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International Center for Agricultural Research
in the Dry Areas

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CONTENTS

Foreword v

Food Security: the Big Challenges 1

Milestones 4

Research Highlights 7

- The agro-ecosystem focus 7
- Policy-oriented research boosts barley yields in Syria 8
- Identifying benchmark watersheds for research in Libya 9
- Biocontrol methods fight crop pests while generating income 10
- Crop models analyze the impacts of climatic change 11
- Conservation cropping takes off in Iraq and Syria 12
- Farmer-participatory research improves livelihoods in Eritrea 13
- Freeze-resistant chickpeas offer higher, more stable yields 14
- Women's roles in agricultural marketing in West Asia 15
- Dairy goat project improves women's welfare in Afghanistan 16
- Accessing markets for herbs and aromatic plants 17
- New sources of animal fodder in Libya 18
- Supplemental irrigation improves water productivity 19
- Understanding pathogen evolution in wheat stripe rust 20
- GIS tools help identify sites for rainwater harvesting in Eritrea 21

Partnerships and Outreach 22

- Nile Valley and Sub-Saharan Africa 24
- North Africa 25
- West Asia 26
- Central Asia and Caucasus 27
- Arabian Peninsula 28
- South Asia and China 29
- Highlands Regional Network 30

Capacity Development 32

Honors and Awards 33

Appendices 34

FOREWORD

Global food production has increased by 20% in the past decade – but food insecurity and poverty remain widespread , while the natural resource base continues to decline. International research centers, which have helped drive previous improvements, must continue to deliver new technologies to support sustainable growth in agriculture; and to work with other partners to accelerate the dissemination of these technologies.

During 2010, CGIAR Centers and their partners developed a new framework to help achieve these goals. The framework includes a series of multi-disciplinary research programs where different organizations will work closely together, sharing resources and providing complementary skills. These programs will cover dryland agriculture, climate change, water, livestock, crop improvement and other areas. ICARDA will lead the CGIAR Research Program on dryland systems; and play a key role in the programs on wheat, grain legumes, dryland cereals, water, livestock, climate change, and policies, institutions and markets.

Farming conditions in 2010 were difficult, particularly in dryland environments: drought, new disease epidemics, and continued food insecurity for the poorest households. But research results were encouraging, suggesting that these challenges can be gradually overcome. Twenty-five new crop varieties, developed from ICARDA germplasm, were released for cultivation in eleven countries. Low-cost methods to increase water productivity were refined. Conservation agriculture techniques were scaled out across more than 27,000 hectares in West Asia. New tools (biotechnology, GIS, simulation models) were successfully applied to supplement conventional methods. Market analyses helped identify income opportunities for small-scale farmers. And a number of exciting new research projects were launched, on crop improvement, biodiversity, water and land management, socio-economics and policy and other areas.

Partnership is the key – to mobilizing resources, developing and scaling out new technologies, and strengthening policy and institutional support for agriculture. We are happy to report that these partnerships are flourishing. The President of India visited ICARDA headquarters in November 2010, paving the way for a major expansion of collaborative research in South Asia. National policy makers, including Ministers of Agriculture from four countries, visited ICARDA to discuss research plans. Key donors announced formal agreements to accelerate technology dissemination, under which ICARDA technologies will be scaled out through donor-funded development projects. A conference initiated by ICARDA led to agreement among 24 countries and 12 international organizations, on an action plan to ensure food security in developing countries despite the threat of climate change.

This report describes some of the successes of 2010. It is not a comprehensive record. Rather, it aims to provide a flavor of how much can be achieved, even in very difficult farming environments, when good science is combined with strong partnerships.

Henri Carsalade
Chair, Board of Trustees

Mahmoud Solh
Director General

FOOD SECURITY: THE BIG CHALLENGES

What do smallholder farmers have in abundance? Answer: problems. This section highlights three particularly serious problems in the dry areas – drought, which is a constant threat... plant diseases, where constantly evolving pathogen strains are causing large-scale epidemics... and climate change, which will make hot, dry areas even hotter and drier.

How are ICARDA and its partners responding to these challenges? Some highlights of research results from year 2010.

Fighting drought

New findings and new research tools are helping to combat drought – one of the biggest challenges to smallholder agriculture in dry areas.

'Synthetic' wheat lines – developed at ICARDA by crossing wild progenitors with cultivated wheat – have shown very high levels of drought tolerance. Recombinant inbred lines (RILs) derived from synthetics were analyzed using more than 220 molecular markers. Several markers have been identified as being associated with grain yield under drought conditions.

The results provide new insights on how different genotypes respond to drought stress, and how these traits are inherited from one generation to the next.

A long-term study of wild wheat relatives (*Aegilops tauschii*) continued, with field experiments in Syria and Lebanon. *Aegilops* lines from Pakistan were tested last year, and showed the ability to develop highly productive tillers even in moisture-stressed environments. In 2010, these genotypes were crossed with cultivated wheat varieties to produce several new primary synthetic lines.

Other experiments examined the relationship between root structure and the plants' ability to extract moisture from the soil at different growth stages, and under different moisture regimes. The results are helping to provide clues on the role of root length, thickness and density, and how root development is affected by soil moisture levels.

An experiment on stress responses in durum wheat and barley is helping to identify physiological traits (and molecular markers associated with these traits) that plant breeders can use to select for drought tolerance and nitrogen use efficiency.

Drought and salinity stresses are often linked – so researchers examined tolerance levels in lentil, chickpea and faba bean. A set of legume genotypes was tested at ICARDA's Tel Hadya station, and by partner centers in Morocco, Portugal and Syria. The results have helped identify hardy, drought- and salt-tolerant genotypes which will be used in the breeding program next season. These include 15 highly drought-tolerant genotypes: six chickpea, seven lentil and two faba bean.

Another key research area is water productivity – maximizing yield and/or financial return per unit of water used. ICARDA's research has helped promote supplemental irrigation, where irrigation is limited in quantity but applied at critical plant growth stages, for maximum effectiveness. This is far superior to the common practice of flood irrigation.

The aim is to establish 'threshold' levels for different crops: how much moisture deficit can the crop tolerate and still give acceptable yields? For example, providing two-thirds of requirements (rather than the full requirement) will maximize water productivity without significant yield reduction.

Protecting the world's wheat supplies

The world's wheat supplies are threatened by rust diseases. Ug99, a new race of the fungus that causes stem rust, has spread from East Africa to West Asia, and could spread further, into South Asia, Central Asia, China and the Mediterranean region. A dozen countries suffered epidemics of stripe rust in 2009 and 2010. The incidence of leaf rust is also increasing.

ICARDA is part of global efforts to develop new rust-resistant varieties, better understand how the pathogens evolve, and halt the spread of rust diseases. Our partners include the Borlaug Global Rust Initiative, CIMMYT, FAO, Cornell University and others.

In 2010, ICARDA pathologists, working with researchers from several countries, identified the cause of recent stripe rust epidemics: aggressive new race(s) of the pathogen had overcome a widely used resistance gene known as Yr27.

More than 550 durum and bread wheat genotypes developed at ICARDA were analyzed using molecular markers. Of the 250 durum wheat genotypes tested, nearly one-third contained the 'slow rusting gene' Sr2, which minimizes stem rust damage (although it does not prevent infection). Out of 300 bread wheat genotypes, 70% contained Sr2, and 43% contained slow-rusting genes effective against stripe and leaf rusts.

Surveillance and monitoring were scaled up in 2010, to help track the spread of rust pathogens and provide early warning of epidemics. Extensive field surveys were conducted in seven countries (Azerbaijan, Ethiopia, Iran, Iraq, Morocco, Syria, Uzbekistan) that suffered stripe rust epidemics last year.

A landmark study of pathogen variability, using data from 32 countries, highlighted the rapid spread of virulent new races of stripe and stem rust, and identified hot spots of vulnerability to leaf rust.

Ultimately, the goal is to develop new resistant varieties to replace current ones – more than 80% of today's commercial wheat varieties are susceptible to stem and/or stripe rust. Several thousand ICARDA genotypes were tested by national research centers in ten countries; more than 500 wheat wild relatives were evaluated at Tel Hadya for novel resistance genes.

In Ethiopia – where stripe rust epidemics destroyed 80% of the wheat crop in some areas – three new high-yielding varieties with combined resistance to multiple rusts have been released. Two high-yielding winter wheat varieties resistant to stripe rust, developed jointly by Turkey, ICARDA and CIMMYT, are under pre-release testing in Uzbekistan. Two Ug99-resistant wheat lines, after three years of field testing, are expected to be released shortly in Afghanistan.

A USAID-funded, ICARDA-led program is helping to accelerate the

Scientists are using a variety of tools to fight rust diseases: field surveys, genebank collections, plant breeding programs, pathogen race analysis, biotechnology... Research findings will help prevent future epidemics.

dissemination of the new varieties by rapidly multiplying seed in Ethiopia, Egypt and Pakistan.

Climate change

There is a broad consensus among the scientific community that climate change is being reflected in current weather patterns. ICARDA climatologists analyzed global climate models to understand how climate change would affect precipitation in different regions.

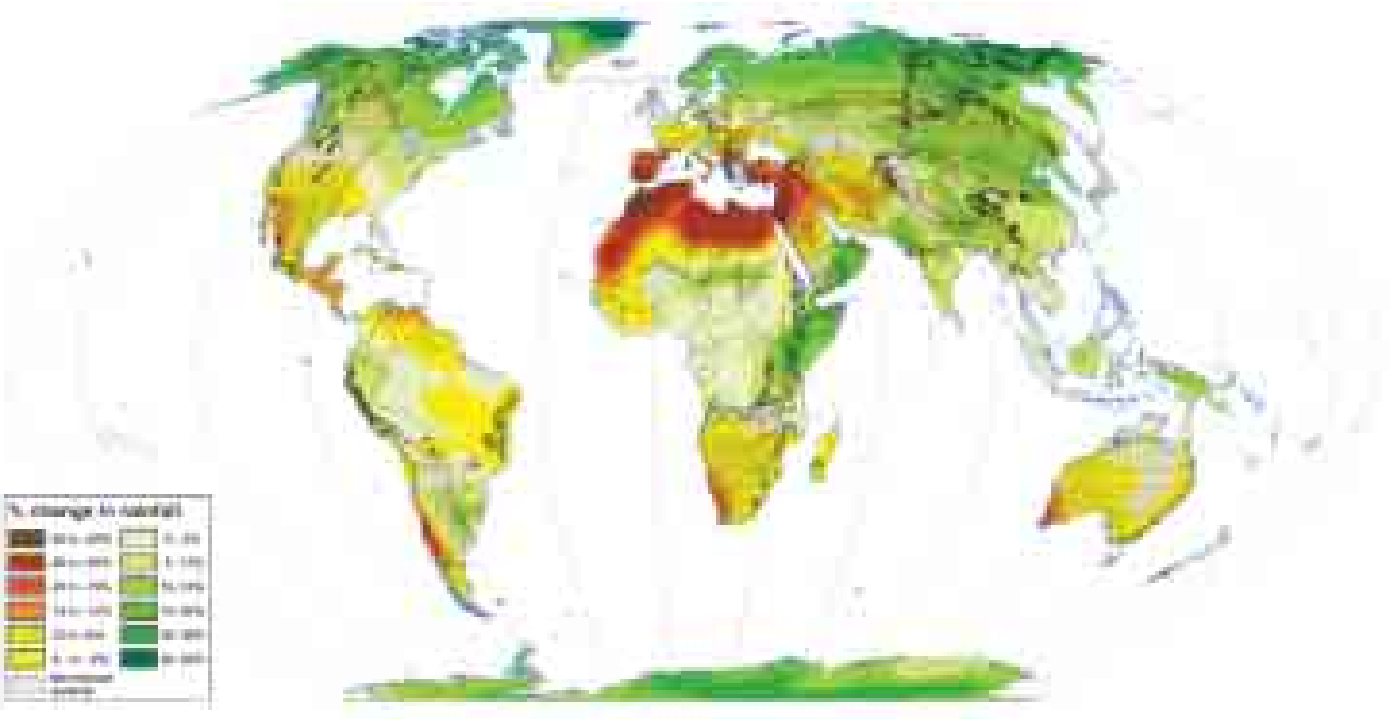
For example, Scenario A1b of the Intergovernmental Panel on Climate Change – which assumes a future with manageable greenhouse gas emissions – makes projections over a 100-year period, 1980/89 to 2080/99. Over this period, average temperatures in dryland areas will rise by 2-4°C. Changes in precipitation will vary by region, with a clear tendency towards higher precipitation in non-dryland areas and tropical drylands, and a mixed pattern of increase or decrease in non-tropical drylands.

Non-tropical drylands will be doubly affected: by higher temperatures and lower rainfall. The map shows how rainfall is likely to change in different regions over the next 100 years, based on projections by different climate models. West Asia and North Africa – which already suffer food insecurity and poor rainfall – are particularly vulnerable. Mean rainfall will decline by at least 20% in most parts of the region, and up to 50% in many areas.

ICARDA's climate change research combines three aspects: adaptation, mitigation and ecosystem resilience. This includes drought- and heat-tolerant crop varieties; better management of water and rangelands; use of indigenous plant and livestock genotypes; and application of tools such as GIS, remote sensing and simulation models. We're also helping to identify policy options that could help smallholder communities adapt to climate change; and to develop new analytical tools to assess climate change impacts.

Three major projects on climate change were launched in 2010.

- The CGIAR Research Program on Climate Change, Agriculture and Food Security will help develop technologies, policies and institutions to strengthen climate change adaptation and mitigation in developing countries worldwide.
- An IFAD-funded project targets five countries: Egypt, Eritrea, Ethiopia, Sudan and Yemen. It aims to promote improved crop and livestock technologies to improve livelihoods and adaptation to climate change.
- A project funded by the Asian Development Bank targets Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan) and China. It uses crop simulation models and 'downscaled' climate scenarios to assess the impact on food production; and economic models to assess the impacts of adaptation measures.



