ICARDA

International Center
for Agricultural Research
in the Dry Areas

Annual Report 2012

SCIENCE FOR BETTER LIVELIHOODS IN DRY AREAS



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Foreword

For ICARDA, 2012 has been a time of change and evolution. We have been busy tackling the many issues of dryland agriculture and global food production against a backdrop of focusing our efforts as a force for change for people living in the world's drylands and our areas of scientific expertise.

The increased unpredictability of temperature extremes and extended droughts has the most severe impact on those living in dry areas and on marginal lands. ICARDA, with its expertise in an integrated agro-ecosystems approach to dealing with such challenges, which we have developed over the years with partner countries, is particularly well-placed today to provide effective and practical solutions for the challenges facing dry areas.

The world of research for development is evolving rapidly, as is the CGIAR Consortium, of which ICARDA is a member. In 2012, ICARDA made significant progress as the leader of the CGIAR Research Program on Dryland Systems. In the program's inception phase a broad range of partners came together to set research priorities and conduct detailed site characterizations in five target regions – extending from Central Asia to West Asia, and North and sub-Saharan Africa. The program is set for full funding and implementation in early 2013. ICARDA is active in ten other CGIAR Research programs – jointly with the International Maize and Wheat Improvement Center (CIMMYT) in the Wheat Program, and as a partner in nine others.

The conceptual approach of the Dryland Systems Program grows out of the experience and research accomplishments achieved over the past decades by many organizations and science programs, including CGIAR and its many national partners. ICARDA brings unique expertise to the Program – through its 35 years' experience in refining integrated agro-ecosystems approaches with more than 40 dryland countries – to develop improved crop varieties, effective water and land management practices, integrated crop-livestock production systems, and institutional and policy options.

This year, we are pleased to report progress in linking research innovations to results in farmers' fields in a number of areas. These research-for-development initiatives are testing technology and policy packages with farmers in their production situations. For example, in sub-Saharan Africa ICARDA leads the wheat component of the regional initiative on Support to Agricultural Research for Development of Strategic Crops in Africa (SARD-SC). The overall program is led by the International Institute of Tropical Agriculture (IITA), with the Africa Rice Center and International Food Policy Research Institute (IFPRI), and funded by the African Development Bank.

The project, Enhancing Food Security in Arab Countries, has helped increase wheat yields by 25% in project sites in Egypt, Jordan, Morocco, Sudan, Syria, Tunisia, and Yemen. It has also introduced new technologies to some 6000 farmers through farmer field schools and travelling workshops.

In the tripartite India–Morocco–ICARDA Food Legumes Initiative, ICARDA facilitates the testing and sharing of practices and new varieties between these regions. A further notable innovation is the introduction of lentil during fallow periods of rice cultivation in West Bengal. This innovation for the region brings improved nutrition, new income-generating products, better soil health, and a new crop – producing up to 1.1 ton/ha of lentil, where nothing was previously produced, during these periods.

Those who know ICARDA have seen that 2012 has not been without its significant challenges. The positive steps that we report have been achieved against the backdrop of the situation in our host country, Syria, and the need for the Center to temporarily leave its main research station in Tel Hadya, Aleppo, and set up operations in a number of countries across the region. We have posted regular updates on our website informing you of the steps taken. The 2011/12 cropping season at Tel Hadya was successfully completed, including all field experimentation and seed increases. Our international nurseries were distributed, as planned. Most buildings and laboratories are safe, including the gene bank. All our gene bank accessions have already been safety duplicated in locations outside Syria. All e-mail and financial systems and our databases had already been transferred to the cloud and are fully accessible.

All expatriate staff were relocated by July 2012 and continue to implement their collaborative research programs and projects in more than 40 countries. This temporary relocation has gone smoothly, but such changes always place an additional burden on staff and their families and we sincerely thank them for their dedication and perseverance.

We would like to pay tribute to the Board Chair for most of 2012, Mr. Henri Carsalade, who maintained close communications with the Center throughout the year and devoted considerable time and energy to the oversight of ICARDA's contingency measures.

We would also like to recognize the unconditional support of our national partners who have opened their research stations and scientific research labs to ICARDA, enabling us to continue our research programs.

Given the on-going uncertainty in Syria, the Center also began developing its plans for longer term decentralization to integrated research platforms throughout the dry areas, building on our long-established partnerships with national programs. Elements of the strategy were approved by the Center's Board of Trustees in its meeting in October 2012, and will be further developed and implemented during 2013.

Overall, we have set ourselves a tough agenda with ambitious targets to meet. This is necessary if we are to make a real contribution to the goal of improving the situation of millions of people in the dry areas and to see a more productive and sustainable future. Our mandate – to tackle poverty, food insecurity, natural resource degradation, and climate change – has never been more relevant or important.

Mahmoud Solh
Director General

Camilla Toulmin
Chair, Board of Trustees

CGIAR Research Program on Dryland Systems

Integrated agricultural production systems for improved food security and livelihoods in dry areas.

The CGIAR Research Program on Dryland Systems is led by ICARDA with a wide range of international, regional, national, and local partners in five regions of the world – West African Sahel and Dry Savannas; East and Southern Africa; North Africa and West Asia; Central Asia and the Caucasus; and South Asia. It follows a unique 'integrated agro-ecosystems' approach – refined by ICARDA in its work with partner countries, and by a number of other research and development organizations, over the past three decades.

The CGIAR Research Program on Dryland Systems targets high-level outcomes in two types of agro-ecosystems:

- **Low-potential and marginal drylands:** strategies and tools to minimize risk and reduce vulnerability.
- **Higher-potential dryland regions:** supporting sustainable intensification of agricultural production systems.

To achieve these goals, the Program identifies and develops resilient, diversified, and more productive combinations of crop, livestock, rangeland, aquatic, and agroforestry systems that increase productivity, reduce hunger and malnutrition, and improve the quality of life of the rural poor. These packages will combine improved plant and animal varieties, and diversification of agricultural systems as a tool for mitigating risk and increasing income for dryland farmers and rural communities.

Progress in 2012 – setting the research agenda

The primary achievement of the Program in 2012 was the completion of the research proposal in response to detailed consultations and review, and the 12 month inception phase that set the research agenda for a series of target sites. This involved intense priority setting and detailed characterization of the five research sites. In each research target region, the process involved detailed scientific consultations among several dozen partners – for site selection, development of the research program, and defining outcomes in each of the five regions where Dryland Systems will operate.

Gender and youth in dryland agro-ecosystems

Women and youth are the two groups in dryland agriculture who are most affected by high levels of inequity and marginalization, and a priority cross-cutting area of the CGIAR Research Program on Dryland Systems.

Women often run the farm in addition to managing the home, as in many cases their husbands work outside the region to supplement the family income. Including gender in the research portfolio also increases the potential for overall program impact; leaving it out means that a significant part of the population is excluded.

The inception phase sparked new relationships and learning between partners. It generated some 800 pages of characterization data and research planning. Site characterizations cover socioeconomic and biophysical conditions, using data on climate, soil, land use, poverty, market linkages, and major constraints affecting these farming systems, and potential opportunities to raise productivity and farmer income.

The site selection and characterization process has inspired similar processes used in the past year by the World Bank's Drylands Program, the USAID Africa Rising Initiative, and the French CIRAD Transmed Program, who have referred to the Dryland Systems method in their planning.

With the inception process completed and the research agenda set, the Program is set for full funding from the CGIAR Fund Council and other donors in early 2013.

Resources: all materials about the Program can be accessed at http://drylandsystems.cgiar.org

Regional targets

In the coming six years, the program aims to improve the lives of:

- **23 million people in the West African Sahel and Dry Savannas** region, and to mitigate land degradation on over 200,000 km^2.
- **20 million people in East and Southern Africa**, and to mitigate land degradation on 600,000 km^2.
- **1.1 million people in North Africa and West Asia**, and to mitigate land degradation on 18,600 km^2.
- **500,000 people in Central Asia and the Caucasus**, and to mitigate land degradation on 2,900 km^2.
- **65 million people in South Asia**, and to mitigate land degradation on 465,000 km^2.

Regions covered by the Program *(see maps on right)*

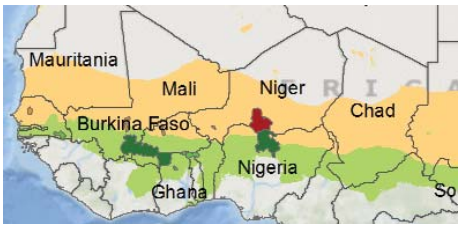
West African Sahel and Dry Savannas
Agriculture in these areas faces considerable constraints: drought, poverty, soil erosion, poor infrastructure, and a lack of institutional support. Restricted livestock mobility and the loss of marginal lands to crop cultivation also threaten the viability of pastoral and agro-pastoral systems. Interventions such as increasing smallholder linkages to regional livestock markets, and facilitating access to new technologies, have the potential to improve resource management and productivity.

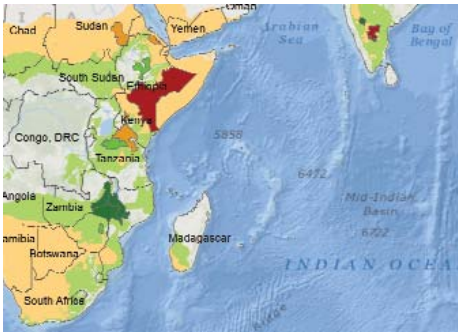
East and Southern Africa
Large swathes of land in this region are under arid or semi-arid agro-ecosystems, and suffer from frequent droughts. Vulnerability to drought is exacerbated by poor infrastructure, limited ability to serve poor communities, and restricted market engagement. With soil inputs and effective extension services, however, farmers could better adapt to adverse environmental conditions.

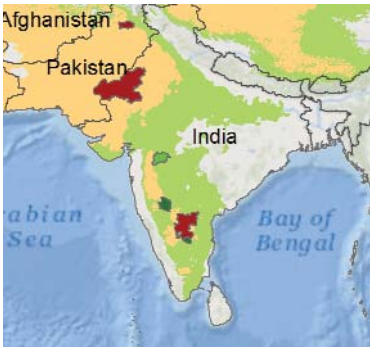
North Africa and West Asia
Here, on-going aquifer degradation is likely to worsen due to climate change. Out-migration, farm fragmentation, and the abandonment of agro-pastoral lifestyles are also threatening the sustainability of farming in the region. Smallholder farmers in this region have the potential to apply new approaches for sustainable intensification and diversification of their agricultural production to increase incomes and generate employment, including tapping the lucrative European export markets for legumes.

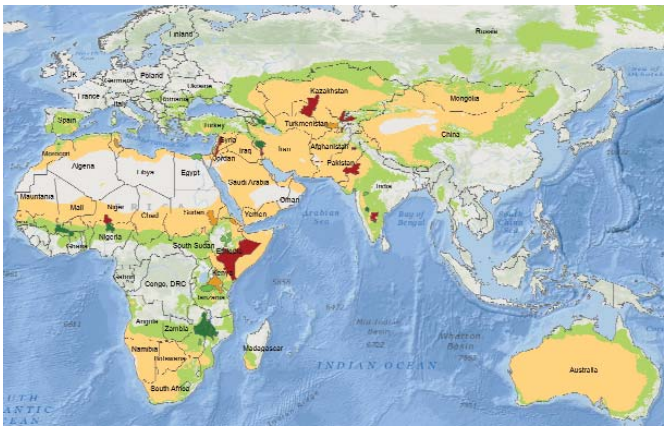
Central Asia and the Caucasus
This region requires improved mechanization for the region's relatively large-scale farms, as well as support to farming communities to complete the transition from the former state-owned and centrally-planned agricultural economy to smallholder production. Often inexperienced, farmers require specialized irrigation training to utilize the region's significant saline water resources.

South Asia
Greater levels of mechanization will help this region to manage its extensive areas of hyper-arid land more effectively, and develop more efficient production in these rainfed areas. Although salinity is a major problem in irrigated agricultural areas, increasing productivity is possible in regions where groundwater resources are not being over-exploited.









The Dryland Systems research-for-development partnership
The Program involves a broad range of partners, including more than 60 national agricultural research systems, advanced research institutions, development agencies, civil society partners, and the private sector.

- **Regional agricultural development, research, and capacity building organizations:** GFAR, AARINENA, APAARI, CACAARI, FARA, ASARECA, and CORAF.
- **International research centers and programs:** Nine CGIAR Centers (Bioversity International, CIAT, CIP, ICARDA, ICRAF, ICRISAT, ILRI, IWMI, WorldFish), and the CGIAR Challenge Program for Sub-Saharan Africa. The program is led by ICARDA.

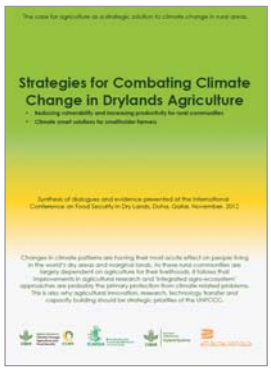
Impacts in 2012: translating research into action and policy influence

ICARDA's efforts to translate its research into practical policy options and practices took significant steps forward last year as the Center increased its presence on the international stage and shared its research findings with a wide range of national and international stakeholders. The Center's Director General, Dr. Mahmoud Solh, participated in a series of high-level conferences and forums, profiling a range of proven and appropriate interventions that could help dryland countries raise productivity against a backdrop of rising climate change and water scarcity.

These included presentations at the World Water Forum and the 31st FAO Near East Regional Conference, where Dr. Solh presented options for improving food security and livelihoods, and showcased examples of successful collaborative research partnerships. Dr. Solh was also a panelist at a number of international workshops and debates: exploring efforts to help smallholder and commercial farmers at the Global Food Security Forum in Rabat, for example, and analyzing research, challenges, and the prospects for greater collaboration activities across the Mediterranean region at a roundtable event in Barcelona.

In addition, ICARDA provided substantive inputs from its research program to the international conference on Food Security in the Dry Lands, hosted by the Qatar National Food Security Programme, in Doha, which brought together researchers, decision makers, and government ministers to address various challenges in the context of food security and water resources.

The Center also participated in the CGIAR's Agriculture, Landscapes and Livelihoods Day, a parallel event of the Conference of the Parties to the UN Framework on Climate Change Convention. ICARDA launched a high-profile policy report together with the CGIAR Research Programs on Climate Change, Agriculture and Food Security, and Dryland Systems – Strategies for Combating Climate Change in Drylands Agriculture. It presented the case for agriculture as a strategic solution to climate change in rural areas and was cited widely in the international media and on a special web page on the topic created by the UK Department for International Development (DFID).



Director General, Dr. Mahmoud Solh (center), was a speaker at the IDRC lecture series, where he spoke on Dry Areas Agriculture: A Challenge that Can be Overcome. Pictured here with IDRC President, Jean Lebel (left), and Past President, David Malone (right).

ICARDA shares international expertise and policy insights in Doha

ICARDA applied its expertise at a high-level international conference on Food Security in the Dry Lands in Doha this year, presenting a wealth of evidence and approaches from its research program. Director General, Dr. Mahmoud Solh, presented in the opening plenary and the ministerial dialogue which shaped the meeting's 'Doha Declaration', a statement by ministers that defines future actions and investments on improving food security in the world's drylands.

The Center also organized two technical sessions with the International Fund for Agricultural Development (IFAD), which considered the role of science and technology and presented the proven interventions and technology transfer models that ICARDA had applied in partner countries. Input was provided by Dr. Camilla Toulmin, Board Chair and Director of the International Institute for Environment and Development, and Dr. Habib Halila, Regional Coordinator of ICARDA's project on Food Security in Arab Countries.

Strengthening collaborative research with Canada

ICARDA strengthened relations with development partners in Canada in 2012. Director General, Dr. Mahmoud Solh, met with high-level representatives from the International Development Research Centre (IDRC) to explore joint research projects on climate change and food security – complementing IDRC's on-going financial contributions to the CGIAR Research Program on Dryland Systems.

Interactions with the Canadian Department of Agriculture and Agri-Food (AAFC) offered the chance for AAFC scientists to propose potential areas of cooperation with ICARDA – including the possibility of cultivating lentils and other crops in the dryland regions of Saskatchewan and Alberta. A Memorandum of Understanding (MoU) between the two organizations provided an important framework to explore future collaboration.

ICARDA expands its research partnerships in South Asia

ICARDA expanded its portfolio of projects across South Asia in 2012, implementing research on a range of crucial issues

affecting the region's dryland farmers including pulse cultivation, rangeland improvement, crop-livestock integration, and water productivity. The Center also committed itself to regional capacity development and sponsoring graduate studies. The second regional coordination meeting, hosted by the Bangladesh Agricultural Research Institute (BARI), attracted over 300 participants and involved scientists from six countries, including India, Pakistan, Nepal, and Bangladesh. Collaboration with Bangladesh has resulted in improved varieties of lentil, which are expected to generate significantly higher yields and ultimately improve rural incomes and livelihoods.

Attendees included the Honorable K. S. M. Shajahan, Chairman of the Parliamentary Standing Committee, Ministry of Agriculture, who requested ICARDA's expertise in wheat and barley cultivation, protected agriculture, and the utilization of rice fallows.

ICARDA International Congress explores approaches to climate change mitigation in India

ICARDA was co-organizer of the Third International Agronomy Congress in India where the critical issue of agricultural diversification and management in the face of climate variability and change was explored. The conference was held in New Delhi and opened by the Union Minister of State for Agriculture and Food Processing, H. E. Dr. C. D. Mahant, and brought together over 1200 participants.

To better link research solutions with policy action, the meeting included a number of senior government decision makers and leading researchers. Dr. Mahant stressed the importance of food processing for nutritional security, while other presentations highlighted the role of agriculture as an important source of employment and income. H. E. Dr. Shri Tariq Anwar, Union Minister of State for Agriculture and Food Processing, called for action to raise farmers' income levels, and Dr. S. Ayyappan, Director General of ICAR and Chairman of the Board of Governors of the Congress, argued that agriculture and its allied sectors can generate more economic opportunities for rural communities.

Research for development in Palestine: strengthening food security and climate change adaptation

Activities with the Palestinian authorities were strengthened in 2012 with the signing of a MoU and the implementation of a series of initiatives aimed at enhancing the Territory's food security. The MoU, which was signed in Amman by Dr. Ahmad Majdalani, former Acting Minister of Agriculture for the Palestinian National Authority, sets out an ambitious research-for-development agenda. This includes crop improvement initiatives, sustainable water management, adaptation to climate change, and strengthened policies and institutions. Emphasis has also been placed on improving the capacity development of national research and extension systems.

ICARDA's commitments to the Territory's agricultural development were highlighted during a workshop in October, co-organized with Palestine's National Agricultural Research Center (NARC). Hosted by Walid Assaf, Minister of Agriculture, the event attracted a range of partners, including representatives from government, NGOs, and universities. Attendees acknowledged the continued financial contributions of the Arab Fund for Economic and Social Development (AFESD) and the Government of the Netherlands whose support has made ICARDA's activities possible.

Raising strategic crop productivity in Africa

ICARDA expanded its activities across Africa in 2012, leading the wheat component of a CGIAR initiative to develop the continent's strategic crops. Implemented in 22 countries alongside the lead CGIAR center, IITA, with AfricaRice, and IFPRI, the program also targets the cultivation of cassava, maize, and rice. ICARDA's contributions will focus on research platforms in Ethiopia, Nigeria, and Sudan – with additional research sites in eight other countries.

The ambitious five-year initiative aims to reduce poverty and improve food security through capacity building and technology development and dissemination. Planners predict a range of positive impacts – improved yields of up to 20%, a 20% increase in the number of households achieving food security, and a 60% rise in average household incomes. The African Development Bank (AfDB) has committed US$63 million to the initiative – with a further US$24 million donated as in-kind contributions from national research programs in target countries.

Improving seed systems in Ethiopia

A robust, high-yielding seed system can notch up productivity and profits on farmlands – and strengthen food security at the national level. Ethiopia is the largest producer of wheat in sub-Saharan Africa but its wheat farmers have struggled with poor productivity and, more recently, a virulent attack of rust disease that devastated their crops. ICARDA's scientists, working in partnership with the Ethiopian Institute of Agricultural Research, have turned around wheat farming for smallholder farmers across several major growing regions through the use of focused duplication and dissemination approaches.

Rust-resistant, high yield wheat varieties combined with the practice of fast track seed multiplication is increasing yields – sometimes by almost two-fold – and reaping higher profits. In another effort, under the Africa Rising initiative, ICARDA is helping smallholder farmers in Ethiopia's Bale Highlands improve yields and incomes through improved varieties of faba bean, field pea, lentil and chickpea seeds, combined with seed multiplication. The partnership is demonstrating and promoting seed multiplication methods for redistribution during the planting season to improve the cropping systems. ICARDA's scientists have also shared their expertise with local researchers and rural development specialists, teaching them about seed quality and measurement; seed production principles and techniques; and alternative approaches to seed delivery. Both of these initiatives are supported by USAID.

The Turkey-ICARDA partnership was expanded to include new research initiatives, including a wheat rust program at the Aegean Agricultural Research Institute. This initiative is a primary line of defense against the disease for developing countries. Director General, Dr. Mahmoud Solh; Board Member, Dr. Masum Barak, Director General of Agricultural Research, Ministry of Agriculture and Rural Affairs, Turkey; and Board Chair, Henri Carsalade, meet with Turkish partners.

ICARDA delegation to Iraq: ICARDA Director General, Dr. Mahmoud Solh, met the Iraqi Minister of Agriculture, H. E. Izz Al-Din Al-Dola. A subsequent inception meeting, involving all major stakeholders, planned the implementation process: detailing action plans, designating responsibilities, and reaching agreements on capacity development needs.

Building national research capacity in Libya

A new phase of collaborative research was initiated with Libya in 2012, promising to strengthen national research capacity and generate positive impacts in the areas of water management, cereal improvement, and small ruminant production. Part of an on-going commitment to agricultural development in the North African country, these activities were outlined in a five-year agreement signed with Libya's Agricultural Research Center (ARC).

The agreement follows a high-level meeting between Eng. Sulaiman Abdel Hamed Boukharrouba, Minister of Agriculture, Animal Health, and Marine Resources, and Dr. Mahmoud Solh, ICARDA's Director General. Future plans include efforts to upgrade research facilities and equipment, strengthen ARC's documentation unit, and link ARC with international research centers. Discussions with ARC staff and ministry officials later established a framework to guide negotiations over future work plans and budgets. Relations were also strengthened with the National Biotechnology Laboratory in Tripoli. A meeting with the lab's Director General, Dr. Nabil Nattah, resulted in a commitment to a MoU that would promote the use of biotechnology applications in plant breeding and horticulture.

Encouraging conservation agriculture in North Africa

ICARDA's cropping systems specialists are expanding their expertise in conservation agriculture to smallholder farmers across North Africa in a new project. While the conservation approach has brought benefits to many of the world's farming production systems, it has not yet been taken up in North Africa on a large scale. It has brought little respite to low-income countries because of the expensive imported seeder machinery required. Teaming-up with a range of partners, ICARDA's scientists are adapting the approach to local needs – encouraging local manufacturers to develop and provide repair of low-cost, zero-tillage seeders. The team is building on its success in several West and Central Asian countries, where conservation agriculture projects, funded by the Australian Center for International Agricultural Research, are attracting the attention of a growing number of farmers. The projects demonstrate lower production costs for comparable increased yields and improved soil health – critical factors for productive dryland agriculture.

Research impact: record wheat yields in Sudan

The positive impacts of ICARDA interventions in Sudan were clearly demonstrated in 2012 when smallholder farmers participating in a collaborative research initiative experienced significant increases in wheat yields. Implemented in Northern State and Gezira (and multiple sites in other countries), the project tests and promotes technology packages, combining improved crop varieties and sustainable water and land management techniques.

Project farmers showcasing these new technologies on small demonstration plots achieved yields that were 27–79% higher than average yields in Northern State, and 43–163% higher in Gezira – despite significant heat-stressed environments. The initiative – entitled Enhancing Food Security in Arab Countries – is supported by Sudan's Agricultural Research Corporation (ARCo) and a range of international donors: the AFESD, the Kuwait Fund for Arab Economic Development, the Islamic Development Bank, and the OPEC Fund for International Development.

The most successful farmers were honored at a ceremony hosted by ARC, which was attended by project stakeholders, including ICARDA's Director General, Dr. Mahmoud Solh. Speaking at the ceremony, Dr. Gaafr Ahmed Abdalla, State Minister of Agriculture and Irrigation, thanked ICARDA for its contributions to agricultural development and predicted that Sudan would achieve wheat self-sufficiency in the near future.

Strengthened seed systems for higher productivity in Afghanistan

ICARDA strengthened its commitment to the development of effective seed systems in Afghanistan in 2012, working alongside the country's Ministry of Agriculture and a host of international partners to explore crucial issues related to seed production and dissemination. A meeting convened to discuss seed policy brought together a broad coalition – including representatives from FAO, the World Bank, ICARDA and the Afghanistan National Seed Organization – to consider appropriate legislation and potential areas of policy reform.

Issues discussed included efforts to limit the seed sector's dependency on government subsidies and donor funding;

Excellence in barley breeding: a special award to the international team led by Dr. Flavio Capettini, ICARDA Senior Barley Breeder, and Principal Investigator, Dr. Ariel Castro, professor at the College of Agriculture of the University of the Republic of Uruguay.

ICARDA scientists exchange with research partners, development specialists, and policy makers from Bangladesh, Bhutan, China, India, Nepal, and Pakistan at the regional coordination meeting hosted by the Bangladesh Agricultural Research Institute.

the development of new varieties and their evaluation; marketing and extension linkages; quality control; import and export regulations; and the ownership and protection of different varieties.

ICARDA previously played a key role in the development of seed systems in Afghanistan: it established a network of village-based seed cooperatives, and helped draft both a seed law – the country's first – and a Code of Conduct for international development agencies. Despite considerable progress in recent years, domestic seed production still falls short of demand, necessitating the need for further external assistance.

Climate change adaptation: hope for farmers in Central Asia and China

Climate change and the increasingly severe droughts that affect Central Asia and China threaten the incomes and livelihoods of the region's smallholder farmers. Using a combination of geographic information systems (GIS) mapping, crop modeling, and socioeconomic assessments, ICARDA and its partners worked with national researchers and decision makers in 2012 to identify policy options that will help farmers adapt to shifting conditions.

The Center was also involved in a new regional research platform – the Center for Dryland Agricultural Ecosystems – which is developing new appropriate technologies and interventions for small producers. Working alongside China's Lanzhou University, the University of Western Australia, and the World Agroforestry Centre, ICARDA scientists are developing new improved drought-tolerant crop varieties, introducing crop-livestock integration, and promoting sustainable water and land management practices.

ICARDA's innovative date palm biotech research recognized

ICARDA's innovative approach to the genetic improvement of date palm received a significant endorsement in 2012 from the government of the United Arab Emirates. The 4th Khalifa International Date Palm Award was given to a team of ICARDA researchers, led by Dr Aladdin Hamwieh, which successfully developed more than 1000 microsatellite markers of date palm – a breakthrough that will assist gene tagging, genetic diversity analysis, and marker-assisted genetic improvement.

Despite the economic and cultural importance of date palm across the Middle East, up to 30% of its production is lost each year – making genetic improvement of this crucial crop a regional priority. The research was conducted in collaboration with a broad range of partners, including the Plant Tissue Culture Laboratory in Qatar, the University of Baghdad in Iraq, and the Institut National de la Recherche Agronomique in Morocco.

This initiative complements previous date palm research conducted by ICARDA and its partners. Funded by the Gulf Cooperation Council and implemented across six Gulf countries, these initiatives have helped to develop and disseminate a range of innovations to improve yields, manage pests and disease, maintain fruit quality, and process date palm products.

Shaping collaborative research in Turkey

2012 was an important year for ICARDA's growing relationship with Turkey – the Center met with high-level Turkish officials and further committed to an ambitious joint research agenda. Policy makers, including Dr. Mehmet Mehdi Eker, the Minister of Food, Agriculture and Livestock, pledged their continued and full support to collaborative research programs. These include efforts to investigate plant pathology and integrated pest management in Izmir, drought research in Konya, small ruminant and rangeland research in Sanliurfa, and winter wheat breeding in Ankara.

The ICARDA–Turkey MoU will also be expanded to include new research initiatives, including a program investigating wheat rust disease at the Aegean Agricultural Research Institute. This initiative will form a primary front of defense against this disease that has caused significant crop devastation across the region in recent years.

Research-for-development program

ICARDA's research for development is put into action through four research programs – that form an integrated approach to improving smallholder crop and livestock production systems to benefit communities living in dry areas.

We use a multi-disciplinary, integrated agro-ecosystems approach, working closely with partner organizations and local communities.

The integrated approach links the research themes with the strong partnerships developed through country offices. An added dimension is the link between research and development that is provided by ICARDA's research-for-development initiatives – large projects that involve clusters of research themes, and national partner and development actors who help test and scale-out technologies and approaches on the ground in a number of regions.

See section on Research-for-Development Initiatives, page 34.

The ICARDA research-for-development program is also intimately linked to the CGIAR Research Programs. The Center leads the CGIAR Research Program on Dryland Systems, and is a partner providing outputs and outcomes in nine other research programs.

