicability of the FAP approach. The approach will be extended in Morocco to faba bean.

In contrast to the method of seeding wildflower strips, which is promoted by most researchers globally, FAP makes the whole field area productive, providing a source of extra income to farmers. The results are helping scientists develop a 'blueprint' that farmers can use to enhance pollination services and boost their yields at very low costs – a win-win strategy for farmers and biodiversity (see FAP guide for smallholders).

(Reference: Christmann, S., Aw-Hassan A.A., 2012. Farming with Alternative Pollinators (FAP) - an overlooked win-win-strategy for climate change adaptation. In: Agriculture, Ecosystems and Environment 161, 161–164.)

2 INNOVATIVE MATH APPLICATION ALLOWS EVIDENCE-BASED CROP BREEDING FOR THE FIRST TIME

Developing improved crop varieties is a long journey for breeders – on average lasting 10 years or even more. The search for desired traits entails evaluation of varieties through a series of field trials over multiple locations and years, continually rejecting some, retaining others and adding new varieties into the mix. This process generates large volumes of data, but this wealth of information lies under- or un-utilized from a lack of a definitive method to harness existing data. Breeders use results from current trials, starting evaluations of genotypic materials afresh.

In a new development, the biometrics specialists at ICARDA have applied Bayesian analysis – a statistical procedure that estimates the probability based on evidence or information available – in the brand new context of crop breeding. The framework allows for prior



The procedure is ready to use by crop breeding programs, which will progressively refine the statistical framework and put crop breeding on a more well-grounded, evidence-based path.

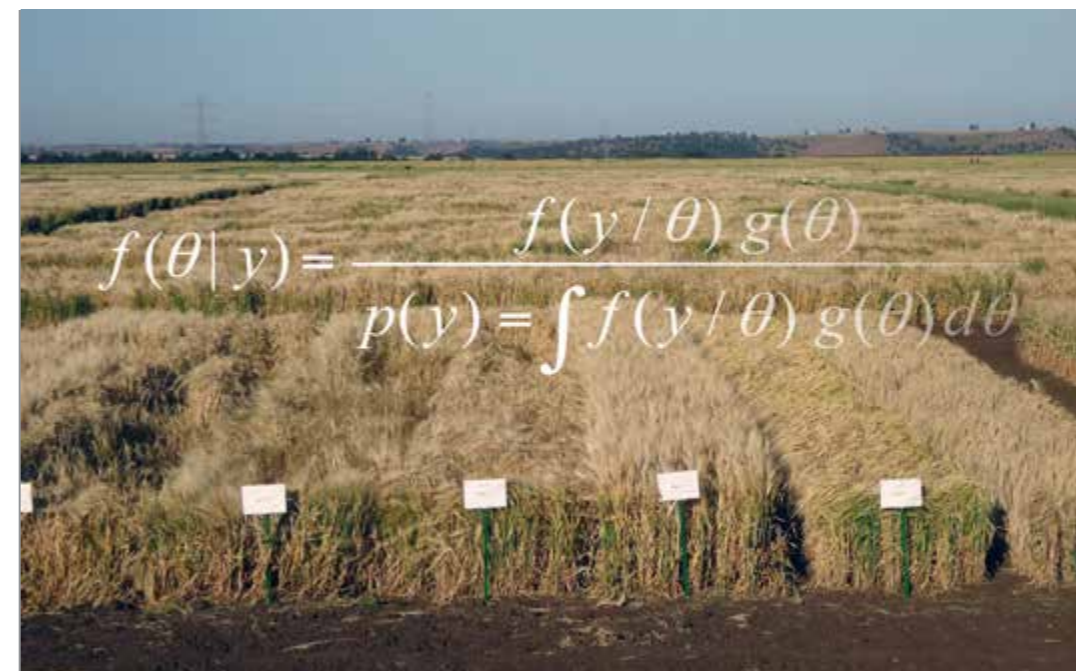
- Murari Singh, Senior Biometrician, ICARDA

Funded by: The Government of Italy, the CGIAR Research Programs on Dryland Cereals and Dryland Systems



Our next step is to integrate NASA's recent advances in soil-moisture mapping to inform decisions for maximum returns from different land types, along with needed agricultural inputs, such as green manure and the extent and type of irrigation.

- Chandra Biradar, Head of Geoinformatics Unit, ICARDA



evidence from field trials to be infused into the iterative process of genetic selection. This capability enriches the current information in identifying the potential of a variety and predicting the genetic gain when certain genotypes are crossed to make progress toward desired traits – for example, crossing a high-yielding wheat variety with a drought-tolerant wheat variety. The framework was constructed using crop yield data on 30 barley genotypes developed at ICARDA as of 2011, and incorporating data from a series of 20 other previous trials.

In 2015, the approach was successfully illustrated on sorghum breeding data from Sudan, achieving higher genetic advance and precision in heritability for yield trait. Breeders plan further application to chickpea and mung bean crops in demonstration trials in Afghanistan.

The methodology is published in *Crop Science*, December 2014, Vol. 55 No. 2, as an open access publication.

3 POWERING UP THE PRODUCTION OF PULSES IN INDIA WITH SPATIAL SOLUTIONS

ICARDA's 'Spatial Solutions for Integrated Agro-Systems' initiative is harnessing the power of geoinformatics to improve food and environmental security in the dry areas of the developing world. Scientists are delving into open-source geospatial data gathered by satellites and integrating these datasets using mathematical algorithms to develop near-real time decision-support tools at the level of farms to agroecosystems. This capability is uniquely empowering farmers, researchers and policy-makers to make smarter, holistic decisions about land, crops, water usage, agricultural inputs and markets.

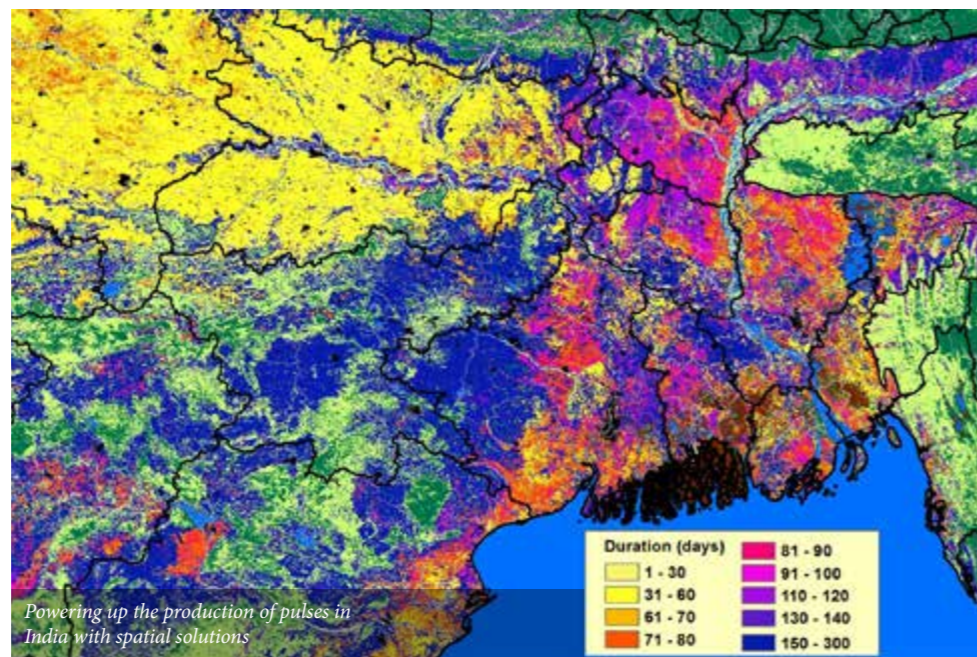
One such GIS tool is augmenting pulses (grain legumes) research in India, allowing scientists to strategically tap the vast tracts of lands that are left fallow every year after the first crop harvest to grow pulses. ICARDA is targeting rice fallows in India for growing pulses. The improved early maturing and higher yielding pulses varieties being developed by the scientists in collaboration with the Indian Council of Agricultural Research can fit in between two rice-cropping seasons, allowing rice farmers to gain an additional crop of pulses, which can not only supplement their income, nutrition and fodder, but also improve soil health through nitrogen fixation, a chemical process by which atmospheric nitrogen is assimilated into soils.