Many dryland areas will be severely hit by climate change. Changes in mean annual precipitation between 1980/1999 and 2080/2099, scenario A1b, average of 21 global circulation models.

MILESTONES

President of India pledges support

Her Excellency the President of India, Smt. Pratibha Devisingh Patil, visited ICARDA headquarters on 29 November – marking a new chapter in the partnership between India and ICARDA. "The results of ICARDA's research are directly relevant and useful to farmers in developing countries," the President said. "This is an institution of global importance."

Collaborative programs will develop new farming technologies for dry areas; and share, with other developing countries, the lessons learnt from India's remarkable growth in agriculture. ICARDA works with 27 institutions from 14 provinces in India. Three new collaborative research projects were launched in 2010, on barley, natural resource use efficiency and policy options, and integrated crop-livestock- rangeland systems.

A press release by the President's office said (in part): "Dryland farming is of great importance for global food security as well as for a second Green Revolution in India. As 40% of farming in our country is dryland farming, the work being done in ICARDA will provide valuable inputs for improving agricultural productivity and food production in India. ICARDA has agreed to my suggestion to take up India-specific research and development, for which project assistance could be provided."

The President of India (left) wants research partnerships to be expanded. Rainfed agriculture – ICARDA's core expertise – accounts for 40% of farmland in India.

The Amman declaration

The International Conference on Food Security and Climate Change in Dry Areas, held in Jordan in February 2010, brought together scientists and policy makers from 24 countries and 12 regional and international organizations. The meeting culminated in the Amman Declaration – a concrete action plan to enhance food security and reduce vulnerability to climate change in dry areas worldwide.

The action plan covers natural resource conservation, agro-ecosystems, policies and institutions, and regional initiatives to strengthen cooperation and information sharing. Implementation of the Declaration – coordinated by ICARDA – is proceeding rapidly. Several new initiatives were launched in 2010: a food security project for the Arab region (see below); an IFAD-funded crop-livestock program in Egypt, Eritrea, Ethiopia, Sudan and Yemen; and a water management project for highland areas in Jordan, Lebanon and Morocco, also funded by IFAD. Other proposals are being discussed, and implementation is likely to begin in 2011.

The proceedings of the Amman conference: a comprehensive scientific review of how climate change could affect food security, and what solutions are available.

Expanding partnerships in Ethiopia

The Ethiopian Institute of Agricultural Research (EIAR) hosted a meeting of ICARDA's Board of Trustees in October 2010. In addition to the Board and ICARDA staff, participants included H.E. Mitiku Kassa, State Minister for Agriculture and Rural Development, the EIAR Director General, heads of several national research organizations, and representatives of ASARECA, the African Development Bank, the CGIAR and FAO.

Their perspectives on various issues – production constraints, agricultural policy, infrastructure, training needs – helped identify opportunities to expand collaboration based on synergies between partners.

Field visits during the meeting showed that collaborative research programs have created substantial impacts. For example, EIAR-ICARDA teams have developed lentil varieties that can give six times the yield of traditional landraces; and chickpea varieties that can be successfully grown in areas prone to waterlogging and fungal diseases. As a result, Ethiopia's legume exports grew by 600% between 2005 and 2008.

H.E. Tefera Derbew, Ethiopia's Minister for Agriculture, pledged his support for expanding this partnership further. This expansion will include, for example, a new project on integrated watershed management in rainfed areas, involving Ethiopian research organizations, ICARDA, BOKU University in Austria, and other partners. The project inception workshop was held in April 2010, and the first field trials were planted a few months later.

H.E. Tefera Derbew (center), Ethiopia's Minister for Agriculture, discusses research plans with an EIAR-ICARDA delegation. At extreme right is Dr Solomon Assefa, EIAR Director General.

Field trials in Egypt. The food security project will develop high-yielding, disease-resistant wheat varieties for different agro-ecological zones in five countries.

Food security project launched

A seven-country research initiative "Enhancing food security in Arab countries" was launched in July 2010, supported by the Arab Fund for Economic and Social Development (AFESD), the Islamic Development Bank and the Kuwait Fund. The first phase targets wheat-based farming systems in five countries – Egypt, Morocco, Sudan, Syria and Tunisia – and includes adaptive research, dissemination programs and training of young scientists from partners countries.

Field trials and demonstrations of improved wheat technologies have been established at eight sites, representing the major agro-ecologies in each of the five countries. Site characterization – agro-ecosystems, livelihoods, socio-economic conditions, production constraints – has been partly completed. Five scientists (one from each country) are undergoing training at ICARDA headquarters.

More crop per drop. New technologies are helping farmers use water more efficiently, to produce bigger harvests without depleting water reserves.

Water benchmarks project: Phase II begins

Phase II of ICARDA's flagship project on natural resource management was launched in 2010. The WANA Benchmarks Project, supported by AFESD, operates from benchmark sites in eleven countries: Algeria, Egypt, Iraq, Jordan, Libya, Morocco, Palestine, Saudi Arabia, Sudan, Syria and Tunisia. The project targets the three major agro-ecosystems

in these countries: rainfed areas, irrigated systems and rangelands.

In Phase I, researchers used a participatory, community-led approach to develop and test a number of effective, low-cost technologies to increase water productivity and optimize water use at farm level. The 4-year second phase will build stronger linkages with policy makers, development agencies and others to disseminate these technologies more widely, and create policy and institutional support to encourage adoption.

ICARDA scientist collects germplasm in Georgia. This was the country's most successful biodiversity conservation effort in many years.

Biodiversity – protect, monitor, share

One of ICARDA's key goals is to protect and effectively utilize agricultural biodiversity. In 2010, we shipped 63,000 germplasm accessions to the Svalbard Global Seed Vault in Norway; and distributed more than 8000 accessions to 30 countries, for use in their research programs.

We're also helping to monitor plant diversity in 65 natural habitats in the Fertile Crescent, one of the word's most important centers of agrobiodiversity. In 2010, eco-geographic surveys were conducted in Jordan, Lebanon and Syria, highlighting the continued loss of biodiversity due to overgrazing and habitat degradation. There were three notable exceptions – including the Mahareb area in Jordan, where water harvesting techniques introduced under an ICARDA project are helping to rehabilitate degraded rangelands. ICARDA is also assisting afforestation programs in all three countries, under which wild species of fruit trees (wild almonds, pistachio and others) have been introduced.

The Caucasus region is another hotspot of biodiversity. In 2010, we worked with national research centers to collect 1124 indigenous plant genotypes from Armenia and Georgia – the largest collection ever made in these countries, and one of the largest anywhere in recent decades.

Women teaching women. Training programs in Afghanistan help disseminate simple, low-cost treatments to prevent animal diseases.

Capacity development

Capacity development is at the heart of ICARDA's mandate. In 2010, we continued to offer training opportunities to researchers, students, extension staff, farmers and other groups. The program relies on support from a wide range of partners: national agencies, donors, international R&D organizations, and universities from 21 countries, for co-supervision of graduate students.

During the year, 727 researchers from 43 countries benefited from training courses and internships on a variety of subjects: crop improvement, livestock, water and land management, socio-economics, biotechnology, simulation modeling, statistics, geographic information systems and other areas. Another 62 scientists and 24 interns are progressing towards MSc or PhD degrees, co-supervised by ICARDA and their parent university. About one-fifth of participants in these programs were women.

RESEARCH HIGHLIGHTS

ICARDA's research portfolio spans the entire research-for-development continuum, from basic research, through applied research, policy and institutional studies, technology dissemination and impact assessment. It is based on a 10-year Strategic Plan adopted in 2008. All research is planned, implemented and monitored jointly with national agricultural research systems. There are four thematic programs (see box).

ICARDA's UNIQUE APPROACH: THE AGRO-ECOSYSTEM FOCUS

ICARDA's research focus and approaches evolve in response to the changing needs of partner countries and their situations. Three decades of collaborative research have shown that long-term food security and productivity growth in dry areas can be achieved only by looking beyond specific crops and commodities, to focus on **improving the performance of agro-ecosystems**.

A better understanding of this systems approach and how it can benefit countries – from field to national or regional level – is an area where ICARDA's unique expertise is well recognized. The systems approach includes, for example: research on integrated crop-livestock-rangeland systems, more efficient use of soil and water resources, and the introduction of new crops and crop varieties into traditional farming systems to improve yield and yield stability, nutrition, incomes and livelihoods. Policies and institutions are also a key part of the farming system. Improving this national 'infrastructure' can have a direct impact on the lives and incomes of smallholder farmers and pastoralists.

While others work on parts of this picture, ICARDA is one of the few research centers to link integrated agro-ecosystem based research on global issues such as water scarcity and climate change, with hands-on work with farmers and communities – understanding the practical problems they face, and working with communities to find effective, low-cost solutions.

System intensification is a key part of ICARDA research programs, its work with government partners and smallholder farmers – and in the CGIAR Research Program on Dryland Systems. This new multi-partner program aims to better understand the nature of system-level interventions, and promote approaches that can be scaled up for maximum benefit across the world's dry regions.

During a recent visit to ICARDA, the President of India, H.E. Pratibha Patil, commented that the next Green Revolution would be driven by productivity growth in rainfed farming systems. Finding the right solutions for these systems is ICARDA's key area of expertise.

Biodiversity and Integrated Gene Management

Conserving agro-biodiversity in dry areas and using this genepool to improve food security, nutrition and livelihoods. Research covers cereals, legumes, grain, forage and pasture crops, conservation and characterization of genetic resources and germplasm enhancement.

Integrated Water and Land Management

Improving the management of scarce water resources. Research aims to develop options for sustainable, equitable, and economic use of all water sources to improve water productivity, land management and drought adaptation and mitigation.

Diversification and Sustainable Intensification of Production Systems

Developing integrated technology 'packages', including elements developed under the other research programs. Research aims to improve agro-ecosystems, livestock management and market linkages; and support sustainable diversification into higher value crops.

Social, Economic and Policy Research

Understanding rural poverty, livelihood strategies and gender, in order to better target research and development investments. Research includes value chains and markets, policy and institutional options to improve livelihoods, natural resource economics, and adoption and impact assessment.

Policy-oriented research
boosts barley yields in Syria

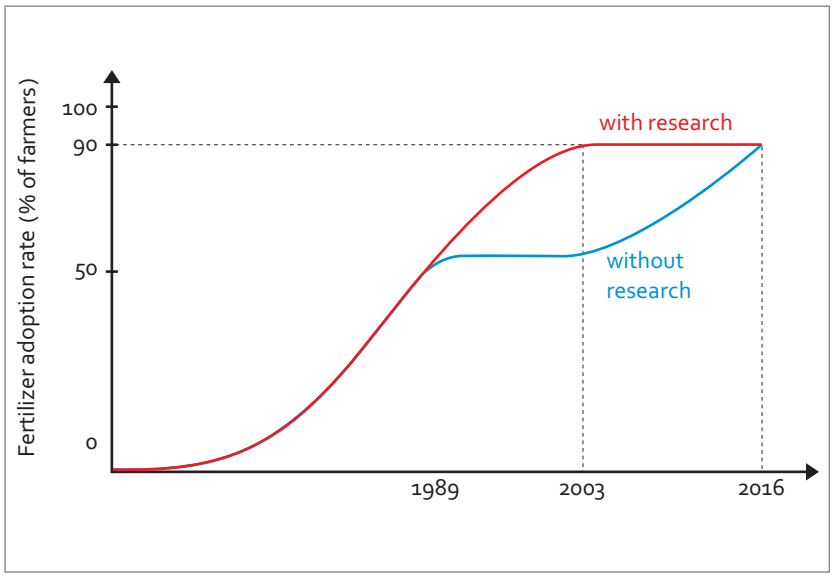
Research in Syria led to a major change in the government's fertilizer policy for barley... which led to savings of US$ 2 million a year through reduced imports.

Barley is the main source of animal feed in Syria, accounting for 96% of the area of rainfed forage crops and 40% of total cereal cultivation. The crop is well adapted to dry areas, but until 1989, yields were poor because the government allocated little or no fertilizer to dry rainfed areas, where most barley is grown.

This policy has changed, thanks to a four-year research project by ICARDA and Syria's Soil Directorate. Barley area has fallen by nearly 50% since 1989, but production has fallen only slightly, mainly because the government now allocates fertilizer to barley in rainfed agricultural zones. The new policy has allowed farmers to intensify barley production, with higher yields, more stable fodder supplies and higher incomes.

Research shapes policy

The new policy was introduced in 1989, based on evidence from this research.



This research moved the 'adoption curve' forward by 13 years: 90% levels were reached in 2003 instead of 2016.

In moderately dry areas (rainfall at least 250 mm in two years out of three) farmers receive loans from the Agricultural Cooperative Bank to buy fertilizer. In very dry areas (rainfall at least 250 mm in half the years), farmers do not get loans, but are allowed to buy fertilizer for barley.

Before allocating limited fertilizer supplies to low-rainfall areas, policymakers needed to know how much fertilizer should be applied to barley in these environments, what the risks are, and whether or not it will be profitable. This research helped provide the answers. A strong 'national champion', the Director of the Fertility Division of the Soil Directorate, presented the evidence to policy makers. And different stakeholders – researchers, extension workers, farmers, policymakers – worked together to implement the change.

Measuring the impacts

The returns on investment in this research were measured using an economic surplus model. The net economic surplus to consumers and producers was US$ 73.42 million. The rate of return on research and extension investment was a remarkable 70%.

With the new policy, Syria has reduced the cost of barley imports by around US$ 2 million a year – saving about US$ 54.5 million between 1989 and 2016. Clearly, this research project has reduced import dependence and substantially improved food security in Syria.