ICARDA participation in CGIAR Research Programs

ICARDA is lead center for:

Dryland Systems: Integrated agricultural production systems for improved food security and livelihoods in dry areas

CIMMYT and ICARDA work together on the CGIAR Research Program on:

- Wheat

ICARDA is a partner in:

- Policies, Institutions and Markets
- Grain Legumes
- Dryland Cereals
- Livestock and Fish
- Agriculture for Nutrition and Health
- Water, Land and Ecosystems
- Climate Change, Agriculture and Food Security
- Managing and Sustaining Crop Collections

Crop improvement: biodiversity and integrated gene management (BIGM)

The crop improvement program works to conserve agricultural biodiversity in dry areas and to use these resources to improve food security, nutrition, and livelihoods through breeding. It covers durum and bread wheat, barley, chickpea, lentil, faba bean, grasspea, and forage and pasture crops. BIGM scientists work on biodiversity conservation as well as crop improvement. Activities take both conventional and biotechnological approaches, and include integrated disease and pest management, and seed production and delivery systems to enhance adoption of new varieties.

Integrated water and land management (IWLM)

The water and land management program aims to improve the management of scarce water resources, and to combat desertification and land degradation. IWLM scientists develop technical, institutional, and policy options for improving water productivity in both rainfed and irrigated production systems; for sustainable, equitable, and economic use of all water sources; and for improved land management and drought mitigation. Research focuses on appropriate, effective technologies, such as supplemental irrigation and rainwater harvesting.

Production systems: diversification and sustainable intensification of production systems

The production systems program focuses on improving livelihoods, and reducing risk by intensifying and diversifying traditional production systems. Research covers agronomy, integrated crop-livestock-rangeland systems, market linkages, supporting diversification into higher value crops, and creating new income opportunities through value adding to crop and livestock products. Activities also include improving forages and other feed technologies, conservation agriculture, community-based livestock breeding programs, and protected (greenhouse) agriculture.

Social, economic and policy research

This program aims to better understand rural poverty, livelihood strategies, and gender and youth issues to improve the targeting of research and development investments and accelerate technology adoption. Activities include poverty mapping, value-chain and market analysis, and policy and institutional options in agriculture. Adoption and impact studies help identify barriers to the adoption of new technologies, provide lessons for the design of research and development programs, and provide quantitative evidence of the returns to research investments.

Regional and country programs

- Arabian Peninsula Regional Program
- Central Asia and Caucasus Regional Program
- Highlands Regional Network
- Nile Valley and Sub-Saharan Africa Regional Program
- North Africa Regional Program
- South Asia and China Regional Program
- West Asia Regional Program

Results and achievements in 2012

Technology and policy packages to improve country food security

Faced with more unpredictability in climate patterns and growing populations, countries with dryland production systems need to apply a combination of options, to ensure food security.

A number of innovative technology and policy packages have been developed and refined across ICARDA's country partnerships in 2012. These approaches bring evidence and practices that are ready for scaling-up and for use by dryland agriculture countries worldwide.

Here are highlights of the achievements of ICARDA's science partnerships in 2012.

Improving crops to combat disease and drought

Screening of wheat stripe rust at ICARDA.

Wheat research: tackling a neglected problem

Stripe rust, or yellow rust, is a fungal disease that stunts and weakens wheat plants. The disease has decimated wheat yields in recent harvests, increasing food prices and threatening rural livelihoods and regional food security.

Stripe rust has long been endemic in many non-tropical dryland countries. But the problem is now getting worse. Climate change is causing stripe rust to spread rapidly to areas previously unaffected. Additionally, aggressive new types of stripe rust are emerging, favoring warmer climates and fueling the spread of the disease nearer the Equator.

Despite the widespread damage caused by stripe rust, investments to tackle the problem have been minimal. Instead, the disease's deadly relative, stem rust, has taken center-stage in the research agenda. Recognizing that the effective surveillance and control of stripe rust have never been more urgent, ICARDA has recently concentrated its efforts as a global leader in this field.

During 2012, ICARDA tackled the problem of stripe rust from two angles: identifying, breeding, and distributing varieties of wheat resistant to the disease, and setting up surveillance systems to monitor and combat the problem. In the next stage of the research, ICARDA will work with the Government of Turkey to establish a wheat-testing laboratory.

RESULTS IN 2012

Developing crop resistance

One way of combating stripe rust is to breed strains of wheat that are resistant to the disease. In 2012, ICARDA scientists studied existing wheat plants to identify germplasm suitable for breeding resistant cultivars.

In 2012, ICARDA screened more than 5000 cultivars and landraces for resistance to all three forms of wheat rust – stripe rust, leaf rust, and stem rust. The scientists did this by inoculating the plants with rust spores and observing which genotypes had the most healthy plant growth at both seedling and adult stage. These resistant plants will provide genetic material for the next stage in the work on stripe rust; to breed cultivars with all-round resistance to the disease, suitable for a variety of environmental and climatic conditions.

Delivering seed to farmers

ICARDA distributed to farmers the seed of wheat varieties that, so far, show the strongest resistance to stripe rust. These varieties are the result of previous ICARDA work breeding bread and durum wheat varieties (see case study on Ethiopian seed systems, page 26).

Setting up surveillance systems

In 2012, ICARDA continued working closely with wheat-producing countries to monitor stripe rust outbreaks and develop early warning systems. These systems raise the alarm for immediate spraying programs and are essential for dealing with rapid outbreaks of stripe rust.

Because stripe rust spreads so quickly, and is appearing in areas previously unaffected, repeated surveys of wheat rust occurrence are required to stay abreast of the problem. For this reason, ICARDA has continued its work with national partners to carry out surveys in Morocco, Iraq, Iran, Sudan, Ethiopia, Turkey, Azerbaijan, Uzbekistan, and Georgia. These surveys show where stripe rust is most virulent, and where crop resistance is strongest, and are

an essential component of ICARDA's overall work in tackling the problem.

Next steps: localized testing

As well as refining its plant breeding in the laboratory, ICARDA continues to test wheat strains in stripe rust hotspots in West and Central Asia and North Africa. Work carried out by ICARDA in 2012 showed that the resistance or non-resistance of wheat to stripe rust may be site-specific and depend on local environmental or climatic conditions. Localized testing is therefore essential if genetic resources are to provide farmers and national wheat production systems with optimal protection in the future.

Creating access to rust testing and research

In a partnership with the Government of Turkey, ICARDA is planning the world's first Cereal Rust Research Center in the developing world. The Center will also study rust races from outside the country and will operate year round. The laboratory will provide low-income countries with a rapid testing service for wheat samples affected by, or showing resistance to, rust.

Until now, rust laboratories in France, Denmark, and the USA have been the main providers of wheat-testing services. But access to these laboratories is limited and the tests are expensive. In contrast, the laboratory in Turkey will be in the heart of the region most affected by rust and will offer an on-hand affordable testing service to countries to monitor their stripe rust risks.

The center will operate under strict biosafety conditions. This will allow researchers to study their own germplasm against exotic rust races that have not reached their countries yet. This avenue of research, compared to laboratory breeding which involves exposure to exotic landraces and cultivars, may yield wheat varieties with greater resistance to stripe and other forms of rust in the long term.

Drought-tolerant chickpea – a promise of stable harvests for farmers on marginal lands

Chickpea is a major pulse crop in South and West Asia, North and sub-Saharan Africa, Australia, and Mexico. It is an important source of protein for poor farming families and contributes significantly to regional food security.

The major constraint to chickpea production is drought, especially towards the end of the growing season. To help countries increase crop yields when water resources are scarce, ICARDA has been breeding drought-tolerant strains of chickpea.

ICARDA's approach combines conventional and biotechnology research to identify molecular markers for drought tolerance in chickpea. These markers are used to make future breeding programs more precise.

Identifying molecular markers

ICARDA evaluated 181 chickpea recombinant inbred lines for drought-related and yield-related traits. These were first obtained by crossbreeding varieties that survived severe drought when planted late in the growing season.

The ICARDA scientists analyzed the genetic characteristics of the most healthy and productive plants. This analysis led to the identification of two molecular markers for drought tolerance. An allele of one of these markers explained 80% of yield increases when chickpea was planted late under drought stress conditions.

Next steps: future breeding

The markers identified by ICARDA will enable breeders in the developing world to single out in the laboratory other chickpea cultivars which are drought tolerant. The benefit of this 'marker-assisted selection' is that it will make the breeding process faster and more precise. As a result, farmers in drought-affected regions will see rapid improvements in chickpea production, enabling them to improve livelihoods and boost food security.

Evaluating chickpea germplasm under water stress conditions.

Donors

- Grains Research and Development Corporation (GRDC), Australia

Managing genetic resources

The ICARDA genebank holds 141,052 accessions in its active collection, of which 96.2% are safety duplicated and 78.46% are also stored in the Svalbard Global Seed Vault (see table). In light of the prevailing situation in Syria, priority was given to the dispatch of 23,950 accessions to other genebanks for safety duplication and temporary storage. All routine activities have continued, including the collecting of 1985 new accessions and the multiplication and characterization of more than 11,000 accessions planted at Tel Hadya. Collaborators in 11 countries received 1446 accessions and 3681 were provided to ICARDA scientists.

Number of accessions conserved in active collection and safety duplicated

Taxon	Total accessions in active collection	No. and % safety duplicated		No. and % conserved at Svalbard	
Barley	28,465	25,377	(89.2%)	24,393	(85.69%)
Wild *Hordeum*	1989	1954	(98.2%)	1497	(75.26%)
Durum wheat	19,635	19,626	(99.9%)	18,884	(96.18%)
Bread wheat	14,100	14,072	(99.8%)	12,158	(86.23%)
Primitive wheat	912	911	(99.9%)	625	(68.53%)
Wild *Triticum*	1584	1584	(100%)	1569	(99.05%)
Aegilops	4057	4032	(99.4%)	3073	(75.75%)
Wheat hybrid	50	50	(100%)	0	(0.0%)
Lentil	10,496	10,493	(99.9%)	10,201	(97.19%)
Wild *Lens*	587	587	(100%)	574	(97.79%)
Chickpea	14,214	14,032	(98.7%)	10,332	(72.69%)
Wild *Cicer*	270	265	(98.1%)	144	(53.33%)
Faba bean	9542	9426	(98.8%)	6060	(63.51%)
Medicago	8398	8348	(99.4%)	6491	(77.29%)
Lathyrus	3996	3966	(99.2%)	2434	(60.91%)
Pisum	6106	6048	(99.1%)	3796	(62.17%)
Vicia	6144	5930	(96.5%)	3411	(55.52%)
Range and pasture	5802	4473	(77.1%)	3407	(58.72%)
Trifolium	4536	4303	(94.9%)	1605	(35.38%)
Other cereals	169	169	(100%)	18	(10.65%)
Total	**141,052**	**135,646**	**(96.2%)**	**110,672**	**(78.46%)**

Partners

Yemen
- Agricultural Research and Extension Authority (AREA)
- Social Fund for Development (NGO)
- Aden University
- Sanaa University

Tunisia
- National Genebank of Tunisia

Morocco
- INRA

Greece collection mission
- Department of Forestry and Management of Natural Environment, Laboratory of Rangeland Science, Greece
- Agricultural Research Centre of Northern Greece
- Greek GeneBank
- AgResearch Grasslands
- Margot Forde Germplasm Centre, New Zealand

Cyprus collection mission
- Genebank and Herbaria section of the Cypriot Agricultural Research Institute, Nicosia
- AgResearch Grasslands
- Margot Forde Germplasm Centre, New Zealand

Jordan collection mission
- Jordanian Genebank

Donors
- The Arab Fund for Economic and Social Development
- Global Crop Diversity Trust
- Netherlands Government
- Islamic Development Bank
- The World Bank, Rainfed Agricultural and Livestock Project

RESULTS IN 2012

Promoting on-farm conservation of dryland agrobiodiversity

For some 25 years, ICARDA has been developing a holistic approach to community-driven in situ/on-farm conservation of dryland agrobiodiversity. These practices have been put in place in Jordan, Lebanon, Palestine, and Syria.

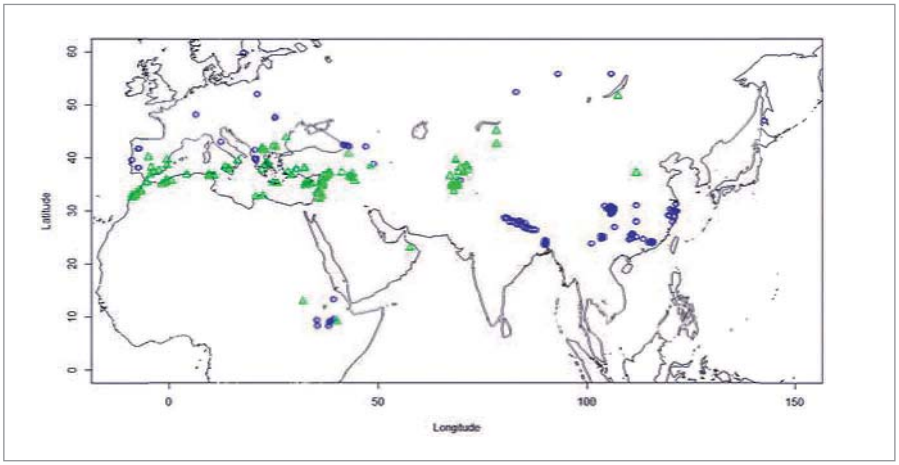
In Yemen, ICARDA provided technical backstopping and training to the World Bank's Rainfed Agriculture and Livestock Project which targets the conservation of landraces of major crops. The project has established 70 seed producers' groups, the members of which are involved in participatory improvement of their landraces followed by seed multiplication, cleaning, and treatment. By the end of 2012, 428 farmers were members of groups and these groups produced over 180 tons of quality seed.

2000 new accessions

ICARDA jointly organizes collecting missions with national programs and other partners. Missions target novel genetic diversity based on the global databases for wheat, barley, lentil, chickpea, faba bean, grasspea, and their wild relatives. Since 2010, ICARDA has added more than 3500 new accessions from 12 collecting missions.

In 2012 the ICARDA genetic resources team participated in three collection missions. A biodiversity conservation mission in Greece – the country's first international collaborative germplasm collecting mission in a decade – covered 59 sites in nine provinces and yielded 1195 new acquisitions of 212 species in 51 genera for the national genebank. The second joint collecting mission, in Cyprus, targeted crop wild relatives, and forage and rangeland species, focusing on those with potential for salt tolerance. This mission yielded 252 accessions of 63 species in 20 genera. The third mission was organized with Jordanian partners. This mission targeted landraces and wild relatives with potential for heat and drought tolerance. The team collected 368 accessions of cereals, food legumes, and forage legumes.

FIGS – a new approach to mining agricultural genebanks to speed the pace of innovation and food security



Pinpointing faba bean traits that resist climate change. This map shows the geographic distribution of the collection sites for the faba bean data set from dry environments (green triangles) and from wetter environments (blue circles). Eight climatic variables were used to determine the dryness or wetness of a site.

Since its introduction six years ago, the '*Focused Identification of Germplasm Strategy*', known as FIGS, has been continuously refined by the ICARDA team that created it.

In 2012, detailed work and its application in a number of research projects has resulted in improvement of the FIGS tool, and the presentation and publishing of several papers on how this 'focused' approach to mining the world's agricultural genebanks can improve the effectiveness of crop breeding programs – and ultimately, national food security. Three conference papers were presented and three peer-reviewed journal articles were published in 2012.

The FIGS tool uses cutting-edge applied Bayesian mathematics to match plant traits with geographic and agroclimatic information about where the samples were collected. This allows very rapid searching of thousands of plant samples conserved in genebanks to pinpoint high-potential areas where traits that meet a breeder's strategy, for example, disease resistance or adaptability to extreme weather conditions, are likely to have evolved.

Accessions from these areas are more probable to contain the traits and genes of interest than accessions from other areas. Smaller subsets of genetic material can be assembled that have high potential for the plant traits that breeders need to develop robust new varieties. FIGS is now at the validation stage, requiring widespread 'road-testing' and implementation funding before it is rolled out to become an accepted and valued tool for gene discovery.

Current approaches to identify plant genetic traits range from 'lucky dip' to 'core collection' approaches. The 'core collection' approach aims to capture as much genetic diversity as possible, using a small subset of 5–10% of a total collection. A core (or reference) collection offers the benefit of an easy-to-manage set of plant genetic material. But this approach does not necessarily deliver the material that is most likely to contain the specific traits required by breeders as they look to improve crop performance.

Some recent FIGS results

Recent investigations by the FIGS team are showing how this approach gets results where large-scale 'screening exercises' have previously failed. New genes for resistance to Powdery Mildew, Sunn Pest, and Russian Wheat Aphid have been identified in relatively small plant genetic FIGS sets. In a desktop study using the results of a large screening exercise to identify genes conferring resistance to wheat stem rust strain 'Ug99', the FIGS method proved highly efficient at discerning environments that yield resistant plants and those that do not.

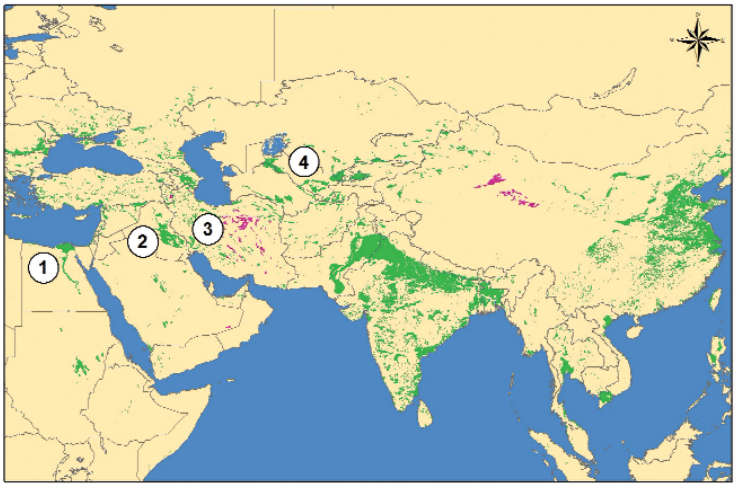
Another encouraging example is the multi-year search by an ICARDA researcher – of thousands of plant types in the ICARDA genebank – for bread wheat types with resistance to the Sunn Pest insect, which causes major economic losses to crops in non-tropical dryland countries in the developing world.

Over this period, no resistant accessions (individual samples conserved by a genebank) were identified using classic random search approaches. Recently, using a specially targeted FIGS subset of potentially resistant plant material, the same researcher found nine accessions with resistance to Sunn Pest at the seedling stage which are now being used in the ICARDA breeding program, and are available to other breeders on request.

Partners
- Vavilov Institute, Russia
- Nordgen genebank, Nordic Region
- Australian Winter Cereals Collection

Donors
- Grains Research and Development Corporation, Australia

Managing soil salinity to boost food security



Irrigated areas with ICARDA focus on salinity management.

ICARDA's experience in supporting partners to manage salinity in their production systems can benefit many more countries – for policy options, farming practices, and management frameworks.

The build-up of salts in soil (salinization) affects agricultural land right across the world, but is most acute in dry areas. Crop growth and yield are poor. This impacts badly on farmers, reducing incomes or even forcing them off the land. Salinization is a particular problem in irrigated agriculture, reducing the world's irrigated area by 1–2% each year.

Tackling the effect of salinization in agriculture is crucial for achieving food security. But in many affected countries, clear strategies for reducing or managing salinity in agriculture and investing in addressing the problem are limited. Through its country partnerships with agricultural ministries and research agencies in Central Asia, Egypt, Iraq, and Iran, ICARDA is developing research-based coping strategies for farmers and water managers dealing with salinization. This experience, the practices developed with partners, and research can benefit other areas of the world where agricultural production is threatened by increasing levels of salinity, such as China, Pakistan, India, and other countries.

During 2012, ICARDA worked with farmers and water managers in regions affected by soil salinization to develop and implement science-based techniques for improving agriculture. The Center also used remote sensing and field surveying to create salinity maps: an invaluable resource in establishing where to concentrate resources.

The expertise and guidance provided by ICARDA offer a springboard to partner countries. With ICARDA's support, several of these nations are now in a position to continue activities towards the development of national strategies for managing salinity and improving food security.

RESULTS IN 2012

Targeting affected regions

In Egypt's Nile Delta, ICARDA studied salinity problems in irrigation water, caused by the shallow groundwater associated with the delta's flat terrain. The research also considered how artificial surface and sub-surface drainage systems contribute to improved salinity management. Actively managing drainage systems, as opposed to the more traditional passive drainage systems, allows for more efficient water use while optimizing salt leaching from the soil.

In West Asia, ICARDA's research and development targeted the Mesopotamian plain in Iraq and the Lower Karkheh Basin in Iran. In the former, water availability is limited, irrigation water is affected by salinity in the plain between the Tigris and Euphrates rivers, and millennia of irrigation practices have led to a widespread accumulation of salts in the soil and groundwater. In the latter, insufficient natural drainage and increasing water shortages have led to the salinization of agricultural land. Improved irrigation management at the farm level reduces water seepage into groundwater, thus reducing the processes contributing to increased salinity. In the Mesopotamian plain, the introduction and development of a salinity management framework for a regional approach to salinity management was the main output of the project.

Installation of subsurface drainage pipe using specialized equipment.

Accumulated salt is removed from an evaporation pond, one option to manage salt on-farm.

In Central Asia, ICARDA considered how the expansion of irrigated areas has reduced water resources overall and created a build-up of salts in the soil. In particular, ICARDA studied methods to manage soil salinity under different climate change scenarios, using increased drought and salt-tolerant wheat varieties and improved water and soil management practices.

Taking a two-fold approach

Scientists at ICARDA follow two main strategies for managing soil salinization: fighting salinity and living with salinity. Fighting salinity involves reducing the impact of salinity on potentially productive lands. One way to do this is to reclaim or install drainage systems that allow salts to be washed out of the soil in combination with better irrigation water management, creating salinity levels acceptable to productive crops. The national agricultural research organizations partnering with ICARDA in West and Central Asia and the Nile Delta are applying improved management systems.

Living with salinity is a more pragmatic approach whereby ICARDA looks at ways of adapting to more saline conditions. For example, during 2012, ICARDA worked with national agricultural research partners on improving wheat varieties in Uzbekistan. Another activity involved a socioeconomic study in the southern part of Iraq to investigate alternative income sources to salinized agriculture.

Working with farmers and water managers

To ensure the success of interventions addressing problems of soil salinity, ICARDA scientists' work is at both field scale and regional scale. A prime example of this in 2012 was ICARDA's work in the Nile Delta. Here, ICARDA worked with farmers and managers to install field drains creating a flow of saline water away from the farmland. The Center also worked with regional planners and water managers to ensure that this flow is kept separate from irrigation water, thereby avoiding adverse impacts for farmers downstream.

Next steps

Salinity management cannot be done only at the farm level. The activities that ICARDA conducted in 2012 are working towards the development of a road map to implement a salinity management framework. This framework contributes to shared objectives among all involved stakeholders (e.g. policy makers, water managers, and farmers) across different spatial scales (regional, irrigation project, and farm level). This road map will be the guide towards improving integrated salinity management across dry areas.

Partners

Iraq salinity project

- Government of Iraq
- Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia
- University of Western Australia
- International Water Management Institute (IWMI), Sri Lanka
- International Center for Biosaline Agriculture (ICBA), United Arab Emirates

Donors

- Australian Centre for International Agricultural Research (ACIAR)
- Australian Agency for International Development (AusAID)
- Government of Italy

The Iraq salinity assessment: strategies and solutions to ensure food security in lands faced with saline agriculture

A partnership of the Government of Iraq, with research led by ICARDA and international and Australian centers.

In 2012, ICARDA supported the Government of Iraq to complete the final stage of a project focused on the Mesopotamian plain in central and southern Iraq. The purpose of the project was to analyze irrigation practices, salinity levels, and management strategies and identify innovative solutions and investment options for coping with salinization.

In meeting these aims, the ICARDA-led research proposed evidence-based practical solutions to improve the livelihoods of rural communities and smallholder farmers, who are put at risk by increasing salinity on their lands.

Multi-national, integrated research

In conducting the Iraq research, ICARDA headed a multi-national research team. This team included partners in Australia where similar salinity problems affect the Murray-Darling river basin. What makes the Iraq research stand out is its integrated approach. Rather than simply focusing on rehabilitating irrigation infrastructure, the work also looked at production systems, crop diversification, and drought-tolerant crop varieties.

Assessing the problem

The Iraq study estimated that soil salinity on the Mesopotamian plain is much more widespread than previously thought, with virtually all areas affected. It observed that the slight slope of the river plains and low rainfall in the region limit natural drainage. As a result, salts from the irrigation water of some millennia have accumulated in the topsoil. These salt concentrations are much higher (two to three times) than those in the groundwater because of the higher temperatures in the upper parts of the soil.

The ICARDA-led team calculated that salinization in Iraq leads to agricultural losses of around US$300 million per year. It also observed that current efforts to manage soil salinity in Iraq are piecemeal, with little emphasis on controlling salinity in surface waters.

Identifying solutions

The ICARDA-led research highlighted a number of recommendations for tackling soil salinization to ensure future food security. In particular, it advised that improving drainage facilities is paramount for ensuring that Iraqi farmers are able to grow crops successfully in the future.

The research also recommended identifying farming systems suitable for different areas and educating farmers on the technical and management aspects of these systems. Also it highlighted the usefulness of allocating water based on crop needs rather than infrastructural capacity.

Other solutions included controlling surface water salinity by implementing a management framework for the entire Tigris–Euphrates river system, and focusing investment on land and water with the highest capability for food production. Additionally ICARDA identified the growth of salt-tolerant forage species for ruminant livestock as the only opportunity to use land and water resources that are too saline for conventional crops and forages.

Developing innovative models

As part of the Iraq project, ICARDA developed an innovative approach for modeling and mapping salinity using remote sensing and field surveying. The models will inform management decisions, such as where to develop agriculture and where to control salinity.

The models developed are applicable to dryland areas beyond Iraq. The ICARDA-led team therefore intends to share the innovation with scientists and policy makers worldwide.

Conservation agriculture: lower costs, higher profits, cleaner environment

The benefits of conservation tillage: farmer, Mohammed Kher Semalka, from eastern Syria, shows off his crop sown with a zero-tillage seeder in late 2012.

Zero-tillage farming produces immediate economic gains and long-term environmental benefits

Dust storms are common in many dry areas, especially in developing countries. Not only is this a risk to human health and a public nuisance, but the dust comes from the most fertile topsoil in agricultural fields, reducing their productivity. As populations grow and climate change increases the threat of more frequent and more severe drought and dust storms, so food production techniques need to change and adapt.

ICARDA's work on promoting the use of conservation agriculture in low-income countries is building on the success of trial projects in the arid climates of Northern Iraq and Syria. Extending the method and its benefits to other regions, particularly the Indian subcontinent and sub-Saharan Africa, is a high priority. ICARDA's expertise in conservation agriculture is based, not just on its work in Iraq and Syria, but on long-term research and evidence from its partners in high- and middle-income countries. Despite the clear benefits and successes of conservation agriculture around the world, it is little practiced in less wealthy countries. This is a missed opportunity that ICARDA is working to change through education, demonstration, and policy and technical support. ICARDA programs are expanding throughout the non-tropical dryland regions to support mainly smallholder farmers, who are the most vulnerable to crop failure and the most in need of innovation and low-cost technology.

RESULTS IN 2012

Challenging perceptions, changing practices

ICARDA chose to focus on reduced tillage as the first step towards introducing the conservation system, rather than promoting all principles at once. This enables farmers to introduce changes incrementally, reducing risk and allowing gradual change. The elimination of plowing (zero-tillage) is in itself a major change in thinking. It means crops can be sown earlier, providing immediate improvements in the efficiency of water use and crop yields in most years. Crop residues are an important source of feed for livestock producers in the region, and it is a major challenge to convince farmers to maintain cover to reduce erosion and improve soil. Crop rotations are currently dominated by cereals, and grain legume crops are not widely grown, but a more diverse rotation can have greater benefits. ICARDA will build on its incremental approach as part of its on-going work to support farmers.

Though the benefits of zero-tillage can be considerable, the challenge is to change the widespread misconception that plowing is essential for weed and pest control, and seed bed preparation. Through education, demonstration and support, development partners and policymakers can help raise awareness and promote rapid adoption of zero-tillage. The experience of wealthier countries provides important evidence, as does the experience of farmers in poorer countries who have successfully applied the principles of conservation agriculture.

A practical constraint to wider adoption is the limited availability of appropriate and affordable seeding machinery, critical for the approach to succeed. Zero-tillage planting requires specially designed seeding equipment that is capable of sowing into undisturbed soil where crop residues have been retained. These seeders also maximize seed germination and crop establishment allowing farmers to save up to two-thirds on seed costs.