The tool using digital interactive datasets shows fallow durations, start and end of the fallow periods, seasonality, and cropping intensity, superimposed on land cover and vegetation patterns. Analyzing these datasets identifies potential fallow areas for growing

Improved crop technologies will allow about **3 million ha** of rice fallow lands to be used to produce pulses.

high-yielding, short- or long-duration pulses. Furthermore, crop breeders have developed extra early-maturing varieties (58 days), dual-purpose crops and zero-tillage practices for resource-efficient intense cropping systems in areas assessed as good fits by the spatial decision tool.

India is facing an increasing dependence on expensive pulses imports, which reached 20% of all pulses consumed in 2014-15, jeopardizing the nutrition security of the millions of people who depend on them. Analysis indicates about 3 million ha of rice fallow lands can be readily used to produce pulses with improved crop technologies – a substantial opportunity to increase pulse production in India.



Funded by: the OCP Foundation and the Government of India's National Food Security Mission

4 NITROGEN BUDGET MAPPING TO MITIGATE SOIL NUTRIENT LOSS ACROSS THE INDUS BASIN

Agricultural systems in Pakistan's Indus basin are challenged by acutely inefficient absorption of nitrogen fertilizers by crops. Cropping systems often use only 30-40% of applied nitrogen. The remainder is lost to the environment, causing both poor crop yields (far below world average) and greenhouse gas emissions. Poor access to affordable fertilizers is yet another factor preventing farmers from achieving optimal yields. All in all, a multidisciplinary approach is needed to improve the fertilizer distribution, use and management to alleviate soil nutrient loss and improve crop yields.

A research collaboration of ICARDA with the University of Agriculture, Faisalabad and the National University of Science and Technology, Pakistan, has used SWAT (Soil and Water Assessment Tool) modeling to map the nitrogen budget, assessing the nutrient status in space and time for the entire Indus basin. This is the first undertaking at this scale in Pakistan. The SWAT model was calibrated and validated annually over 5 years for nitrogen uptake by plants, comparing the remotely sensed crop biomass accumulated during a complete cycle of crops against the SWAT-generated biomass.

The fertilizer industry has been particularly receptive in using the model to identify regions where the nitrogen losses are the largest, and is looking to finance the mapping of other soil nutrients on a yearly basis. The farmers also look forward to being able to proactively manage fertilizer applications based on a knowledge of nutrient deficiencies in time and space. Further, soil scientists in universities are already training MSc/PhD students on the SWAT model for enhanced management of soil nutrients and irrigation in the future.

We had an encouraging response on the SWAT model from various stakeholders: policy-makers, researchers, farmer groups, and even the fertilizer industry.

- Usman K. Awan, Groundwater Hydrologist, ICARDA

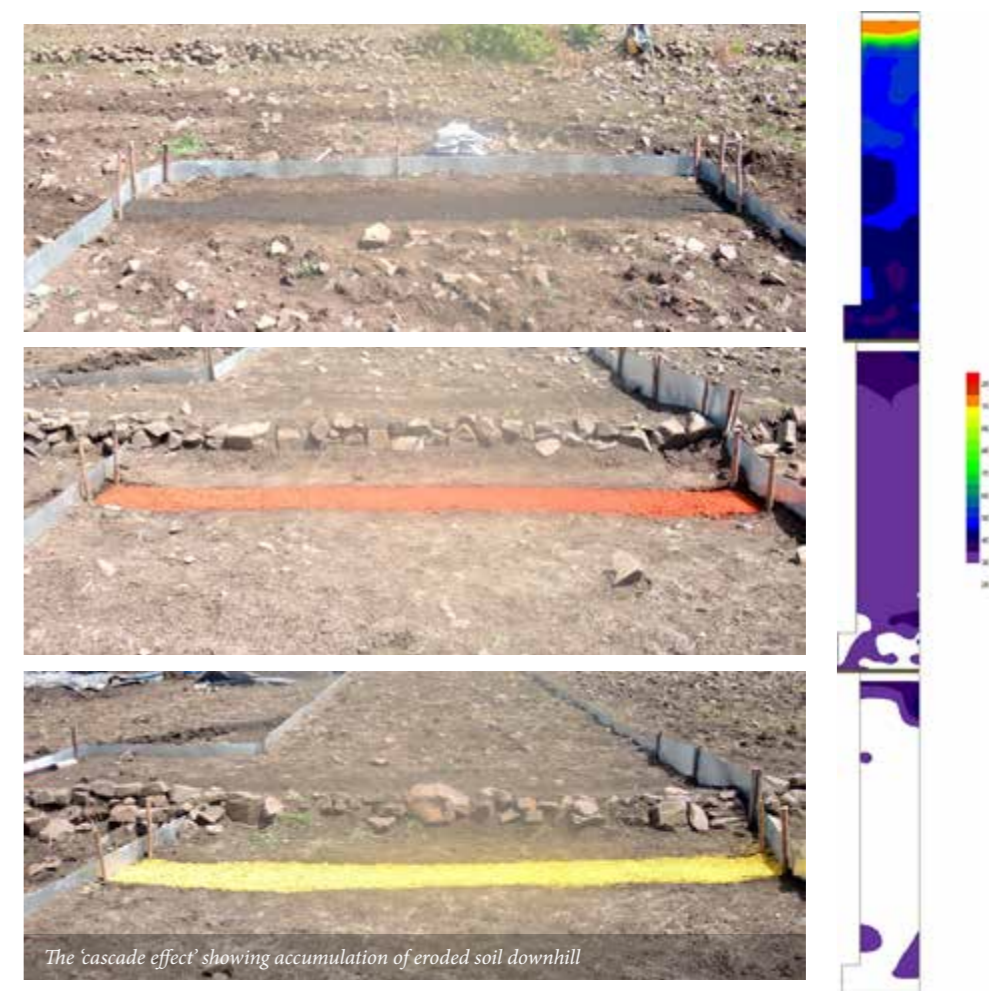
Funded by: the CGIAR Research Program on Water, Land and Ecosystems

STONE BUNDS MITIGATING SOIL DEGRADATION: WHERE DOES THE SOIL GO?