Partner

- Syrian Ministry of Agriculture and Agrarian Reform

Identifying benchmark watersheds for research in Libya

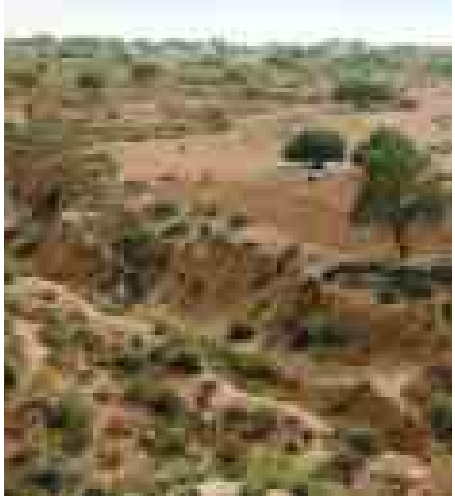
A multidisciplinary approach, used to select watershed research sites in Libya, provides a model for developing countries worldwide.

Good management of watersheds is the key to agricultural development, particularly in areas with low and variable rainfall. The first step is to identify 'benchmark' sites where watershed management technologies can be tested. ICARDA is using an integrated, multidisciplinary approach to select and characterize such sites. One example is Libya, where seven large watersheds (about 5000 square kilometers) have been identified, and 21 sites and 51 sub-sites selected.

Representative sites

A research site must be representative of conditions over a larger area – this will help scale out results to similar ecologies elsewhere. The study to identify suitable sites was conducted in the Tripolitania region in western Libya and the Cyrenaica region in the east. Both are important agricultural zones with a mixture of cropping, forestry and livestock production.

Multidisciplinary teams – GIS experts, water and land scientists, rangeland experts, socio-economists and others – first identified the key characteristics of an 'ideal' site. They collected information on the biophysical and socioeconomic conditions in all major watersheds in the two regions: rainfall, land use and cropping patterns, soils, topography, location and size of population centers, transport links... Geographic information systems (GIS) were then used to compare the data with the characteristics of 'ideal' sites, to identify the most suitable locations for an integrated research program.



Benchmark watershed in Libya. Slopes, flat areas and water channels – ideal for water harvesting.

The next stage was 'ground-truthing'. The teams visited each potential watershed to better understand factors that would not be readily apparent from the data alone, such as land suitability, local knowledge, attitudes of communities to innovation and their willingness to participate in the research. It also allowed the teams to assess the degree to which each site was representative of other areas.

Once the benchmark watersheds were chosen, the team collected detailed baseline data on soil, hydrology, socioeconomic characteristics, and current and potential land use patterns. This was used as a basis for selecting sites for specific research topics (such as small-scale water harvesting and supplemental irrigation) and for future out-scaling and dissemination.

Research for development

These benchmark sites will help pilot an integrated package of technologies, including new varieties and improved land and water management methods. Research is being carried out in farmers' fields, with the community, to identify and test each technology component, and then to integrate components into a 'package' for sustainable agriculture and improved livelihoods.

Partners

- Agricultural Research Center, Libya
- University of Omar Al Mokhtar, Al Bayda, Libya
- University of Al Fatih, Tripoli, Libya

Biocontrol methods fight crop pests while generating income

Environment-friendly pest control: medicinal herbs are being inter-planted with crops, to attract insects that prey on crop pests.

Natural biological control can help reduce the damage caused by insect pests. But when natural habitats are destroyed and farmers use too much pesticide, natural biological control agents – the natural enemies of pests – become ineffective.

Herbs for pest control

Native dryland herbs like anise, coriander and others, are well adapted to dryland conditions. They also provide food and shelter for insects that prey on or infest pests that damage wheat, lentil and chickpea and other crops. The natural habitats for these herbs are shrinking rapidly, but they can be grown as cash crops. Planting these herbs within crop fields can substantially improve pest control, and also generate extra cash for the farmer.

Seven medicinal herbs were tested at ICARDA's Tel Hadya research farm during the 2009-10 season. Natural enemies of crop pests were particularly attracted to four species: anise *(Pimpinella anisum)*, coriander *(Coriandrum sativum)*, fennel *(Foeniculum vulgare)* and safflower *(Carthamus tinctorius)*.

ICARDA's biocontrol research has been particularly successful against the Sunn pest, which causes widespread damage to wheat crops over a vast area from Morocco to Kazakhstan. Pesticide control is effective but costly. A better alternative is a parasitic wasp known as *Trissolcus grandis*, which lives on the eggs of the Sunn pest. Researchers found that *T. grandis* was particularly attracted to the flowers of coriander and fennel. The high sugar concentration in their nectar and pollen seemed to make the *T. grandis* parasite live longer and reproduce faster. Laboratory experiments confirmed this. When *T. grandis* wasps were fed on coriander nectar and flowers, their lifespan tripled – to over three weeks, compared to one week when fed on other herb species.

Finding the right combination

Field experiments were then conducted, on how best to implement biocontrol. Parasitism levels of T. grandis were 25% in a normal wheat crop, but increased to 75% when coriander was inter-planted with wheat.

Clearly, biocontrol can help farmers reduce crop losses, cut production costs, generate additional income from the sale of high-value herbs, and reduce pesticide damage to the environment. Experiments are ongoing, to identify the most effective herbs and the best herb-crop combinations, to boost populations of the natural enemies of crop pests.

Partners

- General Commission for Scientific Agricultural Research, Syria
- University of Aleppo, Syria
- Michigan State University, USA

Syrphid fly feeding on anise flowers. Pest management that is cost-free, environment-friendly and generates cash.

Crop models analyze the impacts of climate change

Crop simulation models are helping to quantify the impacts of climate change on crop yields and food security.

Projections by the Intergovernmental Panel on Climate Change (IPCC) provide a broad picture of climate change globally – but little information is available on the likely impact on crop yields at local levels. ICARDA and its partners are using biophysical models to fill this information gap, with durum wheat in Syria as a test case. The study showed that future yields are likely to be not only lower, but much more variable from year to year.

Medium- and long-term changes

The climate model PROTHEUS indicates only minor climatic changes in northern Syria in the medium term (2011-2050) under the IPCC's scenario A1B. This scenario – which many scientists consider overly optimistic – assumes greenhouse gas emissions will remain within manageable levels. PROTHEUS suggests that, in the medium term, rainfall in northern Syria will not change markedly, while temperature will rise by about 0.9°C from current levels. Crop model simulations indicate that under this scenario, average durum wheat yields will fall by about 6%, from 1.87 tons (1980-2010 average) to 1.75 tons per hectare (2011-2050 average). But more importantly, year-to-year yield variations will increase, mainly because of rainfall fluctuations.

Looking further into the future, the picture is even bleaker. According to one prediction for 2070-2100, average rainfall in northern Syria will decline by 17%, while average annual temperature will rise by 4°C, putting crops under extreme water stress. This prediction is based on a modified version of the HadCM3 model under the IPCC's A2 scenario, which assumes higher greenhouse gas emissions. Using this data, crop models predict a 26% decline in durum wheat yields, and much higher year-to-year variation. Yields are expected to fall below 500 kg per hectare one year in four, compared with one year in eight at present.

These results highlight the importance of initiating research today, to address tomorrow's problems; to develop varieties and production systems adapted to the conditions farmers will face in the second half of this century.

Climate change will reduce wheat yields and increase year-to-year fluctuations in food supplies.

Managing water wisely

The crop model also suggests that supplemental irrigation at critical growth stages could offset these yield declines and even lead to large increases in wheat production in rainfed areas. However, water resources in Syria are limited, and the quantity as well as the percentage share available for agriculture will decline. Some tough decisions will need to be made in order to allocate water more efficiently. For example, should water be priced? Should farmers be allowed to use irrigation for summer crops?

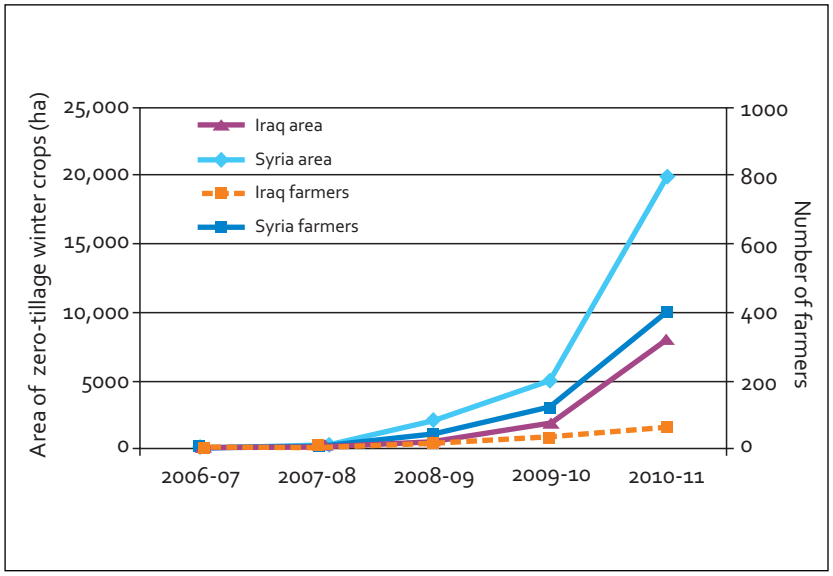
Conservation cropping takes off in Iraq and Syria

Conservation agriculture is spreading rapidly in West Asia. Adoption has grown from near-zero to more than 27,000 hectares in four years.

Conservation cropping – which combines minimal soil disturbance, early planting, stubble retention and crop rotations – reduces production costs, improves soil structure and water retention and reduces soil erosion. Zero-tillage, the key to conservation cropping, is widely used in many countries, but not in West Asia – until recently.

New methods, new equipment

Long-term trials in Iraq and Syria, on a variety of crops, have demonstrated the yield and income benefits. In northern Syria, zero-tillage with early planting gave significantly higher yields than conventional tillage and late planting. For example in 2009-10, barley yields increased by 12%, from 3.35 tons to 3.74 tons per hectare. In wheat, net returns increased by US$ 250 per hectare – even without counting the benefits of improved soil structure, erosion control and water conservation.



Adoption of conservation agriculture took off once low-cost zero-tillage seeders became available.

The trials in Syria also showed that most currently available varieties are suitable for conservation cropping. But ICARDA is also scaling up a specialized breeding program to develop new varieties even better adapted to zero-tillage conditions.

Zero-tillage requires specialized planters that can place seeds accurately into unplowed soil, but the currently available models are imported, and too expensive for most smallholder farmers. An Australia-ICARDA project worked with Iraqi and Syrian entrepreneurs to manufacture – locally and at low cost – planters suited to local conditions. These gave the same results as imported planters, at a fraction of the cost: US$ 1500-5000 versus US$ 50,000-60,000.

Rapid expansion

In 2006-07, three farmers in Syria planted 15 hectares of crops using zero-tillage. In the 2010-11 season, 400 farmers planted 20,000 hectares. In Iraq, adoption has grown from 52 hectares to nearly 8000 hectares in the same period. To encourage adoption, NGOs and government extension services provided zero-tillage seeders on loan, but every farmer provided inputs from his own resources – which means they find the technology attractive and profitable.

Partners

- In Australia: Univ. of Western Australia; Department of Agriculture and Food, Western Australia; Univ. of Adelaide
- In Iraq: State Board for Agricultural Research, Univ. of Mosul, Ninevah Directorate of Agriculture, Ninevah State Board for Agriculture Research
- In Syria: General Commission for Scientific Agricultural Research, Dept. of Extension, Aga Khan Foundation, Syrian Libyan Company
- Local zero-tillage planter manufacturers in Syria and Iraq

Farmer-participatory research improves livelihoods in Eritrea

Farmer-participatory research helps develop, test and promote new technologies in the highlands of Eritrea.

Some 600,000 people live in the Atbara river basin in Eritrea; 80% of them rely on agriculture, but few have access to new farming technologies. A long-term project (2004-2010) implemented jointly with a number of government agencies has helped introduce new technologies, new farmer-participatory research methods, and village-based seed enterprises to disseminate new varieties.

Participatory plant breeding

An innovative breeding program was implemented in four pilot zones: Adi Keyh, Dubarwa, Dekamhare and Serejeka sub-provinces. Farmers, researchers and extension staff jointly evaluated a wide range of crop varieties, both indigenous and introduced, to select those that best suited local needs. Using this approach, as many as 23 promising varieties of five crops (barley, wheat, lentil, faba bean, chickpea) have been identified.

Farmers first. Community participation was the key to rapid dissemination of new crop varieties.

The barley trials, to give one example, illustrate the value of the new varieties as well as the participatory approach used to identify them. In Adi Keyh, two barley lines gave more than double the yield of the popular local variety. In Serejeka, two lines yielded 40-60% more than the local variety. In Dekamhare, one line yielded 20% more.

The project also developed a number of improved barley lines by crossing indigenous varieties with introduced genotypes with specific traits such as early maturity or disease resistance. The new lines gave yields up to 30% higher than the local variety. One line, of Yemeni parentage, showed unusually wide adaptation, and is being used as raw material for the breeding program.

Community-led technology dissemination

To accelerate the dissemination of new varieties, a farmer seed cooperative was established in Tera Emni village. A group of pilot farmers was provided with 'nucleus' seed of new varieties developed by the project, together with training on seed production, quality control and storage. In the 2010 season, the cooperative produced nearly 14 tons of wheat seed, and earned a 165% net return on investment. They are now multiplying new varieties of barley, wheat and lentil for distribution to other farmers in the area. This work is being scaled up through an IFAD-funded project launched in 2010.