Another green revolution for low-income countries

Conservation agriculture is a proven approach to food production with a lower environmental impact and better long-term outcomes for soil and water conservation, air quality and greenhouse gas emissions. The approach is based on three principles:

1. The **elimination of plowing** has a wide range of benefits, both economic and environmental. Less plowing (tillage) means less fuel consumption and less breakdown of soil organic matter, thereby reducing greenhouse gas emissions. Minimal disturbance improves soil structure and allows more efficient use of rainfall or irrigation because it infiltrates better and is more available for plant growth
2. The **retention of crop residues** from previous crops on the soil surface, reduces soil temperatures over summer and water loss though evaporation, and most importantly, protects the soil from wind and water erosion. As the crop stubble breaks down it also releases nutrients into the soil and can increase soil organic matter
3. **Diverse crop rotations** reduce the build-up of weeds, pests, and diseases, and the use of legumes can reduce nitrogen fertilizer inputs for following crops.

These three principles – no plowing, stubble retention and crop rotation – reduce erosion, greenhouse gas emissions, fuel and labor costs, and increase soil fertility and productivity in the long term. The long-term environmental benefits of conservation agriculture emerge gradually over a few years, and are most effective when applied over large areas of the landscape. On the other hand, some economic benefits are immediate and can be enjoyed through adoption on a much smaller scale. Conservation agriculture was instrumental in increasing agricultural production in Brazil, Australia, Canada, and other countries in the past two or three decades. Evidence shows that on average the approach gives at least the same yields as conventional tillage, often more, and requires less time, energy, and investment in the form of seeds, fuel, fertilizer, and labor.

Dr Jacky Desbiolles, ICARDA research partner, University of South Australia, and trainees from Iraq discuss seeder performance.

Zero-tillage seeders from abroad are too heavy, complex and expensive for small-scale farming. But this obstacle can be overcome by supporting the development of local industry to manufacture and repair simple zero-tillage seeders or converting existing seeders to zero-tillage.

Once farmers are aware of the issues with plowing and simple and affordable zero-tillage seeders are available, they can be encouraged to test them free of charge in their own fields and share their experiences with their community. Ideally this process should involve all stakeholders – researchers, extension specialists, manufacturers and other private industry partners, policymakers, and farmers. ICARDA's work over the past seven years in Syria and Iraq has shown that by using this participatory approach the results speak for themselves. Farmers are rapidly convinced that tillage is not only unnecessary, but damaging, and the zero-tillage technology works. They are typically keen to purchase new zero-tillage seeders or convert their own seeders, and interest spreads quickly to neighboring villages and towns. One result of ICARDA's work on conservation agriculture speaks volumes about the benefits: farmers who convert to zero-tillage rarely, if ever, return to plowing.

The next challenge is to promote the retention of crop residues and diverse rotations, so that the full benefits of conservation agriculture can be realized.

The bottom line

Work by ICARDA and partners, particularly in Syria and Iraq, have shown significant reductions in costs and increased profits for small-scale farmers in developing countries adopting zero-tillage and early sowing. Based on the field trial results and farmer experience, conservation agriculture can increase farmers' income from wheat by up to US$200/ha in Syria and up to US$300/ha in Iraq.

In Syria, a ton of wheat sells for US$400, so a yield increase of 20%, or an additional 250 kg/ha, increases earnings by US$100/ha. The elimination of two tillage operations saves US$40/ha. Reducing the seeding rate from 300 kg/ha (the traditional broadcast rate) to 100 kg/ha saves US$80/ha. On the down side, zero-tillage may require increased herbicide applications, costing about $20/ha. Thus, overall, the zero-tillage package increases the profitability of wheat in Syria by about US$200/ha. Zero-tillage was used on about 30,000 hectares of crops in Syria in 2011/12. Assuming this was all wheat, the most commonly planted crop, the total benefit to the Syrian economy would have been US$6.0 million or more.

In Iraq, where wheat sells for US$700/ton, a 20% yield increase brings in an additional US$175/ha, and optimal seeding saves US$140/ha. Factor in the same savings from reduced plowing and the cost of herbicides, and conservation agriculture increases profitability by US$335/ha. In Iraq the area using conservation agriculture is about 8,000ha, with a net benefit of about US$2.7 million. The more efficient use of rainfall or irrigation in conservation agriculture also reduces vulnerability to drought and crop failure so food security is improved. The wider environmental benefits have not yet been quantified.

Partners
- University of Mosul, Iraq
- Ministry of Agriculture, Iraq
- University of Western Australia
- University of Adelaide, Australia

Donors
- Australian Centre for International Agricultural Research (ACIAR)
- Australian Agency for International Development (AusAID)

Dr. Abdul Sattar, University of Mousul, Iraq, discusses the development of conservation agriculture with farmers from Tel Kief in Iraq.

Uptake of conservation agriculture in northern Iraq and Syria – phase 3

Despite the added challenges of working in a conflict-affected region, the Conservation Cropping in Northern Iraq and Syria project began its third phase in 2012, with funding from ICARDA's Australian partners, ACIAR (Australian Centre for International Agricultural Research) and AusAID. This phase builds on the success of earlier work on promoting the adoption of reduced tillage seeders and improving crop practices in the Iraqi governorates of Nineveh, Kirkuk, Saladin, and Anbar, and in Syria, where much of the adaptive research was conducted.

The number of farmers adopting and recognizing the benefits of conservation agriculture continues to increase, and the area sown without tillage is expanding. Since 2005, when no farmers were using zero-tillage, the land under conservation cropping has grown to 7,800 ha in Iraq and to roughly 30,000 ha in Syria. This is a significant achievement, but it is still a fraction of the total cropped area.

Savings and increased revenue

In Syria, fuel shortages due to the on-going conflict there are helping to accelerate adoption of the less energy-intensive techniques of zero-tillage farming. One farmer said that if it had not been for his zero-tillage seeder and the elimination of plowing, he would have only been able to afford to plant a quarter of the crop that he was able to sow in late 2012. Food security and economic stability both benefit from the adoption of conservation approaches.

The development of low-cost, zero-tillage seeders suitable for smallholdings, manufactured locally, or converted from conventional seeders, has been a key part of success in Syria and Iraq. The project brought in agricultural engineering expertise from Australia to improve the capacity of manufacturing and servicing industries supporting farmers who convert to the zero-tillage approach. Seven manufacturers of the special seeders are now operating in Syria, and production of the first zero-tillage seeder was completed in Mosul, Iraq. This is an opportunity for local industry to help overcome a barrier to the wider use of conservation agriculture.

Evidence from field trials and the experience of farmers themselves suggests some key lessons for effective conservation cropping:

- Stop plowing and, if needed, kill weeds at sowing with a herbicide
- Plant as early as possible
- Use zero-tillage seeders for all crops
- Use good quality seed of the best adapted varieties
- Reduce seed rates; 50–100 kg/ha for cereals; 100–150 kg/ha for pulses
- Sow consistently at a depth of 4–6 cm and use the best fertility and weed/disease/pest management available
- Include non-cereals in the rotation, if possible
- Keep crop residues on the soil surface if possible, but graze the stubble if needed.

Reversing rangeland degradation and improving productivity

Making rangelands more resilient: ecological-based models were used to combine environmental parameters with grazing pressure to assess the vulnerability of three plant species to climate change.

Rangelands are the dominant land use type across the non-tropical dryland regions of the developing world. They fulfill multiple roles as sources of subsistence, food security, income, and social status. They provide income for the poorest and most marginal pastoral and agro-pastoral communities raising herds of sheep and goats.

Despite their significant economic and cultural value, rangelands suffer from low productivity and increasing rates of degradation and desertification. Unless immediate action is taken their capacity to support livelihoods and vital ecosystems is likely to rapidly decrease in the near future. A combination of environmental and human factors is contributing to this worrying scenario. Already low potential – their soils tend to be shallow and rocky – rangelands are also adversely affected by frequent droughts and overgrazing, posing an increasing threat to food security in all dryland countries.

Working with country partners, ICARDA's Rangeland Research Program aims to reverse rangeland degradation and desertification through the development of sustainable integrated range–livestock production systems, and the development and adoption of new technologies. The program uses a participatory and multi-dimensional approach involving all those involved – government agencies, farmers' organizations and farmers, rural communities, and fellow researchers in national agricultural programs. By adopting new advances in technology and understanding, it develops and adapts proven interventions that address degradation while raising productivity sustainably.

RESULTS IN 2012

Modeling the impact of climate change

Inventories, monitoring, and appropriate mapping are needed to assess the use and condition of rangelands ensuring sustainable products for future generations.

Ecological-based models combining environmental parameters with grazing pressure have been used to assess the vulnerability to climate change of three rangeland plant species – *Haloxylon salicornicum* from Syria, *Haloxylon schmittianum* from Tunisia, and *Salsola vermiculata* common to both study areas. Results indicate that threatened species, such as *S. vermiculata* which were subjected to continuous grazing pressure, showed high vulnerability to climate change. However, the two *Haloxylon* species with low palatability and broad ecological niches were at an advantage due to reduced competition for water and nutrients.

The impacts identified warrant a clear focus on monitoring across species to detect early signs of change. Experiments are needed that determine physiological thresholds for species to validate and refine the models. Clearly, an adaptation strategy to increase the resilience of the most vulnerable species based on better control of grazing pressure, the selection of more drought-tolerant species, and the establishment of other mitigation measures, such as water-harvesting techniques, need to be developed.

Although considerable progress has been made in mapping and monitoring rangeland vegetation using remote sensing data, more research is needed. Such research would use large-scale (higher resolution) geospatial information and in particular hyperspectral remote sensing to enhance the ability to discriminate between vegetation species and produce more accurate assessments throughout the non-tropical dryland regions of the developing world.

Screening cactus species for cold tolerance

There is an urgent need to identify range and forage species that are tolerant to drought, cold, and salinity to rehabilitate and restore degraded sites. These species must be able to withstand water shortages, high temperatures, and shallow soils with poor fertility. Several indigenous species already exist but are rapidly declining.

Cacti can satisfy these requirements and are becoming increasingly important for both subsistence and market-oriented activities. *Opuntia* species have phenological, physiological and structural adaptations enabling them to grow in arid environments.

Over 40 varieties of the spineless cactus (*Opuntia ficus-indica* f. *inermis*) were acquired from various locations (North Africa, Italy, Argentina, and Brazil). Preliminary results from the study have already indicated the vulnerability of several accessions, and cactus pads from Argentina seem to withstand cold the best. Also spring transplantation is recommended over fall plantation. This research is at an early stage and more studies are needed before definite recommendations can be made.

Reintroducing indigenous forage species

Overgrazing reduces rangeland productivity, as well as the relative abundance of plant species. And when rangelands do not provide sufficient rainfed forage, farmers extract groundwater to produce irrigated forage – further exacerbating water shortages.

A potential solution to water and rangeland problems in the Arabian Peninsula is to develop production and rehabilitation systems based on indigenous species because they are already well adapted to the regional environment. Compared to exotic forage species, the irrigated water use of indigenous forages may be reduced. Exotic species are likely to suffer significantly if irrigation is reduced, in comparison to indigenous species.

For some years, ICARDA, through the Arabian Peninsula Regional Program and in close collaboration with the local national agricultural research systems (NARS), has reintroduced several indigenous forage species (*Cenchrus ciliaris, Panicum turgidum, Lasiurus scindicus, Coelachyrum piercei* and *Pennisetum divisum*). Of these, buffel grass (*Cenchrus ciliaris*) was found to be the best irrigated forage to replace the exotic Rhodes grass (*Chloris gayana*), which despite its high water requirements is a widely used forage crop on the Arabian Peninsula. Buffel grass is high-quality forage, and although its annual yield under drip irrigation is equivalent to that of Rhodes grass (20 tons of dry matter per hectare), it uses 50% less water. Farmers in the United Arab Emirates are now officially discouraged from growing Rhodes grass and the government stopped marketing it in the Western Region in 2010 and in Abu Dhabi in 2011.

By the end of 2012, the number of large farms supported by the project in the Arabian Peninsula using buffel grass for irrigated forage had increased to more than 110, compared to 64 at the end of 2011 – an increase of over 56%.

Twenty demonstration plots have been established in six other countries. ICARDA has also helped set up seed multiplication fields and five seed technology units in Oman, Qatar, Saudi Arabia, United Arab Emirates, and Yemen. In summary – new technologies, effective dissemination, better nutrition for livestock, and bigger profits for their owners.

The success of these pilot growers has encouraged other growers to adopt the technology. At the moment, the total number of growers using buffel grass has reached about 200. Previous ICARDA research has shown that each ton (dry matter) of buffel grass produced saves about 850 m^3 of water compared to Rhodes grass. Other research activities are still on-going in Oman and Saudi Arabia aimed at doubling the amount of water saved.

Opuntia species have gained an important place in agricultural systems as a fruit, forage, and fodder provider, particularly in subsistence agriculture where they have a comparative advantage due to their capacity to grow with minimal agronomic inputs.

Partners

Jordan
- National Center for Agricultural Research and Extension (NCARE), Jordan
- University of Jordan

Tunisia
- Institut des Régions Arides – Médenine, Tunisia

ARIs and international organizations
- Oregon State University, USA
- FAO-ICARDA CactusNet

Kuwait
- Public Authority for Agricultural Affairs and Fish Resources

Qatar
- Ministry of Environment, Agricultural Affairs Directorate

Saudi Arabia
- Ministry of Agriculture, National Agricultural Animal Resources Center

Oman
- Ministry of Agriculture and Fisheries, Agriculture and Livestock Research Center

UAE
- Ministry of Environment and Water Abu Dhabi Food Control Authority (ADFCA)

Yemen
- Ministry of Agriculture and Irrigation, Agricultural Research and Extension Authority

Donors
- CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)
- Arab Fund for Social and Economic Development (AFESD)
- International Fund for Agricultural Development (IFAD)
- OPEC Fund for International Development (OFID)

Increasing the productivity of small ruminants

'Awassi' sheep flock in Beqqa valley in Lebanon. 'Awassi' are a mainstay of livelihoods in many dryland farming systems. (Photo: Adnan Termanini for the IFAD Awassi sheep project)

Sheep and goats bring food security and income to communities, improving the livelihoods of the rural poor. But small-scale farmers usually lack the resources and information needed to improve animal health, productivity, and profitability. Consequently, they still use suboptimal husbandry and milk processing practices, resulting in reduced meat and milk production, less food on their tables, and lower incomes. ICARDA's expertise in modern husbandry techniques, optimal feed composition, genetic selection of robust breeds, animal health, and milk processing can help farmers increase the productivity of their flocks, strengthening food security at the village level and directly benefiting farming families and wider communities.

Farmers' Training Workshop. Capacity development session on 'Awassi' sheep management – a crucial step in moving research innovations into use in communities (IFAD Awassi sheep project).

RESULTS IN 2012

Tools reveal constraints to improved feeding in Ethiopia

In Ethiopia, feed is a critical constraint to the intensification of livestock production – a mainstay of rural livelihoods contributing essential services such as traction and manure for arable production as well as a key source of financial security for many poor smallholder farmers.

The Ethiopian Livestock Project (ELF), led by the International Livestock Research Institute (ILRI), set out to test and refine a suite of rapid diagnosis tools for feed resource and demand assessment, value chain analysis, rapid market appraisal, and feed technology prioritization in three value chains (dairy, beef, and sheep). The three tools, FEAST (the feed assessment tool), Techfit (a discussion support tool for prioritizing feed technologies), and the Value Chain Assessment checklist were developed by ILRI and the International Center for Tropical Agriculture (CIAT), with ICARDA contributing to the testing and refining of FEAST. FEAST is a systematic and rapid method for assessing feed resource availability and utilization and determining the potential of site-specific feed interventions. It helps in the design of intervention strategies seeking to optimize feed supply and utilization.

Following a training workshop to familiarize participants with their use, national partners tested the tools in the field (at Debre Birhan, Debre Zeit, and Holetta) with backstopping from ILRI and ICARDA. Participants included researchers from Ethiopian agricultural research centers and ILRI, India, with resource persons from ICARDA and ILRI, and national and international consultants.

The results showed that the tools rapidly generated a good overview of the farming system and some of the constraints to improved feeding. Generating ideas for feed intervention was more challenging and probably requires existing insight into what might work. However the tools were helpful in guiding thinking, and in

ensuring that suggestions for feed improvement took into account system constraints, such as land availability, material inputs, financial resources, and skills. While these tools are not recipes for generating workable feed interventions, the process of working with them at field level could help to arrive at interventions which are more likely to succeed. This is particularly true if researchers work with development agents in applying the tools, as was the case in this project.

Sharing knowledge to improve the livelihoods of sheep farmers in Lebanon and Syria

ICARDA and the Lebanese Agriculture Research Institute (LARI) designed and implemented a project providing information and training on the management of 'Awassi' sheep to agricultural extension workers, small-scale farmers, and women processors in Lebanon and Syria. Since June 2012, both organizations have worked together to enable smallholders to enhance productivity by improving their sheep management skills.

The project set out to capture global and local knowledge generated over the last 30 years in technical bulletins. The information was then presented in an easily accessible format and published as a curriculum carefully tailored to local farmers' realities. The resulting *Best practices for managing Awassi sheep* compilation includes ten practical field guides. In 2012, ICARDA completed eight of these guides, and has already distributed more than 800 printed copies of the set. The last two guides in the compilation are currently in print and will soon be distributed.

Initially, the intensive training sessions were planned to focus on Syria. Because of the situation in the country, the project relocated to Lebanon. ICARDA launched a planning and scoping mission in Lebanon in June 2012, followed by a brief baseline survey on local sheep management practices. Four farmer training workshops were subsequently conducted at ICARDA's station in Terbol and in three target villages. The workshops introduced the information and techniques presented in the field guides and facilitated discussions on their hands-on application under local conditions. The sessions were carefully sequenced throughout the year to track the seasonal management calendar of 'Awassi' sheep. About 30 farmers attended the different sessions of ICARDA's training curriculum in 2012, taking valuable new knowledge home to their farms and communities.

Looking forward, the project's training series in Lebanon will be rounded off with two sessions in early 2013 – one on sheep selection strategies and one on dairy processing for women.

Selecting sites for sheep and goat value chain development in Ethiopia

A crucial starting point for the initiation of value chain development is a well-informed, transparent, and consultative site selection process. In Ethiopia, stakeholder discussions and planning for the small ruminant value chain development project began in mid-2012. By November, sites were selected and teams were trained to carry out rapid value chain assessments at the project's seven research sites.

This project is a component of the CGIAR Research Program on Livestock and Fish and the site selection process followed a harmonized guideline across the Program. Main stakeholders from research and development organizations and projects interested in goat and sheep value chain development were identified and invited to plan together with the CGIAR team. The process consisted of geographical targeting and a series of stakeholder consultations during July and August. It was completed with site visits in September and October using checklists to confirm that the preselected sites match with the selection criteria defined and agreed during the stakeholder consultations. It is estimated that the number of households at the seven sites is about 1,800 (12,600 people), among them about 20% are households headed by women. It is planned to scale-up successful interventions to four additional villages after two years of testing, thus increasing the potential target population by about another 3,600 households (25,000 people).

Sheep farmers participating in the FEAST tool-testing exercise at Wonji Kuriftu in Ethiopia's Adama District.

Partners

Diagnostic tools
- ILRI
- Ethiopian Institute of Agricultural Research (EAIR)
- Holetta Agricultural Research Center
- Debre Zeit Agricultural Center
- Amhara Regional Agricultural Research Institute

'Awassi' sheep
- Lebanese Agriculture Research Institute (LARI)

Value chain development
- ILRI
- Ethiopian Institute for Agricultural Research (EIAR)
- Ministry of Agriculture and Rural Development (MoARD)
- Regional Research Centers: Tigray Agricultural Research Institute (TARI), Southern ARI (SARI), Amhara Region ARI (ARARI), Oromia ARI (OARI), and the Somali Region Pastoral and Agro-pastoral Research Institute (SoRPARI)

Donors

Diagnostic tools
- Australian Centre for International Agricultural Research (ACIAR)

'Awassi' sheep
- International Fund for Agricultural Development (IFAD)

Value chain development
- CGIAR funds (ICARDA and ILRI)

Robust food security depends on good seed

Farmers' field day to popularize a new bread wheat variety 'Shorima' (ICARDA origin) at Guagusa Shikuda woreda (district) in Ethiopia.

National and local seed systems that produce and distribute quality seed are an indispensable pillar of healthy agriculture and global food security. However, 80–90% of food grains in many developing countries still depend on informal seed systems that consist of recycling seed of older varieties saved during harvest and uncoordinated exchanges of seed among farmers.

Meanwhile, public sector seed systems in many of these countries often lack efficiency and market orientation. Farmers' current dependency on weak seed systems results in the slow adoption of new improved varieties, low yields, and heightened susceptibility to crop diseases, imperiling food security at the household, national, and global levels.

During the 2011/12 cropping season, ICARDA drew on its expertise to work with countries – including Egypt, Ethiopia, Pakistan, and Yemen – to comprehensively strengthen the various elements that enable seed systems to function effectively. ICARDA implemented a project to strengthen seed systems by supporting variety testing and release, seed production and distribution, the popularization of new disease-resistant varieties, and institutional capacity building.

ICARDA's work has focused on reducing the threat of wheat rust diseases – the potential threat of stem rust (black rust) and the current attacks over the past four years by yellow rust (stripe rust) that have damaged wheat harvests in large areas (see box on page 26). The emergence in 1999 of a virulent strain of wheat stem rust called 'Ug99' and its rapid spread through parts of Africa and the Middle East has raised alarm among the international community. Most widely cultivated wheat varieties are susceptible to this fungus, highlighting the fact that agricultural problems in one location can potentially affect the food security of billions of people across national borders. ICARDA works with many developing countries to improve their formal and informal seed systems, to maximize the productivity and sustainability of agriculture, and to ensure resilience in the face of natural disasters, climate change, and crop pandemics such as 'Ug99'.

RESULTS IN 2012

Accelerating variety testing and release, and seed multiplication

ICARDA has long advocated that fast-tracking variety testing and release is crucial for the rapid deployment of rust-resistant and high-yielding varieties to replace existing commercial varieties susceptible to rust. In 2012, ICARDA's partners in Egypt, Ethiopia, and Pakistan evaluated several promising lines for final release. In Ethiopia, for example, three bread wheat varieties (one from ICARDA) and two durum wheat varieties (from ICARDA) were released for large-scale commercialization.

Accelerating seed multiplication helps farmers access such new improved varieties quickly and sow them in their fields. ICARDA's approach addresses both the pre-release and post-release stages of seed multiplication of early generation seed (breeder to basic). During the pre-release period, ICARDA initiates seed multiplication earlier to guarantee that sufficient quantities of basic (foundation) seed are available when the variety is released.

Over the past 12 months, pre-release multiplication of 31 potential promising lines was carried out in Egypt, Ethiopia, and Pakistan with ICARDA's support. During this period, ICARDA also supported the post-release seed multiplication of 23 varieties with yellow rust and/or 'Ug99' resistance which were fed into large-scale certified seed production and marketing by the public or private sector.

Following these practices, Egypt has produced nearly 11,000 tons of seed of two new rust-resistant varieties by its public and private sector, enough to plant some 6% of the land devoted to wheat in the coming year. In Ethiopia, the production of over 27,000 tons of seed of two new rust-resistant varieties by public sector enterprises will be enough to plant around 10% of its total wheat area. In Pakistan, some 11,780 tons of seed of one rust-resistant bread wheat variety was multiplied by the private and public

sector sufficient for about 10% of the area in southern Punjab. The accelerated seed multiplication was initiated with 25–50 kg source seed supplied by the international agricultural research centers to national partners for evaluation of elite lines and initiation of accelerated seed multiplication on the launch of the project in the 2008/09 crop season.

Bringing new varieties of seeds to the fields

Popularizing new resistant varieties enables farmers to replace their old rust-susceptible varieties with new rust-resistant ones. With ICARDA's support, national agriculture research systems in Egypt, Pakistan, and Ethiopia in 2012 actively popularized new improved seed varieties by spreading word among farmers about the threats of rust and the availability of resistant varieties. In Egypt, the National Wheat Research Program carried out 1,233 demonstrations across 23 governorates to disseminate knowledge about the new varieties and their associated agronomic practices. Some 450 fields were planted with the two newly-released wheat cultivars 'Misr1' and 'Misr2', both of which are resistant to 'Ug99'. The demonstration plots showed that farmers using the new varieties can increase their grain yield by around 20%.

These new varieties can be hard to obtain in remote areas in some developing countries. Bringing seed to farmers in such regions requires an innovative approach based on decentralized seed production and marketing with the participation of farmers themselves. In Pakistan, ICARDA initiated farmer-based seed production in partnership with BARI-Chakwal, CCRI-Nowshera, and NIFA-Peshawar. Entrepreneur farmers received seed of new varieties and fertilizers together with training on quality seed production. They were monitored regularly and given access to low-cost mobile seed cleaning and treatment machines designed by ICARDA. The farmers produced over 56 tons of seed from eight different bread wheat varieties, and many succeeded in selling their seed at prices that were 30–50% above the local grain price.

Meanwhile, in Ethiopia, ICARDA directly engaged with farmers to ensure the rapid deployment of rust-resistant and high-yielding wheat varieties. A total of 4,239 farmers planted 176 tons of seed from 13 different rust-resistant varieties, producing 3,720 tons of seed. Farmers kept 10% of the produce for their own future use, returned the amount they had originally received from the project in kind, and exchanged the remaining seed through local channels or sold it to the formal sector for further distribution to farmers.

Establishing seed technology units

Working with partners in the Arabian Peninsula, ICARDA initiated an extensive research and technology transfer program on identifying and promoting local production and utilization of indigenous plant species for feed production and range rehabilitation. The ultimate goal of the program is to save the scarce water resources in the region, minimize degradation, and conserve local plant flora and biodiversity through improved indigenous forage seed multiplication and distribution.

ICARDA assisted in the establishment of seed technology units, responsible for seed production of target species through improved agronomic management practices, appropriate harvesting and processing technologies, and extensive capacity building. In 2012, ICARDA supported the creation of units in Yemen where appropriate equipment was identified and staff trained, in addition to those already established in UAE, Oman, and Saudi Arabia.

Building seed systems capacity for a food secure future

In NARS, the commercialization of a new variety after its release is a difficult process. Frequent obstacles include the lack of physical and financial resources, the lack of a clear mandate, and risk avoidance. In order to address this issue, ICARDA worked with national partners to strengthen their institutional and human capacity for seed commercialization.

In 2012, ICARDA provided field machinery (four tractors, four seed drills/planters, two levelers, four rotovators, and four threshers) to four NARS partners in Pakistan to strengthen early generation seed production. In addition, ICARDA organized courses on seed science and technology, giving 100 participants from 11 countries in Asia and Africa the opportunity to study subjects such as variety identification and maintenance, seed production, seed marketing, seed enterprise development, and seed quality assurance.

Future plans for this seed systems work with partner countries include expanding its framework for the rapid deployment of new rust-resistant varieties – originally developed in response to 'Ug99'. This approach will be adapted to other crop improvement and seed delivery processes to ensure that natural disasters, climate change and crop pandemics pose less of a threat to national food security.

Ethiopia's fast-track screening and seed multiplication to avert the threat of yellow rust

A new partnership between Ethiopia and ICARDA, supported by USAID, rapidly multiplies and disseminates yellow-rust-resistant wheat varieties to reduce risk to farmers and strengthen and raise productivity in Ethiopia.

Ethiopia, sub-Saharan Africa's largest producer of wheat, was threatened by the persistence of the yellow rust (stripe rust) fungal disease, which causes crops to become stunted and develop lesions or spores. The disease thrived here in 2010 due to the unusually wet conditions that occurred during the year.

Despite receiving an early warning, Ethiopia was unable to procure enough fungicide in time and the wheat harvest was severely affected by yellow rust, which devastated large swathes of local wheat varieties in central and western regions. Losses in some areas approached 80% or even higher. The following year it spread to northern regions of Ethiopia. In Tigray, for example, over 7,000 hectares of wheat were devastated in 2011.

Tackling the threat

To combat yellow rust, the Ethiopian Institute of Agricultural Research (EIAR) initiated a project with ICARDA – supported by USAID – for the rapid multiplication and distribution of improved high-yielding and rust-resistant wheat. Early indications suggest that the project is making good progress in equipping Ethiopian farmers with the technologies and knowledge to resist yellow rust. ICARDA has been charged with identifying appropriate wheat lines and accelerating the release of high-yielding, disease-resistant varieties for distribution across major wheat-producing regions.

Nationwide, this partnership is helping contain the threat of yellow rust disease. Improved rust-resistant varieties now cover 10% of Ethiopia's wheat area, concentrated in locations susceptible to the disease. The country is also fully prepared – emergency seed stores and a functioning early warning system ensure that Ethiopia will no longer experience a repeat of the devastation caused by yellow rust in 2010.

Seed multiplication

Aggressive germplasm screening resulted in the selection of over 3,200 lines – of these over 2,200 lines were planted in project areas. The improved varieties include 'Danda'a', 'Kakabu', 'Shorima', and 'Huluka'. The project has also initiated an impressive seed multiplication drive, distributing improved seed to farmers and seed companies. Since the project's inception, 400 tons of resistant, high-yielding seeds have been distributed to farmers in the country's four major wheat-producing regions: Amhara, Oromia, SNNP, and Tigray. Planted on over 2,600 hectares across 40 districts, these varieties are increasing farmer productivity and producing higher and more stable yields.