Rainfall-driven soil erosion is a serious problem in the Ethiopian Highlands, a consequence of rampant deforestation and land cultivation, with 90% of the country's people residing in these parts. The loss of fertile top soil is affecting the livelihoods of millions as 80% of the country's population depends on farming for livelihoods. To counteract this, several soil and water conservation (SWC) measures have been undertaken, stone bunds being one of the most common techniques. While there is some evaluation of these interventions at landscape level, the spatial response of the soil at the level of farmers' interaction is largely unknown.

A novel soil tracer experiment was implemented during the rainy season in 2015 to investigate the movement of fertile soil to enable better optimization of SWC interventions with direct consequence to farmers. The experiment, conducted by a group of graduate students guided by soil scientists, made use of the magnetic susceptibility of the top soil, based on the different iron oxides in the soil (magnetite, goethite and hematite), to sample soils and identify the accumulation of the eroded soil originating from the tracer-tagged areas. The 'cascade effect' of cumulative contour measures downhill showed the relationship between hill slope length and SWC efficiency, and gave insights such as the hill slope length when erosion becomes severe. Furthermore, the allocation of erosion and accumulation zones provided feedback on the evolving spatial distribution of fertile and productive areas at the field level, helpful for more effective SWC design in the future.

The work was presented at the Water Engineering Conference (Jornadas de Ingenieria del Agua) in Cordoba, Spain, October 2015; and TropiLakes Conference, Ethiopia, September 2015. The project was conducted in collaboration with Ethiopia's Gondar Agricultural Research Center and Amhara Regional Agricultural Research Institute; the University of Natural Resources and Life Sciences, Austria; and the Institute for Sustainable Agriculture, Spain.



Funded by: the Austrian Development Agency and the CGIAR Research Program on Water, Land and Ecosystems

A PEEK AT 2015 CROP IMPROVEMENT ACHIEVEMENTS AT ICARDA

BARLEY

Completed genotyping of two populations and identified several sources of resistance in barley germplasm to stripe rust and spot blotch diseases for use in breeding programs

LENTIL

'Idlib 5' released in Syria, tolerant to Fusarium wilt and suitable for mechanical harvesting 'BARI Masoor 8' released in Bangladesh, tolerant to Stemphylium blight with high iron & zinc content

CHICKPEA

'FLIP97-114C' released in Morocco, with resistance to Ascochyta blight, large seed size, short cycle & high yield

FABA BEAN

'Chams' released in Tunisia, tolerant to Orobanche and foliar diseases, with large seed size, & high yield

WHEAT

'Obora' and 'Dambal' bread wheat varieties released in Ethiopia, resistant to rust disease and adapted to high rainfall highland areas

'Beni Mestina' durum wheat released in Algeria, tolerant to cold and drought

'Metin' winter wheat released in Turkey, resistant to yellow rust and leaf rusts and with high yield

NEW VARIETIES RELEASED 2015

WHEAT **15** BREAD **7** DURUM **4** WINTER WHEAT **4**

LENTIL **4**

CHICKPEA **2**

FABA BEAN **2**



2015 was especially a big year of successes for improved wheat varieties using ICARDA's germplasm in sub-Saharan Africa. These new varieties that we are promoting under the SARD-SC project are highly adapted and disease- and stress-tolerant, yielding 4-6 t/ha even under a hot climate.

- Michael Baum, Head of Biodiversity and Integrated Gene Management Program, ICARDA

FIRST TIME IN AFRICA: BIG STRIDES IN WHEAT TECHNOLOGIES

22 new improved wheat varieties in the pipeline for release across sub-Saharan Africa: Eritrea, Kenya, Lesotho, Mali, Mauritania, Niger, Tanzania, Zambia, and Zimbabwe

Funded by: the African Development Bank





PARTNERSHIPS
FOR SUSTAINABLE
AGRICULTURAL
DEVELOPMENT

ICARDA implements research-for-development initiatives in close partnership with the national research and extension systems (NARS), research institutes and universities, policy- and other decision-makers, non-governmental organizations, and the private sector to ensure stakeholder buy-in and holistic impact on the ground in countries, while advancing the global scientific knowledge and technologies for sustainable food production in drylands.

ICARDA's regional and country programs combine research with extensive focus on capacity development and rural advisory services to foster national scientific talent, needed for self-sustained progress within the agricultural sectors of countries.

With the center's decentralization in 2013, ICARDA's regional and country programs are covering over 50 countries across Africa and Asia.



A GLIMPSE OF PROGRESS AND HOPE IN CONFLICT ZONES

Many of the dryland countries in which ICARDA operates are either in conflict or post-conflict zones. Long periods of strife have heightened food insecurity and weakened farmers' livelihoods with lack of quality seeds and other inputs, and limited or no access to improved agricultural technologies and know-how. The stress on limited resources has also caused further marginalization of weaker sections of society, particularly the women.

ICARDA's agricultural research for development and capacity-building activities are proving to be a steady path for revitalizing rural communities, building food security and improving livelihoods that have been affected by conflict. Over the years, ICARDA's longstanding partnerships with the NARS and other national and regional actors in places such as Afghanistan, Iraq, Iran and Palestine have led to a firm foundation for its programs, allowing smallholders, rural women and entire communities to benefit from improved crop and livestock productivity, new and stronger value chains, and sustainable natural resource management. Most importantly, ICARDA has earned the trust of communities and formal and informal decision-makers paving the way for socio-economic progress.

First ever women-led village-based seed enterprise in Afghanistan

Nafasgul, a woman farmer in the Parwan province of Afghanistan, is elated at her association with 'Hurra Jalali Agriculture Service and Seed Production Company'. The reason is that this Village Based Seed Enterprise (VBSE) is uniquely led by a woman. According to Ms. Frozan Darwish, ICARDA's gender expert in Afghanistan, the most challenging part of initiating a woman-led VBSE was to motivate women to get involved and take leadership in the seed business.



Nafasgul, a proud member of the woman-led VBSE 'Hurra Jalali Agriculture Service and Seed Production Company'

Paving the path to gender parity, one seed enterprise at a time

In Afghanistan's patriarchal society, seed production is primarily considered to be the task of men. Women farmers have few opportunities to be involved in this activity, which is further exacerbated by their limited land rights. However, ICARDA and Afghanistan's Ministry of Agriculture, Irrigation and Livestock are making concerted efforts to encourage greater participation of Afghan women through community-based activities. The successful implementation of VBSE in Parwan has opened the doors for replicating the model and increasing the number of VBSEs to address the huge gap between the supply and demand of certified seeds in Afghanistan.

Results of a recently concluded project showed a phenomenal increase in the number of farmers that purchased certified seeds of two newly released mung bean varieties, from 5,000 to about 40,000 over a 3-year period.