Partners

- National Agricultural Research Institute, Eritrea
- Hamelmalo Agricultural College
- Agriculture Promotion and Development Department, Eritrea
- Agriculture and Extension Services at province (Debub and Maekal) and sub-province levels

Freeze-resistant chickpeas offer higher, more stable yields

Winter-planted chickpea crops can be severely damaged by cold spells. New genotypes can survive temperatures as low as –24°C.

Chickpea is vital source of protein in many countries – but the crop is often severely affected by cold temperatures at critical stages of growth. ICARDA and its partners are developing varieties that can survive long spells of freezing temperatures during the vegetative stage, and/or rapid temperature fluctuations during the reproductive phase. The first is a long-standing problem. The second is becoming increasingly frequent in West and South Asia.

Winter versus spring

Chickpea can be planted in winter or in spring. In Mediterranean environments winter-planted chickpea could give nearly double the yield of spring-planted crops because it makes full use of rainfall. But it could also be exposed to freezing temperatures during the early growth phase, leading to yield losses or even total crop failure. Another risk – which appears to be increasing, perhaps due to climate change – is the increasing frequency of unpredictable cold spells.

Cold-tolerant (right) versus susceptible. The new varieties can survive sudden cold spells, even sub-zero temperatures.

ICARDA and its partners are screening hundreds of genotypes from genebanks and breeding programs, to identify cold-tolerant materials. Together with partners in West Asia and North Africa, we've identified nine improved chickpea lines that can tolerate a temperature of up to –12°C for 30 to 50 days during the vegetative growth stage.

Working with the Dryland Agriculture Research Institute in Iran, we've also identified three improved lines that can survive temperatures of –20°C without snow cover and –24°C under snow cover (the snow covers the young plants, providing a degree of insulation). These temperatures would kill most chickpea plants. The new lines will enable farmers to take advantage of the greater yields offered by winter-sown crops without the risk of crop failure.

Coping with cold shocks

Over the past two years, chickpea crops in northern Syria have been exposed to short-term cold shocks during the spring, when the crop is entering the reproductive stage. Temperatures have dipped briefly to –6°C, then risen rapidly to well above freezing. Such shocks, which have also occurred in South Asia, cause flowers to abort and pods to shrivel.

Initial screening by ICARDA has identified improved lines and wild relatives that seem able to tolerate these conditions, but more needs to be done to identify suitable breeding stock. Screening will continue at ICARDA's Tel Hadya research station, which regularly experiences these temperature patterns.

Partners

- Dryland Agriculture Research Institute, Iran

Women's roles in agricultural marketing in West Asia

From Syria and Jordan, new insights on how cultural factors influence women's welfare.

Cultural norms can profoundly influence development at multiple scales, from household decision-making to national development outcomes. Studies in Syria and Jordan are examining how gender-based division of labor impacts on women's decision-making power and their contribution to household welfare. The studies looked at two communities in each country, with differences in production system (e.g. migratory pastoral versus mixed farming), degree of external influence (e.g. presence of NGOs) and other parameters.

Gender differences

In both countries, men generally have primary responsibility for economic activities, including marketing, while women's activities are concentrated within the household. Women generally do not own land.

In this study, women were responsible for marketing live animals in only 22% of the households in Jordan, and 15% in Syria. For marketing dairy products, the figures were 39% in Jordan and 13% in Syria. This difference is mainly because women in Jordan have much better market access: they sell from their homes to individual customers as well as traders. In Syria, 54% of the women surveyed said dairy products were largely marketed by men, who also retain control over the income.

Very few of the Syrian women owned livestock, but the majority said they would like to, because they believed it would increase household income (20% thought it would simply increase their workloads). In contrast, 37% of the Jordanian women owned livestock and ran their own dairy businesses, largely because of the work of NGOs and development projects at the study sites.

Women could contribute even more to the household, if livestock ownership and market access were improved.

More income, more power

Women perceive that they contribute 47% (Syria) and 42% (Jordan) of household income. In Jordan, 74% of the women surveyed said the money earned from dairying had improved their standard of living; 20% reported that it was used mainly to purchase food.

Women in both countries felt higher income gave them more bargaining power within the household and a greater role in decision-making. The effect is greater in Jordan, largely as a result of NGO projects and better market access. Clearly, development efforts that increase women's incomes also improve their status and their control over their own and their households' livelihoods.

Partners

- General Commission for Scientific Agricultural Research, Syria
- National Center for Agricultural Research and Extension, Jordan

Dairy goat project improves women's welfare in Afghanistan

A women-oriented project has increased incomes, improved nutrition, and created new platforms for community development.

Goat husbandry offers a good entry point for rural development interventions in Afghanistan for two reasons – goats are a major source of livelihoods, and are generally owned by women. An IFAD-funded project (2006-2009) introduced simple technologies to improve dairy goat production. A 2010 study conducted in 14 villages in Baghlan and Nangarhar provinces of Afghanistan showed that the project had generated huge impacts.

Low-cost technologies

The greatest impact came from de-worming and vaccinating goats against diseases. Mortality and abortion rates fell from 20-25% to 4%. Milk yields increased by 10-15%. By 2010, all households which had received goats from the project, and half of households which had not, had vaccinated and de-wormed their animals. In Nangarhar province, after seeing the results in project villages, 30-40% of farmers in neighboring villages have also begun to vaccinate their goats.

Before the project, dairy processing methods were usually unhygienic and inefficient, and mastitis was widespread.

The project introduced new processing methods and improved hygiene. The shelf life of milk doubled. The number of households producing cheese increased by one-third. The market price of butter and cheese increased by 20% and the price of female goats (does) by 10%. The incidence of sub-clinical mastitis fell from 27% to 4%.

For each technology – vaccination and de-worming, improved hygiene and efficient processing – the financial benefits were almost double the costs.

Genetic stocks, animal health and nutrition, dairy products... impacts of the goat project in Afghanistan.

Creating development platforms

The project distributed does to poor women under a 'pass on the gift' scheme: recipients would give the first female kid to another woman in the village who would do the same in turn. Two hundred women have received does either directly from the project or through this scheme. Community leaders are continuing the scheme even after the project closed.

Women's associations were established in each village to improve marketing and information sharing. The associations now have nearly 550 members in the target villages, and neighboring villages are setting up similar groups. Government agencies and NGOs are now using the associations as platforms for implementing community development programs.

Partners

- Livestock Department, Ministry of Agriculture, Irrigation and Livestock, Afghanistan
- Ministry of Women's Affairs, Afghanistan
- Food and Agriculture Organization of the United Nations
- Dutch Committee for Afghanistan
- Serve Afghanistan
- International Fund for Agricultural Development

Accessing markets for herbs and aromatic plants

Value chain analysis in Egypt and Jordan helps smallholder farmers access markets for herbs and aromatic plants.

Value-chain analysis of herbs and aromatic plants in Egypt and Jordan has highlighted the potential of these crops to generate income for small-scale farmers. The study, funded by IFAD, also identified the key policy and research areas that need to be addressed. Most importantly, farmers need access to improved production practices and better information on processing, markets and prices.

Understanding the value chain

The study covered four aromatic species: chamomile and basil in Egypt, oregano and sage in Jordan. This was the first comprehensive value-chain analysis for these species, covering production, processing, trade, price trends, margins and institutional factors such as the role of cooperatives.

Every group involved in the business – producers, traders, transporters, farmers' associations, exporters, quality standards laboratories, government officials – was interviewed. The team met with 575 producers in 37 communities in the two countries. Although there were differences between crops and between countries, a number of common features emerged that have important policy implications.

Herb 'factory' in Egypt. Farmers can increase their profits by using simple farm-based processing methods.

Weak links in the chain

Farmers' associations can play a crucial role in negotiating prices and credit terms. But there were very few of these associations in Jordan; while in Egypt they have largely been replaced by private-sector associations that may not always serve farmers' interests – almost half of the members interviewed said their associations did not provide information on prices, for example. Clearly, one priority is to encourage (and enable) small-scale farmers to form more effective associations.

Most farmers sell their crops fresh – but the study showed they could substantially increase profits through simple processing. For example, grading alone increases the value of fresh chamomile by 46%. Drying sweet basil in the field increases its value by 51%, yet fewer than 10% of producers in Egypt dry their own crop.

The study found that prices for the same product could vary by 100% in different markets – and vary substantially even within the same market. This makes it all the more important for small-scale producers to have accurate market information. Similarly, quality standards need to be introduced, and testing facilities strengthened, to facilitate access to international markets.

Partners

- Agricultural Research Center, Egypt
- National Center for Agricultural Research and Extension, Jordan
- University of Jordan
- International Fund for Agricultural Development

New sources of animal fodder in Libya

Fodder supplies in Libya are expanding, thanks to new varieties, new crops and better protection for rangelands.

Sheep and goat producers in Libya are facing increasing shortages of animal feed. ICARDA and the Libyan Agricultural Research Center (ARC) are helping to develop more reliable, sustainable feed supplies through a combination of improved fodder varieties, alternative feed sources and protection of rangeland plants.

Improved fodder varieties

Improved fodder varieties can give very high yields under irrigation. In 2010, scientists screened 85 genotypes of five fodder crops (oats, common vetch, bitter vetch, narbon vetch and grasspea) under irrigation at ARC research stations in different parts of the country. Fifteen of these genotypes produced high to extremely high yields. Six new oat lines, introduced from ICARDA, gave more than 12 tons of dry matter per hectare. Among the forage legumes (vetch, grasspea), the best lines gave 6 to 10 tons per hectare. Although forage legumes give lower yields than oats, they contain more protein, and are a valuable addition to the low-protein diet obtained from rangeland grazing.

New oat varieties, introduced in Libya for the first time, yield 12 tons of dry matter per hectare under irrigation.

New fodder crops

Cactus species can be grown as a fodder crop in arid areas, providing reliable feed supplies and simultaneously reducing erosion. Fruiting species of cactus such as the prickly pear (*Opuntia ficus-indica*) are also a highly profitable cash crop. In 2010, the project tested 43 cactus genotypes at four ARC research stations (Al-Hira, Tajoura, Al Fatyeh and Benghazi) in different environments. The cactus species, mainly prickly pear originating from Sardinia and Sicily, appear to be well adapted to Libyan conditions – one genotype produced 26 'pads' only seven months after being established from a single 'pad'.

Saltbush *(Atriplex nummularia)* is another good source of fodder, and can be either sole-cropped or integrated into existing cropping systems. To demonstrate the feed potential, 13,800 cactus pads and 3000 saltbush seedlings were planted at Al-Hira station in western Libya. Both species performed well despite severe drought, and are now being assessed for nutritional content and other parameters.

Protecting rangeland biodiversity

Libya's rangelands, the main source of fodder, are rapidly losing biodiversity. The project team collected 151 species of indigenous rangeland plants from 79 sites in different ecologies: rangelands, mountains, saline and non-saline depressions, and sand dunes. The seeds, now stored in the national genebank in Tripoli, will be grown next season, and key species will be tested, characterized and multiplied.

Partners

- Agricultural Research Center, Libya
- Rangeland Development Project, Ministry of Agriculture, Libya

Supplemental irrigation
improves water productivity

Better irrigation management can save huge quantities of water with little or no loss in grain production.

Water scarcity is usually the biggest yield-limiting factor in dry areas. Supplemental irrigation – providing small quantities of water at crucial growth stages, to supplement rainfall – can increase both yield and water productivity, which is the quantity of grain produced per unit of water used. ICARDA researchers studied yield and water productivity in different crops, at different levels of supplemental irrigation. The results will help farmers make informed decisions on irrigation.

Using water more efficiently

Experiments were conducted at ICARDA's Tel Hadya research station for three years (2007-2010) on five crops – bread wheat, durum wheat, faba bean, chickpea and lentil. Four levels of supplemental irrigation (SI) were tested: zero, full SI (enough water to fill the root zone profile), two-thirds of this amount (2/3 SI), and one-third of this amount (1/3 SI).

Wheat-legume experiment under different irrigation levels. Objective: to measure trade-offs between yield and water use.

The results for grain yield illustrate two things: even small quantities of SI provide substantial benefits, and the incremental benefits taper off at higher SI levels.

For example, 1/3 SI gave large yield increases in all crops. Compared to zero-SI, yields increased by 180% in bread wheat, 206% in durum wheat, 93% in chickpea, 80% in lentil and 50% in faba bean. With more irrigation, i.e. moving from 1/3 to 2/3 SI, yields continued to increase, but more slowly. Compared to 1/3 SI, yields increased by 22% to 36% in different crops. All five crops yielded the most grain under full SI, but in most cases, yields gradually began tapering off at higher SI levels.

Trade-offs between yield and water productivity

Maximum grain yield does not necessarily mean maximum water productivity. In areas with severe water shortages, it may be useful (for the national interest, if not for individual farmers) to maximize water productivity, even at the cost of slightly lower yields. Particularly in cereals, considerable amounts of water can be saved – for example by applying 2/3 SI rather than full SI – without a significant reduction in yield. The saved water can be used to irrigate other fields

These experiments are helping to measure the trade-offs between grain yield and water productivity. In bread wheat, for example, one option is maximum water productivity (12 kg/ha/mm) with a yield of 5.4 tons per hectare. Another option is maximum yield (7 tons) with water productivity of 10.6 kg/ha/mm. Water productivity in wheat was highest at 2/3 SI. But for legume crops, water productivity was highest at full SI – highlighting the difficulties involved in making irrigation decisions in real-world farming systems.

Understanding pathogen evolution in wheat stripe rust

New research on how wheat stripe rust disease is evolving, and how to prevent future epidemics.

The world's wheat supplies are under threat from fast-mutating new strains of stripe rust, also known as yellow rust. The new strains attack hitherto resistant varieties and are spreading to new areas. Unless they are stopped, a stripe rust pandemic could destroy millions of hectares of wheat, with low-income countries suffering the most.