Average yields of durum wheat and bread wheat reached 3.7 tons/ha in 2011/12 and 3.3 tons/ha in 2012/13 – a significant improvement on the performance of traditional varieties which tend to average only 2 tons/ha each year. Regional variations demonstrate even more impressive gains: average yields of improved bread and durum wheat have reached 4 tons/ha in Oromia and 4.2 tons/ha in SNNP.

Benefits to more than 10,000 farmers

The gains now being witnessed on the ground have already benefited over 10,400 wheat farmers in project areas – exceeding expectations and the 4,000 farmers the project had planned to assist each year. If the number of people in farming families are included, the number of beneficiaries is even more significant. In the Amhara region, for example, the project has impacted 900 farmers and over 4,500 individuals living within farming households.

Partners

Egypt
- Agricultural Research Center – Wheat Research Department
- Central Administration for Seed Production
- Central Administration for Seed Certification and Testing
- Private Seed companies
- Farmers

Ethiopia
- Ethiopian Institute of Agricultural Research (EIAR)
- Amhara Regional Agricultural Research Institute
- Oromia Regional Agricultural Research Institute
- Tigray Agricultural Research Institute
- Ethiopian Seed Enterprise
- Amhara Seed Enterprise
- Oromia Seed Enterprise
- South Seed Enterprise
- Private Seed companies
- Farmers

Iraq
- Ministry of Agriculture and Water Resources, KRG, Iraq

Pakistan
- Pakistan Agricultural Research Council
- Ayub Agricultural Research Institute (AARI) – Wheat Research Institute
- Barani Agricultural Research Institute (BARI)
- National Agricultural Research Center (NARC)
- Regional Agricultural Research Institute (RARI), Bahwalpur
- National Institute of Food and Agriculture (NIFA)
- Cereal Crop Research Institute (CCRI), Pirsabak
- Pakistan Seed Corporation
- Private seed companies
- Pakistan seed farmers

Yemen
- Agricultural Research and Extension Authority

Donors
- AFSED, IFAD, and OFID – Technology Transfer to Enhance Rural Livelihoods and Natural Resource Management in the Arabian Peninsula
- AFSED – Enhancing Food Security in Arab Countries, Young Scientists Program
- Japan International Cooperation Agency – Third Country Training Program for Afghanistan and CWANA countries
- Japan International Cooperation Agency – Project for Wheat Productivity Improvement Towards Food Self-Sufficiency, Kurdistan Regional Government, Iraq
- United States Agency for International Development (USAID) – Accelerating Seed Multiplication to Counter the Threat of Stem Rust in Wheat, Egypt, Ethiopia and Pakistan
- United States Agency for International Development (USAID) – Pakistan Wheat Productivity Enhancement Project
- World Bank – Rainfed Agriculture and Livestock Project, Yemen

Water benchmarking: interventions to improve efficiency

Traditional management of surface irrigation.

In the non-tropical drylands of the developing world, farmers contend with poor soils and low rainfall. Efficient use of these scarce resources is the best way to maximize agricultural productivity, but how to do this is not always clear. To increase food security in the region, farmers and water managers are in need of research-based guidance on how to best make use of water and soil.

ICARDA's research on approaches to better land and water management to improve crop productivity in dry areas and marginal lands has produced a range of approaches that can benefit many countries. A package of tested methodologies can be used by planners and decision makers to strengthen food security. These approaches integrate technology and policy options. They are evidence-based – informed by data obtained using a range of innovative modeling tools and combining Geographic Information Systems and Remote Sensing (GIS/RS) technologies with soil science and field observation, applied to rainfed, irrigated, and rangeland agriculture. With these approaches, ICARDA focuses on the specific needs and problems of a country, selecting the most appropriate technologies for their situation.

ICARDA's Integrated Land and Water Management team is currently testing and disseminating the technologies developed in past research and river basin 'benchmarking' to current partner countries, and beyond.

All the technologies, policy options, and water management decision-making tools developed in ICARDA's water benchmarking project are being disseminated across the main and satellite project sites in Egypt, Sudan, Iraq, Morocco, Tunisia, Algeria, Jordan, Syria, and Libya.

RESULTS IN 2012

Water and land technology packages

After a decade developing a solid understanding of specific water and land interventions, ICARDA has been working with partners to develop and test technology packages. Using these packages, ICARDA's partner countries can improve their food security while producing more food with less water.

The intervention packages evaluated by ICARDA and partners relate to the three existing agricultural systems in dryland areas: rainfed, irrigated, and rangeland agriculture.

For rainfed systems, work has focused on supplemental irrigation with particular reference to timely cultivation and application of nitrogen fertilizers. It has also considered crop varieties and other on-farm techniques.

For irrigated systems, ICARDA and partners have been looking at raised-bed planting, deficit irrigation (where water is only applied during drought-sensitive stages of a crop's growth) and approaches to mitigate the effect of soil salinity on crop yields.

For rangeland agriculture, work has focused on micro-catchment and macro-catchment water-harvesting techniques and use of the Valerrani system, which uses a special plow to make continuous and intermittent contour ridges for collecting rainwater.

Identifying 'best fit' options – water harvesting and allocation

In 2012, ICARDA worked with farmers, agricultural extension workers and policymakers to develop decision support systems that help them identify 'best fit' interventions for specific agro-ecosystems. During the year, ICARDA worked with five countries in West Asia and North Africa to identify and develop appropriate technologies.

In Morocco, ICARDA worked with in-country scientists to model water allocation at both macro-scale (river basin) and micro-scale (tertiary canal), in order to optimize water use in the country.

In Egypt, ICARDA worked with in-country scientists on another modeling exercise to improve water-use efficiency and productivity. Here, the team is building a water and nutrients model to assess processes, dynamics, and the water and nutrients/salts balance in agricultural land.

In Jordan, ICARDA worked again with in-country scientists to model water availability and use. The team adapted a watershed model known as SWAT (soil and water assessment tool). This model enabled the team to assess the impact of water harvesting and soil conservation interventions on mitigating land degradation and re-habilitating pastoral lands in West Asia and North Africa.

Another ICARDA research project provided additional information on water harvesting during 2012. Working with farmers and planners in **Jordan**, **Libya**, and **Eritrea**, ICARDA used a new characterization technique to gain precise information on the whereabouts of untapped micro-catchments and to pinpoint catchments that are nearest to communities. The technique combined information from GIS with field-level observations, soil sampling and information in existing cadastral maps. The resulting data will be used to design national strategies and action plans to create simple reservoirs and aquifers and so bring new water sources to farmers living on marginal lands.

Assessing infrastructure and policy

During 2012, ICARDA also looked at institutions responsible for managing water resources. In so doing, ICARDA scientists have developed recommendations for improving policies to maximize the uptake of appropriate water management technologies in Egypt, Jordan, and Morocco.

Making grey water fit for irrigation

In August 2012, ICARDA and the National Center for Agricultural Research and Extension in Jordan concluded a three-year project developing and promoting community-based interventions for the productive use of wastewater from domestic activities, or grey water.

The project, funded by the Coca Cola Foundation, focused on grey water as an alternative source for irrigation water in gardens and on small-scale farms. As a result of the project, 13 grey water treatment units are now installed in the Madaba governorate of Jordan.

Working with local communities

The project team worked with farmers and villagers throughout the Madaba governorate. The team organized 28 training events dealing with various aspects of grey water use. The training targeted local institutions and residents, including women. Through the project, villagers and farmers established their own grey water reuse association.

Creating a clean resource

The treatments applied by the Madaba association showed that medium-sized volcanic tuff is more effective as a treatment than medium-sized gravel. The reduction in biochemical oxygen demand – commonly used to gauge the effectiveness of wastewater treatment plants – was 73% and 49% in the treated water when using volcanic tuff and gravel, respectively.

After monitoring the grey water treatment units, the Madaba association identified and implemented several modifications. The main alterations were to increase water aeration to activate aerobic bacteria and control odor, and to facilitate the manual cleaning process. Once the association had implemented these modifications, the treatment systems operated more efficiently with reduced odor.

Communicating success

The grey water treatment initiative in Madaba has acted as a technical 'hub' for other areas in the Middle East. With training provided by the hub, other community associations have established new units: four in Lebanon and two in Palestine. Fourteen Palestinian farmers and 25 Jordanian women householders have also visited the site to learn more about the treatment plant. Other communications include three radio interviews, two posters, a promotional video, and a booklet describing the community-based approach in using grey water for irrigating small-scale crops.

Local beneficiaries of grey water treatment are the women in the community.

Partners

Egypt
- National Water Resource Center (NWRC)
- Agricultural Research Center (ARC)
- American University in Cairo (AUC)
- Faculty of Agriculture – Ain Shams University
- Faculty of Agriculture – Cairo University
- Faculty of Agriculture – Banha University
- Faculty of Agriculture – Zagazig University

Iraq
- State Board for Agricultural Research (SBAR)
- College of Agriculture/Baghdad University
- Ministry of Water Resources
- Iraqi National Program for Preparation of Agro-Ecology Zone Map

Jordan
- National Center for Agricultural Research and Extension (NCARE)
- University of Jordan (UJ)
- Jordan University of Science and Technology (JUST)

Lebanon
- Lebanon Agricultural Research Institute (LARI)
- American University of Beirut (AUB)
- Lebanese University (LU)

Palestine
- National Agricultural Research Center (NARC)
- Applied Research Institute of Jerusalem (ARIJ)
- Land Research Center (LRC)
- Hebron University (HU)

Syria
- General Commission for Scientific Agricultural Research (GCSAR)
- Directorate of Modern Irrigation Conversion (DMIC)
- Directorate of Extension (DoE)
- General Commission for Management and Development of Al Ghab
- National Universities (Damascus and Aleppo)

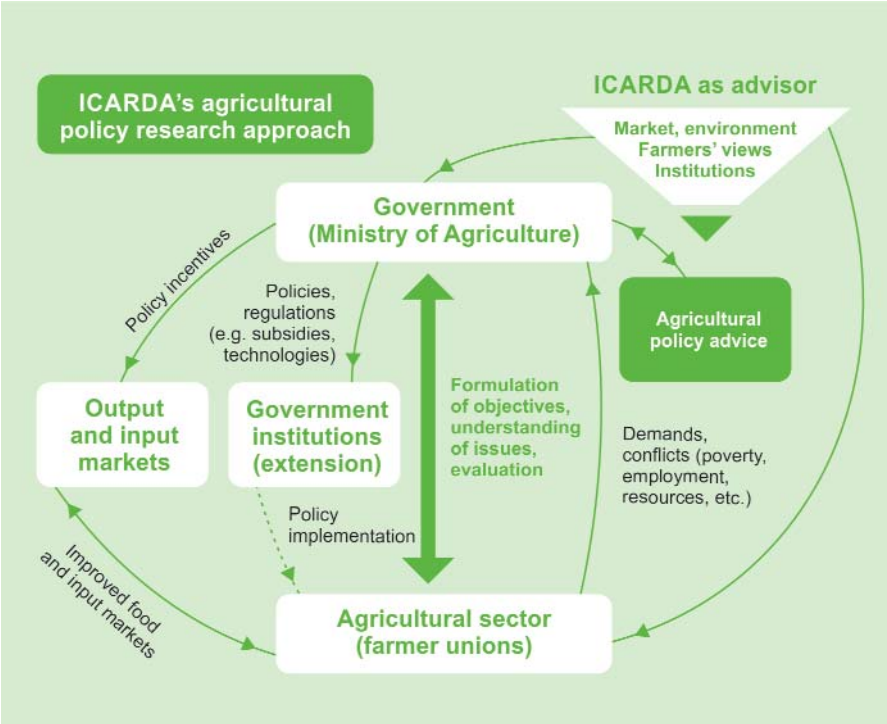
Yemen
- Agricultural Research and Extension Authority (AREA)
- National Water Resources Authority (NWRA)
- Aden University

CGIAR Centers
- International Water Management Institute (IWMI)
- International Food Policy Research Institute (IFPRI)

US Universities
- University of California Davis (UC-Davis)
- University of Florida (UF)
- Texas A&M University (TAMU)
- University of Illinois at Urbana-Champaign (UIUC)
- Utah State University (USU)

Donors
- United States Agency for International Development (USAID)

ICARDA's demand-driven approach to policy research



Source: ICARDA Socioeconomics Program, 2013

Much has been written about agricultural policies and ideal practices. But how much of these findings are actually acted on by governments?

ICARDA's agricultural policy research team is working with a range of partner countries to provide them with support to create policies that will be put into action. The team's approach is to work directly with ministries, defining their needs, and bringing the experience gained in other locations into this dialogue. Through this process, government decision makers are exposed first-hand to the problems and opportunities that farmers face on a daily basis – and the choices they need to make. Working alongside the policy research team, they see the rigor with which the research is conducted and have access to the information and analysis at each stage of the policy development cycle. This increases confidence in the results and ensures ownership throughout the cycle, from design to implementation, evaluation, and use.

ICARDA believes that policy advice produced in this inclusive and demand-driven way is better for famers and the government. Close ministry involvement increases the likelihood that the advice will be turned into action on the ground. ICARDA then works with the ministry to complete the analysis by monitoring and evaluating the policies that are implemented. This information becomes a crucial input to further policy research, enabling all stakeholders to build-up reserves of knowledge for future evidence-based policy-making.

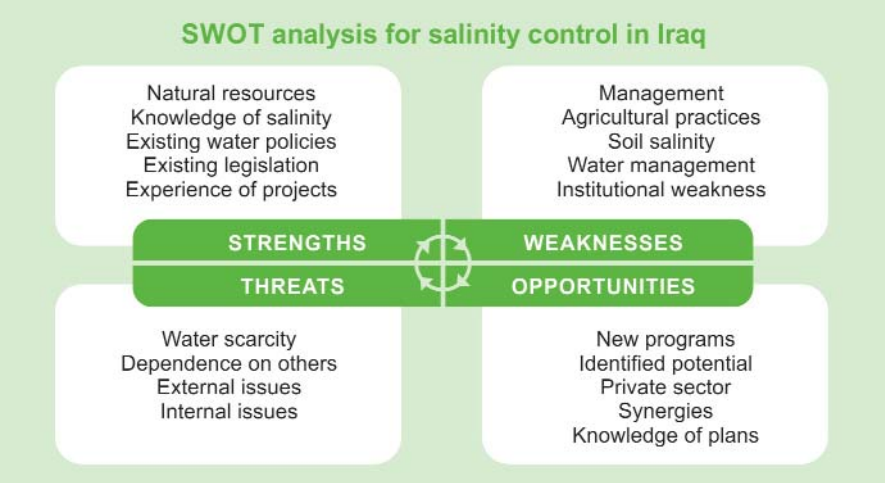
RESULTS IN 2012

Policy advice on groundwater abstraction in Syria

Since the late 1980s, the groundwater-irrigated area and number of groundwater wells in Syria has steadily risen, reaching a peak in 2004 of just under 800,000 ha of land and approximately 19,000 wells. However, since then the groundwater-irrigated area has steadily decreased, despite a continuing increase in the number of wells. This indicates the belief among farmers that investment in wells will be profitable, while the decreasing groundwater-irrigated area suggests a drop in their productivity. This is likely to be caused by lower groundwater supply and thus aquifer depletion. The current policy supporting groundwater abstraction is therefore depleting water resources, distorting wheat and cotton prices and encouraging the misallocation of production resources. ICARDA has advised the Syrian Government to cease subsidies on fuel used in agriculture. This removal will provide an incentive to earmark resources according to their real opportunity cost, and to allocate water to those commodities that are most profitable.

Soil salinity management in central and southern Iraq

Through the project Soil Salinity Management in Central and Southern Iraq, ICARDA assisted the Ministry of Agriculture and Water Resources to undertake a historical review of agricultural policies in Iraq, with particular emphasis on policies to control salinity. A quarter of the country's farmland is severely affected, with salinity levels so high that cultivation is difficult or impossible. One study done in the project worked with several ministries to analyze the policy landscape and create a 'SWOT' analysis of the capabilities and constraints facing Iraq in the management of salinity in the country. Key strengths were the current policies and programs of the government, evolving partnerships between government and local communities, and promising new salinity management technologies. Opportunities included new programs



Analysis of salinity management policies in Iraq. The SWOT analysis (strengths, weaknesses, opportunities, threats) helps decision makers determine if specific objectives to reduce salinity can be achieved, given the SWOT profile of the country and of the Ministry of Agriculture with regard to salinity control.

under implementation, as well as agricultural potential that has development interest from the private sector. Poor agricultural practices that have contributed to salinity were a weakness, while water scarcity and social instability were identified as threats. The study proposed practical recommendations for salinity management, including advice on modern and cost-effective salinity control techniques and the importance of establishing water user associations to ensure equitable distribution of water.

Knowledge management for integrated natural resources management – MENARID and OASIS

Policy makers from the Middle East and North Africa region can be better influenced by agricultural innovations that have been developed within and for the region. The MENARID project, supported by IFAD and the Global Environment Facility (GEF), benefits Jordan, Algeria, Morocco, Tunisia, Yemen, and Iran by providing a knowledge sharing process and information platform to promote innovations, technologies, and best practices developed by their projects. ICARDA systematizes the innovations developed by the different projects and puts those agricultural-related innovations at the service of project managers and decision makers. A web platform (https://menarid.icarda.org) enables this sharing, and also includes information on the projects, meetings, monitoring and evaluation, as well as policy action notes.

In the OASIS project decision makers from Morocco, Jordan, Yemen, and Pakistan produced and shared their analyses of the key policies, market and institutional issues that have contributed to land degradation. The reports (downloadable here: http://temp.icarda.org/wli/research_OASISPublications.html) document the current drivers of land degradation for each country. They offer a synopsis of current legislation and initiatives to combat land degradation in each country, and identify the main constraints on their effectiveness.

Promoting conservation agriculture – improving production while conserving the environment

Zero-tillage cropping – where the soil is not plowed before planting – saves money, improves yields, and promotes better soil health. In Australia, conservation farming practices boosted yields from 2 to 3 tons/ha between 1990 and 2010. So why has it been slow to spread to low-income countries in Asia, the Middle East and Africa? Creating enabling policy environments to promote this practice is part of the answer.

ICARDA is working to provide information that policymakers need to convince them of the merits of this approach. For example, in Syria, ICARDA found that famers could improve profitability per hectare by nearly 50% through savings such as fewer plowings and reduced seeding rates, in addition to a 20% higher yield. Economic planners can thus anticipate more stable production and yields, strengthening food and economic security. And, because conservation agriculture is much more environmentally friendly than modern conventional farming, marginal areas such as highlands may be brought carefully into production that is profitable and sustainable over the long term. Convincing governments and famers to change long-established and well-known practices is a major challenge. But ICARDA's evidence shows that, once farmers try conservation tillage, almost none revert to conventional methods.

Looking ahead to 2013

ICARDA's socioeconomics team is responding to a number of requests to support country decision makers in assessing and developing policies. The schedule for work on agricultural policies in 2013 looks to be a busy one. Water policy research agendas have been agreed with the Egyptian Ministry of Water Resources and Irrigation, the Moroccan Ministry of Agriculture and Fishing, and the Jordanian Ministry of Water and Irrigation. This research will be done as a part of the CGIAR Research Program on Policies, Institutions and Markets to strengthen food security and incomes for the rural poor. The program is identifying country-led, country-driven, and country-owned development processes.

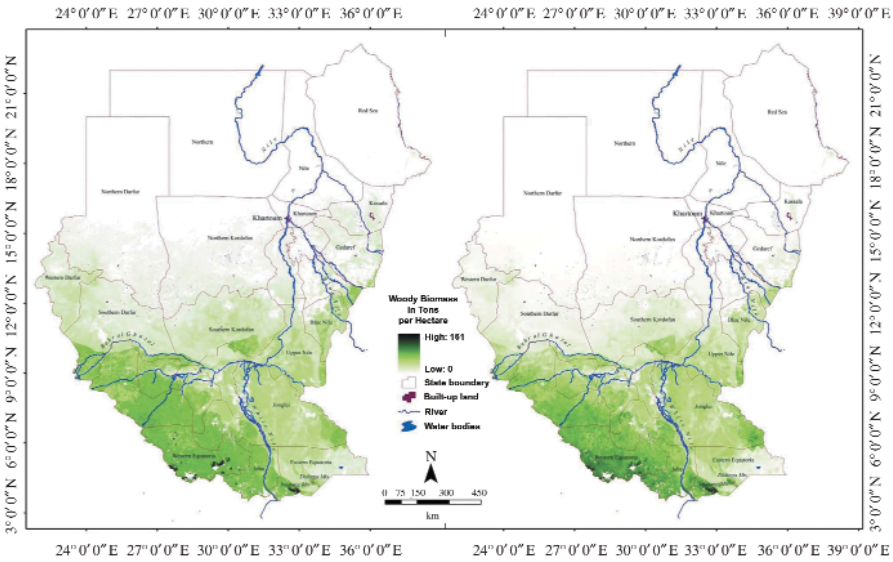
Partners

- Agricultural-related ministries, national agricultural research systems and farmer associations of the WANA region
- US universities (such as University of California)

Donors

- IFAD
- USAID
- Australian Government
- JICA

Geo-informatics



Woody biomass maps of Sudan in 2007 (left: summer and right: fall) by remote sensing.

Assessing woody biomass in African tropical savannahs by remote sensing

The Geographic Information Systems (GIS) Unit provides services and research support to ICARDA research themes and projects with spatial analysis and thematic mapping using remote sensing, climate, soil and other data, as well as doing its own research activities.

The GIS team has developed an integrated operational methodology and models to assess woody biomass in the northern tropical savannahs of Africa, using multi-scale remote sensing. The biomass maps produced (see map above) will provide decision makers with information about potential woody biomass (including biofuel), enabling them to make adjustments to land use and management practices to mitigate carbon emissions and climate change. In 2012 more detailed work was completed to validate the canopy cover Normalized Difference Vegetation Index (CC-NDVI) model, which was used to estimate tree canopy cover through time-series decomposition and quantify woody biomass. The accuracy of the woody biomass maps produced was also assessed, using a ground-approximation approach. This methodology will be useful to scientists and provide a replicable approach to woodland/forest biomass assessment and carbon emission analysis in tropical savannahs.

The GIS team provides training in the woody biomass methodology. A paper on this research was published in the *International Journal of Remote Sensing* (34: 4525-4549, DOI: 10.1080/01431161.2013.777487). The full report of the woody biomass and multi-biome biomass mapping project will be prepared for internal publication by ICARDA during 2013.

RESULTS IN 2012

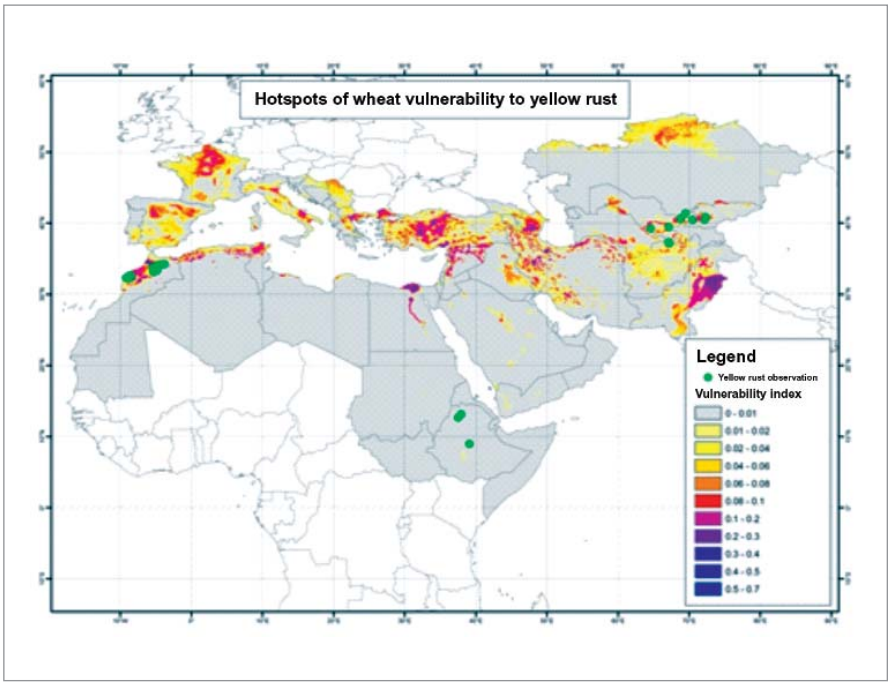
Thematic mapping

In the framework of the CGIAR Research Program on Climate Change, Agriculture and Food Security and the IFAD Livestock Project, the GIS Unit produced climate change maps (including precipitation, temperature, drought trends, and temperature trends) by downscaling global raster datasets for Tunisia, Morocco, Iran, Syria, and Jordan. It also produced wheat disease and rust risk maps for the whole of Central and West Asia and North Africa. The team has also mapped the worldwide activities of all CGIAR Research Programs. The maps presented on the website http:/drylandsystems.cgiar.org provide examples showing the risk and vulnerability of wheat to yellow rust in Central and West Asia and North Africa, and climate change trends in Syria and Jordan.

Research activities

In 2012, the GIS Unit provided services to a number of ICARDA research activities.

- Salinity management in central and southern Iraq
- On-farm soil salinity management in the Al-Nassiriah area of Iraq
- Improving food security and climate change adaptability of livestock farmers in Iraq and Jordan
- Afghanistan catchment management project
- CGIAR Research Program on Water, Land and Ecosystems: Iraq salinity mapping project
- CGIAR Research Program on Climate Change, Agriculture and Food Security.



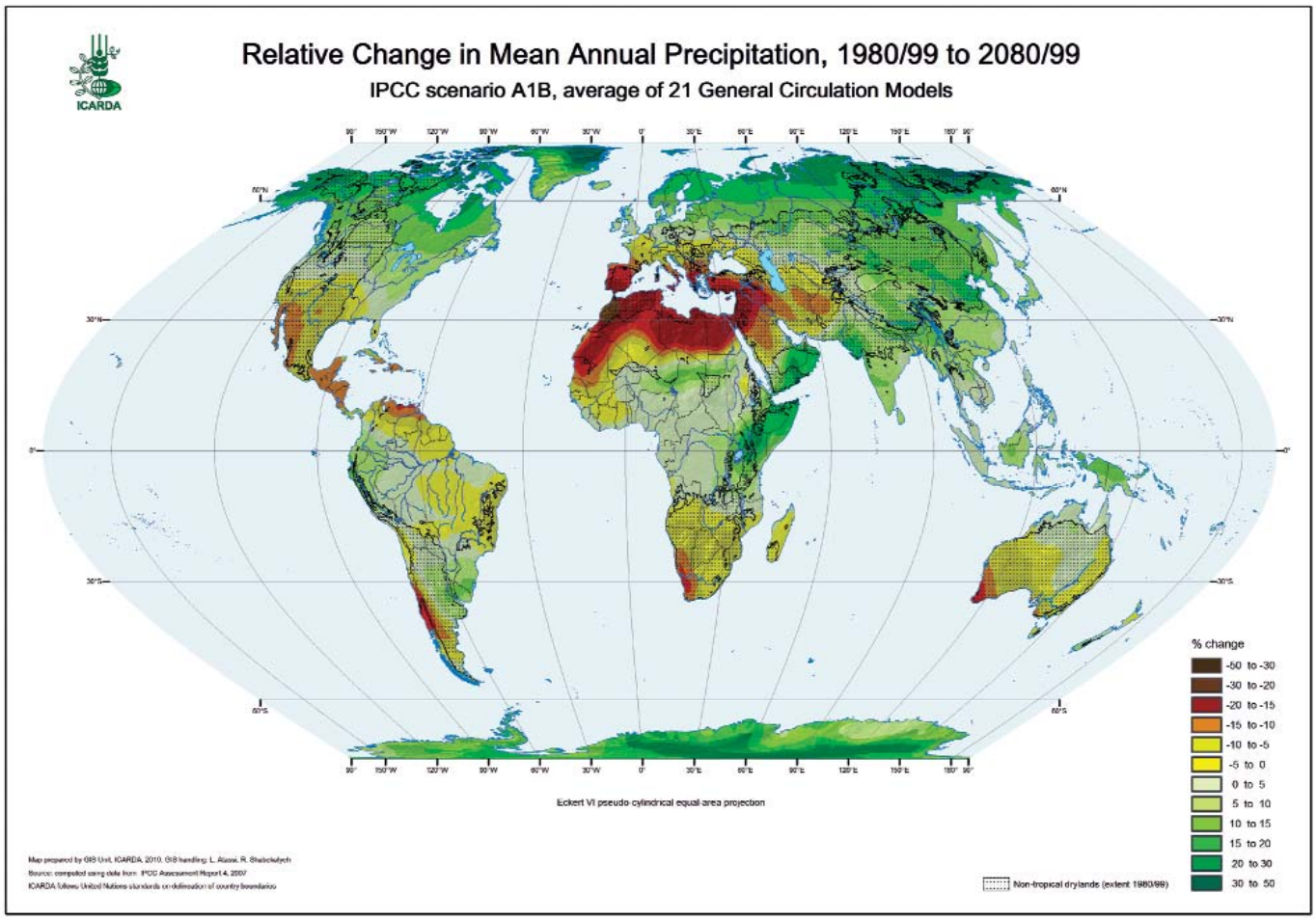
Incidence of wheat stripe rust (yellow rust), a chronic disease of wheat in many wheat growing dry areas, which has been spreading to new areas due to changing climate patterns.