In a big step forward for gender parity, a number of woman-led and a mixed-gender VBSEs were formed in Parwan province. They were registered and received an investment license. Women farmers from these companies also used foundation seeds and fertilizers and are now ready with commercial seeds for distribution. This achievement has further encouraged women's participation in seed companies.



Parwan-Bastan was one of the companies with no women members previously. Now seven women farmers have taken membership here.

- Ms. Frozan Darwish, Gender Expert, ICARDA-Afghanistan



Funded by the: International Fund for Agricultural Development

Formerly, around 130 seed production companies had been formed by international organizations in different provinces of Afghanistan. However, all these companies were male dominated and the presence of women was almost non-existent.

“Women had to be encouraged to accept social and security challenges and get involved in seed production, and their skills had to be upgraded to compensate for their lack of previous experience in seed production,” explained Ms. Darwish. This was addressed by many meetings organized in collaboration with the Directorate of Agriculture, Irrigation and Livestock, the Directorate of Women’s Affairs, Community Development Councils, District Development Assemblies, and female and male members.

These activities are part of ‘Community-based Agriculture and Livestock Project (CLAP)’; an initiative of the Afghan Ministry of Agriculture, Irrigation and Livestock that is funded by the International Fund for Agricultural Development and implemented by ICARDA to improve food and feed crops for the farmers and seed systems.

Increasing incomes and strengthening livelihoods in Palestine

In Palestine, about 40% of households depend on the agricultural sector for their livelihood. They are engaged in crop, livestock and mixed crop-livestock farming. The cultivated area in Palestine fluctuates depending on the amount of rain. This in turn affects the price of fodder, and the production of food and livestock, especially sheep and goats, which depend mainly on rangeland vegetation cover.

Promoting sustainable agricultural development through economic benefits

Farmers saw an average reduction in farming costs of **US\$250/ha** from using zero-till technology disseminated as part of the crop productivity package.



Farmers evaluating new wheat varieties under the participatory breeding approach in Palestine

In a recently concluded project to provide high-yielding cereal and forage seeds, more than 75 tonnes of improved seeds of wheat, barley, vetch, clover, sorghum, corn and millet were distributed to almost 500 livestock holders in the project area. The improved wheat varieties gave 8-20% more grain yield than the farmers’ commonly grown variety (‘Kahatat’), with better seed quality. The improved barley, vetch and clover varieties gave 10-18%, 25% and 14% more yield respectively than the commonly grown local varieties.

A project, entitled ‘Strengthening Livestock Holders’ Livelihoods in the Rawasi Area’ (2013-15) was funded by Cooperative for Assistance and Relief Everywhere (CARE) and implemented by ICARDA along with Palestinian Agriculture Relief Committee (PARC), the Ministry of Agriculture and farmer associations. The overall objective was to strengthen the resilience and increase the income of sheep and goat herders, with a specific focus on women and Bedouins. There was also a strong emphasis on capacity building in civil society.

To increase productivity in animal husbandry, farmers were introduced to silage and feed block production from agricultural byproducts and crop residues of millet and corn. Micro-catchment water-harvesting systems were demonstrated in ten locations at six sites in the project target area to protect soil from erosion and control land degradation.



A zero-till machine prototype developed with a local manufacturer

The project also introduced and demonstrated zero tillage packages at ten sites for soil and moisture conservation and to improve crop productivity and tolerance to drought conditions. While reducing farming costs, crops grown under zero tillage gave 8-12% more yield for wheat and 3-5% for barley compared to previous farming practices. The project also engaged a local manufacturer to develop a prototype of a zero tillage machine that was used in sowing 25 ha of field crops and forage during the 2015-16 season.

As part of capacity building, ICARDA conducted courses to train staff from CARE and PARC on the principles and applications of effective rangeland management and monitoring, improving agricultural water productivity and economic assessment of agricultural technologies, as well as marketing of livestock and dairy products. Women farmers were also trained on sheep milk processing in cooperation with the National Center for Agricultural Research and Extension in Jordan. Farmers’ field schools were established with community-based organizations to provide livestock holders the opportunity to observe, learn and test new and innovative technologies without risking their own limited resources.

Value chain mapping and analysis was done for dairy products in selected locations and inputs were provided to community-based organizations and other small and medium social enterprises to strengthen livestock holders’ access to markets and optimize their products’ value chain. Lessons learned from this project are expected to help the livestock holders in effectively increasing incomes and strengthening their livelihoods.

Funded by: Cooperative for Assistance and Relief Everywhere

Number of MSc and PhD students: **37**
 Individual non-degree: **7**
 Internships: **15**
 Group courses: **663**

Total number of participants: **722**
 Total number of women participants: **218**

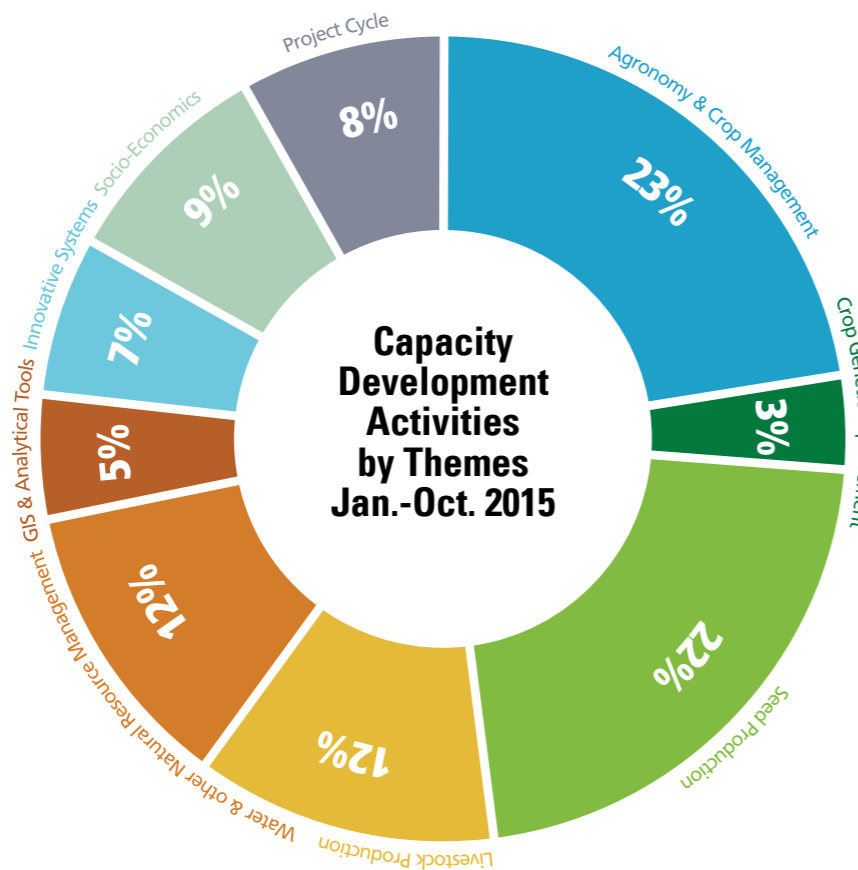
ICARDA rolls out online training courses

To offer flexibility and control training costs, ICARDA conducted two online courses for the first time in 2015. The courses, one held in partnership with the University of Western Australia and the other with the Swiss Cooperation Agency and funded by the Arab Fund for Economic and Social Development, were successfully completed and provided valuable lessons for developing future online courses.