Crumbling defenses

In 2009-10, an epidemic of stripe rust swept across West Asia. Syria lost 25-30% of its wheat harvest in 2010 as a combined result of drought and stripe rust. Shortly after the first signs of serious infection were spotted in February and March, national partners and ICARDA researchers began tracking rust pathogens and analyzing their virulence in different areas, and on different wheat varieties, in order to understand how the pathogens move and behave.

The epidemic was caused by a new strain that overcame the resistance provided by the widely used stripe rust resistance gene Yr27. Two varieties (Cham 8 and Cham 10) that were grown on 70% of Syria's bread wheat area, were particularly susceptible. By comparing differences and similarities in resistance between wheat varieties in Syria, neighboring countries and other continents, researchers identified varieties and breeding materials resistant to the new pathogen strain.

Stripe rust epidemic in Syria. Urgently needed: a 'basket' of genetically diverse resistant varieties.

Diversity and genetic resistance

This work represents a major advance in our understanding of the evolution of new strains and the genetics of resistance. The best insurance against rust is to develop not one but a range of resistant varieties suitable for various environments. The risk of a large-scale epidemic is greatly reduced when farmers across a region grow a range of rust-resistant varieties, not just one genetically uniform variety that might suddenly succumb to a new strain. ICARDA is running field trials to assess the resistance of different wheat varieties to different races of rust in different environments.

Researchers have identified stripe rust resistance genes that act in similar ways under different conditions. This information is being used to develop 'slow rusting' varieties that, while not resistant, will suffer only minimal losses in yield and grain quality. Such varieties are the best defense against stripe rust, particularly in areas where fungicides are unavailable or too expensive.

Partners

- National research centers in Egypt, Ethiopia, Kenya, Pakistan, Sudan, Syria and Turkey
- Borlaug Global Rust Initiative partners: CIMMYT, FAO, Cornell University
- USAID

GIS tools help identify sites for rainwater harvesting in Eritrea

GIS analysis helps identify water harvesting sites in drought-prone Eritrea.

Rainwater harvesting – trapping runoff water and channeling it to more productive use – can greatly improve food production as well as water productivity ('more crop per drop'). An IFAD-funded collaborative program in Eritrea used geographic information systems (GIS) to identify the best locations for water harvesting systems in the country's Southern Zone (Zoba Debub).

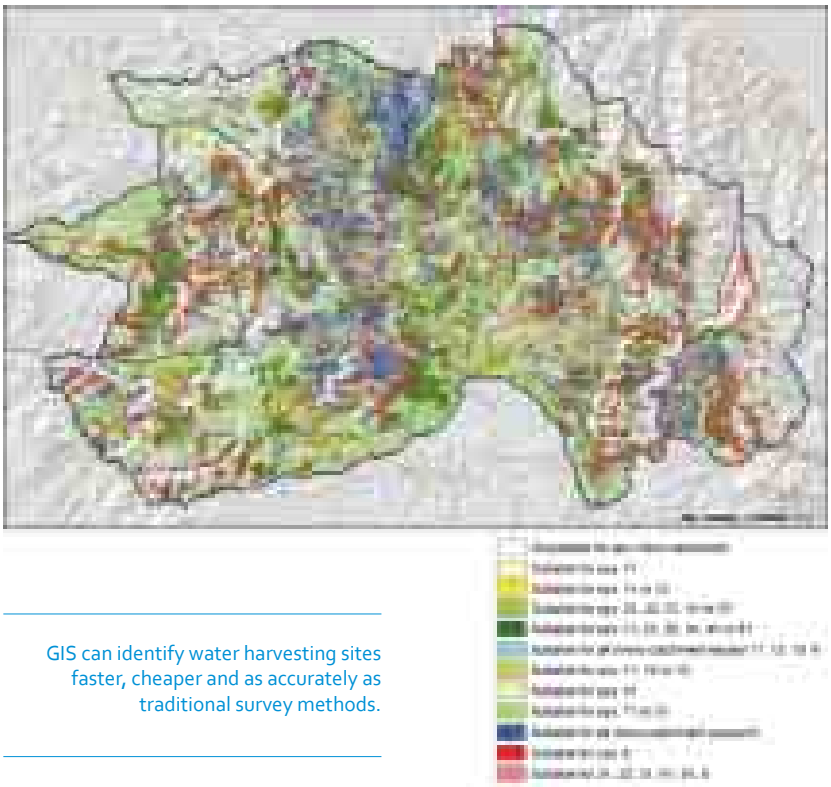
GIS-enabled spatial analysis

The first task was to compile hard-to-find information on land cover, topography, soils and precipitation – the key factors that determine whether a site is suitable for water harvesting. Using GIS and data integration tools, this information was transformed into maps showing suitability for different kinds of water harvesting systems.

The study looked at two kinds of systems: micro-catchments, where the field is also the catchment area; and macro-catchments, where many fields share water trapped from a large catchment area.

Site suitability was assessed for six micro-catchment systems (contour ridges, semi-circular bunds, small pits, small run-off basins, run-off strips, contour bench terraces) under three different land-use scenarios: range shrubs, field crops, and tree crops. For macro-catchment systems, suitability for catchment and for farming were analyzed separately, followed by an assessment of the constraint imposed by distance between farm and catchment area.

The results indicate excellent potential for water harvesting schemes – 70% of Zoba Debub is suitable for at least one micro-catchment system.



GIS can identify water harvesting sites faster, cheaper and as accurately as traditional survey methods.

Making water harvesting work for farmers

Eight watersheds were shortlisted for potential pilot projects. The selection was based on the GIS analysis as well as other criteria including population concentration, and availability of water, land, and agricultural data.

To begin with, pilot water harvesting systems will be built at two of the eight shortlisted sites: Tselema watershed in the north-west of Zoba Debub, and Hazemo watershed in the south-east.

Food production in Eritrea has dropped by 60% over the last decade, largely because of frequent droughts. The ICARDA maps could help plan a water harvesting program to reverse this trend.

Partners

- National Agricultural Program, Eritrea
- International Fund for Agricultural Development

PARTNERSHIPS AND OUTREACH

Partnerships have always been ICARDA's strength. New linkages were created and existing ones expanded during the year, to work in new areas, to build on synergies with partner organizations, and to promote a more integrated, systems-based approach to foster agricultural development.

ICARDA's primary partners are the national research and extension systems in each country. Continuous interactions on the ground ensure that all research is planned, implemented and monitored jointly. Regular meetings with policy makers help develop clearly focused, long-term plans.

The Ministers of Agriculture for Jordan, Lebanon, Syria and Turkey visited ICARDA during 2010; while the Ministers of Agriculture for Algeria, Egypt, Eritrea, Ethiopia, Sudan, Turkmenistan and UAE (and policy makers in a number of countries) hosted meetings with ICARDA's Director General and senior management. These interactions helped identify research priorities, and adjust ICARDA's portfolio in response to emerging needs.

H.E. Dr Adel Safar (right), Syria's Minister for Agriculture and Agrarian Reform (and later the country's Prime Minister) discusses research plans with ICARDA's senior management.

Expanding horizons

A new agreement was signed with the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), to expand collaborative research in Africa. Activities will include technical assistance to the ten ASARECA countries in developing a comprehensive strategy for climate change adaptation.

Formal agreements were signed with the national research programs in Algeria (March 2010) and Morocco (November). The agreements set out specific priorities for collaborative research – in crop improvement, water management, livestock, policy and market studies, biotechnology and other areas – that will support national development plans.

Partnerships in South Asia are expanding rapidly. Three new research projects were launched in India, funded by the Departement of Agriculture and Cooperation. Other research proposals have been developed jointly with China, Bangladesh, India and Nepal, including plans for the new Center of Excellence for Dryland Agriculture in Beijing, China, which will be managed jointly by the Chinese Academy of Agricultural Sciences, ICARDA and ICRISAT.

ICARDA will also play a key role in a new regional partnership initiated by the Asian Development Bank, IFAD, FAO and other partners. A 3-year agreement, signed in Manila, 7-9 July outlines a framework for this partnership to support national efforts to improve household food and nutritional security in Asia and the Pacific region, particularly for small-scale farm households.

H.E. Dr Hussain Al-Haj Hassan, Lebanon's Minister of Agriculture, looks at new wheat varieties being tested at ICARDA's research station.

Support from development investors

Key donors have scaled up their support. IFAD and ICARDA have developed a comprehensive framework for a long-term, multi-year commitment (rather than grants for individual research projects), to scale out new technologies through IFAD development projects. The AFESD funded several large-scale regional initiatives, some of which are co-funded by other donors. Two other investors – the Islamic Development Bank and the Kuwait Fund – have increased funding levels several-fold compared to previous years.

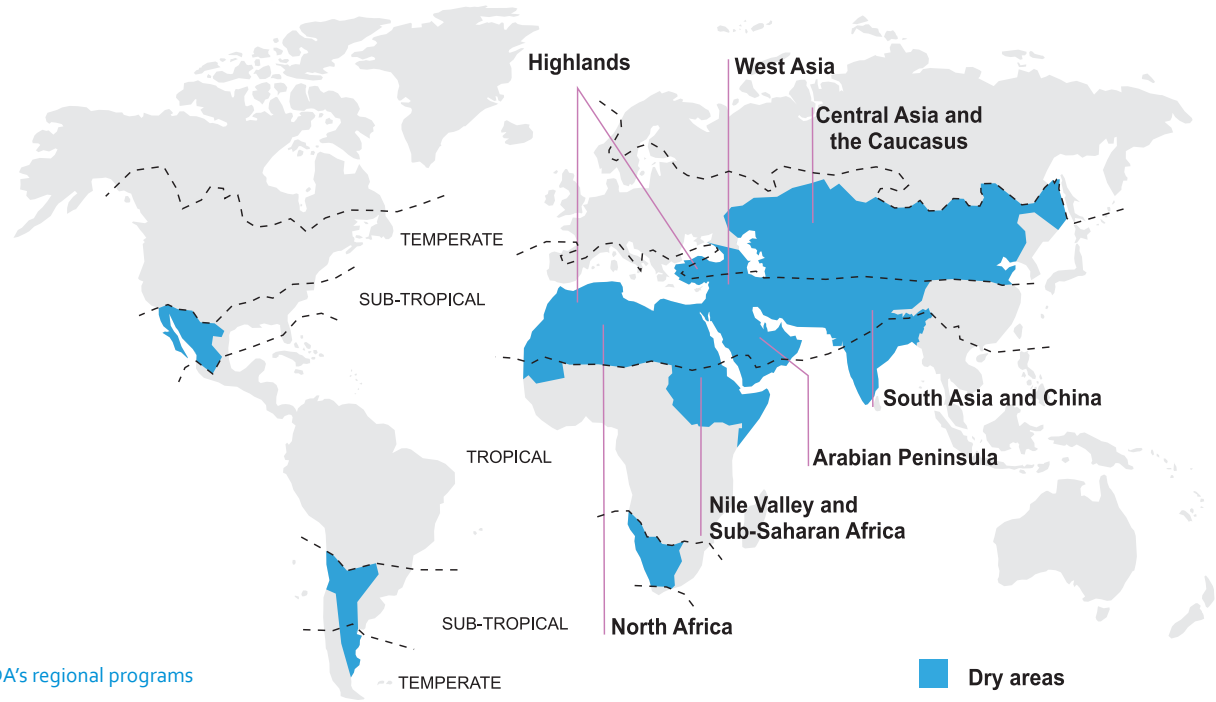
A new agreement to expand research in Africa, signed by Dr Seyfu Ketema (left), ASARECA Executive Secretary, and Dr Mahmoud Solh, ICARDA Director General.

The regional focus

ICARDA's research is planned, implemented and monitored in collaboration with national agricultural research systems. These linkages are coordinated by a network of regional programs and country offices which act as a bridge, helping to disseminate new technologies to farm communities and feeding back research needs to scientists.

Given the complexity of dryland farming systems and the scale of the challenges, synergy and partnership are critical. The regional programs provide technical support, training and other resources to partner organizations in each country; while national research centers provide complementary skills, resources and local knowledge.

This regional approach also benefits from 'opportunities of scale'. In most cases, agro-ecological zones cut across national borders. Different countries may share the same production constraints – which means technologies developed and tested at pilot sites can be scaled out (with local modifications as needed) to other countries in a region. It is this regional focus that has enabled ICARDA and its partners to generate huge benefits from relatively small investments.



ICARDA's regional programs

Nile Valley and Sub-Saharan Africa Regional Program

Activities in Egypt, Eritrea, Ethiopia and Sudan, with spillover benefits to other countries in Africa

Countries in the Nile Valley and sub-Saharan Africa share a number of common problems, including low agricultural productivity, limited water resources, food insecurity, and climate variability and change. ICARDA's regional approach helps address these shared problems more effectively, and accelerate the scaling out process. This helps ensure that new technologies move quickly from pilot sites to surrounding farming systems to other countries.

For example, new rust-resistant wheat varieties developed through partnerships with Egypt, Ethiopia, Kenya and Sudan, are being used in many other countries. Water management innovations are being scaled out within and beyond the region.

The collaborative program in Ethiopia is widely acknowledged as a model for multi-partner initiatives in low-rainfall farming systems. Poverty mapping studies in Sudan are helping to target development interventions more effectively, within the country and in similar ecologies elsewhere.

Major research projects

Egypt and Sudan are key implementation sites for a major regional project to improve food security in Arab countries funded by AFESD, the Islamic Development Bank and the Kuwait Fund. The project is helping to test and promote improved wheat varieties and crop management methods. For example, farmers in Egypt have been able to reduce water use by 20% and fertilizer use by 35% without significant reduction in yield.

Five new wheat varieties resistant to stem rust disease have been released for cultivation. One more will be released in 2011.