Partners

- Ministry of Agriculture, Iraq
- Ministry of Water Resources, Iraq
- Ministry of Environment, Iraq
- Ministry of Sciences and Technology, Iraq
- NCARE, Jordan
- NARS, Afghanistan
- CSIRO, Australia
- IWMI, Tashkent

Donors

- Australian Centre for International Agricultural Research (ACIAR)
- Italian Government
- CGIAR Research Programs: Dryland Systems; Water, Land and Ecosystems; Climate Change, Agriculture and Food Security.



A picture of future climate variability: the countries with the lowest levels of rainfall will be the hardest hit by changing climate patterns.

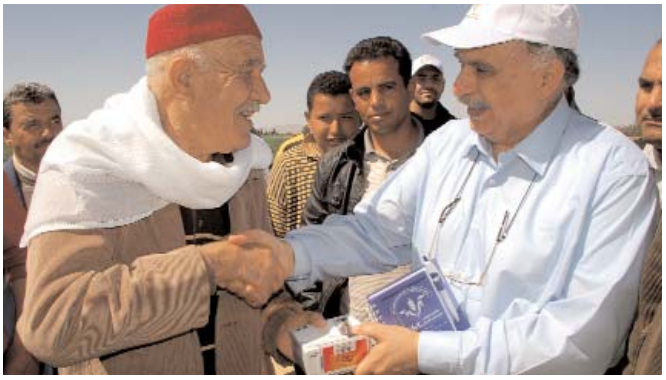
Research-for-development initiatives

Partnerships that get research into use

The sharp end of ICARDA's research program is a series of 'research-for-development initiatives' that link ICARDA's research teams with on-going partnerships with countries to assess, test, and scale-up interventions to improve the performance of agriculture in a number of dryland countries. These partnerships help the partner countries put new technologies and practices into action to improve farming productivity. The results and learning are also made available by ICARDA for use by all countries that can benefit from them.

Here is an update on progress and achievements in 2012.

Enhancing Food Security in Arab Countries



The Food Security project tests different technology transfer approaches. In Tunisia the lead farmer concept was tested – adapted from similar methods used in India – where a lead farmer mentors ten 'satellite' farmers. Mobile phones are provided to lead farmers, to facilitate rapid and easy access to other farmers, extension services, and researchers. Dr Mahmoud Solh (right), ICARDA Director General, presents a mobile phone to a lead farmer in Tunisia, launching this new technology transfer initiative.

Technologies, practices and transfer approaches bring increased yield and income to communities

Innovations and approaches from an ICARDA-coordinated research project, Enhancing Food Security in Arab Countries, can benefit all countries that need to increase the productivity of their dryland production systems. Research results include tested technology and policy packages that produce increased yields, and proven technology transfer approaches that countries can adopt to move new practices to rural communities.

All countries that depend on dryland production systems for national food supply face a rapidly changing set of climatic, policy, and social circumstances. These changes are challenging farmers and policy makers to respond swiftly to ensure enhanced food security, while successfully navigating a complex set of inter-related factors that impact on agriculture. Changing rainfall patterns, population trends and consumer preferences are posing challenges to farmers, while biotechnology and advances in knowledge need to be communicated to producers.

The Enhancing Food Security in Arab Countries project is taking innovative approaches to address these challenges in six countries: Egypt, Tunisia, Morocco, Sudan, Syria and Jordan. With multiple technology transfer methods, rigorous 'live' testing in farmers' own fields, and integrated capacity-building components, the project is providing practical solutions to improve wheat production and enhance food security and sustainable agriculture in the region.

The project has convincingly demonstrated substantial benefits to farmers from improved varieties and agricultural practices. In Egypt, comparative demonstrations on raised-bed planting technology conducted over two seasons

Technology transfer: a choice of tested options for countries to scale-up and popularize improved agriculture

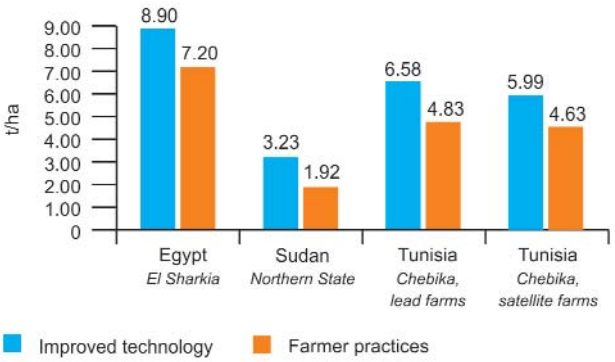
A unique aspect of the project has been its multiple methods for disseminating information and improved practices. In Egypt, a **mass dissemination** approach was used. At any given site or village, the highest number of demonstration plots were implemented in farmers' own fields, in order to cover different areas, types of soils and irrigation systems. Each plot had support from a village extensionist, and every eight to ten plots were supervised by a project team that included plant and soil specialists.

Tunisia and Morocco implemented a **leading and satellite (clustered) farmers** approach. Leading progressive farmers were selected to receive a full improved wheat production package, with eight to ten satellite farmers around them. The satellite farmers were coached in the technologies, either through a simple problem-solving demonstration or through technical advice on best practices. In Tunisia, an innovative communication approach was trialed, whereby leading farmers were given mobile phones to facilitate communication between them, the satellite farmers, and the extension and research team.

In Sudan, Syria and Jordan, a **multi-tool dissemination approach** was used. Based on the classic technology transfer methodology, it involved a number of demonstration plots randomly distributed around farmers' fields. Farmers' field schools, field days and traveling workshops then disseminated information and popularized the improved technologies.

Building from these successes, the project targets to expand the number of farmers in the demonstration network to continue the uptake of improved methods and further improve wheat yields across the region.

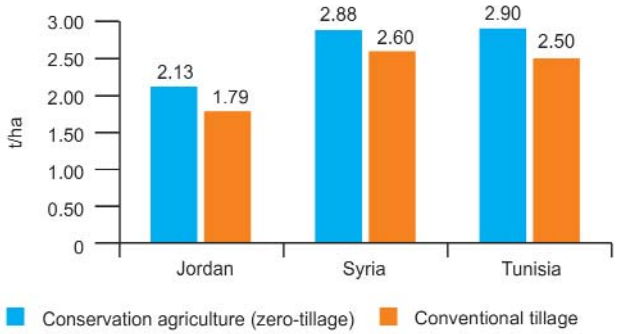
Yields of wheat: improved technology vs. farmer practices



resulted in an average 30% increase in wheat yield, 24% saving in irrigation water, and 72% increase in water-use efficiency over farmer technology. In Northern State, Sudan, the cultivar 'Imam' demonstrated exceptional performance. Yields were up to 134.9% higher – more than double those of the farmers' usual varieties.

On-farm demonstrations of conservation agriculture based on the no-till system were established on ten farms in Jordan. Conservation agriculture techniques resulted in generally higher biological yields (6.7 ton/ha versus 3.5 ton/ha) and grain yields (2.1 ton/ha versus 1.8 ton/ha) than conventional tillage. The net benefit of conservation agriculture stemming from reduced cost of land preparation and increased yield ranged between 56 and 611 US$/ha.

Yields of wheat: conservation agriculture vs. conventional tillage



As well as testing improved packages in Tunisia, irrigation demonstrations were carried out in Chebika. These confirmed past seasons' results that the tensiometer-based method for monitoring crop irrigation needs and scheduling is more efficient than either the Penman or the Class-A evaporation methods. The tensiometer method proved easier to apply and led to higher grain yields and greater water-use efficiency.

Tensiometer-based irrigation needs monitoring vs. other methods

	Tensiometer method	Class-A evaporation	Penman
Yields (t/ha)	7.5	5.2	6.2
Water-use efficiency (kg/m³)	1.8	1.7	1.4

Types of agro-ecosystems

The Project has carried out activities in a number of agro-ecosystems in the participating countries, with examples given below:

Agro-ecological conditions	Country (and area)
Rainfed and supplemental irrigation	Algeria (Oued Smar and Beni Mestina); Jordan (Irbid); Morocco (Chaouia-Ouardigha); Tunisia (Fernana); Morocco (Tadla perimeter)
Irrigated	Egypt (El-Sharkia); Sudan (Northern State and Gezira Scheme); Tunisia (Chebika)
Rainfed and supplemental irrigation	Syria (El Bab); Yemen (Jahran; no field activities conducted yet)

Demonstrating the tensiometer method for crop irrigation needs monitoring and scheduling.

The project has also targeted capacity-building activities during the year, despite difficulties due to unrest in the region. A total of 9,240 participants attended a variety of capacity-building events. Over 7,100 farmers, extensionists, researchers, policy makers and other participants attended 178 farmers' field schools, while over 720 participants attended in-country training courses or symposiums. Regional activities also took place, such as a farmers' traveling workshop, which involved farmers, extension agents, and researchers from the six countries. The enthusiastic feedback from participants indicates that it was successful in allowing them to share experiences, create links, and strengthen farmers' confidence in new technologies.

Next steps

During the 2012/13 season the project will expand the dissemination activities. More farmers will be included in the demonstration network to achieve wider adoption of improved technologies and further improve wheat yields in the region.

Partners

- Institut National de la Recherche Agronomique (INRAA), Algeria
- Agriculture Research Center (ARC), Egypt
- National Center of Agricultural Research and Extension (NCARE), Jordan
- Institut National de la Recherche Agronomique (INRAM), Morocco
- Agricultural Research Corporation (ARCo), Sudan
- General Commission for Scientific Agricultural Research (GCSAR), Syria
- Institut National des Grandes Cultures (INGC), Tunisia
- Agricultural Research and Extension Authority (AREA), Yemen
- International Center for Agricultural Research in the Dry Areas (ICARDA)

Donors

- Arab Fund for Economic and Social Development (AFESD)
- Kuwait Fund for Arab Economic Development (KFAED)
- Islamic Development Bank (IsDB)
- OPEC Fund for International Development (OFID)

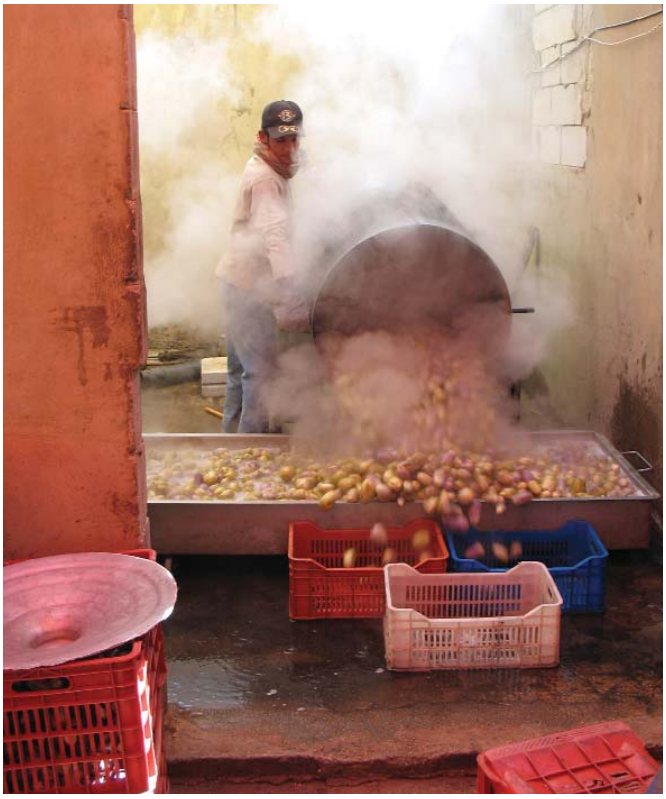
Middle East Water and Livelihoods Initiative

In 2012, the Water and Livelihoods Initiative (WLI) team explored 40 different technologies for sustainable water and land management across benchmark sites in seven countries in the region. Some of the technologies are at the pilot stage. Others are ready to be scaled-out in project countries and throughout the region.

More opportunities for women through better water use in Lebanon

Eggplant is used in many everyday dishes in Lebanon. Demand for fresh and preserved eggplant is strong and there is potential for expanding production of this high-value crop. In El Qaa in Lebanon's Bekaa Valley, growing, selling, and preserving eggplant are important economically. Both men and women are involved in growing eggplant, and preserving and marketing are mostly done by women. But growing more eggplant to develop the industry will be difficult unless scarce water can be used more efficiently.

The Lebanese WLI team has run field experiments and demonstrations to show how water productivity can be improved through technologies such as drip irrigation. The team is now piloting ways of engaging the local community to improve water management and develop livelihood strategies for women.



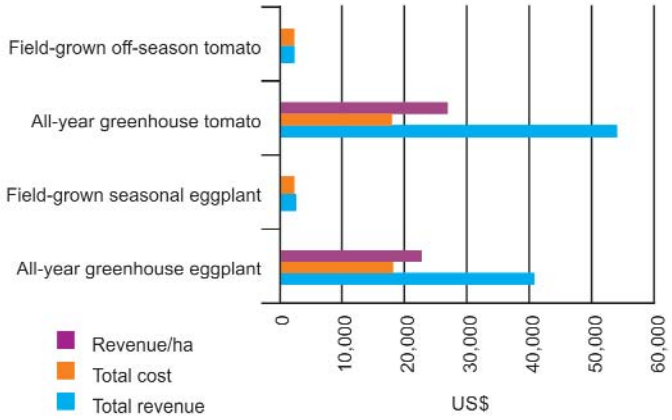
Working with farmers and women entrepreneurs to improve growing, marketing, and preserving eggplant can boost both water productivity and local livelihoods.

Saving water and boosting profits in Iraq: high-value greenhouse crops improve profits

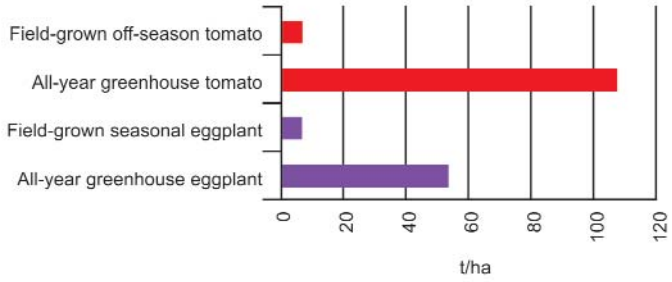
One way of using water efficiently in water-scarce countries like Iraq is protected agriculture. Farmers in four out of ten districts in the Abu Ghraib benchmark site have greenhouses.

The Iraq WLI team carried out a socioeconomic survey of 115 farmers who grow eggplant and other vegetables off-season. The results showed that although the costs of growing eggplant and tomato in greenhouses were higher than growing them in open fields, the yields and profits were also far higher because vegetables produced off-season fetch a better price.

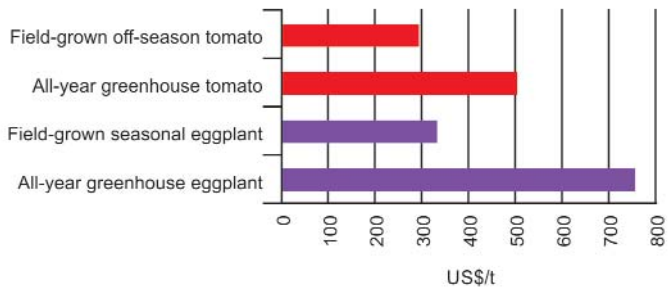
Costs and revenues of greenhouse and field tomato and eggplant, Abu Ghraib, Iraq



Yield of greenhouse and field tomato and eggplant, Abu Ghraib, Iraq



Price fetched by greenhouse and field tomato and eggplant, Abu Ghraib, Iraq



Sub-surface irrigation saves water

The team also piloted other ways to increase water productivity and yield. One on-farm experiment compared surface with sub-surface drip irrigation of eggplant. Sub-surface drip irrigation both saved water and increased yield. Lengthening the interval between irrigations saved water but did not reduce yield. As nearly 400,000 tons of eggplant are grown in Iraq in a season the amount of water that could be saved by scaling-up sub-surface irrigation and increasing the interval between irrigations could be significant.

Yield of eggplant (kg/plant) under different irrigation treatments, Abu Ghraib benchmark site, Iraq

Irrigation interval (days)	Yield (kg/plant)		
	Sub-surface drip irrigation	Surface drip irrigation	Surface irrigation
1 day	0.830	0.900	0.600
3 days	0.710	0.560	0.940
5 days	0.820	0.310	0.500

Farmers in Iraq inspect a sub-surface drip irrigation system in a field of eggplant. The sub-surface system saves water and boosts yields compared to flood or surface drip irrigation.

Partners

Egypt
- National Water Resource Center (NWRC)
- Agricultural Research Center (ARC)
- American University in Cairo (AUC)
- Faculty of Agriculture – Ain Shams University
- Faculty of Agriculture – Cairo University
- Faculty of Agriculture – Banha University
- Faculty of Agriculture – Zagazig University

Iraq
- State Board for Agricultural Research (SBAR)
- College of Agriculture/Baghdad University
- Ministry of Water Resources
- Iraqi National Program for Preparation of Agro-Ecology Zone Map

Jordan
- National Center for Agricultural Research and Extension (NCARE)
- University of Jordan (UJ)
- Jordan University of Science and Technology (JUST)

Lebanon
- Lebanon Agricultural Research Institute (LARI)
- American University of Beirut (AUB)
- Lebanese University (LU)

Palestine
- National Agricultural Research Center (NARC)
- Applied Research Institute of Jerusalem (ARIJ)
- Land Research Center (LRC)
- Hebron University (HU)

Syria
- General Commission for Scientific Agricultural Research (GCSAR)
- Directorate of Modern Irrigation Conversion (DMIC)
- Directorate of Extension (DoE)
- General Commission for Management and Development of Al Ghab
- National universities (Damascus and Aleppo)

Yemen
- Agricultural Research and Extension Authority (AREA)
- National Water Resources Authority (NWRA)
- Aden University

CGIAR Centers
- International Water Management Institute (IWMI)
- International Food Policy Research Institute (IFPRI)

US universities
- University of California Davis (UC-Davis)
- University of Florida (UF)
- Texas A&M University (TAMU)
- University of Illinois at Urbana Champaign (UIUC)
- Utah State University (USU)

Donors
- United States Agency for International Development (USAID)

'HSAD' – Harmonized Support for Agricultural Development in Iraq

In Iraq, a new partnership brings a competitive edge to farmers and agribusiness

The program for Harmonized Support for Agricultural Development, 'HSAD', – a new multi-year partnership between the Government of Iraq and ICARDA, and funded by USAID – plans to improve the agricultural value chains and access to markets for millions of smallholder farmers in the country. Started in late 2012, HSAD is tapping ICARDA's expertise in production systems, water and land management, higher performance crop technologies, and socioeconomics to test packages that can improve incomes and productivity for farmers.

HSAD – meaning *harvest* in Arabic – seeks to strengthen Iraq's agricultural value chains; improving the delivery of proven techniques and technologies, developing effective policies, regulations, and institutions, and building the capacities of beneficiaries.

Today the productivity of Iraq's agricultural sector faces challenges in its policies, and the effectiveness of its extension of new practices and technologies to the field. Farmers and agri-businesses lack a competitive edge and are unable to take full advantage of market opportunities. Because of these constraints, they struggle to achieve their full potential.

This nationwide initiative prioritizes smallholder farmers and women. It targets commodities crucial to Iraqi food security and promotes national ownership, placing Iraq's Ministry of Agriculture at the center of reform efforts alongside a range of international partners providing support and expertise. HSAD builds on and learns from the results of previous research and extension successes in the region. It seeks to raise rural incomes and improve the livelihoods of Iraqis who are dependent on agricultural production.

Engaging and building capacity with communities

The program takes a consultative approach, interacting closely with provincial authorities, officials across a range of government ministries, and regional committees. This ensures that local needs and priorities are taken into account. Extension activities also emphasize participation, replacing top-down approaches with pluralistic farm-led and market-driven strategies.

HSAD works to improve the competitiveness of agricultural value chains and raise the incomes of farmers and agri-businesses. To achieve this requires the creation of an enabling environment – a reform agenda for Iraqi laws and regulations to facilitate effective public sector engagement – and the restructuring and improvement of extension services. Improved skills and professional capacity is the key to achieving this positive change. Capacity-building activities will target the Ministry of Agriculture to equip officials with the skills to deliver training, accurately assess technology and policy constraints, and promote self-reliance. This will strengthen national ownership and ultimately reduce the need for external support – a key priority of the program. HSAD's international partners support the Iraqi Ministry of Agriculture, the lead organization.

HSAD Technical meeting.

HSAD objectives

1. **Delivering technologies to farmers:** proven interventions for crop, livestock, and natural resource management, including stress tolerant plant varieties, alternative feed sources, and supplemental irrigation
2. **Developing reform action plans:** summarizing constraints, piloting enabling options, and recommending policy reforms
3. **Strengthening and supporting the Iraqi extension system to increase its effectiveness in technology and service delivery:** shifting from 'top-down' extension models to participatory approaches involving farmers and rural communities
4. **Developing new policies, rules, and regulations:** a new informed policy framework based on the results of pilot programs and assessments
5. **Developing an impact evaluation of new policy options, rules, and regulations:** a persuasive and robust analysis of policy and regulation impacts approved and enacted by Iraqi authorities
6. **Training targeting farmers and agri-businesses:** helping beneficiaries to effectively navigate new services, policy rules, and regulations.

The HSAD approach – strategic commodities and value chains, critical to Iraq's food security

A set of strategic commodities and value chains, critical to Iraq's food security, were developed in detailed consultations between ICARDA and the Iraqi Ministry of Agriculture. These include wheat and barley, forage and food legumes, small ruminant meat and dairy products, and date palm. Program management will be from a national coordination unit in Baghdad with three regional centers in central (Baghdad), northern (Erbil), and southern (Basra) Iraq.

Activities will be executed at a series of action sites, representing distinct agro-ecologies and production systems, and satellite sites that offer bases for gap-filling, and given on-going security threats, risk minimization strategies. Expected results will be achieved through a multi-dimensional approach prioritizing operational, institutional, and policy reforms.

Implementation will assume a consultative character involving continuous coordination and interaction across regional governments and relevant Iraqi ministries, including the Ministries of Irrigation and Water Resources, Environment, and Planning. The initiative also prioritizes flexibility – value chains can be added, switched, or dropped as the project progresses – and works through regional committees to ensure activities reflect local priorities.

Partners

HSAD will be led by the Iraq Ministry of Agriculture with support from international partners who will draw upon knowledge gained from completed and on-going projects in Iraq and similar agro-ecologies in other countries. ICARDA is the executing agency and will work alongside the following partners:

- Ministry of Irrigation and Water Resources
- Ministry of Higher Education and Scientific Research
- Ministry of Science and Technology
- Ministry of Trade
- Ministry of Planning
- Ministry of Environment
- Ministry of Agriculture and Water Resources – KRG-Iraq
- Provincial universities/agricultural colleges

And an international research-for-development consortium:

- International Food Policy Research Institute (IFPRI)
- University of Illinois – Urbana-Champaign
- Texas A&M University
- University of Florida
- University of California, Davis
- CGIAR centers

Donors

The program: Harmonized Support for Agricultural Development (HSAD) is made possible with support from the American people, delivered through the United States Agency for International Development (USAID).

Seeing the benefits of conservation agriculture – ICARDA researchers, farmers, and Iraqi extension colleagues.

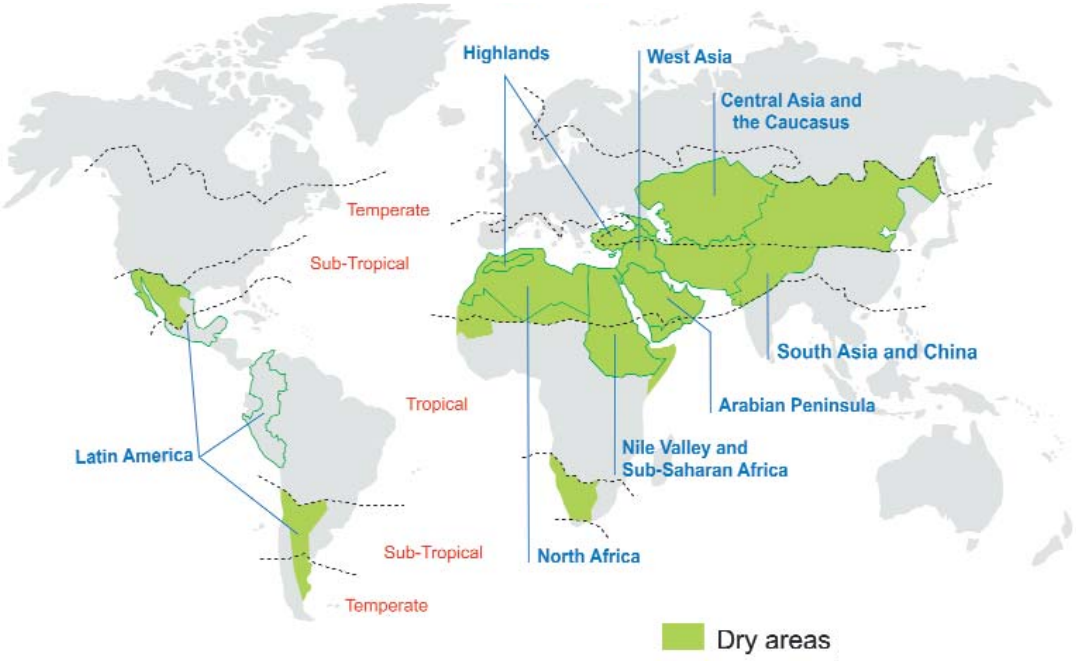
Partnerships and outreach

ICARDA's chief partners are national research and extension systems. Frequent meetings, particularly with ministers and other policy makers, ensure that our research supports national and regional development priorities. On the ground, regular interactions with scientists, officials, and extension staff maintain and strengthen these partnerships.

Regional partnerships are key to ensuring that research generates strong development impacts. ICARDA's regional programs, networks, and country offices promote these partnerships, introduce and promote new technologies, and build national research capacity.

ICARDA has seven regional programs and networks:

- Arabian Peninsula Regional Program
- Central Asia and Caucasus Regional program
- Highlands Regional Network
- Nile Valley and Sub-Saharan Africa Regional Program
- North Africa Regional Program
- South Asia and China Regional Program
- West Asia Regional Program



Nile Valley and Sub-Saharan Africa Regional Program

Activities in Egypt, Eritrea, Ethiopia, and Sudan

Agriculture is a major activity in the Nile Valley and sub-Saharan Africa, employing 70% of the workforce and using 80% of water resources. But the region faces huge challenges: climatic variability, minimal investment in agricultural research and development, weak plant improvement programs, and poor quality seed production and distribution systems. To tackle these problems, the Nile Valley and Sub-Saharan Africa Regional Program works with farming communities on improving crop and livestock systems in the region.

During 2012, the Nile Valley and Sub-Saharan Africa Regional Program worked with rural communities to develop and promote high-yielding and disease-resistant varieties of wheat and legume crops. Throughout the year, the Program distributed high-yielding and rust-resistant wheat varieties to 4,000 farmers in Egypt, Eritrea, Ethiopia, and Sudan.

In addition, the Program worked with Ethiopia's national agricultural research system to produce and distribute 200 tons of wheat and legume seed, bred to tolerate a range of crop diseases. It also worked with Egyptian research agencies to produce and distribute more than 150 tons of improved wheat varieties throughout 22 governorates. In another crop improvement project, 12 countries received improved wheat cultivars from the Program for further testing and evaluation.

Improving crop–livestock systems

In 2012, the Program continued its work developing and promoting integrated crop and livestock systems. In particular, it looked at ways of improving livestock feeds. Data from this project shows that farmers in Egypt, Eritrea, and Sudan increased their livestock feeds by 10% in the 2012 growing season.

In Egypt, the Program looked at the genetic biodiversity of indigenous small ruminants in order to identify breeds that are heat tolerant and suitable for crop–livestock systems. Other research in the country aimed to help livestock farmers cope with climate change and annual feed gaps, and take advantage of emerging markets for animal products.

Crop improvement – heat-tolerant variety in Sudan.

Managing water and soil

During 2012, the Nile Valley and Sub-Saharan Africa Regional Program developed and promoted practical solutions for dealing with water shortages and poor soils. In Ethiopia, the Program enabled farmers to increase crop productivity by 100% and reduce soil erosion by 50%.

In Egypt, farmers adopted raised-bed technology developed by the Program and Egypt's Agricultural Research Center, increasing the area cultivated from 4,000 acres in 2010/11 to more than 15,000 acres in 2011/12. Other research, in Eritrea, produced a suitability map showing that 70% of the Zoba Debub area is suitable for micro-catchment water-harvesting techniques.

Looking ahead

The Nile Valley and Sub-Saharan Africa Regional Program is currently developing a range of new projects to assist farmers in the region. Project topics include wastewater management, small-scale irrigation, seed delivery systems, community-based livestock breeding, and management of salt-affected lands.