DEVELOPING CAPACITY OF NATIONAL PARTNERS TOWARDS SELF-SUSTAINED PROGRESS AND DEVELOPMENT

ICARDA's capacity development activities in 2015 imparted knowledge and training to national scientists, agricultural extension workers, farmers, and research students on diverse topics, ranging from crop genetics and seed production to GIS and socio-economics. ICARDA's capacity development program uses a variety of fora, embedding them within the research activities to impart hands-on skills; these fora include farmer field schools, field trials, thematic workshops, training courses, degree and non-degree research awards, and study tours tailored to desired focus areas.

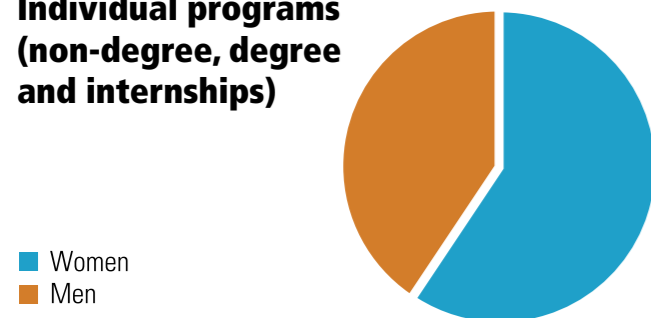
Capacity development activities by research focus areas (January 2015 to December 2015)



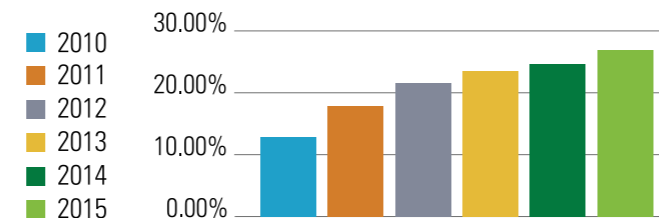
Encouraging development of women scientists in countries

ICARDA has been successfully increasing participation from women across all its capacity development activities.

Individual programs (non-degree, degree and internships)



Percentage of women participants in group courses from 2010 to 2015



Course on 'Impact Assessment and Livelihood Analysis in Systems Research', held 22-26 November, 2015, Amman, Jordan



Funded by: the Arab Fund for Economic and Social Development, Japan International Cooperation Agency, and the Kuwait Fund for Arab Economic Development



Through the training, I learnt more about the biological nitrogen fixation from sowing legumes in cereal-based cropping systems and how that improves soil quality and yields. I hope to form a soil and environment association which will work with scientists, farmers and the new generation to create a new mentality of environmental preservation and sustainable development in Tunisia.

- Mouna Mechri, final year PhD student in agronomy, Tunisia

Ms. Mouna Mechri was selected for training under the Young Agricultural Scientists Program (YASP), a national capacity strengthening initiative of the 'Enhancing Food Security in Arab Countries' project. YASP selects motivated young men and women from participating countries to work alongside ICARDA's scientists in a range of areas, such as plant breeding, biotechnology, plant protection, agronomy, irrigation, water and soil management, conservation agriculture, cereal quality and seed technology, and agricultural economics.

Collaborating Institutions in Central Asia

- **Kazakhstan** – Kazakh Research Institute of Soil Science and Agrochemistry; Southwestern Research Institute of Livestock and Plant Science
- **Kyrgyzstan** – Ministry of Agriculture and Melioration; Kyrgyz Research Institute of Irrigation; Kyrgyz National Agrarian University
- **Tajikistan** – Tajik Academy of Agricultural Sciences; Research Institute of Farming
- **Turkmenistan** – Academy of Sciences; Turkmen State Water Management Scientific Production and Design Institute
- **Uzbekistan** – Research Institute of Soil Science and Agrochemistry

International Partners

- GIZ
- FAO
- WOCAT
- World Bank

Funded by: the International Fund for Agricultural Development, Russia

More than 90 sustainable land management practices, systematized and tested in all five countries of the region, are now available to farmers interested in increasing their land's productivity. www.cacilm.org

Implemented under the framework of CGIAR's Global Research Program on Dryland Systems, led by ICARDA

A KNOWLEDGE PARTNERSHIP TO ADAPT COMMUNITIES TO CLIMATE CHANGE IN CENTRAL ASIA

In Central Asian countries of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan, the rural people relying on natural resources to make a living face an incredible challenge. These countries consist mostly of desert and mountain pastures – only 10% of the land is arable. Yet, their populations are highly agrarian with 60% living in rural areas. The effects of climate change are immediately felt in Central Asia's fragile agroecosystems as farmers are facing more extreme temperatures, erratic precipitation and more frequent droughts. Further, the region suffers from high degrees of salinization, soil erosion and land degradation. With limited awareness, farmers continue to rely on outdated technologies and land management practices, jeopardizing their livelihoods as well as the delicate ecosystem balance in these parts.

A knowledge partnership initiated in 2013 came to fruition in 2015 contributing to consolidation and up-scaling and out-scaling of a suite of proven sustainable land management (SLM) technologies and practices. These SLM technologies were developed and tested under the prior region-wide initiative of Central Asian Countries Initiative for Land Management (CACILM) (Phase I: 2007-2009), funded by the Asian Development Bank (ADB). A knowledge platform was put in place that synthesizes and packages information, fills knowledge gaps, builds capacity and effectively communicates on SLM technologies and practices to farmers, extension workers, local development organizations and decision-makers. The resource integrates use of website, databases, advisory services, trainings, video materials and blogging, all made available in English and Russian.

Demonstration sites were a major part for SLM validation and knowledge dissemination, which targets four agro-ecosystems that represent important environments for human livelihoods: rain-fed, irrigated, mountains and rangelands.