The ICARDA-Egypt Agricultural Research Center Wheat Improvement Program is developing improved wheat germplasm, improved crop management methods, and strengthening national research capacity. Similar work is ongoing in Sudan through the Bread Wheat Breeding Program. In Egypt, Eritrea, Ethiopia and Sudan, another project focuses on integrated crop-livestock management, through farmer-participatory research in 12 pilot communities. An IFAD-funded project helped identify ways to improve farmers' access to markets for herbs (see page 17).

Integrated crop-livestock technologies are helping to increase productivity and profits for small-scale producers.

Building partnerships, sharing knowledge

A new memorandum of understanding was signed with the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), focusing on climate change in sub-Saharan Africa. In Egypt, new partners have joined the USAID Water and Livelihoods Initiative, including the Ministry of Agriculture and Land Reclamation, the Ministry of Water Resources and Irrigation, and five universities.

Research findings were shared at several meetings, including the First Arab Forum for Agricultural and Food Investment and the 10th International Conference on Development of Drylands, both held in Egypt. A regional traveling wheat workshop was organized in Egypt in April 2010, bringing together scientists and farmers from seven countries.

Plans for 2011

New projects are being developed on wheat and legume-based cropping systems, climate change adaptation, and seed delivery systems. Ongoing pilot programs will be scaled out, including community-based livestock breeding, improving water productivity and irrigation efficiency, and management of salt-affected soils.

North Africa Regional Program

Activities in Algeria, Libya, Mauritania, Morocco and Tunisia

Agricultural development in North Africa is severely limited by water scarcity (among other problems). Many production constraints, are similar across large parts of the region; so we work with partners to address constraints that are important in multiple countries. This approach helps generate technologies and research methods that are widely applicable, not limited to one area or country.

One example is the introduction of saltbush (*Atriplex*) to increase fodder supplies. Studies began in Morocco, were scaled out to other countries in the region, and are now being successfully applied in South and West Asia as well. Integrated livestock technologies (nutrition, fertility treatments, flock management) have been tested at pilot sites and scaled out widely, within and beyond the region.

Participatory, community-led R&D methods first developed in Tunisia, are now being widely used in different countries, and have been formally integrated into national development plans.

Collaborative research in Libya

The Agricultural Research Center Libya–ICARDA Collaborative Program was a major focus in 2010. This program has a broad mandate to improve water harvesting and irrigation management, wheat- and barley-based systems, and small ruminant productivity.

Seven benchmark watersheds (three in western Libya, four in the east) were identified and characterized and potential research sites were selected for further evaluation. Trials on supplemental irrigation were initiated in the eastern region.

Landraces of wheat and barley were collected from farmers' fields. They are now conserved in the national genebank in Tripoli, and are being characterized and evaluated. Field trials identified wheat cultivars that yield up to 10 tons per hectare under irrigation in desert conditions. Adoption of new varieties is growing, following farmer-managed testing and demonstration trials. Fodder supplies are being improved with a combination of improved varieties, new fodder sources and rangeland conservation (see page 18).

Farmers, researchers and extension staff evaluate new wheat varieties at a field day in the Sabha region, southern Libya.

Partnerships and training

ICARDA signed new memoranda of understanding with INRA-Morocco and INRA-Algeria. Both countries have identified a number of priorities for collaborative research, including improvement of cereal- and livestock-based systems, water and land management, climate change adaptation, biotechnology and capacity development.

Coordination and planning meetings were held for projects in Libya and Algeria to monitor research progress and plan for the coming seasons. The Regional Program was also involved in a number of workshops in the region, including the African Development Bank–CGIAR Workshop on Support for Agricultural Research in Africa, held in Tunisia.

Capacity building was another important area. Some 350 Libyan scientists participated in training events on experimental design and data analysis, plant breeding, pest management and characterization of livestock breeds. Researchers from Algeria, Mauritania, Morocco and Tunisia also participated in a variety of training courses at ICARDA's headquarters in Syria. The subjects included plant genetic resources, biometrics and socioeconomics.

Looking ahead

The North Africa Regional Program will continue its work with countries in the region to strengthen smallholder agriculture and build human resources, particularly skills development of young scientists. New projects are being developed on conservation agriculture, food security, climate change and mountain agriculture.

West Asia Regional Program

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

West Asia includes a range of agro-ecosystems, but several problems – water scarcity, high climate variability, land degradation – are common throughout the region. ICARDA helps address these problems through collaborative research with a regional focus.

New technologies for rangeland rehabilitation, developed in Jordan, are being applied in other countries. Research on pest management and the use of organic fertilizer is leading to findings that could benefit wheat and date palm growers in multiple countries, far beyond West Asia. A new project in Iraq addresses salinity – a huge problem not only in Iraq, but in dry areas worldwide.

Most importantly, the Regional Program brings partners together from different countries to address common problems. One example was the International Conference on Food Security and Climate Change (see page 4), at which 24 countries agreed on a clearly articulated, shared research workplan.

Research progress

Integrated pest management (IPM) techniques developed by an IFAD-funded project have halved pest damage to date palm orchards in target areas in central and southern Iraq. Six 'field schools' were established and 36 farmers trained in IPM techniques. Other ongoing projects include the USAID Middle East Water and Livelihoods Initiative, the Water Benchmarks Project funded by AFESD, and a project on community-based management of graywater, supported by the Coca Cola foundation.

In Jordan, 13 pilot wastewater treatment units were installed in villages in the Madaba Governorate, and households trained to operate and maintain them. Fifty-four farmers worked with scientists in a participatory breeding program on barley.

Implementation of two new programs began in 2010: a Netherlands-funded program to enhance food security and livelihoods in Palestine, and a project to conserve genetic resources in Jordan, funded by IDRC-Canada.

A graywater treatment unit in Jordan. The unit, costing about US$ 1500, enables the family to re-use household wastewater to irrigate fruit trees.

New partnerships

A memorandum of understanding was signed with the Palestinian Agricultural Relief Committee, to strengthen cooperation. New partnerships were initiated with the FAO regional project on IPM and farmer field schools, and with the Japan International Cooperation Agency for research in northern Iraq. ICARDA is helping to rebuild the seed sector in Lebanon, in response to a government request. In 2010, we provided 100 tons of seed of improved durum wheat varieties to help establish a 3-year seed multiplication program.

Research planning, capacity development

During 2010, we organized 22 conferences, workshops and visits – including the International Conference on Food Security and Climate Change in Dry Areas. The Regional Program also supported the participation of 45 scientists from the region, in workshops and training courses held in several countries. Planning and coordination meetings were held for the Palestine and Iraq projects.

Plans for 2011

An Australian-funded project on salinity management in Iraq held its inception workshop in December; implementation will begin shortly. IFAD has approved funding for two new projects: one on the impact of climate change on barley/livestock production systems in Iraq and Jordan, the other on water management in mountain agricultural systems in Jordan, Lebanon and Morocco. Implementation of both projects will begin in 2011.

Central Asia and Caucasus Regional Program

Activities in Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan in Central Asia; and Armenia, Azerbaijan and Georgia in the Caucasus

The eight countries in Central Asia and the Caucasus share a number of commonalities, biophysical as well as socio-economic. Agro-ecologies such as the cold, dry steppe span multiple countries. ICARDA's regional approach is ideally suited to such circumstances.

Research on winter wheat is helping to develop new varieties for farmers across the region, and 'raw material' for plant breeders worldwide. A program to create new income opportunities for women (through mohair processing) began in Tajikistan, and has been scaled out to Kazakhstan, and now to Iran. Studies on climate change adaptation, initiated in 2010 in four countries, will lead to results applicable to similar ecologies in many different countries.

Crop improvement, climate change

Considerable progess has been made in fighting stripe rust disease in winter wheat. Three new high-yielding, resistant varieties are ready for release in Uzbekistan. Twenty-three more genotypes from the CIMMYT-ICARDA-Turkey International Winter Wheat Improvement Program, which gave high yields under severe stripe rust disease pressure in Uzbekistan, were distributed to national research centers for further testing.

A new 3-year project was launched, to develop salinity-tolerant winter wheat varieties using wild crop relatives. Four hundred genotypes have been tested and several salt-tolerant lines selected for use in the breeding program. The project is funded by the German Agency for International Cooperation.

Other projects focused on climate change. A regional project on adaptation to climate change in Central Asia and China is funded by the Asian Development Bank. Data collection has been completed, to calibrate and validate the CropSyst crop model at test sites in four countries.

Field trial of new winter wheat varieties in Uzbekistan: consistently good performances across multiple locations and seasons.

A related project in Tajikistan focused on two villages where melting of glaciers is expected to reduce water availability. The aim is to assess the communities' exposure, sensitivity and capacity to adapt to such changes.

Widening partnerships, building skills

A series of meetings with national policy makers in June 2010 helped to review progress and plan new research projects. Government decision makers – including Uzbekistan's Deputy Prime Minister and Turkmenistan's Minister of Agriculture – are eager to expand collaboration to include crop-livestock systems, salinity management, irrigation methods and other areas.

Other meetings brought together scientists, development experts and policy makers from different countries to evaluate progress and develop workplans and new research proposals. These included the Steering Committee Meeting of the CGIAR Program for CAC; and a consultation on a new regional initiative to be funded by the Russian government.

Training events included courses on wheat genetics and breeding in Uzbekistan, experimental design and analysis for young scientists from Azerbaijan, Georgia, Kazakhstan and Uzbekistan, and workshops on goat production and management for livestock producers in Tajikistan.

New projects

A number of new projects will be implemented beginning in 2011. They include economic and social impact assessments, and productivity enhancement in irrigated farming systems in Azerbaijan, Kazakhstan, Turkmenistan and Uzbekistan.

Arabian Peninsula Regional Program

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

Most countries in the Arabian Peninsula share the same challenges: acute scarcity of water and arable land, and heavy dependence on food imports. ICARDA uses a regional approach to address these challenges simultaneously in multiple countries.

New technologies for greenhouse production are being applied throughout the region – and also in Afghanistan and Pakistan. Studies on native forage species are helping to improve fodder supplies and conserve plant biodiversity in several countries. A project on date palm – the most important commercial crop in the region – has led to significant improvements in six countries, and spillover benefits for date producers in West Asia and elsewhere.

Technologies for arid environments

Integrated production and protection management (IPPM) techniques in protected agriculture in Yemen have increased growers' incomes by 15% and reduced pesticide use by 85%. In Oman, IPPM methods have reduced whitefly infestation by almost 90%.

In the United Arab Emirates (UAE), more than 300 greenhouses – compared to only eight in 2008 – are using simplified hydroponics techniques developed by the Program. In Oman, farmers using hydroponics increased cucumber yields by 10% and water productivity by 200% compared to conventional soil-based systems.

Other studies are helping to cut the costs of hydroponic systems, with no loss of performance. Using alternative construction materials, establishment cost has been reduced by 30%. Other low-cost alternatives are being tested, such as the use of coconut husks as a growth medium.

Adoption of buffel grass (*Cenchrus ciliaris*) for forage production continued to increase in UAE, with 30% more farmers than in 2009.

Date palm research

A research project on date palm, funded by the six countries of the Gulf Cooperation Council, continues to deliver innovations to improve yields and fruit quality. 'Liquid pollination' techniques were successfully tested in Bahrain and Oman. They are as effective as other techniques, but easier, faster and cheaper.

Farmers in UAE are now using low-cost processing methods introduced by the project, such as sun-drying in glasshouses to prevent post-harvest damage. Large-scale surveys have identified more than 300 insect pests that attack date palm – as well as 17 natural predators that could help control the most important pests. Studies in Saudi Arabia and UAE have identified botanical pesticides that are effective and environment-friendly.

Partnerships and training

In collaboration with the World Vegetable Center (AVRDC), we're testing vegetable varieties in Bahrain, Qatar and Saudi Arabia. Screening trials have given promising results.

The Regional Program's annual review and planning meetings were held in Kuwait, hosted by AFESD and organized jointly with Kuwait's Public Authority for Agricultural Affairs and Fish Resources.

More than 180 researchers, farmers and extension staff participated in four training courses held in Kuwait, Qatar, Saudi Arabia and Syria, and two field days (on buffel grass, in Oman, and hydroponics and IPPM, in UAE).

Training programs on hydroponics, for growers and extension agents: high-quality produce, efficient use of water, and minimal agrochemicals.

South Asia and China Regional Program

Activities in Bangladesh, China, India and Nepal

The countries targeted by this Regional Program are extremely diverse. The common thread is the critical importance of rainfed agriculture to national food security, and the need to accelerate technology dissemination to smallholder farmers in dry areas.

ICARDA aims to build on synergies with two of the world's largest agricultural research programs – China and India – to generate benefits across the region, and to share globally, the lessons learnt from the remarkable growth in agriculture in these two countries.

2010 highlights

A collaborative program in India is helping to promote cactus cultivation. Fifty genotypes of spineless cactus, assembled from genebank collections, are being tested at the Central Arid Zone Research Institute in Rajasthan.

The Regional Program is helping to address nutritional deficiencies that are common in South Asian diets. Improved iron- and zinc-rich varieties of lentil have been identified in Bangladesh, Nepal and India. In Bangladesh, varieties Barimasur-4, 5 and 6 contain more than 80 parts per million of iron and 55 parts per million of zinc, and give yields 90% higher than the national average. These varieties are grown on 110,000 ha.

Three new projects on legume crops were launched in India, funded by the Department of Agriculture and Cooperation: broadening the genetic base of chickpea and lentil, enhancing lentil production for food and nutritional security, and enhancing grasspea production to provide food and fodder.