Partners

- Ministry of Agriculture and Land Reclamation, and Ministry of Water
- Resources and Irrigation, Egypt
- Ministry of Agriculture and Hamelmalo Agriculture College, Eritrea
- EIAR and Ministry of Agriculture
- Various regional state governments, bureaus, research institutes, seed enterprises, farmers' unions, and seed growers' and processors' associations, Ethiopia
- Ministry of Agriculture and Agriculture Research Cooperation, Sudan
- Ten universities, Egypt, Ethiopia, and Sudan
- Sasakawa Africa Association

Donors

- United States Agency for International Development (USAID)
- International Fund for Agricultural Development (IFAD)
- Australian Centre for International Agricultural Research (ACIAR)
- African Development Bank (AfDB)
- Islamic Development Bank (IsDB)
- Arab Fund for Economic and Social Development (AFESD)
- Kuwait Fund for Arab Economic Development (KFAED)
- International Development Research Council (IDRC), Canada
- Austria Development Agency
- Government of Egypt

North Africa Regional Program

Activities in Algeria, Libya, Mauritania, Morocco, and Tunisia

The agricultural challenges facing countries across North Africa are similar, from limited water supplies to food security. By working in partnership with NARS and other stakeholders, ICARDA's North Africa Regional Program aims to tackle these issues by generating technologies and research findings that can be applied across the region.

In 2012, six farmers' associations were established in the Chaouia region of Morocco to promote the use of no-till technologies, which research has shown to be useful in tackling food security issues and improving the livelihood of farmers in the drylands. The technologies were adopted on 600 ha of land.

Surveillance yielded information on the distribution and severity of major crop pests. There was increased adoption of the resistant bread wheat variety 'Arrihane' during 2012 as a result of research into management of the hessian fly. The use of biotechnology enabled the development of genetic protocols to introduce *Orobanche* resistance into faba bean; and drought tolerance into wheat.

Native plants were collected in Morocco with the aim of rehabilitating pastoral rangelands and conserving species. The on-going focus of the project will be to develop techniques for optimal germination using water and soil management techniques.

New areas of research

New initiatives launched in 2012 included a project encouraging collaboration between 12 sub-Saharan countries including the major wheat growers, Ethiopia, Nigeria, and Sudan. In Algeria, Morocco, and Tunisia, a project looked at barriers to smallholders adopting conservation agriculture and assisted in the development of low-cost machinery and new cropping systems.

In July 2012, a new five-year agreement was signed to resume collaboration between ARC Libya and ICARDA on developing resources through degree-level education and a new research program. India and Morocco launched a new initiative to increase the productivity of food legumes and diversify cropping systems to improve human nutrition.

Training and networking

Through workshops, exchanges, training, and the provision of equipment, goat farmers in Morocco were educated about goat milk processing and cheese production, to improve their incomes. The project also contributed to the development of private enterprises and NGOs involved with goat rearing.

New income from novel crops: Moroccan women farmers share experiences and demonstrate home-made products made from their medicinal plants.

In the Eastern Atlas region of Morocco, two women's cooperatives were established that taught members how to grow and maintain aromatic and medicinal plants, and how to procure the equipment needed to process them. Members helped establish quality control, certification, and labeling for their products, and were able to establish marketing agreements with traders and large processing institutions.

Looking ahead

In 2013, a project funded by IFAD will focus on increasing productivity and profitability through crop–livestock integration in Algeria, Tunisia, and Tajikistan. A two-year program in Tunisia will model the effect of global climate change on cropping systems to improve the use of scarce water resources. In Morocco, the Collaborative Grant Program will continue existing research into dryland cereal-based systems, biotechnology, and soil fertility as part of a new five-year agreement.

Partners

- Agriculture Research Center of Libya (ARC)
- Australian Centre for International Agricultural Research (ACIAR)
- Institut National de Recherche Agronomique, Morocco (INRA)
- Institut Agronomique et Vétérinaire Hassan II, Morocco (IAV Hassan II)
- Institute of Arid Regions – Medenine (IRA), Tunisia
- National Agronomic Institute of Tunisia (INAT)
- Institut National de la Recherche Agronomique de Tunisie (INRA), Tunisia
- OCP Foundation, Morocco
- Swaminathan Foundation, India
- United States Department of Agriculture – Agricultural Research Services (USDA-ARS)

Donors

- Ministry of Agriculture, Libya
- African Development Bank (AfDB)
- International Fund for Agricultural Development (IFAD)
- Australian Agency for International Development (AusAID)
- Ministry of Agriculture, Morocco
- OCP Foundation Morocco
- Arab Fund for Economic and Social Development (AFESD)
- Food and Agriculture Organization of the United Nations (FAO)
- European Union (EU)

West Asia Regional Program

Activities in Cyprus, Iraq, Jordan, Lebanon, Palestine, Syria, and lowland Turkey

West Asia faces severe food scarcity problems. Challenges spanning the region – such as water scarcity, droughts as a result of climate change, and desertification – are compounded by a lack of necessary investment in agriculture. The West Asia Regional Program works with partners from across the region on impact-rich and replicable activities to address these issues.

The West Asia Regional Program collaborates with the Agricultural Research Center in Cyprus to conserve and use genetic resources. The 2012 joint collecting mission saw 210 new wild relatives of legumes and cereals added to the collection, which were then planted.

A Program-led community participation project improved populations of 14 landraces of wheat and barley, selecting superior heads resulting in 6.6–35% more grain yield than the original landraces.

In 2012, the Program worked with the Ministry of Agriculture in Iraq to test ways to manage date palm pests. ICARDA scientists tested treatments for lesser date moth infestation, resulting in reduced levels of 49–69% in just four weeks. Successful tests of integrated pest management to control stem borers led to a yield increase of 22%. For the serious threat of the Dubas bug, the Program developed a bio-control material using neem which reduced the pest's population by 72%. This led Iraq's Ministry of Agriculture to use neem for Dubas bug control over 12,000 ha during 2012.

Building partnerships

The third Biennial Regional Coordination Meeting for the West Asia Program was held over 3–4 January 2012 in Amman, Jordan. Directors General and senior scientists of the research institutions from Iraq, Jordan, Lebanon, Palestine, and Syria met with 12 ICARDA scientists in this key forum to review past work and develop regional strategies.

In 2012, ICARDA signed a MoU with the American University of Beirut. The newly strengthened partnership will conduct research in areas such as information exchange and joint agricultural research.

Also, 2012 saw a MoU signed between ICARDA and the Faculty of Agriculture and Forestry at the University of Mosul. It outlines implementation plans for the third phase of the on-going agriculture conservation project, which is funded by the ACIAR and AusAID.

Coordination meeting brings together partners from across ICARDA's West Asia Region.

Capacity development

In 2012, the Program continued to run training workshops across the region. The West Asia Regional Program arranged workshops for 50 Lebanese livestock producers where they learned best management practices during the mating period and pregnancy, while 174 participants in Palestine were instructed in ICARDA's new technologies.

Also in Palestine, the Program published leaflets and guideline booklets on such topics as seed certification, the safe use of waste water, and grey water. In Iraq, the Program published and distributed five brochures addressing recent findings on organic fertilization, and on growing date palm, wheat, and chickpeas.

Looking ahead

ICARDA met with Palestine's Minster of Environment Dr. Yousef Abu-Safia to discuss future collaborative work. Projects planned as a result will focus on rangeland conservation, safe reuse of wastewater, and biodiversity conservation.

Other planned activities include a project with the Lebanese Agricultural Research Institute, funded by the EU and IFAD, to enhance smallholder wheat–legume cropping systems, and a project which once funded will map agro-biodiversity in the Mediterranean.

Partners

- National Agricultural Research and Extension Systems (NARES), Iraq, Cyprus, Jordan, Lebanon, Palestine, and Syria
- Ministries of Agriculture and Ministries of Water and Irrigation
- Faculties of Agriculture at the national universities
- Private sector
- NGOs

Donors

- International Fund for Agricultural Development (IFAD)
- Arab Fund for Economic and Social Development (AFESD)
- Netherlands Government
- United Nations Development Programme (UNDP)
- United States Agency for International Development (USAID)
- Japan International Cooperation Agency (JICA)
- Australian Agency for International Development (AusAID)
- Australian Centre for International Agricultural Research (ACIAR)
- European Union (EU)

Central Asia and the Caucasus Regional Program

Activities in Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan

ICARDA partners with eight countries in Central Asia and the Caucasus (CAC) in the research areas of plant genetic resources, germplasm enhancement, soil and water management, feed and livestock production, socioeconomic and policy research, and strengthening national agricultural research organizations.

The 15th Steering Committee Meeting of the Regional Program for Sustainable Agricultural Development in Central Asia and the Caucasus was hosted by the Kyrgyz Republic. It brought together senior agricultural officials from Armenia, Azerbaijan, Georgia, Kazakhstan, the Kyrgyz Republic, Tajikistan, and Uzbekistan, and international agricultural research centers.

In **Kazakhstan**, the program works on germplasm enhancement of wheat, barley, chickpea, and lentil. It also identifies winter wheat varieties resistant to salinity and promotes conservation agriculture.

In 2012, the program and its partners selected superior genotypes of wheat, barley, chickpea, and lentil from international nurseries evaluated by national partners.

A farmer field day demonstrated improved technologies for irrigation, conservation agriculture, and crop diversification. A training course on conservation agriculture reached 72 farmers, researchers, and local officials. Currently, conservation agriculture is practiced on 869 hectares.

Efforts are underway in **Kyrgyzstan** to enhance the germplasm of wheat, barley, and chickpea, promote conservation agriculture, and improve the livelihoods of small farmers and rural women through value-added processing and export of cashmere, wool, and mohair.

Superior genotypes of cereals and legumes were identified for further evaluation. The winter wheat variety, 'Petr', selected from the nursery of the International Winter Wheat Improvement Program (IWWIP), was released for commercial cultivation. As part of a project on mohair and cashmere, 55 women farmers were able to considerably increase their incomes by using improved fiber processing technology.

International winter wheat travelling workshop in Uzbekistan. (Photo: Shakhodat Bobokulova)

In **Tajikistan**, the program also works on the germplasm enhancement of wheat, barley, chickpea, and lentil and promotes income generating activities for rural women processing and exporting cashmere, wool, and mohair. As part of the cashmere project, the livelihoods of 75 women farmers were improved.

Two varieties of chickpea were provided to 268 smallholders across 18 districts of Tajikistan in 2012. This success story and its impact are described in more detail in the box on page 46.

In **Turkmenistan**, winter wheat varieties resistant to salinity were identified. For example, in 2012 seven winter wheat varieties from IWWIP nurseries were selected as promising sources for new salt-tolerant cultivars.

In **Uzbekistan**, the program works on germplasm enhancement of wheat, barley, chickpea, and lentil. There is a specific focus on conservation agriculture, better coordination of common rangeland use and management, and the identification of winter and salt-resistant wheat varieties. For example, 32 superior wheat lines were selected for their high yields and salinity tolerance. Field days and training courses were held on conservation agriculture, reaching 81 policy makers, Agriculture Ministry officials, researchers, and farmers.

Activities in **Azerbaijan** are also focused on germplasm enhancement of wheat, barley, chickpea, and lentil, and promotion of conservation agriculture. A field day reached 70 farmers and local authorities. Another training session reached 58 people, including policy makers, officials from the Ministry of Agriculture, researchers, and farmers. Conservation agriculture was practiced on 1246 hectares in Azerbaijan in 2012.

In **Armenia**, germplasm enhancement of wheat, barley, and chickpea are the focus of cooperation. Some superior cereals and barley lines were selected from the nurseries provided by ICARDA in 2012. Efforts to enhance wheat, barley, and chickpea germplasm in **Georgia** resulted in the release of one chickpea variety ('Aragvi') and one lentil variety ('Tsilkani').

In 2012, the ICARDA-CAC Program organized training courses on plant genetic activities and seed production in all eight CAC countries.

Cold-tolerant chickpea brings Tajik farmers 25–50% better yields

Farmer partnership approaches provide new varieties and support for scaling-up. The ICARDA-CAC program actively collaborates with national partners to strengthen their programs, especially in the areas of seed multiplication of newly developed varieties and expanding superior crop varieties, which ultimately leads to improved livelihoods for the people in the region.

With the release of two new cold-tolerant chickpea varieties, selected from ICARDA germplasm and tested in Tajikistan, farmers now have the opportunity to plant chickpea in the autumn and harvest it in late spring, before temperatures increase creating heat stress. Chickpea crops planted in winter also use moisture from melted snow and produce a 25–50% higher yield than chickpea crops planted in spring.

The collaborative research activities between the Crop Husbandry Institute (CHI) of the Tajik Academy of Agricultural Sciences and ICARDA-CAC resulted in the release of the 'Hisor-32' improved chickpea variety in 2009 and the 'Sino' improved chickpea variety in 2011. In order to reach remote areas of Tajikistan with these improved varieties, CHI and ICARDA-CAC launched a varietal out-scaling program in 2010. One ton of seed of the 'Hisor-32' and 'Sino' chickpea varieties was supplied to farmers. Both are high-yielding varieties, with resistance to the diseases prevalent in Tajikistan and are suitable for autumn and spring planting.

In 2010, a collaborative pilot project between CHI and ICARDA-CAC was started with 50 chickpea farmers by making available 20 kg of seed of each variety on condition that the recipient farmers returned the amount of seed received. This project continued with an additional 2 tons of seed in 2011 and 2012. Through the seed return scheme and on-farm trials demonstrating the performance of the new varieties, out-scaling was expanded to additional districts of Tajikistan in 2011 and 2012.

Within the short span of two years, these two varieties of chickpea have been provided to 268 smallholder farmers across 18 districts, which include several remote mountainous districts in Tajikistan. On average, in 2012 under rainfed conditions, the farmers harvested yields of 0.8 ton/ha of 'Hisor-32' and 0.9 ton/ha of 'Sino'. At the end of the 2012 crop season, around 22 tons of seed of these two varieties were available to the farmers for further planting in 2013. Since smallholders traditionally save some of the chickpea grains produced for planting the following year, and a farmer to farmer barter trade in chickpea seed is common in the remote districts of Tajikistan, the out-scaling project is expected to become sustainable.

Impact

The project in Tajikistan, where improved varieties of chickpea, wheat, and barley were made easily available through partnerships among farmers, the national agricultural research and extension system in Tajikistan, and ICARDA, has helped to improve rural livelihoods.

This model of partnership can have direct implications for the other countries of Central Asia. In fact, ICARDA-CAC is already supporting another larger initiative on accelerating adoption of eight yellow rust-resistant winter wheat varieties in Uzbekistan and Tajikistan through a Partners Grant scheme under the CGIAR Research Program on Wheat. Under this new initiative, eight stripe rust-resistant varieties of winter wheat were planted on an area of 126 ha for seed multiplication in Uzbekistan and Tajikistan. This new project intends to plant these wheat varieties on over 50,000 ha of farmers' fields in 2015.

Partners

- Azerbaijan Agrarian Scientific Center, Azerbaijan
- Ministry of Agriculture, Armenia
- Academy of Agricultural Sciences and the Agrarian University, Georgia
- Kazagroinnovation, Kazakhstan
- Ministry of Agriculture, Kyrgyzstan
- Tajikistan Academy of Agricultural Sciences, Tajikistan
- Ministry of Agriculture and Academy of Science, Turkmenistan
- Uzbek Scientific Production Center for Agriculture, Uzbekistan

Donors

- International Fund for Agricultural Development (IFAD)
- Food and Agriculture Organization of the United Nations (FAO)
- Asian Development Bank
- Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Germany
- Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU), Germany
- Ośrodek Studiów Wschodnich (OSW), Russia

South Asia and China Regional Program

Activities in Bangladesh, Bhutan, China, India, and Nepal

South Asia is home to about half of the world's undernourished people. With an increasing food demand and the problems caused by a changing climate, food and nutritional insecurity is a major challenge to the region. To address these issues, the Regional Program focuses on diversifying crops, crop improvement for higher yields under various crop production systems, and socioeconomic conditions of marginal farmers.

Achievements in agriculture

Conservation agriculture methods can significantly increase pulse crop efficiency. Since 2010, ICARDA has run trials in various states of India for zero-tillage planting as well as no-till relay cropping, where legumes are direct-seeded into the standing rice crop. The trials resulted in up to 60% higher yields at a reduced production cost, with great potential to scale out these technologies to neighboring countries.

Working with its partners, the ICARDA regional program has continued to promote and distribute new, micronutrient-rich strains of lentil to farmers across the region. In 2012, seeds of iron- and zinc-rich cultivars were distributed to nearly 3000 farmers in Bangladesh, Nepal, and India, to raise awareness of just how healthy these new strains are for consumers.

Barley for feed, food, and malt are very important in China, India, and mountainous regions of Nepal and Bhutan. Using ICARDA genetic materials, these countries have developed barley varieties for multi-purpose use that will thrive in their environments.

New partnerships

In 2012, a consortium including ICARDA was established, under the India–Morocco Food Legume Initiative, to increase food legume production in India and Morocco. As a result, ICARDA's South Asia and China Regional Program is responsible for enhancing income and pulse production of 6,000 Indian farmers in the coming years.

The OPEC Fund for International Development launched an initiative to enhance pulse production through the intensified use of rice fallows in Nepal and Bangladesh. ICARDA will be the implementing center for this initiative.

In addition, a new partnership involving ADB, FAO, WB, WFP, IFAD, and ICARDA are to work in Bangladesh, India, China, and Nepal on crop genetic enhancement, sheep and goat farming improvement, and human capacity development.

Value addition for higher income. Indian women display various lentil food products.

Capacity building

The program has continued to provide training to build capacity over the last three years. Working with Indian partners, a project to boost pulse production through training has reached 6,500 farmers at some 350 events since its inception two years ago.

In South Asia, women take care of the storage and processing of seeds into edible forms. Over the last two years, about 280 women were trained by the program in value addition through storage and processing technologies. Furthermore, specialized training for women was organized in India on detoxifying grasspea seeds by pre-cooking.

Looking ahead

The program will be working on a number of new research projects in the coming years. These include widening the genetic base of lentil and chickpea; genetic detoxification of grasspea; adaptation research on cacti species for multi-purpose use; developing super-early pulse varieties for Bangladesh, eastern India, and Nepal; and finding suitable herbicides to control a range of weeds in pulse crops.

Partners

- Bangladesh Agricultural Research Council
- Bangladesh Agricultural Research Institute
- Bangladesh Institute of Nuclear Agriculture
- Council for Renewable Natural Resource Research of Bhutan
- Bhutan Ministry of Agriculture
- Chinese Academy of Agricultural Sciences
- Yunnan Academy of Agricultural Sciences, China
- Indian Council of Agricultural Research (Indian Institute of Pulses Research; Directorate of Wheat Research; Central Arid Zone Research Institute; Indian Grassland and Fodder Research Institute; Indian Agricultural Research Institute; Vivekananda Parvatiya Krishi Anusandhan Sansthan; National Bureau of Plant Genetic Resources)
- Indian Department of Agriculture and Cooperation
- 12 Indian State Agricultural Universities
- Nepal Agricultural Research Council

Donors

- National Food Security Mission, India
- Ministry of Agriculture, India
- Indian Council of Agricultural Research
- Indian Ministry of Agriculture
- CGIAR Research Program-Grain Legumes
- CGIAR HarvestPlus Challenge Program
- Organization of the Petroleum Exporting Countries (OPEC) Fund for International Development
- OCP Foundation, Morocco

Arabian Peninsula Regional Program

Activities in Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, the United Arab Emirates, and Yemen

Farmers on the Arabian Peninsula have to contend with very scarce water supplies and poor soils. Agricultural activities are limited to around 1% of land, so maximizing productivity per unit area is paramount. ICARDA's Arabian Peninsula Regional Program aims to enhance agricultural productivity and rural livelihoods in the region by transferring promising technologies to farmers.

In 2012, the Arabian Peninsula Regional Program continued promoting integrated production and protection management (IPPM) in protected agriculture on the Arabian Peninsula. A study conducted with Yemen's national agricultural research and extension system concluded that adopting IPPM increased pilot growers' incomes by 12% and reduced the number of pesticide sprays on cucumber crops to just three (compared with 20 in control greenhouses).

Growing crops without soil (hydroponics) was another protected agriculture technique promoted by the Program. Providing high yields and water productivity (amount of 'crop per drop'), the hydroponics system was adopted by 48 growers working with the Program in 2012. In addition, individual nations in the region encouraged growers to adopt soil-less growing. For example, in the United Arab Emirates, the Ministry of Environment and Water covered 50% of growers' costs in establishing hydroponics systems, which were consequently used in more than 600 greenhouses by the end of 2012.

Other technology transfer in 2012 focused on indigenous forage crops. The Program worked with more than 35 farmers in the region to grow buffel grass as a forage crop with water productivity around 35% higher than the commonly grown Rhodes grass. The Program also established two new seed units, in Qatar and Saudi Arabia, to conserve and promote indigenous forage species.

New areas of research

In Oman, the United Arab Emirates and Qatar, the Arabian Peninsula Regional Program worked with 15 pilot growers to test an automatic controller for administering a nutrient solution in hydroponics systems. Initial results are very promising.

Another area of study was the relationship between irrigation, water use, and yield of buffel grass in Oman, Qatar, and Saudi Arabia. Other research involved trialing spineless cacti on two farms and a research station in the United Arab Emirates. Results from these studies will become available in 2013.

High quality pepper crop with a close soilless production system on a pilot grower farm, UAE.

Training and networking

During 2012, the Arabian Peninsula Regional Program organized seven training courses and two field days, attended by 170 growers, researchers, and extension workers. In December, the Program held its 5th Annual Regional Technical Coordination Meeting and Regional Steering Committee Meeting in Dubai. These meetings were organized jointly with the Ministry of Environment and Water, United Arab Emirates.

Looking ahead

The Arabian Peninsula Regional Program's current project will close at the end of 2013. However, at the request of countries in the region, the Program is currently submitting a project proposal to cover the period up to December 2018. Through this project, the Program hopes to continue existing work and move into new areas of research including integrated animal production systems and use of marginalized lands. The date palm project in the Gulf Cooperation Council countries will be continued for five more years, starting in the 2013/14 season.

Partners

- Ministry of Municipal Affairs and Urban Planning, Bahrain
- Public Authority for Agricultural Affairs and Fish Resources, Kuwait
- Ministry of Agriculture and Fisheries, Oman
- Ministry of Environment, Qatar
- Ministry of Agriculture, Saudi Arabia
- Ministry of Environment and Water, United Arab Emirates
- National Agricultural Research and Extension System, Yemen

Donors

- Arab Fund for Economic and Social Development (AFESD)
- International Fund for Agricultural Development (IFAD)
- Organization of the Petroleum Exporting Countries (OPEC) Fund for International Development
- Gulf Cooperation Council Secretariat

Afghanistan Country Program

Activities in Afghanistan

Approximately 37.5% of the population of Afghanistan lives below the national rural poverty line. Agriculture requires a 5% annual growth rate over the next decade to facilitate adequate economic development. Introducing new technology and increasing education will help realize this goal.

Empowering women and increasing capacity in rural areas are two themes central to ICARDA's vision to help generate growth in Afghanistan. Techniques include mobilizing communities, introducing new agricultural technologies, and on-going training.

Projects and training

Through cultural awareness, ICARDA facilitated the participation of women in domestic and overseas training. The popular train-the-trainer method encourages women to pass on taught skills and knowledge to other women, increasing the number of qualified females even further.

The program worked with 546 women from 14 villages, focusing on dairy goat rearing. Three hundred women received a native 'Gujry' breed goat, increasing milk production in these households. Beneficiaries receive goat kids via the *Pass on the Gift Policy*, developed by the NGO, HEIFER, helping to create sustainable communities.

The training of Basic Veterinary Workers, Community Female Facilitators, and Village Female Activists began in 2006, and the following year saw the creation of 14 women's associations. During 2011 and 2012, the project introduced new agricultural methods to 3,717 women during four farmers' field days, and 24 overseas and 30 indigenous trainings, addressing the persistent issue of capacity development. A complete capacity development plan for the Ministry of Agriculture, Irrigation and Livestock researchers in water and dryland agriculture-related topics is underway.

Investigations into drought-resistant varieties of wheat and legume crops through 10 trials at five research stations allowed farmers to increase productivity in the dryland areas. Training is on-going in a community-based catchment site in the Khulm district covering 250 ha.

Nurseries for 162,000 pistachio and *Atriplex* (saltbush) saplings have been created and 500 women tend them. The monthly meetings, attended by approximately 25 women per village, are crucial for the exchange of knowledge and skills.

Achievements

New technologies increased milk yields by 10–15% permitting an additional 4.5 kg per month per household for activities such as cheese making. Longer shelf life and a higher market price for milk are among other tangible benefits.

Veterinary health care improvements were a key focus, and mortality and abortion rates decreased from 20–25% to 4%. The gross benefit of the project stands at US$1,440,040 and the internal rate of return is 96%.

Solar power is being introduced to distribute water collected through the watershed for the first time in Afghanistan. Demonstrations on sub-surface and supplemental irrigation, micro-catchment of water, and raised-bed wheat cultivation occurred in two provinces. The press transmits a technical bulletin on watersheds and on-farm watershed management encouraging national awareness and understanding.

Group meetings initiated by the project are on-going as the villages continue to enjoy the benefits that self-sustainability has brought them. These new approaches have spread to neighboring villages.

Simple technologies, extensive teaching programs, and complete community participation are essential ingredients in this comprehensive ICARDA program. Offering numerous positive results in Afghanistan makes the research project a suitable model for other developing countries.

Partners

- Ministry of Agriculture, Irrigation and Livestock (MAIL), Government of Afghanistan
- Agriculture Research Institute of Afghanistan (ARIA), MAIL
- Agriculture Directorates (MAIL) of Baghlan, Herat, Jowzjan, Kabul, Mazar, Nangrahar, Samangan, and Uruzgan provinces
- Women Affairs Department in Baghlan, Mazar, Nangarhar, and Urzgan provinces
- Barg-e-Sabz, an All-Women Business Association, Kabul
- Village-based seed enterprises (VBSEs) in Nangarahar, Mazar, and Uruzgon provinces
- Herbal Remedies Producers' Associations (HRPA) in Helmand, Nangarahar, and Uruzgon
- Solidarite, an international NGO
- SERVE, an international NGO
- Dutch Committee for Afghanistan, an international NGO
- Asian Vegetable Research and Development Center (now World Vegetable Center)
- CGIAR Centers (CIP, ICRISAT, CIMMYT, IRRI)
- Japan International Cooperation Agency (JICA)
- UN agencies (FAO)
- Indian Institute of Pulse Research (IIPR), Indian Council of Agriculture research (ICAR), India
- Central Research Institute for Dryland Agriculture (CRIDA), ICAR, India
- Directorate of Medicinal and Aromatic Plants Research, ICAR, India
- Embassy of India, Ministry of External Affairs, India

Donors

- Ministry of Agriculture, Irrigation and Livestock (MAIL), Afghanistan
- International Fund for Agricultural Development (IFAD)
- Australian Centre for International Agricultural Research (ACIAR)
- Australian Agency for International Development (AusAID)
- Netherlands Government
- Government of India

Iran Country Program

Activities in Iran

With an average annual rainfall of 240 mm, Iran is a dryland area where water scarcity is a major challenge. Agricultural research innovations are vital to development as 90% of Iranian land is classified as arid or semi-arid. It is essential to introduce new crop varieties tolerant to drought and continue to educate the farming community.

The Iran/ICARDA collaboration works to achieve long-term results through training and research. In 2012, ICARDA and its partners developed more sustainable varieties of lentil, vetch, and bread wheat. These new varieties, which are suitable for the characteristically dry terrain, provide some solutions to the problems associated with arid land.

The lentil variety 'Bilesovar', with an average yield of 951 kg/ha, offers a 20% extra return over previous choices. This development is worth an extra US$10 million per annum. The vetch variety 'Golsefid', offers an average yield of 3,500 kg/ha, more than double what the local type currently produces (1,300 kg/ha). The barley variety 'Nik', offers a higher yield (6,052 kg/ha) than 'Reihan' (5,460 kg/ha) and is a durable alternative, resistant to barley powdery mildew and stripe disease.

Projects and training

In 2012, some 10 project proposals looked at topics such as drought tolerance and disease resistance. Increased focus on these issues will help combat the challenges posed by water scarcity. Nine research projects on seed improvement also got underway in 2012. In addition to the Integrated Land and Water Management's existing CGIAR Challenge Program on Water and Food project, six multidisciplinary research proposals on improved agricultural technologies and practices for increasing production in the Karkheh River Basin were implemented.

A project started in 2009, Improving the livelihoods of farmers and rural women through value-added processing and export of cashmere and wool, has continued with IFAD funding. The major collaborative activities and achievements are selection of pilot sites and groups of beneficiaries, collection of baseline information on nomad cashmere goat production systems, continuation of goat breeding programs, production of yarn and knitwear, the formation of women's groups, and on-going research on goat producers and fiber production.

Training courses, workshops, and scientific visits were also established. These activities contribute to human and institutional capacity development and enhance regional collaboration, which will create a dynamic environment for exchanging the latest scientific innovations.

Selection of superior cashmere 'Raein' goats in nomadic areas of Kerman province, Baft city, Iran.

Conservation agriculture is important in sustainable production systems and for the stability of crop production. ICARDA has signed an agreement on conservation agriculture with the Deputy Ministry of Jihad-Agriculture for Plant Production of the Islamic Republic of Iran to encourage scientific collaboration.