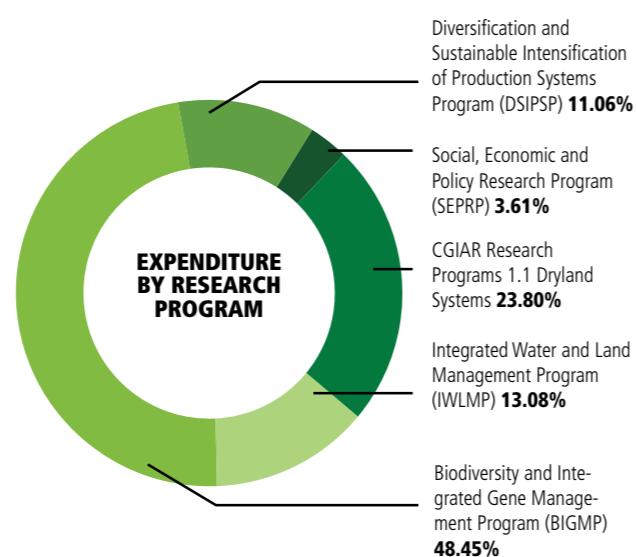
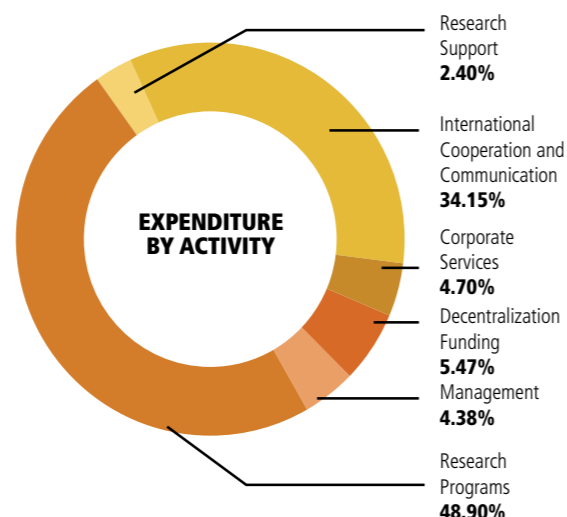
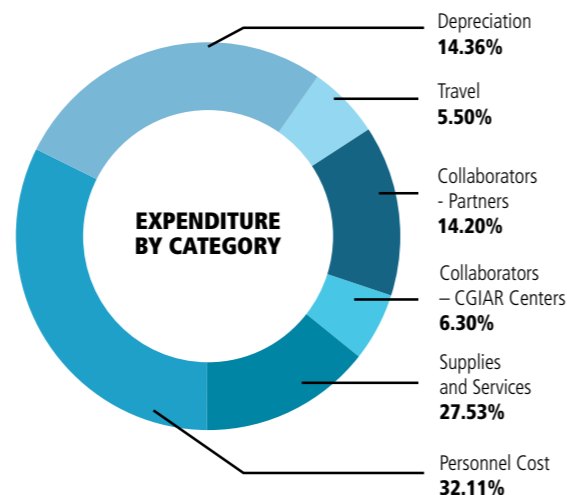


AUDITED FINANCIAL SUMMARY

Statement of Activity (US\$ x 1000)		
	2015	2014
REVENUES		
Grants (core and restricted)	52,141	68,358
Other revenues and gains	597	614
Total revenues and gains	52,738	68,972
EXPENSES AND LOSSES		
Program related expenses	52,332	70,375
Management and general expenses	5,216	6,815
Other losses and expenses	-	-
Total expenses and losses	57,548	77,190
Indirect costs recovery	(4,380)	(6,423)
Net Expenses and losses	53,168	70,767
Net surplus from ordinary activities	(430)	(1,795)
Extra-ordinary expenses	-	-
Overall surplus (deficit)	(430)	(1,795)

Statement of Financial Position (US\$ x 1000)		
	2015	2014
ASSETS		
Current assets	32,882	37,014
Property & equipment	2,733	2,913
Other assets	-	-
Total assets	35,615	39,927
LIABILITIES AND ASSETS		
Current liabilities	27,084	30,769
Long term liabilities	-	-
Total liabilities	27,084	30,769
Net assets = Reserves	8,531	9,158
Total liabilities & net assets	35,615	39,927

Statement of Grant	
DONORS	AMOUNT
Abu Dhabi Food Control Authority (ADFCA)	298
Afghanistan Ministry of Agriculture, Irrigation, and Livestock (MAIL)	1,305
Arab Fund for Economic and Social Development (AFESD)	4,942
Australian Centre for International Agricultural Research (ACIAR)	3,107
Austria	378
CGIAR Fund	6,870
Eurasian Center for Food Security at Moscow State University (ECFS)	925
European Commission	1,789
Germany	609
Global Crop Diversity Trust (GCDT)	2,476
Grains Development and Research Corporation (GRDC)	848
Gulf Cooperation Council (GCC)	514
HarvestPlus	263
Impulsora Agricola, S.A. de C.V. (IASA)	330
India	1,048
International Crop Research Institute for Semi-Arid Tropics (ICRISAT)	3,617
International Food Policy Research Institute (IFPRI)	346
International Fund for Agricultural Development (IFAD)	2,330
International Institute of Tropical Agriculture (IITA)	4,164
International Livestock Research Institute (ILRI)	1,005
International Maize and Wheat Improvement Center (CIMMYT)	3,457
International Water Management Institute (IWMI)	616
Iran	257
Japan	408
Kuwait Fund for Arab Economic Development (Kuwait Fund)	1,299
Libya - Agricultural Research Center	1,290
OCP Foundation	765
Turkey	289
United States Agency for International Development (USAID)	1,515
United States Department of Agriculture (USDA)	2,885
Miscellaneous	2,196
TOTAL	52,141



HONORS & AWARDS IN 2015



Mahmoud Solh
Director General, ICARDA

Gregor Mendel Innovation Prize

Mahmoud Solh received the award on behalf of ICARDA for successfully securing ICARDA's globally important collection of crop genetic resources stored in its genebank in Tel Hadya, Syria, despite the ongoing challenges. With the dedicated team work of researchers and technicians in Syria, ICARDA was able to duplicate 100% of the 148,000 accessions in its Genebank. The collection is a unique global resource for food security with 65% of it being unique landraces and wild relatives of cereals, legumes and forages collected from the centers of biodiversity. ICARDA's Genebank distributes up to 25,000 samples yearly to collaborators and requestors around the world, particularly national programs in developing countries, to provide breeders, scientists and farmers with genetic materials with favorable traits that can improve crop yields in the face of changing climate.

Eighty percent of the collection is now duplicated at the Svalbard Global Seed Vault in Norway, as well as spread across many other partners, such as CIMMYT, ICRISAT, Vavilov Research Institute- Russia, USDA in USA, India and Germany.

(Coverage in media: The Guardian, Smithsonian, WIRED, Climate Central)

Genebank activities funded by: Arab Fund for Economic and Social Development, Australian Centre for International Agricultural Research, CGIAR, Germany, Global Crop Diversity Trust, Grains Research and Development Corporation of Australia, World Bank



Atef Swelam
Irrigation Scientist, ICARDA

Japan International Award for Young Agricultural Researchers 2015

Atef Swelam received this prestigious award for his contributions in the development of a cost-effective raised-bed machine for small-scale farms as a solution to the severe water stress in the Nile Delta region. The machine was developed in partnership with Egypt's Agricultural Research Center and Zagazig University with the goal of mechanizing raised-bed farming to encourage smallholders in the Nile Delta to switch from the traditional flood irrigation to water and land conservation practices in the intensively farmed region. Its excellent results in producing more yield with less water on wheat, maize and sugarbeet have promoted the adoption of the technology in wheat-growing areas of Egypt from 1,670 ha to 45,000 ha over just three years (2011 to 2014). Further up-scaling is in progress in 22 governorates, backed by the Food and Agriculture Organization and the Egyptian Government, as part of a national campaign to sustainably intensify wheat production.