In China, faba bean variety Yandou 147, developed from ICARDA material, covers almost one-third of faba bean area in Yunnan province – one of the world's largest faba bean production zones. And three-fourths of the barley area in Yunnan is sown to varieties originating from ICARDA material. They include Yundamai No. 2, which yielded 10.8 tons per hectare during the 2010 season – the highest ever recorded in China.

Biofortification, the next research frontier. New varieties rich in protein, iron and zinc are helping to improve child nutrition in South Asia.

Technology dissemination

ICARDA was involved in a number of meetings, seminars and training programs in India, organized by the National Food Security Mission, to help farmers increase yields of legume crops. Similar efforts were made in Nepal and Bangladesh through travelling workshops and field days. In Nepal, two field days on legume production technologies were organized at Rampore and Nepalgunj, with 220 farmers participating. In Bangladesh, 350 farmers attended two field days that showcased improved legume varieties.

Partnerships expand

The research portfolio was scaled up in 2010, following a visit to ICARDA headquarters in May by scientists and heads of research centers from India and Bangladesh. Proposals are being developed on water management, management of rust diseases, crop improvement (wheat, barley, lentil, chickpea, grasspea) and training.

The President of India visited ICARDA in November 2010, offering strong support for collaborative research programs with Indian institutions (see page 4). Discussions with national decision makers during and following the President's visit helped outline plans for new projects, which will be funded by the Indian government and implemented jointly by national research centers and ICARDA.

Several new initiatives are now at an advanced stage of discussion. They include production technologies for cultivation of grain legume crops in post-rice fallows, introduction of legumes to diversify cereal-based production systems, and improved varieties of fodder legumes to assist small-scale livestock producers.

Highlands Regional Network

Network activities cover highland ecologies in Afghanistan, Iran, Pakistan and Turkey

AFGHANISTAN

Working with communities
A multi-institution, farmer-participatory research program is helping to develop improved varieties of wheat, chickpea, lentil, mungbean (with AVRDC), potato (with CIP) and rice (with IRRI). Improved production practices have been introduced for chickpea. A high-yielding wheat variety has been identified, resistant to stem rust (race Ug99) as well as stripe rust.

A new project, funded by IFAD and the Afghan Ministry of Agriculture, distributed dairy goats to 1000 families, and trained 1740 women in husbandry, animal nutrition, and milk processing. This builds on an earlier 3-year project (see page 16).

New initiatives
A new 3-year program was launched in June, funded by the Netherlands government. ICARDA will work with government agencies, international research centers and NGOs to scale out technologies developed and tested by earlier projects. The project will scale out new crop varieties in five provinces; upgrade facilities at two research centers, and support farmer associations to produce seed and high-value plant medicinal products.

In December 2010, the government of Afghanistan launched a new initiative on rainfed agriculture, at the country's first International Workshop on Dryland Farming (co-organized by ICARDA). H.E. Asif Rahimi, Minister of Agriculture, Irrigation and Livestock, described it as "a permanent and dramatic change in Afghan agricultural policy." Plans include research and promotion of new technologies, establishment of two dryland research stations – the first in the country – and new arrangements to enable farmers to lease government land.

Building capacity
Five Afghan researchers attended training programs in Australia, India and Kenya on crop breeding and rust surveillance. Eighteen researchers and policy makers received training at ICARDA headquarters. Ten field days on food and forage legume production were held in four provinces. More than 450 farmers participated.

New wheat varieties in Afghanistan. Use of a 'fast-track' approach has helped test and disseminate more than 20 crop varieties in the past few years.

IRAN

New crop varieties
ICARDA provided more than 5000 lines of improved genetic materials to Iranian research centers in 2010, for use in breeding programs. Saji, a durum wheat cultivar developed from ICARDA germplasm, was released in 2010 by the Dryland Agricultural Research Institute (DARI). Thirteen high-yielding lines of wheat, barley, chickpea, lentil and forages from ICARDA-derived materials are candidates for release in 2011-2012.

Knowledge sharing, capacity development
Twenty Iranian researchers visited ICARDA research stations to share experiences on crop improvement, soil and water management and agricultural biotechnology. Five researchers attended training courses at ICARDA. Three Iranian PhD students worked at ICARDA during their thesis research. ICARDA also supported training courses at research centers in Iran, with external experts as resource persons.

More than 120 participants from 12 national research centers attended the 18th Iran–ICARDA Annual Coordination Meeting in September 2010. Twenty researchers from Iran, Turkey, and ICARDA took part in a regional barley travelling workshop organized jointly with DARI and the Seed and Plant Improvement Institute (SPII).

New projects
New projects are being developed on integrated land and water management in collaboration with ten Iranian research institutes, and on various crops in collaboration with DARI, SPII, and the Agricultural Biotechnology Research Institute. These projects will come on-stream beginning in 2011.

Cereal-legume systems are helping to diversity farming systems and increase farm income in highland areas in Iran.

PAKISTAN

Watershed management, crop improvement
Field trials showed that erosion-control techniques developed by the Pakistan program reduced soil erosion and improved moisture conservation. Integrated water and crop management practices – improved varieties, seed rate, time of sowing and fertilizer application – were tested on farmers' fields, and significantly improved crop yields and water productivity.

Improved wheat production practices were trialed, including relay cropping wheat with cotton, planting on ridges instead of on the flat, and zero tillage. In the relay-cropping experiments, wheat was planted after the cotton harvest, and earlier than traditional practice, leading to better stands and crop vigor. Ridge planting significantly improved water use, compared with planting on the flat.

Screening for resistance to stem rust (race Ug99) continued. Two sets of rust-resistant lines were assembled at ICARDA headquarters and sent to Pakistan: one for irrigated, favorable areas, and the other for low-rainfall areas. Three other yield trials consisted of lines selected for productivity, yield stability and resistance to the prevailing diseases in their targeted areas.

Building capacity
Two students completed their MSc research on watershed management in 2010. Twenty-five scientists received training in writing technical reports.

Narrowing the yield gap
There is a large gap between the yields achieved on research stations and those achieved in farmers' fields. ICARDA is working with national agencies to disseminate improved crop management practices and identify policies needed to narrow this gap.

TURKEY

Wheat improvement
The International Winter Wheat Improvement Program (IWWIP), implemented jointly by Turkey, ICARDA and CIMMYT, has developed and distributed more than 40 improved varieties to farmers in 12 countries. In 2010, a high-yielding, disease-resistant cultivar, Zare, was released in Iran. IWWIP varieties are now grown on 1.7 million hectares.

Capacity development
Iran and IWWIP signed a new workplan in 2010. This provides basic guidelines for shuttle-breeding activities in Iran, as well as scientific exchanges and training. IWWIP activities in Uzbekistan were also strengthened.

Training courses in 2010 included a four-month program on winter wheat breeding, pathology and agronomy for three young scientists from Kyrgyzstan, Tajikistan and Uzbekistan; a one-month program on wheat breeding for three mid-career scientists from Iran; and a four-month intensive English course for 75 young researchers from Turkey.

Renewing partnerships
Two Memoranda of Understanding (MoUs) were revised in 2010, and will be signed in 2011. The agreement with the South Eastern Anatolia Regional Administration (GAP) covers a number of areas including integrated crop-livestock research. The agreement with the Ministry of Agriculture and Rural Affairs includes new collaboration on drought, with research in Turkey and at ICARDA headquarters, and research to improve the productivity of Awassi sheep, which are the dominant breed in many countries in the Middle East.

Low-cost earth and stone structures are helping to prevent erosion and conserve moisture in Pakistan's Balochistan province.

CAPACITY DEVELOPMENT

Capacity development is at the heart of ICARDA's mandate. We offer a range of opportunities: specialized training courses, internships, sponsorships for graduate students, on-the-job training, farmer field schools, and participation in field projects. The target groups are equally varied: researchers, graduate students, extension agents, farming communities, women's cooperatives, owners of small-scale agribusinesses...

During the year, 727 researchers from 43 countries benefited from training courses and internships. Another 62 scientists and 24 interns are progressing towards Masters or PhD degrees, co-supervised by ICARDA and their parent university. Training courses coverd crop improvement, livestock, natural resources management, socio-economics, biotechnology, simulation modeling, statistics, GIS and other areas.

This breadth of scope and geographic coverage is possible only because activities are implemented jointly with a network of partners worldwide. For graduate student training, for example, we work with universities in 21 countries – Austria, Azerbaijan, Canada, Denmark, Ethiopia, France, Germany, Iran, Italy, Japan, Jordan, Lebanon, the Netherlands, Sudan, Sweden, Switzerland, Syria, UAE, UK, USA and Uzbekistan.

Global knowledge, applied locally

ICARDA's regional programs play a key role in building national capacity. For example, scientists from Egypt, Iraq, Syria and Yemen participated in an ICARDA-FAO training program on rust surveillance; and are now part of a regional network to monitor the spread of new rust pathogens across West Asia and North Africa.

In Central Asia, training on digital vegetation charting techniques (introduced by ICARDA in partnership with Oregon State University) is helping national researchers conduct the first large-scale assessment of rangeland conditions in the region.

In Afghanistan, more than 2500 farmers, researchers and extension staff participated in training programs during 2010. Women's cooperatives are now producing high-value products (e.g. mint oil, herbal remedies, cheese, yogurt) for sale in urban markets.

In Libya, 350 researchers have acquired new skills in water management, crop improvement, livestock breeding, land use mapping and other areas; and equipment has been upgraded at the country's main research stations.

In Ethiopia, 53 researchers and many more farmers are part of new initiatives launched in 2010. 'Farmer research groups' are helping to scale out new crop varieties and water and soil conservation measures.

In the Arabian Peninsula, more than 180 farmers, researchers and extension agents attended training programs on rangeland management, protected agriculture, forage production and other areas. These technologies are helping to increase food production in areas with extreme water scarcity.

An Australian-funded program is helping to upgrade research skills, improve extension effectiveness and promote conservation agriculture practices across the region. Nine training courses were conducted at ICARDA headquarters in 2010, and attended by 85 scientists, technicians and farmers from Iraq, Libya and Syria. The courses covered zero-tillage practices as well other subjects, including genetic resources, variety maintenance, extension methods, statistics, GIS analysis, and seed enterprise management.

Tel Hadya, Syria: researchers from different countries learn how to identify and manage insects pests of wheat.

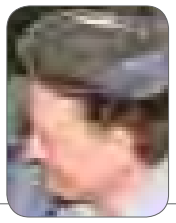
HONORS AND AWARDS

Dr Sanjaya Rajaram, former Director of ICARDA's Biodiversity and Integrated Gene Management Program, won the M.S. Swaminathan Award for Leadership in Agriculture. The award was presented by Dr Abdul Kalam, former President of India.

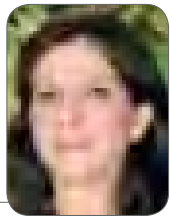
Dr John Ryan, Consultant Soil Scientist, was named Fellow of the American Association for the Advancement of Science (AAAS). The American Society of Agronomy selected Dr Ryan as a Mentor in their Golden Opportunity Scholars Program; and as a Member of the Rapid Action Task Force. He was also named as a Committee Member of the Agricultural Science Foundation.

Dr Ahmed Amri, Head, Genetic Resources Section, was selected as a Member of the Panel of Experts of the International Treaty on Plant Genetic Resources for Food and Agriculture. The UN-mandated panel helps oversee global efforts on biodiversity conservation.

Two ICARDA staff in Afghanistan – Dr Javed Rizvi, Country Manager, and Mr Abdul Rahman Manan, Senior Agriculture Advisor – were nominated by the Ministry of Agriculture, Irrigation and Livestock as permanent members of two national bodies: the Task Force on Agricultural Knowledge and Information Systems, and the Wheat Committee.



Dr Siham Asaad, Head, Seed Health Unit, was re-elected as Member of the International Seed Testing Association's Seed Health Committee, which provides technical guidelines to 80 countries. She was also nominated by the Syrian Minister of Agriculture as a member of National Technical Committee to amend Syria's quarantine lists.



Dr Flavio Capettini, Barley Breeder, was named Adjunct Professor in the Department of Plant Sciences at North Dakota State University, USA. He will co-supervise research in Syria and Ethiopia by graduate students, in addition to working on collaborative research projects.

Dr Mounir Louhaichi, Range Ecology and Management Scientist, was appointed a courtesy faculty member at Oregon State University, USA. This will involve collaborative research on rangeland management and vegetation monitoring, and co-supervision of graduate students.