What next?

In view of the arid and semi-arid climatic conditions and the subsequent constraints facing natural resources and sustainable crop production, a budget of nearly US$1 million has been allocated to the Iran/ICARDA joint collaborative program on production and protection of soil and water resources. Biodiversity and integrated gene management, diversification and sustainable intensification of production systems, and integrated land and water management in the Karkheh River Basin are the central research principles for 2013.

The program will continue to address water scarcity and implement the CGIAR Research Program on Dryland Systems in the Karkheh River Basin, using an integrated systems approach. These projects will build on the achievements of 2012, encouraging future food security and offering increased profits for the Iranian agricultural industry.

Partners

- Agricultural Research, Education and Extension Organization (AREEO)
- Agricultural Biotechnology Research Institute of Iran (ABRII)
- Agricultural Engineering Research Institute (AERI)
- Animal Sciences Research Institute (ASRI)
- Dryland Agricultural Research Institute (DARI)
- Iran Research Institute for Plant Protection (IRIPP)
- National Salinity Research Center (NSRC)
- Research Institute for Forests and Rangelands (RIFR)
- Seed and Plant Certification and Registration Research Institute (SPCRI)
- Seed and Plant Improvement Research Institute (SPII)
- Soil Conservation and Watershed Management Research Institute (SCWMRI)
- Soil and Water Research Institute (SWRI)

Donors

- Agricultural Research, Education and Extension Organization (AREEO), Islamic Republic of Iran

Pakistan Country Program

Activities in Pakistan

The ICARDA Pakistan Program develops, tests, and transfers technologies for improving the livelihoods and food security of poor communities in rainfed areas. Projects cover crop management, developing sustainable seed systems, and improving small ruminant production. The emphasis is on water and land management, and conservation. Gender and climate change are cross cutting areas.

In 2012, the Pakistan Program implemented three projects in Sind and Punjab provinces. The watershed rehabilitation and irrigation improvement project established 30 demonstration sites for scaling-up improved technologies. Demonstrations included bed planting in wheat, rice, and cotton; drip and sprinkler irrigation in vegetable and field crops; and water harvesting techniques. Farmers, and water management and agricultural extension staff took part.

The introduction of solar energy and water harvesting technologies received a positive response. Many farmers indicated a willingness to use solar technology to generate power for irrigation. A women's group at one site is using rainwater harvested from rooftops for growing vegetables both for home consumption and for sale. Water harvesting technologies to conserve water and reduce water erosion were also demonstrated in orchards.

In the wheat project, collaborators in Pakistan completed five yield trials to evaluate and select promising lines. Twenty-three promising lines were planted on 7 ha and produced 25 tons of seed. To solve the problem of delays in planting wheat because of late cotton harvests, relay cropping of wheat in standing cotton was introduced and evaluated. Relay cropping helped in timely planting of wheat in the cotton–wheat rotation, increased wheat yields significantly, and reduced the cost of land preparation.

Evaluation of ridge sowing technology in irrigated systems showed that it is a good alternative for farmers without bed planters who use a ridger for making ridges after broadcasting wheat. Ridge sowing increased yields by 5–25%, and resulted in water savings of 25–40%. Ridge sowing is gaining popularity with farmers.

In the cotton project, some 2,261 accessions of cotton germplasm for evaluation for resistance to cotton leaf curl virus (CLCV) were imported from USA and distributed for testing at four sites. Two to three lines have shown resistance to CLCV and are being crossed with local cultivars.

A rooftop rainwater harvesting system coupled with low pressure drip irrigation system in Chakwal, Pakistan.

Training and networking

During 2012, 130 professionals were trained in water saving technologies at four sites as part of the watershed rehabilitation and irrigation improvement project. Ten field days attended by 700 farmers were organized on land and water conservation technologies.

As part of the cotton project, 11 Pakistani researchers attended the Beltwide Cotton Conference in Orlando, Florida, USA in January. Four scientists received training in cytology, gene mapping, and virus diversity testing under the Borlaug Fellowship Program. Twenty-seven field facilitators took part in training using the farmer field school approach.

Looking ahead

Work on introducing technologies to save water and improve soil fertility will continue, mainly through training service providers and electronic media. Research and scaling-up food and fodder legumes in wheat-based cropping systems will be strengthened.

Partners

- Pakistan Agricultural Research Council (PARC)
- Barani Agricultural Research Institute (BARI), Chakwal
- Soil and Water Conservation Research Institute (SAWCRI), Chakwal
- University of Agriculture, Faisalabad
- Ayub Agricultural Research Institute, Faisalabad
- PMAS University of Arid Agriculture, Rawalpindi
- National Center of Excellence in Geology, University of Peshawar
- Central Cotton Research Institutes (CCRI), PCCC, Multan and Sindh, Punjab
- Cotton Research Institute, Faisalabad
- National Institute for Biotechnology and Genetic Engineering (NIBGE), PAEC, Faisalabad
- University of Punjab, Lahore

Donors

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

Turkey Country Program

Activities in Turkey

In 2012, the Government of Turkey and ICARDA agreed to establish a Regional Cereal Rust Research Center in Izmir. This center will lead and conduct regional rust surveillance – essential for combating the trans-boundary nature of rust pathogens and studying the pathogenic changes in the region.

Plant-breeding feedback

The International Winter Wheat Improvement Program (IWWIP) is a partnership project led by the Government of Turkey, the International Maize and Wheat Improvement Center, and ICARDA. The partnership works with a network of nurseries to breed genotypes of winter wheat suited primarily to Central and West Asia and the Caucasus, but also to provide winter facultative germplasm globally.

In 2012, IWWIP conducted a survey among the breeding programs of participating countries to obtain feedback on the usefulness of the genetic material and website data it provides. The survey also identified which crop traits are most appropriate for each country involved – information that will help fine-tune future breeding objectives.

More than 50% of respondents were from countries in Central and West Asia and the Caucasus. The survey showed that the breeding programs from this region are happy with the yield potential of the improved winter wheat material. In fact, 83% of these programs select plant material directly from IWWIP resources when developing wheat cultivars.

IWWIP was reviewed by three eminent scientists in 2012. They visited research sites both in Turkey and Syria and developed recommendations to better serve the region. Their recommendations have been studied carefully by the Steering Committee of IWWIP and an implementation plan has been developed.

A regional approach

The scientists will conduct race analyses of rust samples from major wheat-growing areas in Central and West Asia, North Africa and the Caucasus. This will allow for early detection of pathogenic changes in rust diseases and prompt appropriate plant-breeding action.

The center will provide technical support to national rust laboratories and training opportunities for young scientists across the region. It will also serve as a platform for information on how rust pathogens affect commercial cultivars and so facilitate the breeding of rust-resistant wheat varieties by national and regional breeding programs.

Farmers' field day. Giving information on newly released cultivars.

Plans for the new center in Turkey are an important historic advance. The center, located in the region most affected by rust, will offer a testing service that is both accessible and affordable to countries monitoring their rust disease risks.

Field studies and training

In the 2011/12 growing season, 84 back-up nurseries from seven crops obtained from ICARDA headquarters were planted for evaluation.

Another 2012 activity was a traveling workshop to communicate information relating to wheat stripe rust (yellow rust). More than 30 scientists from 10 countries participated and visited research sites across Turkey to improve their knowledge of the stripe rust problem.

Looking ahead

A new Memorandum of Understanding (MoU) between the Government of Turkey and ICARDA is due to be signed in 2013. This MoU will not only relate to the creation of a regional rust center in Izmir but will also allow the partnership to develop other areas of collaborative research.

Partners

- General Directorate of Agricultural Research and Policy (GDAR), Turkey
- 12 GDAR Institutes
- Dryland Agricultural Research Institute (DARI), Islamic Republic of Iran
- Seed and Plant Improvement Research Institute (SPII), Islamic Republic of Iran
- Uzbek Research Institute of Plant Industry (UZRIPI), Uzbekistan

Donors

- Government of Turkey
- International Center for Agricultural Research in the Dry Areas (ICARDA)
- International Maize and Wheat Improvement Center (CIMMYT)

Strengthening national agricultural research systems in 2012

In 2012, ICARDA's training was delivered to some 720 scientists from 25 countries. These scientists returned to strengthen and support the advancement of their national agricultural research systems. As a demonstration of the Center's commitment to training the next generation of agricultural researchers, the participants included 59 scientists who were conducting research for their MSc and PhD degrees.

Training activities were temporarily relocated in 2012 and carried out in different locations away from the training center in Aleppo, Syria at a number of distributed locations. Training was tailored to the strengths and needs of the partner countries and demonstrated a wide thematic and geographic spread. Activities also targeted countries where research capacities were limited – including those where human resources had been depleted by prolonged conflict, such as Iraq, Syria, and Sudan.

Playing to the strengths of the national partners, the training included biotechnology and wheat crop improvement in Egypt; genetic resources management in Tunisia; legume crop improvement in Lebanon and Morocco; and livestock production in Jordan. Additional efforts targeted date palm production in the Gulf Countries and Oman, and water and land management for irrigated agricultural systems in Egypt, the rainfed farming areas of Morocco, and the marginal lands in Jordan.

New subjects and options were added to the training program – a response to emerging needs in dryland countries. These included an emphasis on facilitating access to new technologies and equipping researchers with the knowledge and skills to use these tools more effectively. New subjects included:

- Mapping historical drought and precipitation trends with gridded global datasets
- New techniques and creating shared platforms for managing agricultural information in national agricultural research system libraries in six countries
- Special instruction in research communication and presentation skills
- Planning and implementation of hill lakes in semiarid regions.

Please see the complete list of capacity development activities in Appendix 7.

ICARDA's capacity development approaches

Group training: short-term (one week) and long-term (three weeks) demand-driven training tailored to the needs of NARS partners, combining lectures, interactive sessions, and the continual monitoring of participants' progress

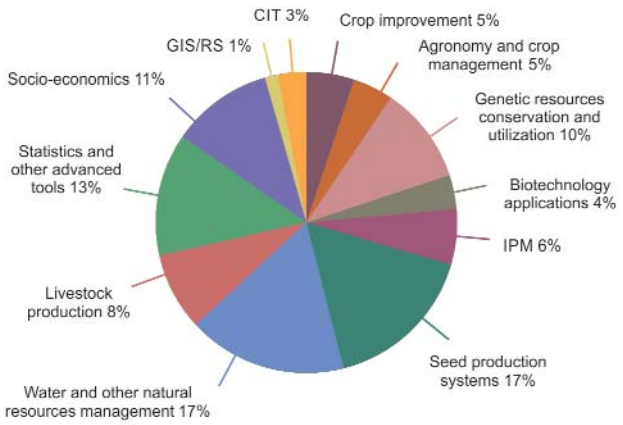
Degree training: two-year (MSc) and three-year (PhD) training which provides funding, joint supervision by an ICARDA scientist, and the opportunity to conduct fieldwork in locations where ICARDA is active

Non-degree training: three- to six-month training prioritizing the use of new technologies for agricultural research. The training targets early-career researchers who receive supervision from ICARDA scientists.

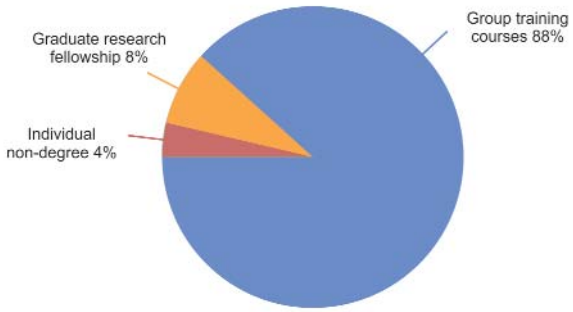
Course themes

- Water and land management
- Crop improvement, biotechnology, plant protection, and genebank management
- Seed production and health (Integrated Quality Management in Village-Based Seed Production and Seed Technology and Policy and Institutions)
- Agronomy, forages, rangeland management, and livestock
- Socioeconomics (Socioeconomic and Policy Analysis of Salinity Problems and Its Impacts on Livelihoods).
- Information technology/modeling, statistics, and research skills.

2012 training activities by theme



2012 training activities by category



Donors

- Arab Fund for Economic and Social Development
- Australian Agency for International Development (AusAID)
- United States Agency for International Development (USAID)
- International Fund for Agricultural Development (IFAD)
- Japan international Cooperation Agency (JICA)

Enhancing the capacity of young Arab scientists in agricultural research for development

With support from the Arab Fund for Economic and Social Development (AFESD), ICARDA offers opportunities to Arab Masters or PhD students in the region to do part of their thesis or dissertation research on an ICARDA research site, jointly supervised by their university supervisor and an ICARDA scientist. Awardees spend 3 to 4 months a year at a field research site, benefitting from the direct mentoring of the ICARDA supervisor. The themes of research for these fellowships include: Plant breeding/biotechnology; Rangeland, forage and small ruminants; Water and land management; Agricultural economics; Rural sociology/gender; Social analysis/rural innovation pathways; Conservation and agro-biodiversity.

Young Agricultural Scientists Program, Food Security Project

The Young Agricultural Scientists Program is a component of the ICARDA Project on 'Enhancing Food Security in Arab Countries'. This special program is designed to strengthen national research capacity for sustainable development in the countries concerned. Every year the participating National Agricultural Research Centers receive a young scientist for 3 to 4 months to undertake non-degree research on an ICARDA site, working with an ICARDA scientist.

Case studies

Facilitating access to new technologies

Responding to the needs and the constraints facing national partners, Geographic Information Systems and Remote Sensing (GIS/RS) training last year focused on two main themes – mapping historical drought and precipitation trends with gridded global databases and developing salinity models through the use of remote sensing technologies. The first was implemented within the framework of a project to improve food security and climate change adaptability among livestock farmers in Iraq and Jordan. The training, led by Dr. Wolfgang Göbel, senior GIS researcher, equipped three Iraqi and eight Jordanian scientists with the skills needed to effectively study the impacts of climate change on agriculture and food security – map a Standardized Precipitation Index (SPI), and conduct trend analyses of precipitation and drought indices.

The second targeted Iraqi scientists faced with rising levels of salinity, building their capacities to assess the threat and distribution of this debilitating condition. Led by Dr. Weicheng Wu, Remote Sensing Specialist, the training helped participants to process remote sensing information and satellite imagery and develop remote sensing salinity models.

Empowering women farmers in Afghanistan

This year, ICARDA and its partners in Afghanistan prioritized the empowerment of a long-neglected and marginalized sector of the country's rural sector – women farmers. Successfully winning the trust of rural communities, ICARDA's Afghanistan team has managed to remove some of the restrictions that place limits on the independence and free movement of women. This has enabled women to fully participate in capacity development training, providing them with the knowledge and skills to raise their productivity and increase their contributions to household incomes.

Over 3,700 women and almost 1,000 men have participated in 54 training sessions and four farmers' field days. Subjects have included the improvement of crop and forage varieties, seed production and marketing, the processing, value addition, and marketing of milk and dairy products, and the production and use of pulses. A training program on watershed management for researchers of Afghanistan's Ministry of Agriculture, Irrigation, and Livestock (MAIL) has also targeted women, by working with women's cooperatives and over 500 of their members, to raise pistachios and mulberries and assist the processing and value addition of medicinal plants.

This ambitious training program seeks to significantly improve Afghanistan's research capacity – often cited as one of the main constraints undermining the country's agricultural productivity. The limited capabilities of the country's researchers, technicians, extension workers, and farmers are routinely identified in consultations and surveys as major bottlenecks for the adoption and dissemination of modern agricultural technologies.

HONORS AND AWARDS

Dr. Mahmoud Solh, ICARDA Director General, was awarded an Honorary Doctorate by the Faculty of Landscape Planning, Horticulture and Agricultural Science, Swedish University of Agricultural Sciences (SLU), Uppsala, Sweden.

Dr. Ashutosh Sarker, Legume Breeder and Regional Coordinator, South Asia and China Regional Program, was recognized by the Bangladesh Agricultural Research Institute, Government of Bangladesh, for his significant contribution to improving pulses in Bangladesh.

Dr. Javed Rizvi, Country Manager, and the ICARDA team in Afghanistan, received certificates of appreciation and recognition from governors and provincial directors of the Ministry of Agriculture, Irrigation and Livestock in Nangarahar and Uruzgon provinces, in recognition of their contribution to enhancing food and nutritional security, and the livelihoods of farming communities in Afghanistan.

Research team led by Dr. Flavio Capettini, ICARDA Barley Breeder, and Principal Investigator, Dr. Ariel Castro, professor at the College of Agriculture of the University of the Republic of Uruguay, received the Award for Scientific Excellence from the Regional Fund for Agricultural Technology (FONTAGRO) for contributing to the project: Identification and utilization of durable resistance to diseases in barley in Latin America. Supported by CGIAR funding, the project is a collaborative effort involving scientists from national agricultural research systems, and universities in Uruguay, Peru, and the USA.

Appendix 1: Varieties released in 2012, developed from ICARDA germplasm

List and key traits of varieties released by NARS partners from ICARDA germplasm in 2012

Crop	Variety	Country	Adaptation and key varietal traits
Bread wheat	Hulluka	Ethiopia	High yield, rust resistant
Durum wheat	Achouri	Algeria	High yield, *Septoria* tolerant
	Aïn Lehma	Algeria	High yield, drought, cold, and *Septoria* tolerant
	Mukiye	Ethiopia	Stem rust, leaf and yellow rust, and *Septoria* tolerant
	Mangudo	Ethiopia	Stem rust, leaf and yellow rust resistant, *Septoria* tolerant
	Louiza	Morocco	
	Ammar10	Morocco	
Winter wheat	Petr	Kyrgyzstan	High yield, drought tolerant, yellow rust resistant
Barley	Fouara	Algeria	Six-row feed barley, drought tolerant
	Savavnna	Brazil	Six-row malting barley
	Gobe	Ethiopia	Two row food barley, early maturing for low moisture areas, scald and net blotch resistant
	IBON 174/03	Ethiopia	Two row malt and food barley for potential areas, scald and net blotch resistant
	PL 807	India	Six-row high yielding feed barley for irrigated areas
	DWRB 91	India	Two-row malt barley for irrigated areas, late sown
	VLB 118	India	Six-row feed barley for rainfed areas, stripe and leaf rust resistant
	Kounouz	Tunisia	For moderate rainfall areas, high yield potential
Faba bean	Nubaria-3	Egypt	Low water requirement
Chickpea	Cakir	Turkey	*Ascochyta* blight tolerant
	Diyar	Turkey	*Ascochyta* blight tolerant
	Ghab 5	Lebanon	Drought and *Ascochyta* blight tolerant
	Nour	Tunisia	*Ascochyta* blight tolerant, *Fusarium* wilt resistant
	Aragvi	Georgia	Medium maturing, *Fusarium* wilt tolerant, *Ascochyta* blight resistant
Lentil	Tsilkani	Georgia	Early maturing, *Fusarium* wilt tolerant
	Khajura 3	Nepal	*Fusarium* wilt and *Stemphylium* blight tolerant
	Yusufhan	Turkey	Yellow cotyledon, cold tolerant
	Ankarayeşili	Turkey	Yellow cotyledon, cold tolerant
	VL516	India	Large seeded, rust and wilt tolerant

Appendix 2: International nurseries

Summary of international nurseries distributed for 2012–13 crop season				
Crop	**Countries**	**Collaborators**	**Sets available**	**Number distributed**
Bread wheat	26	35	3	195
Durum wheat	32	42	3	118
				313
Barley	3	45	10	304
				617
Faba bean	23	35	8	177
Chickpea	31	49	13	380
Lentil	30	46	14	406
Grasspea	17	30	4	103
				1066
Total	**46**	**118**	**55**	**1683**

Appendix 3: Audited financial statements

Statement of Activity (US$x1000)	2012	2011
REVENUES		
Grants (core and restricted)	43,509	35,898
Other revenues and gains	1,457	1,478
Total revenues and gains	**44,966**	**37,376**

	2012	2011
EXPENSES AND LOSSES		
Program related expenses	42,943	33,723
Management and general expenses	4,968	5,979
Other losses and expenses	–	–
Total expenses and losses	47,911	39,702
Indirect costs recovery	(3,961)	(2,665)
Net expenses and losses	**43,950**	**37,037**
Net surplus from ordinary activities	**1,016**	**339**
Extra-ordinary expenses	**(6,732)**	**–**
Overall surplus (deficit)	**(5,716)**	**339**

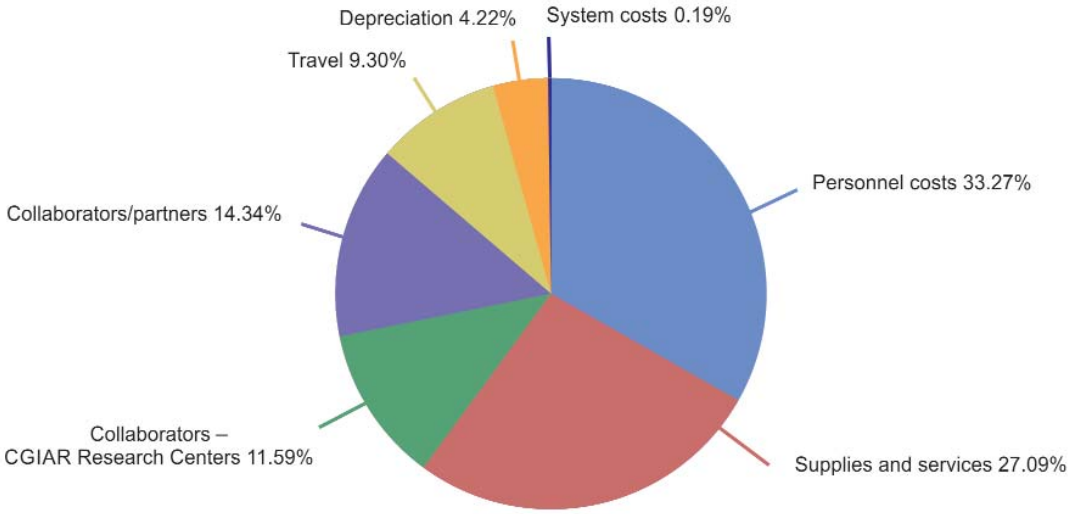
Statement of Financial Position (US$x1000)	2012	2011
ASSETS		
Current assets	36,440	40,435
Property and equipment	1,780	4,961
Other assets	–	–
Total assets	**38,220**	**45,396**

	2012	2011
LIABILITIES AND ASSETS		
Current liabilities	25,901	23,196
Total liabilities	28,521	29,981
Net assets = Reserves	9,699	15,415
Total liabilities and net assets	**38,220**	**45,396**

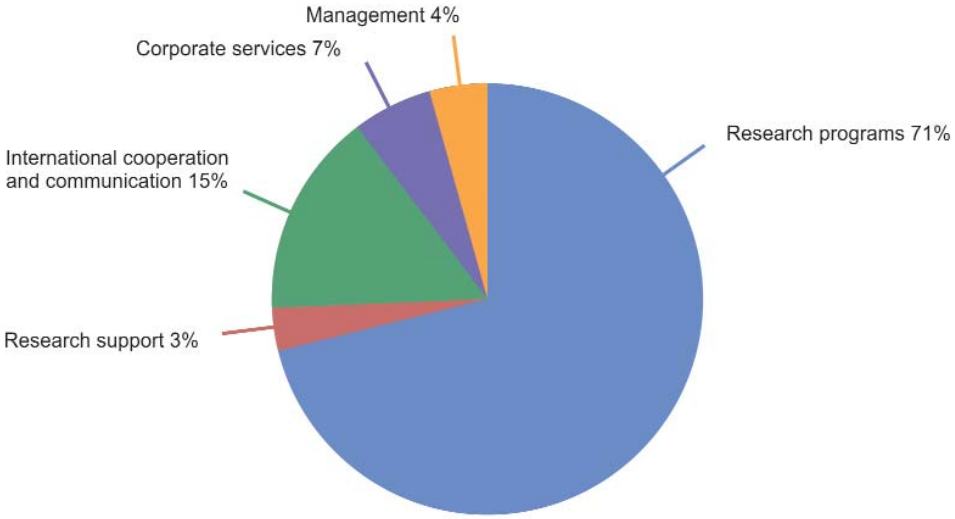
Statement of Grant Revenues, 2012 (US$x1000)	
Arab Fund for Economic and Social Development	2,083
Australia	5,187
Challenge Programs	288
CGIAR	412
Cornell University, USA	292
European Commission	979
Food and Agriculture Organization	270
Germany*	784
Global Crop Diversity Trust	708
Gulf Cooperation Council	281
India	676
International Center for Tropical Agriculture	1,366
International Crop Research Institute for the Semi-Arid Tropics	2,089
International Fund for Agricultural Development	2,687
International Livestock Research Institute	660
International Maize and Wheat Improvement Center	1,894
International Water Management Institute	783
Iran*	376
Italy	516
Kuwait Fund	768
Japan	508
Libya	336
CGIAR Consortium*	10,867
Netherlands*	2,329
United States of America	1,939
United States Department of Agriculture	1,831
Miscellaneous	2,600
TOTAL	**43,509**

* Donors that provided core funds

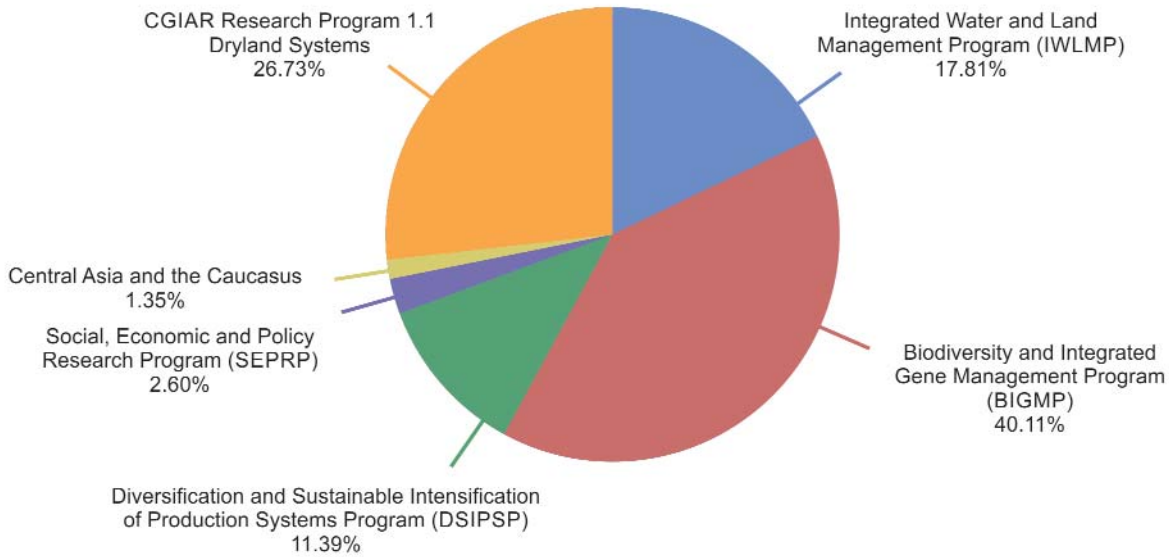
Expenditure by category



Expenditure by program and activities



Expenditure by research program



Appendix 4: Donors and investors

MAJOR DONORS, CUMULATIVE, 1977 TO 2012

USA (incl. USAID, USDA)
World Bank
Germany
United Kingdom
IFAD
Netherlands
Arab Fund for Economic & Social Development (AFESD)
Kuwait Fund for Arab Economic Development
African Development Bank (AfDB)
European Union
Italy
Australia (incl. ACIAR, AusAid, GRDC)
Canada
CGIAR (incl. Consortium and Challenge Programs)
Sweden
Norway
Desertification Trust Fund
Iran
Libya ARC
Japan (incl. JICA, JIRCAS)
IDRC
UNDP
Denmark
OPEC Fund
Egypt
France
Syria
Ford Foundation
Switzerland
Belgium
Austria
FAO
Asian Development Bank
Gulf Cooperation Council
India
Cornell University
Yemen
Saudi Arabia
Morocco
Spain
Turkey
Global Crop Diversity Trust
Tottori University
China
UNEP
UNCCD
Islamic Development Bank
Ethiopia
Finland
South Africa
Mexico
Peru

MAJOR DONORS IN 2012

CGIAR Consortium
Australia (incl. ACIAR, AusAid, GRDC)
USA (incl. USAID, USDA)
World Bank
IFAD
Netherlands
Arab Fund for Economic & Social Development (AFESD)
India
Kuwait Fund for Arab Economic Development
African Development Bank (AfDB)
European Union
Germany
Gulf Cooperation Council
Libya ARC
Austria
Egypt
France
Syria
Japan (incl. JICA, JIRCAS)
FAO
IDRC
Morocco
Mexico
China
Italy
Cornell University
Global Crop Diversity Trust
Asian Development Bank
Islamic Development Bank
Tottori University
Turkey
Iran
OPEC Fund (OFID)
Canada

Appendix 5: Board of trustees

Mr Henri Carsalade (France)*
Board Chair
President, Agropolis Foundation, France
Expertise: agronomy

Dr Camilla Toulmin (United Kingdom)
Board Chair
Director, International Institute for Environment and Development, UK
Expertise: development economics, climate change