Demonstrated benefits of raised-bed machine in Nile Delta (average over 2011-14):

- 30% increase in grain yield
- 25% saving in irrigation water
- 74% increase in water use efficiency

(Coverage in media: FOX News, News & Observer, Saudi Gazette, Phys.org)

Funded in parts by: Arab Fund for Economic and Social Development, International Fund for Agricultural Development, Islamic Development Bank, Kuwait Fund for Arab Economic Development, OPEC Fund for International Development, United States Agency for International Development



Ramesh Pal Singh Verma
Barley Breeder, ICARDA

Honored with a plaque at the 54th Annual Meeting of All India Wheat & Barley Research Workers, Dantewada, Gujarat, India

Ramesh Verma was recognized for the development and release of a new two-row malt barley variety ('DWRB 101') in India, which combines excellent malting quality and disease resistance with high grain yield. The variety responds to the shortage of good quality raw material in India's malting and brewing industry and will help farmers get a premium for cultivating malt barley, thus increasing their incomes.

Funded by CGIAR Research Program on Dryland Cereals

The Genetic Resources Team in Tel Hadya, Syria, successfully completing the mission of duplicating genetic resources in ICARDA's Genebank and shipping them to the safety of Svalbard Global Seed Vault and other facilities around the world.



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DONORS AND INVESTORS

DONORS IN 2015

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Afghanistan
African Development Bank
AMIDEAST
Arab Fund for Economic & Social Development
Asian Development Bank
Australia (incl. ACIAR, GRDC, CSIRO, Curtin University, DPI)
Austria Egypt
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Brazil (incl. EMBRAPA)
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Cooperative for Assistance and Relief Everywhere, Inc.
Cornell University
European Union
Food and Agriculture Organization
France (incl. CIRAD)
Germany (incl. GIZ, ZEF)
Global Crop Diversity Trust
Gulf Cooperation Council
Impulsora Agricola, S.A. de C.V. (IASA)
India
International Center for Biosaline Agriculture
International Fund for Agricultural Development
Iran
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King Abdullah University of Science and Technology
Kuwait Fund for Arab Economic Development
Libya
Morocco (incl. INRA)
OCP Foundation
OPEC Fund for International Development
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Stockholm International Water Institute
Swedish University of Agricultural Sciences
Sudan
Syria
Turkey
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France
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Global Crop Diversity Trust
Gulf Cooperation Council
IFAD
India
Iran
Islamic Development Bank
Italy
Japan (incl. JICA, JIRCAS)
Kuwait Fund for Arab Economic Development
Libya ARC
Mexico
Morocco
Netherlands
Norway
OCP Foundation
OPEC Fund for International Development
Russian Federation
South Africa
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United Nations Convention to Combat Desertification
United Nations Development Programme
United Nations Environment Programme
United Kingdom
USA (incl. USAID, USDA)
World Bank

¹ <http://www.cgiar.org/about-us/governing-2010-june-2016/cgiar-fund/fund-donors-2/>

DONORS BY REGIONAL AND COUNTRY 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 the Caucasus

Food and Agriculture Organization (FAO)
International Fund for Agricultural Development (IFAD)
Russian Federation

Nile Valley and Red Sea

African Development Bank (AfDB)
Arab Fund for Economic and Social Development (AFESD)
Australian Centre for International Agricultural Research (ACIAR)
Bill and Melinda Gates Foundation
Kuwait Fund for Arab Economic Development (KFAED)
European Union (EU)
Food and Agriculture Organization (FAO)
Government of Egypt
Government of Sudan
Grain Research and Development Corporation (GRDC)
International Fund for Agricultural Development (IFAD)
OPEC Fund for International Development (OFID)
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)
Bill and Melinda Gates Foundation
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)
European Union (EU)
Food and Agriculture Organization (FAO)
Grains Research & Development Corporation (GRDC)
International Fund for Agricultural Development (IFAD)
Kuwait Fund for Arab Economic Development (KFAED)
Ministry of Agriculture, Morocco
Ministry of Agriculture, Libya
OCP Foundation Morocco

South Asia and China

CGIAR
Cooperation, Government of India
Indian Council of Agricultural Research (ICAR), Ministry of Agriculture, Foundation, Morocco
Government of China
Government of India
King Abdullah University of Science and Technology
National Food Security Mission (NFSM), Department of Agriculture & OCP
OPEC Fund for International Development (OFID)
State Government of Karnataka, Government of India

Sub-Saharan Africa

African Development Bank (AfDB)
Austria Development Agency
Curtin University of Technology (Australia)
Commonwealth Scientific and Industrial Research Organisation (CSIRO)
Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA)
Impulsora Agrícola, S.A. de C.V. (IASA)
International Fund for Agricultural Development (IFAD)
United States Agency for International Development (USAID)

West Asia

Arab Fund for Economic and Social Development (AFESD)
Australian Centre for International Agricultural Research (ACIAR)
Bill and Melinda Gates Foundation
European Union (EU)
Food and Agriculture Organization (FAO)
International Fund for Agricultural Development (IFAD)
Japan International Cooperation Agency (JICA)
Kuwait Fund for Arab Economic Development (KFAED)
OPEC Fund for International Development (OFID)
United States Agency for International Development (USAID)

Afghanistan

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

Iran

Food and Agriculture Organization (FAO)
Government of Iran

Pakistan

Asian Development Bank (ADB)
Australian Centre for International Agricultural Research (ACIAR)
Food and Agriculture Organization (FAO)
United States Agency for International Development (USAID)
United States Department of Agriculture (USDA)

Turkey

European Union (EU)
Food and Agriculture Organization (FAO)
Government of Turkey

APPENDIX 1: ICARDA GENE BANK: GLOBAL SERVICES AND ACHIEVEMENTS

Table 1. List of varieties released by NARS partners in 2015

CROP	VARIETY	COUNTRY	ADAPTATION AND KEY TRAITS
BREAD WHEAT	Obora	Ethiopia	Rust resistant; adapted to high rainfall highland areas
	Dambal	Ethiopia	Rust resistant; adapted to high rainfall highland areas
	Fentale (Moontij-3)	Ethiopia	High yield; heat tolerant; adapted to irrigated lowlands
	Amibara (Doukkala-4)	Ethiopia	High yield; heat tolerant; adapted to irrigated lowlands
	LACRIWHIT-7	Nigeria	Highland rain-fed areas, tolerant to diseases, high yielding
	LACRIWHIT-8	Nigeria	Tolerant to diseases; high yield; adapted to highland rain-fed areas
	*Shalkot-14	Pakistan	High yielding (released in 2014)
DURUM WHEAT	Beni Mestina	Algeria	Tolerance to cold and drought (facultative winter)
	Sigus	Algeria	Tolerant to cold and drought (facultative winter)
	Utuba (Mangudo2)	Ethiopia	Early flowering; late maturing; resistance to yellow, leaf rust and stem rust (Ug99 races), PM, and HF; high protein content
	Berghouata	Sudan	Early flowering; high yield; resistance to leaf rust and Ug99
WINTER WHEAT	Azhara	Kyrgyzstan	High yield
	Faizbakhsh	Tajikistan	High yield
	Shokiri	Tajikistan	High yield
	*Metin	Turkey	Resistance to yellow rust and leaf rusts; high yield
FABA BEAN	Hashenge	Ethiopia	Resistant to tolerant to Orobanche; moderately resistant to chocolate spot and Ascochyta blight; moderately susceptible to gall
	Cheng Hu 19	China	High yield; high protein content (31%); strong stem; upright pods; dual purpose usage; adapted to lowlands of Chengdu province
CHICKPEA	FLIP97-114C	Morocco	Ascochyta blight resistance; large seed size; short cycle; high yield
	Rebha	Tunisia	Partial resistance to Ascochyta blight; resistance to Fusarium wilt; large seed size
LENTIL	BARI Masur-8	Bangladesh	Micronutrient rich (Fe and Zn); resistance to Stemphylium blight and rust; short duration
	Idlib 5	Syria	Fusarium wilt tolerant; suitable for mechanical harvesting
	Jiru	Ethiopia	Rust resistance; high yield
	Ebba	Tunisia	Powdery mildew resistance; large seeded; high yield
PEA (DRY)	Basma	Tunisia	Powdery mildew resistance; high yield

* Released in 2014 (but not reported)

Table 2. Distribution of international nurseries for 2015/16

CROPS	COOPERATORS	COUNTRIES	SETS	
LEGUMES	Chickpea	62	33	330
	Lentil	58	29	362
	Faba bean	28	22	160
	Grass pea	16	14	69
	Subtotal legumes	75	32	921
CEREALS	Barley	46	29	362
	Durum	62	36	157
	Bread wheat	61	30	239
	Subtotal wheat	89	43	396
	Subtotal cereal	109	49	758
Grand total		177	50	1,679

APPENDIX 2: SCIENTIFIC PUBLICATIONS

Papers in ISI Journals

Abbeddou, S., Rischkowsky, B., Hilali, M., Haylani, M., Hess H.D., and Kreuzer, M. 2015. Supplementing diets of Awassi ewes with olive cake and tomato pomace: on-farm recovery of effects on yield, composition and fatty acid profile of the milk. *Tropical Animal Health and Production* 47: 145–152.

Ahmed, S., M.M. Abang, and F. Maalouf. 2015. Integrated management of Ascochyta blight (*Didymella fabae*) on faba bean under Mediterranean conditions. *Crop Protection* 81: 65–69.

Alam, M.M., Y.S. Saharawat, J.K. Ladha, M.W. Faisal, S. Sharma, A. Saha, S. Noor, and M.A. Rahman. 2015. Improvement of cereal-based cropping systems following the principles of conservation agriculture under changing agricultural scenarios in Bangladesh. *Field Crops Research* 175: 1–15.

Alemu, D., and Z. Bishaw. 2015. Commercial behaviours of smallholder farmers in wheat seed use and its implication for demand assessment in Ethiopia. *Development in Practice* 25(6): 798–814.

Andersson, S.C., E. Johansson, M. Baum, F. Rihawi, and M. El Bouhssini. 2015. New resistance sources to Russian wheat aphid (*Diuraphis noxia*, *Kurdjumov*) in Swedish wheat substitution and translocation lines with rye (*Secale cereale*) and *Leymus mollis*. *Czech Journal of Genetics and Plant Breeding* 51: 162–165.

Aouadi, D., L. Zorghi, M. Neffati, and H. Ben Salem. 2015. The evaluation of the nutritional potential of five Mediterranean woody plants rich in phytochemicals. *Journal of Animal and Feed Sciences* 24: 160–165.

Arslan, A., G.A. Majid, M. Hamdan, P. Rameshwaran, R. Ragab, M. Singh, and M. Qadir. 2015. Evaluating the productivity potential of chickpea, lentil, and faba bean under saline water irrigation systems. *Irrigation and Drainage* 65(1): 19–28.

Ates, S., G. Keles, F. Inal, A. Gunes, and B. Dhehibi. 2015. Performance of indigenous and exotic × indigenous sheep breeds fed different diets in spring and the efficiency of feeding system in crop–livestock farming. *Journal of Agricultural Science* 153: 554–569.

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ACRONYMS AND ABBREVIATIONS

ACIAR	Australian Centre for International Agricultural Research
ADB	Asian Development Bank
AfDB	African Development Bank
AFESD	Arab Fund for Economic and Social Development
ARARI	Amhara Regional Agricultural Research Institute
AusAID	Australian Agency for International Development
CA	Conservation agriculture
CANA	Conservation Agriculture for North Africa
CARE	Cooperative for Assistance and Relief Everywhere
CFC	Common Fund for Commodities
CIMMYT	International Maize and Wheat Improvement Center
CIRAD	Centre de coopération internationale en recherche agronomique pour le développement (France)
CRP	CGIAR Research Program
DZARC	Debre Zeit Agricultural Research Center
EIAR	Ethiopian Institute of Agricultural Research
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GCC	Gulf Cooperation Council
GCDT	Global Crop Diversity Trust
GIS	Geographic information system
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (Germany)
GRDC	Grains Research and Development Corporation
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
IsDB	Islamic Development Bank
IWMI	International Water Management Institute
IWWIP	International Winter Wheat Improvement Program
JICA	Japan International Cooperation Agency
JIRCAS	Japan International Research Center for Agricultural Sciences
KFAED	Kuwait Fund for Arab Economic Development
MAIL	Ministry of Agriculture, Irrigation, and Livestock (Afghanistan)
NARS	National agricultural research systems
NCARE	National Center for Agricultural Research and Extension (Jordan)
NFSM	National Food Security Mission
OFID	OPEC Fund for International Development
OPEC	Organization of the Petroleum Exporting Countries
PARC	Palestinian Agriculture Relief Committee
SARD-SC	Support to Agricultural Research for Development of Strategic Crops in Africa
SWAT	Soil and water assessment tool
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WANA	West Asia and North Africa
WOCAT	World Overview of Conservation Approaches and Technologies

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Established in 1977, ICARDA is one of the 15 centers supported by the CGIAR. ICARDA's mission is to improve the livelihoods of the resource poor in dry areas through research and partnerships dedicated to achieving sustainable increases in agricultural productivity and income, while ensuring efficient and more equitable use and conservation of natural resources.

ICARDA has a global mandate for the improvement of barley, lentil and faba bean, and serves the non-tropical dry areas for the improvement of on-farm water use efficiency, rangeland and small ruminant production. In Central Asia, West Asia, South Asia, and North Africa regions, ICARDA contributes to the improvement of bread and durum wheats, kabuli chickpea, pasture and forage legumes, and associated farming systems. It also works on improved land management, diversification of production systems, and value-added crop and livestock products. Social, economic and policy research is an integral component of ICARDA's research to better target poverty and to enhance the uptake and maximize impact of research outputs. www.icarda.org



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



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