Dr Mona Bishay (Egypt)
Vice Chair
Consultant, International Fund for Agricultural Development
Expertise: economics, project and program evaluation

Dr Michel Afram (Lebanon)
President and Director General
Lebanese Agricultural Research Institute
Expertise: agricultural education and policy

Dr Eve Bosak (Australia)
Director and CEO, Governance Asia Pty Ltd, Australia
Expertise: accounting, finance, corporate strategy

Dr Masum Burak (Turkey)
Director General of Agricultural Research
Ministry of Agriculture and Rural Affairs, Turkey
Expertise: horticulture

Mr John Coleman (Canada)
Coleman, Duffett & Associates, Canada
Expertise: international trade, finance, and development

Dr Mohammed Badraoui (Morocco)
Director
Institut National de la Recherche Agronomique (INRA), Morocco
Expertise: agronomy

Dr Naif Al Salti (Syria)
Director General, General Commission for Scientific Agricultural Research (GCSAR)
Ministry of Agriculture and Agrarian Reform, Syria
Expertise: agriculture, policy, and planning

Dr Susan Schram (USA)
Vice President, Outreach and Cooperative Programs
Agricultural Coop. Development International/Volunteers in Overseas Cooperative Assistance (ACDI/VOCA), USA
Expertise: international agriculture, rural development

Mr Nader Sheikh Ali (Syria)
Director General, International Cooperation Division
State Planning Commission, Syria
Expertise: economics and planning

Dr Mahmoud Solh (ex officio)
Director General, ICARDA
Expertise: plant genetics

Ms Petal Somarsingh (USA)*
Principal, Financial Management Consultant
Olympus Management, USA
Expertise: management and administration

Dr Paul Steffen (Switzerland)
Director, Agroscope Reckenholz-Tanikon Research Station
Zurich, Switzerland
Expertise: agronomy, research management, and policy

Mr Fawzi Al-Sultan (Kuwait)
Senior Partner, F & N Consultancy, Kuwait
Expertise: finance and development

Dr Mohammed Walid Tawil (Syria)*
Director General, General Commission for Scientific Agricultural Research (GCSAR)
Ministry of Agriculture and Agrarian Reform, Syria
Expertise: agriculture, plant breeding

Ms Margaret Thalwitz (Germany)
Independent Consultant
Germany
Expertise: strategy, policy analysis, and policy advice

Dr Carl-Gustaf Thornström (Sweden)
Associate Professor, Department of Plant Biology and Forest Genetics
Swedish University of Agricultural Sciences
Expertise: genetic resources, intellectual property rights

* completed term in 2012

Appendix 6: Senior staff (as of 31 December 2012)

OFFICE OF THE DIRECTOR GENERAL
Dr Mahmoud Solh, Director General
Dr Elizabeth Bailey, Executive Assistant to the Director General and Board Secretary
Dr William Albert Payne, Director – CGIAR Research Program on Dryland Systems
Mr Raymond Melbourne Davies, Consultant – Internal Auditor
Ms Houda Nourallah, Administrative Officer – DG
Mr Wael Tabbarah, Consultant – Legal
Ms Nora Hinnawi, Secretary – Executive

INTERNATIONAL PARTNERSHIPS
Dr Kamel Shideed, Assistant Director General – International Cooperation and Communication
Ms Amira Diab, Executive Secretary

GOVERNMENT LIAISON
Dr Majd Jamal, Assistant Director General – Government Liaison
Mr Mohamad Nabil Traboulsi, Assistant National Research Coordinator
Ms Zukaa Musattat, Executive Secretary

CORPORATE SERVICES
Mr Koen Geerts, Assistant Director General – Corporate Services
Dr Ammar Talas, Consultant – Medical
Ms Nuha Sadek, Executive Secretary
Ms Hanaa Sharif Swar, Manager of Damascus Office
Mr Waheed S. Quader, Head – Physical Plant Unit
Ms Dalida Nalbandian, PSD Manager

FINANCE
Mr Erwin Navarro Lopez, Director of Finance
Mr Mohamed Samman, Treasury Supervisor
Ms Imelda Silang, Financial and Management Reporting Manager
Ms Ralda Gareg, Budget Officer
Ms Nahla Assal, Accountants Associate
Mr Ghiath Nahas, Senior Accounting Supervisor

HUMAN RESOURCES
Mr Nellooli P. Rajasekharan, Director of Human Resources
Mr S.S. Sharat Kumar, Director of Human Resources
Ms Lina Yazbek, Administrator – HR Services
Ms Mary Malki, Specialist – Compensation and Benefits
Ms Lobna Al-Fahili, Administrator – Resourcing
Ms Mouna Rustom, Administrator – Program Assistant/Outreach

INTERNATIONAL SCHOOL OF ALEPPO
Ms Shirley Ann Davis-Phillips, School Head
Mr Munzer Kastaly, Accountant – IISA
Ms Raghad Rahwan, Executive Secretary

STATION OPERATIONS
Mr Antoine Shomar, Assistant Farm Manager
Mr Bahij El-Kawas, Senior Supervisor – Horticulture
Mr Mostafa Arab, Senior Workshop Manager
Mr Abdul Wahab Kabbani, Foreman Fabrication Workshop
Dr Hassan Machlab, Lebanon Country Manager

VISITORS SERVICES
Ms Hiba Eimesh, Manager of Visitor Services

RESEARCH PROGRAMS

OFFICE OF THE DEPUTY DIRECTOR GENERAL – RESEARCH
Dr Maarten van Ginkel, Deputy Director General – Research
Dr Murari Singh, Senior Biometrician
Mr Khaled Al-Sham'aa, Specialist – Experimental Research Informatics
Ms Ourouba Zein el-Deen, Executive Secretary

Biodiversity and Integrated Gene Management (BIGM)
Dr Michael Baum, Director of BIGM
Dr Ahmed Amri, Head of GRS/Deputy Director of BIGMP
Dr Flavio Capettini, Barley Breeder
Dr Wuletaw Tadesse Degu, Senior Scientist – Spring Bread Wheat Breeding
Dr Shiv Kumar Agrawal, Lentil Breeder
Dr Seid-Ahmed Kemal, Pulse Pathologist
Dr Kumarse Nazari, Cereal Pathologist
Dr Safaa Kumari, Plant Virologist
Dr Osman Abdalla El Nour, Bread Wheat Breeder
Dr Mustapha El-Bouhssini, Entomologist
Dr Siham Asaad, Head of ICARDA Seed Health Laboratory
Dr Aladdin Hamwieh, Associate Scientist – Chickpea Breeding
Dr Miloudi Nachit, Durum Wheat Breeder
Dr Fouad Maalouf, Faba Bean Breeder
Dr Zewdie Bishaw, Head – Seed Unit
Dr Sripada M. Udupa, Senior Scientist, Biotechnology
Dr Masanori Inagaki, JIRCAS Scientific Representative
Dr Muhammad Imtiaz, Chickpea Breeder
Dr Izzat Sidahmed Ali Tahir, Wheat Breeder
Dr Abdullah Bari, Genetic Resources Scientist
Mr Mohamed Fawzy Nawar, Documentation Specialist
Dr Athanasios Tsivelikas, Associate Scientist – Genebank Manager – Designate
Dr Michel Edmond Ghanem, Associate Scientist – Wheat Breeding and Biotechnology
Dr Adnan Al-Yassin, Barley Breeder
Mr Abdoul Aziz Niane, Scientist
Dr Mohamed Kharrat, Coordinator EC-IFAD project on Wheat-Legume Systems
Mr Bilal Humeid, Research Associate
Mr Michael Michael, Research Associate
Dr Francis C. Ogbonnaya, Senior Biotechnologist
Dr Manickavelu Alagu, Associate Scientist – Wheat Breeding and Biotechnology
Dr Kenneth Street, Legume Germplasm Curator
Mr Mohammed El Hadi Maatougui, Consultant – PPB Eritera-Italy
Ms Suhaila Arslan, Manager, International Nurseries
Mr Henry Pachayani, Research Associate
Mr Hani Nakkoul, Research Associate
Ms Wafaa Meskine, Administrator
Mr Tawffiq Istanbuli, Research Associate
Ms Sawsan Tawkaz, Research Associate – Biotechnology and Plant Cell Culture
Mr Hasan Al-Hasan, Research Associate
Mr Samir Hajjar, Training Coordinator
Mr Ala'a Yaljarouka, Research Associate
Mr Haitham Kayyali, Research Associate
Mr Munzer Alnaimi, Research Associate
Ms Rita Nalbandian, Executive Secretary
Mr Adonis Kourieh, Research Associate
Dr Ali Shehadeh, Research Associate
Mr Fawzi Sweid, Research Associate
Mr Ali Abdullah Ismail, Research Associate
Mr Fouad Jabi El-Haramein, Research Associate
Mr Samer Murad, Research Associate
Mr Samer Lababidi, Geneticist
Ms Fida Alo, Research Associate

Integrated Water and Land Management (IWLM)
Dr Theib Oweis, Director of IWLM
Dr Rolf Sommer, Soil Fertility Specialist
Dr Ahmed Mohammed Al-Wadaey, PDF – Soil and Water Conservation
Dr Feras Ziadat, Soil Conservation/Land Management Specialist
Dr Caroline King, Manager Middle East Water and Livelihood Initiative
Dr Richard Willem Otto Soppe, Senior Water and Salinity Management Specialist
Dr Mohammed Karrou, Water and Drought Management Specialist
Dr Vinay Nangia, Agricultural Hydrologist
Dr Atef Swelam, Project Coordinator – Nile Delta Project
Dr Manzoor Qadir, Project Manager – ACIAR-Iraq Salinity Projects
Mr Luigi Cavestro, Consultant – Project Manager – ACIAR-Iraq Salinity Projects
Mr Anas Al-Qari, Research Associate
Mr George Estefan, Research Associate
Mr Osama Douba, Research Associate

Diversification and Sustainable Intensification of Production Systems (DSIPS)
Dr Rachid Serraj, Director of DSIPS
Dr David Earle Feindel, Acting Director DSIPSP/Cropping Systems Agronomist
Dr Stephen Peter Loss, Project Leader – Conservation Agriculture – Designate
Mr Atef Haddad, Research Associate – Agronomy
Dr Mounir Louhaichi, Range Ecology and Management Research Scientist
Dr Jane Nyaranga Ambuku Wamatu, Associate Scientist – Animal Nutritionist
Dr Aynalem Haile, Small Ruminant Scientist – Breeding and Genetics
Dr Serkan Ates, Forage Scientist
Dr Muhi El-Dine Hilali, PDF – Dairy Technologist
Dr Barbara Ann Rischkowsky, Senior Livestock Scientist (Small Ruminants Management)
Dr Veronique Alary, Agro-Economist – CIRAD
Mr Fahim Ghassali, Research Associate
Mr Zakarya Al-Motair, Research Associate
Mr Yaseen Khalil, Research Associate
Ms Sawsan Hassan, Research Associate – Forage Systems

Social, Economic and Policy Research (SEPR)
Dr Aden Aw-Hassan, Director of SEPR
Dr Yigezu Atnafe Yigezu, Agricultural Economist
Dr Ahmed Mazid, Agricultural Economist
Dr Boubaker Dhehibi, Agricultural Resource Economist
Dr Malika Martini Abdelali, Socioeconomist, Community and Gender Analysis Specialist
Dr Roberto Telleria Juarez, Agricultural Policy Specialist
Mr Hisham Salahieh, Research Associate
Mr Tamer El-Shater, Research Associate

SUPPORT SERVICES

Capacity Development
Dr Iman El-Kaffass, Head – Capacity Development Unit
Mr Charles Kleinermann, Technical Training Officer
Mr Afif Dakermanji, Training Officer
Ms Laurice Abdul Majid, Officer – Administrative Material and Audio Visual Services

Communication, Documentation and Information Services
Mr Michael Devlin, Head – CODIS
Mr Richard Sanders, Science Writer/Editor
Mr Ajay Varadachary, Communication Specialist
Mr Bernhard Hack, Visiting Scientist
Ms Siba Darouzi, Head of Library and Resource Center
Mr Muhammad Manaf Hamam, Electronic Publishing Associate
Mr Majdi Kebbe, Translator/Translation Coordinator

Geographic Information Systems
Mr Wolfgang Goebel, Acting Head – GISU
Dr Weicheng Wu, Remote Sensing Specialist
Mr Ahmed Hamoud, Research Associate – Meteorological
Mr Jalal Eddin Omari, Scientific Software Developer
Mr Mohamed Fawaz Tulaymat, GIS Analyst
Ms Layal Atassi, GIS Lab Manager

Information Technology
Mr Colin Webster, Manager – ITU
Mr Hashem Abed, Senior Coordinator – Software Development
Mr Michael Sarkisian, Senior Systems Engineer
Dr Fadil Rida, MIS Applications Specialist
Mr Mohy-el-din Ammouneh, MIS Database Administrator
Ms Malake Ballouz, MIS Applications Analyst
Mr Ahmad Al-Mously, Web Developer
Ms Samira Maksoud, Executive Secretary
Mr Avadis Toubal Garajian, Network Administrator

Arabian Peninsula Regional Program
Dr Ahmed Tawfik Moustafa, Regional Coordinator – APRP
Dr Faisal Awawdeh, Consultant – Regional Coordinator – APRP
Dr Naem Thiyab Mazahrih, Consultant – Water/Irrigation Management Specialist
Dr Azaiez Ouled Belgacem, Consultant – Range Ecology and Management Specialist
Dr Mohammad Al-Abid, Date Palm Specialist
Mr Arash Nejatian, Activities Coordinator Officer

Central Asia and Caucasus Regional Program
Dr Jozef Turok, Head of the Program Facilitation Unit, CGIAR Program for CAC and the Regional Coordinator
Dr Zakir Khalikulov, Deputy Regional Coordinator
Dr Ram C. Sharma, Breeder
Dr Stefanie Christmann, Researcher on Environmental Governance
Dr Barno Tashpulatova, Research Fellow
Dr Nurali Saidov, Research Fellow
Mr Murat Aitmatov, Research Fellow
Mr Alisher Mirzabaev, Researcher
Dr Nilufar Fazilbekova, Coordinator Bioversity – CWANA
Ms Tamara Yugai, Accountant
Mr Muzaffar Aliev, Administrator
Mr Nariman Nishanov, Project Field Research Coordinator
Dr Aziz Nurbekov, Regional Project Coordinator

Nile Valley and Sub-Saharan Africa Regional Program
Dr Fawzi Karajeh, Regional Coordinator – NVSSAP
Dr Geletu Bejiga, Consultant – Country Manager – Ethiopia Office
Dr Mohamed Habib Halila, Consultant-Manager, Food Security Project
Dr Adel Hagras, Consultant – Wheat Breeder and Site Manager
Dr Doaa Ezzat Zaki El-Agha, Irrigation System Management Specialist

North Africa Regional Program
Dr Mohammed El-Mourid, Regional Coordinator – NARP
Mr Hichem Hammami, SARD-SC/Wheat Project Accountant – AFDB
Mr. Hakim Boulal, National Project Coordinator – Morocco
Mr Khaled Essaidi, Procurement Specialist

South Asia and China Regional Program
Dr Ashutosh Sarker, Coordinator for South Asia Program and Food Legume Breeder

West Asia Regional Program
Dr Nasri Haddad, Consultant Regional Coordinator – WARP
Dr Mohamed Boufaroua, Water Resources Engineer
Mr Abdallah Alimari, National Project Coordinator – Palestine
Ms Hala Hamati, Executive Secretary

Afghanistan
Dr Syed Javed Hasan Rizvi, Country Manager
Mr Abdul Rahman Manan, Senior Agriculture Advisor
Mr Syed Tehseen Gilani, Administrative and Finance Officer

Iran
Dr Seyed Ata Rezaei, Consultant – Manager of Iran/ICARDA Program

Pakistan
Dr Abdul Majid, Senior Professional Officer
Dr Tassawar Malik, Consultant – Cotton Germplasm Pakistan (USDA)

Turkey
Dr Mesut Keser, Consultant – Country Manager – Turkey/BIGMP

Project Development and Grants Management
Mr Tareq Bremer, Grants Management Officer
Ms Martha Bonilla, Proposal Writing Officer
Dr Nicolas Gennrich, Proposal Writing Officer

Harmonized Support for Agriculture Development Project
Dr Abduljabbar Salman, Chief of Party – HSAD
Prof Dr Eltighani Mirghani Elamin, Monitoring and Evaluation Specialist
Dr Saleh Bader, Consultant – Country Manager, Iraq Project

Appendix 7: Capacity development

COURSES BY TOPIC

Water and Land Management

- Improving Water Productivity in Agricultural Systems
- Soil and Water Management Modeling and Coupling with GIS Facilities
- Supplemental Irrigation
- Water Harvesting
- Scientific Writing and Presentation of Water and Land Research
- Watershed Modeling and Management – on-the-job training – SWAT model (Soil and Water Assessment Tool)
- Hill Lakes in Semi-Arid Regions: from Planning to Implementation
- Soil Salinity Management
- Assessing Soil-Water Balance and Salinity
- On-the-job training on Salinity Model Development by Remote Sensing and Integrated Analysis

Crop Improvement, Biotechnology, Plant Protection, and Genebank Management

- Legume and Cereal Crop Improvement
- Wheat Cultivation and Pest Control
- In situ Conservation of Agro-biodiversity
- Best Practices on Collection, and Conservation of Genetic
- Resources, and Management of Genebanks
- Participatory Improvement of Landraces
- In situ Conservation of Landraces
- Genetic Characterization of Durum Wheat Varieties
- SuperSAGE Analysis of the Drought Stress-Responsive Transcriptome in Chickpea Roots
- Screening Wheat Genotypes Using a Set of EST-SSRs Annotated for Salinity Tolerance
- Analysis of Samples for *Verticillium dahliae* on Olives Using AFLP and SSR Techniques
- Mass Rearing of Entomopathogenic Fungi
- Control of Sun Pest (*Sitona* sp) by Using Biopesticides
- Rot Diseases of Legumes
- Evaluation of Faba Bean Breeding Lines for Heat and Water Stress
- Genetic Diversity Analysis and Development of Core Collection in Durum Wheat Landraces
- Biotechnology Applications in Crop Improvement
- Improving Genetic Resources for Lentil and Grasspea Using EST-SSR Markers
- GMO detection for Soybean from Food Products
- Marker-Assisted Fast Track Improvement of Wheat: Improving Abiotic Stress Tolerance

Seed Production and Health

- Variety Description, Maintenance, and Seed Production and Certification
- Variety Management
- Seed Certification
- Seed Quality Control
- Quality Seed Production
- Seed Marketing
- Management of Seed Health

Agronomy, Forages, Rangeland Management, and Livestock

- Integrated Crop and Livestock Production in Dry Areas
- Spineless Cactus and Feed Blocks: Production Techniques and Animal Feeding
- Conservation Agriculture
- Rangeland Monitoring and Assessment

Socioeconomics

- Socioeconomic and Environmental Impacts of Salinity on Livelihoods and Policy Analysis
- Agricultural Extension and Technology Transfer
- Baseline Survey Methods
- Adoption and Impact Assessment

Information Technology/Modeling, Statistics, and Research Skills

- Creation and Management of Information Infrastructure Using NewGenLib; Management of Document Repositories
- Development of the Regional Agricultural Information Network for West Asia and North Africa (RAIN-WANA)
- Research Communication – Effectively Communicating the Benefits of Your Research
- Advanced Biometrics: Biometrical Techniques in Plant Breeding Including Multivariate Analysis and Statistical Software
- Statistical Design and Data Analysis
- Biometrical Methods in Agricultural Research
- Project Proposal Development
- Mapping of Historical Drought and Precipitation Trends with Gridded Global Datasets
- GIS and Remote Sensing Applications

Appendix 8: Publications

PAPERS IN REFEREED JOURNALS

Ahmed, S., C. Piggin, A. Haddad, S. Kumar, Y. Khalil, and B. Geletu. 2012. Nematode and fungal diseases of food legumes under conservation cropping systems in northern Syria. *Soil and Tillage Research* 121: 68–73.

Alary, V., A. Aboul-Naga, M. Mohamed El-Sheifa, N. Abdelkrim, and H. Metawi. 2012. Dynamics and farmers strategies for small ruminant market in Egypt. *African Journal of Agricultural Research* 7(1): 115–122.

Alemayehu, K., A. Haile, S. Gizaw, T. Dessie, and Y. Mekasha. 2012. The synergetic effects of inbreeding and temperature variability on biotic potential of Walia Ibex (*Capra walie*). *International Journal of Biodiversity and Conservation* 4(6): 260–266.

Al-Shamiri, A., and F.M. Ziadat. 2012. Soil-landscape modeling and land suitability evaluation: the case of rainwater harvesting in a dry rangeland environment. *International Journal of Applied Earth Observation and Geoinformation* 18: 157–164.

Amri, M., Z. Abbes, S. Ben Youssef, M. Bouhadida, H. Ben Salah, and M. Kharrat. 2012. Detection of the parasitic plant, *Orobanche cumana* on sunflower (*Helianthus annuus* L.) in Tunisia. *African Journal of Biotechnology* 11(18): 4163–4167.

Ansari-Renani, H.R., J.P. Mueller, B. Rischkowsky, S.M. SeyedMomen, O. Alipour, M. Ehsani, and S. Moradi. 2012. Cashmere quality of Raeini goats kept by nomads in Iran. *Small Ruminant Research* 104: 10–16.

Atik, O., A. El-Ahmed, M. Baum, S. Ahmed, M.M. Yabrak, A. Al-Assaf, and S. Kabbabeh. 2012. The effects of different BION® treatments on Ascochyta blight (*Didymellarabiei*) of chickpea. *Arab Journal of Plant Protection* 30: 101Y109.

Ayouz, M., V. Alary, and S. Mekersi. 2012. Analyse par enquête et modélisation de la place et du rôle de l'Opuntia (*Opuntia ficus-indica*) dans les systèmes agraires algériens semi-arides. [Analysis of the place and role of Opuntia (*Opuntia ficus-indica*) in the semi arid agrarian systems of Algeria through surveys and modeling.] *Cahiers agricultures* 21(6): 438Y447. (Fr)

Bari, A., K. Street, M. Mackay, D.T.F. Endresen, E. De Pauw, and A. Amri. 2012. Focused identification of germplasm strategy (FIGS) detects wheat stem rust resistance linked to environmental variables. *Genetic Resources and Crop Evolution* 59(7):1465–1481.

Bouajila, A., N. Zoghlami, M. Al Ahmed, M. Baum, A. Ghorbel, and K. Nazari. 2012. Pathogenicity spectra and screening for resistance in barley against Tunisian *Pyrenophorateresf. teres. Plant Disease* 96 (10): 1569–1575.

Bousba, R., M. Baum, A. Djekoune, S. Lababidi, A. Jighly, K. Benbelkacem, M. Labhilili, F. Gaboun, and N. Ykhlef. 2012. Scoring for drought tolerance using molecular markers and phenotypic diversity in durum wheat genotypes. *World Applied Sciences Journal* 16(9): 1219–1226.

Chapagain, T.R., B.B. Khatri, P. Bhattarai, B.P. Luitel, G. Ortiz-Ferrara, and R.C. Sharma. 2012. Maximizing productivity and improving nutrition through intercropping quality protein maize and potato. *Acta Agronomica Hungarica* 60: 221–230. (En)

Christmann, S., and A. Aw-Hassan. 2012. Farming with alternative pollinators (FAP)—An overlooked win-win-strategy for climate change adaptation *Agriculture, Ecosystems and Environment* 161: 161–164.

Daoui, K., M. Karrou, R. Mrabet, Z. Fatemi, X. Draye, and F.J. Ledent. 2012. Genotypic variation of phosphorus use efficiency among Moroccan faba bean varieties (*vicia faba* major) under rainfed conditions. *Journal of Plant Nutrition* 35(1): 34–48.

Durkin, K., W. Coppieters, C. Drögemüller, N. Ahariz, N. Cambisano, C.Fasquelle, A. Haile, P. Horin, L. Huang, L. Karim, S. Moser, K. Oldenbroek, S. Rieder, A. Sartelet, J. Sölkner, H. Stålhammar, T. Leeb, M.Georges, and C. Charlier. 2012. Serial translocation via circular intermediates underlies color-sidedness in cattle. *Nature* 482: 81–86.

Ehsan, S., Bradford, M. Brugger, B. Hamdaoui, Y. Kovchegov, D.E. Johnson, and M. Louhaichi. 2012. Design and analysis of delay-tolerant sensor networks for animal monitoring and tracking. *IEEE Transactions On Wireless Communications* 11(3): 1220–1227.

Elbashier, E.M.E., I.S.A. Tahir, A.S.I. Saad, and A.S. Ibrahim. 2012. Wheat genotypic variability in utilizing nitrogen fertilizer for a cooler canopy under a heat-stressed irrigated environment. *African Journal of Agricultural Research* 7(3): 385–39.

Elhaddoury, J., S. Lhalouia, S.M. Udupa, B. Moatassima, R. Taiqa, M. Rabeha, M. Kamlaouia, and M. Hammadia. 2012. Registration of 'Kharoba': a bread wheat cultivar developed through doubled haploid breeding. *Journal of Plant Registrations* 6: 169–173.

Endresen, D.T.F., K. Street, M. Mackay, A. Bari, A. Amri, E. De Pauw, K. Nazari, and A. Yahyaoui. 2012. Sources of resistance to stem rust (Ug99) in bread wheat and durum wheat identified using focused identification of germplasm strategy. *Crop Science* 52(2): 764–773.

Fernández-Aparicio, M., A. Moral, M. Kharrat, and D. Rubiales. 2012. Resistance against broomrapes (*Orobanche* and *Phelipanche* spp.) in faba bean (*Vicia faba*) based in low induction of broomrape seed germination. *Euphytica* 186(3): 897–905.

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Appendix 9: Acronyms

AARINENA	Association of Agricultural Research Institutions in the Near East and North Africa
ACIAR	Australian Centre for International Agricultural Research
AfDB	African Development Bank
AFESD	Arab Fund for Economic and Social Development
APRP	Arabian Peninsula Regional Program
ARC	Agricultural Research Center
AusAID	Australian Agency for International Development
AVRDC	World Vegetable Center (Asian Vegetable Research and Development Center)
BARI	Bangladesh Agricultural Research Institute
BINA	Bangladesh Institute of Nuclear Agriculture
CAC	Central Asia and Caucasus
CIAT	International Center for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Center
CIRAD	Centre de coopération internationale en recherche agronomique pour le développement (France)
CWANA	Central and West Asia and North Africa
FAO	Food and Agriculture Organization of the United Nations
FONTAGRO	Fondo Regional de Tecnología Agropecuaria (Regional Fund for Agricultural Technology)
GIS	Geographic information systems
HSAD	Harmonized Support for Agricultural Development
ICAR	Indian Council of Agricultural Research
ICARDA	International Center for Agricultural Research in the Dry Areas
ICBA	International Center for Biosaline Agriculture
ICH	Institute of Crop Husbandry (Tajikistan)
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDRC	International Development Research Centre (Canada)
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IIPR	Indian Institute of Pulse Research
IITA	International Institute of Tropical Agriculture
INRA	Institut National de la Recherche Agronomique (France, Morocco)
IPCC	Intergovernmental Panel on Climate Change
IPPM	Integrated production and protection management
IsDB	Islamic Development Bank
IWWIP	International Winter Wheat Improvement Program
JICA	Japan International Cooperation Agency
JIRCAS	Japan International Research Center for Agricultural Sciences
MoU	Memorandum of understanding
NARS	National agricultural research systems
NCARE	National Center for Agricultural Research and Extension (Jordan)
OFID	OPEC Fund for International Development
PGRA	Plant Genetic Resources for Agriculture
RAIN-WANA	Regional Agricultural Information Network for West Asia and North Africa
SWAT	Soil and Water Assessment Tool
UAE	United Arab Emirates
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNU–INWEH	United Nations University – Institute for Water, Environment and Health
USAID	United States Agency for International Development
VBSE	Village-based seed enterprise
WANA	West Asia and North Africa
WIP	Wheat Improvement Program (ICARDA and Egypt Agricultural Research Center)
WLI	Water and Livelihoods Initiative

CGIAR Consortium

International Center for Agricultural Research in the Dry Areas (ICARDA)

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Established in 1977, the International Center for Agriculture Research in the Dry Areas (ICARDA) is one of 15 centers supported by the CGIAR. ICARDA's mission is to contribute to the improvement of livelihoods of the resource-poor in dry areas by enhancing food security and alleviating poverty through research and partnerships to achieve sustainable increases in agricultural productivity and income, while ensuring the 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 the Central Asia and West Asia and North Africa region, ICARDA contributes to the improvement of bread and durum wheats, kabuli chickpea, pasture and forage legumes, and associated farming system. 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.

CGIAR is a global research partnership that unites organizations engaged in research for sustainable development. CGIAR research is dedicated to reducing rural poverty, increasing food security, improving human health and nutrition, and ensuring more sustainable management of natural resources. It is carried out by the 15 centers who are members of the CGIAR Consortium in close collaboration with hundreds of partner organizations, including national and regional research institutes, civil society organizations, academia, and the private sector. www.cgiar.org