APPENDICES

Appendix 1:

Varieties released in 2010, developed from ICARDA materials

Crop	Country	Name	Characteristics
Barley	Ethiopia	Diribe	Adapted to dry areas, resistant to scald and net blotch
	Iran	Bahman	High yield, tolerant to lodging, shattering and terminal drought, moderately resistant to leaf blights. Well adapted to cold areas
	Iran	Fajr 30	High yield, tolerant to cold and drought, resistant to lodging and shattering
	Iran	Yousef	High yield, early maturing, terminal drought tolerance, tolerant to leaf stripe
	Pakistan	Rakhshan-10	Adapted to rainfed areas of Balochistan
	Tajikistan	Pulodi	Early heading, tall plant, thick bush, resistant to diseases, resistant to lodging
Winter wheat	Azerbaijan	Tale 38	High yield, early maturing, large kernels, moderately resistant to yellow rust
	Iran	Zare	High yield, resistant to yellow rust
	Azerbaijan	Tale 38	High yield under irrigation, resistant to fungal diseases, high protein productivity
Spring bread wheat	Egypt	Sid 13	High yield, resistant to yellow rust
	Egypt	EGSeed-7	High yield, resistant to yellow rust
	Ethiopia	Hoggana (Flag 5)	High yield, resistant to yellow rust, stem rust (including race Ug99) and Septoria leaf blotch
	Ethiopia	Shorima (ETBW 5483)	High yield, resistant to yellow rust, stem rust (including race Ug99) and Septoria
	Ethiopia	ETBW 5496	High yield, resistant to yellow rust, stem rust (including race Ug99) and Septoria. Provisionally released
	Syria	Babaga-3	High yield, resistant to yellow rust
Durum wheat	Algeria	Beni Mestina (Icalger)	Cold tolerant, high yield in favorable environments. Tolerant to stripe rust and Septoria. Good milling and processing qualities
	Algeria	Ammar 1	Adapted to dry highland areas. Responds well to supplemental irrigation. Good grain quality, high carotene content
	Algeria	Ammar 6	Adapted to dry inland areas. Responds well to supplemental irrigation. Excellent resistance to yellow, brown and black rusts High carotenoid content and gluten strength, hence ideal for pasta and burghul production
	Turkey	Gundus (Ammar 6)	As above
	Iran	Saji (Syrian 4)	Drought tolerant; high yield with supplemental irrigation. Resistant to yellow, brown and black rust
	Syria	Cham 9 (Miki 3)	Tolerant to drought, cold and heat. High yield potential, resistant to rusts and Septoria. Excellent quality for semolina and pasta
	Syria	Douma 3 (ACSAD 1229)	Adapted to dry areas. Good grain quality and disease resistance, particularly to yellow rust
Lentil	India	VL 514	Large seeds, high yield, rust resistant
Chickpea	Morocco	Arifi	High yield, large seeds, plant height and architecture suitable for mechanical harvesting
Vicia	Iran	Maragheh	Cold tolerant forage variety (*Vicia dasycarpa*), widely adapted, high yield and yield stability

Appendix 2:

Publications

ICARDA's core business is science; and the quality of this science is reflected in the research publications we produce. During 2010, ICARDA scientists authored or co-authored over 400 publications, including 143 papers published in refereed journals, six book chapters, field guides, training manuals, and a range of other material for researchers, scientists, policy makers, development agents and others. They also presented nearly 200 papers, posters and abstracts at science conferences. Some of these publications are listed below. For a full list see http://icarda.catalog.cgiar.org/textbase/search.htm

Papers in refereed journals

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Appendix 3:

Donors and Investors in 2010

Unrestricted funding
Australia
Belgium
Canada
France
Germany
Iran
Italy
Japan
Norway
Sweden
Switzerland
Syria
Netherlands
United Kingdom
World Bank

Restricted Funding/Grants
AFESD
Asian Development Bank
ACIAR
ADA
Agricultural Research Center, Egypt
Agricultural Research Corporation, Libya
Authority of Merowi Dam Area for Agric. Development, Sudan
BMZ, Germany
CGIAR Gender and Diversity Program
CGIAR Systemwide Genetic Resources Programme
CGIAR Systemwide Livestock Programme
CGIAR Systemwide Program on PRGA
China
Coca Cola Foundation
Cornell University
Development Alternatives Inc
European Commission
FAO
Global Crop Diversity Trust
Grains Research and Development Corporation, Austraila
Gulf Cooperation Council
India
IDRC, Canada
IFAD
Iran
Islamic Development Bank
Italy
Japan International Cooperation Agency
Morocco
Murdoch University (through ACIAR), Australia
Netherlands
Oman
OPEC Fund for International Development
Pakistan
Qatar
Regional Fund for Agricultural Technology (FONTAGRO)
Tottori University
Turkey
UNDP
UN University, Institute for Water, Environment & Health
World Food Programme
USAID
US Department of Agriculture
World Bank
World Vegetable Research Center (AVRDC)
ZEF, University of Bonn

Appendix 4:

Audited Financial Statements

Statement of Activity (US$x000)

	2010	2009
REVENUES		
Grants (Core and Restricted)	38,194	31,874
Other revenues and gains	676	1,249
Total revenues and gains	38,870	33,123
EXPENSES AND LOSSES		
Program related expenses	34,300	28,466
Management and general expenses	6,079	5,992
Other losses and expenses	97	39
Total expenses and losses	40,476	34,497
Indirect costs recovery	(2,639)	(1,924)
Net expenses and losses	37,837	32,573
SURPLUS (DEFICIT)	**1,033**	**550**

Statement of Financial Position (US$x000)

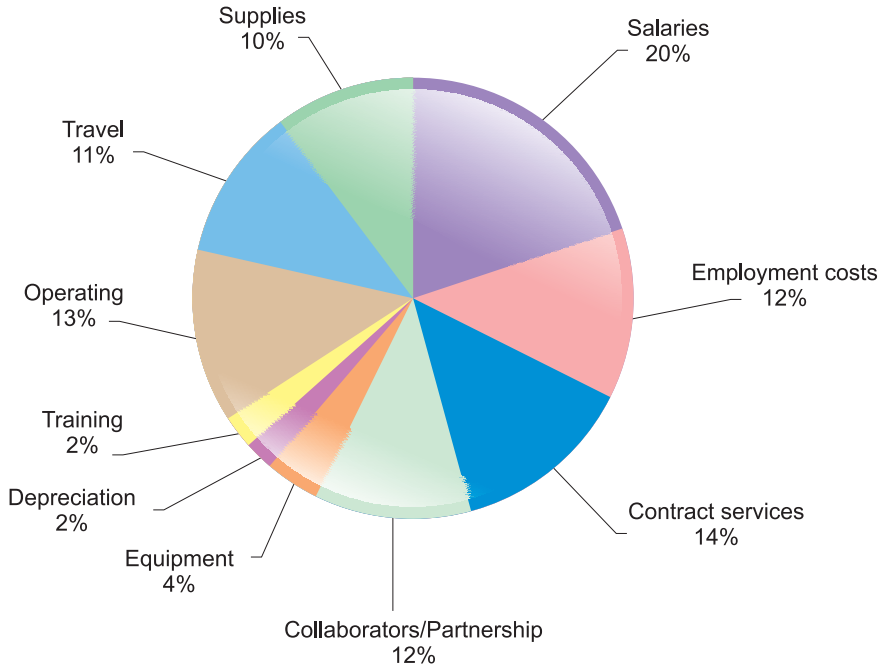
	2010	2009
ASSETS		
Current assets	43,795	41,401
Property & equipment	4,047	3,677
Other assets	-	-
Total assets	47,842	45,078
LIABILITIES AND ASSETS		
Current liabilities	25,590	24,136
Long term liabilities	7,176	6,899
Total liabilties	32,766	31,035
Net assets = reserves	15,076	14,043
Total liabilities and net assets	47,842	45,078

Statement of Grant Revenues, 2010 (US$x000)

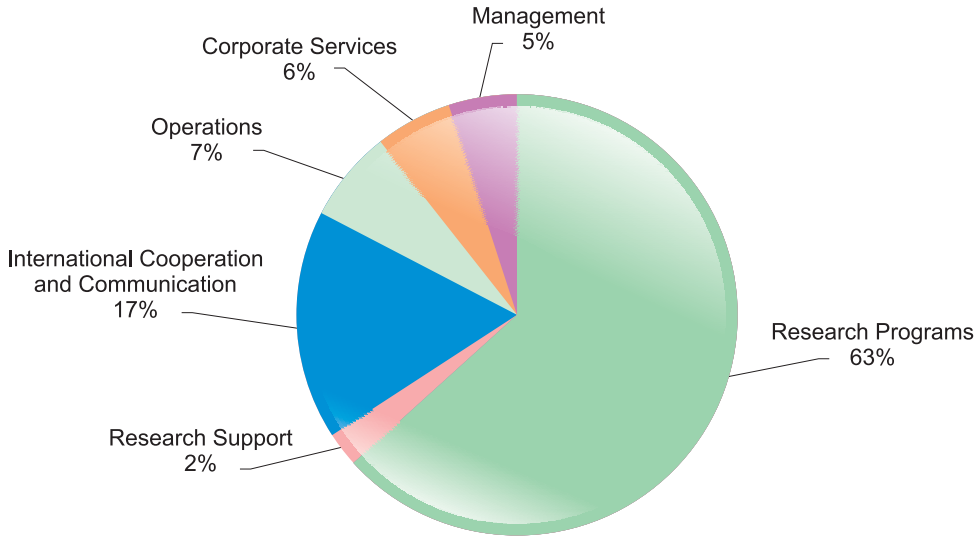
DONOR	Amount
Arab Fund	2,426
Asian Development Bank	443
Australia*	2,986
Austria	402
Belgium*	623
Canada*	1,016
CGIAR	700
Challenge Programs	672
Cornell University, USA	954
European Commission	1,044
FAO	392
France*	221
Germany*	1,116
Global Crop Diversity Trust	365
Gulf Cooperation Council	399
IDRC	481
IFAD	1,607
India	351
Iran*	281
Islamic Development Bank	274
Italy*	364
Japan*	488
Libya	6,318
Morocco	260
Netherlands*	2,096
Norway*	1,060
Sweden*	620
Switzerland*	397
Syria*	500
OPEC Fund	293
United Kingdom*	1,703
United States of America	2,710
World Bank*	2,050
Miscellaneous	2,582
TOTAL	**38,194**

* Donors that provided core funds

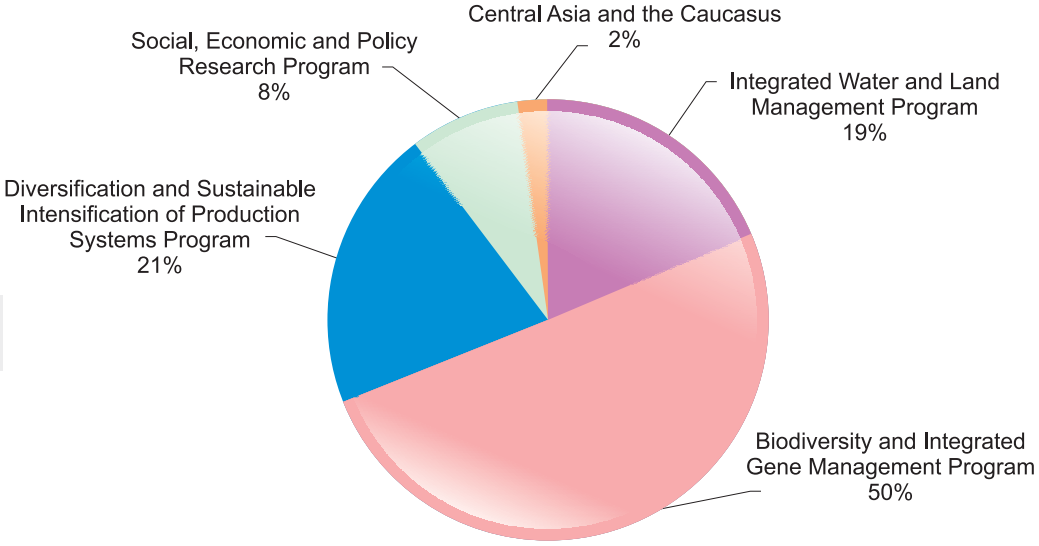
Expenditures by Category



Expenditures by Program and Activities



Expenditures by Research Program



Appendix 5:

Board of Trustees

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

Dr Abdelmajid Slama (Tunisia)**
Board Vice-Chair
Former Director, NENA Division, International Fund for Agricultural Development
Expertise: agronomy and agricultural economics

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

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

Prof. 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 Susan G Schram (USA)*
Vice President, Outreach and Cooperative Programs, ACDI/VOCA (Agricultural Cooperative Development International/Volunteers in Overseas Cooperative Assistance), 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 B 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, Ministry of Agriculture and Agrarian Reform, Syria
Expertise: agriculture, plant breeding

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

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

* joined during 2010
** completed term during 2010

Appendix 6:

Collaboration with Advanced Research Institutes and Regional/International Organizations

CGIAR Centers and Regional/International Organizations
- Arab Authority for Agricultural Investment and Development
- Arab Center for Studies of Arid Zones and Dry Lands
- Arab Organization for Agricultural Development
- Asia Pacific Association of Agricultural Research Institutes
- Association of Agricultural Research Institutes in the Near East and North Africa
- Bioversity International
- Borlaug Global Rust Initiative
- Central Asia and the Caucasus Association of Agricultural Research Institutes
- CGIAR Challenge Program on Water and Food
- CGIAR Knowledge Sharing Project
- CGIAR System-wide Livestock Program
- Economic Cooperation Organization
- European Cooperation in the field of Scientific and Technical Research (COST)
- Food and Agriculture Organization of the United Nations
- Global Forum on Agricultural Research
- International Atomic Energy Agency
- International Center for Biosaline Agriculture
- International Center for Tropical Agriculture (CIAT)
- International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM)
- International Crops Research Institute for the Semi-Arid Tropics
- International Development Research Center, Canada
- International Food Policy Research Institute
- International Livestock Research Institute
- International Maize and Wheat Improvement Center (CIMMYT)
- International Potato Center (CIP)
- International Rice Research Institute
- International Seed Testing Association
- International Water Management Institute
- Man and the Biosphere Programme, UNESCO
- Observatoire du Sahara et du Sahel and Oasis
- TerrAfrica partnership
- United Nations University
- World Vegetable Center (AVRDC)

Argentina
- Instituto Nacional de Tecnología Agropecuaria

Australia
- Australian Winter Cereals Collection
- Centre for Legumes in Mediterranean Agriculture
- Commonwealth Scientific and Industrial Research Organisation
- Cooperative Research Centre for Molecular Plant Breeding
- Dept. of Agriculture and Food, Western Australia
- Dept. of Primary Industries, Victoria
- Grain Foods Cooperative Research Centre
- Grains Research and Development Corporation
- Murdoch University
- New South Wales Dept. of Primary Industry
- Pulse Breeding - Australia
- Queensland Dept. of Primary Industries and Fisheries
- South Australia Dept. of Agriculture
- South Australian Research and Development Institute
- Southern Cross University
- University of Adelaide, Waite Institute
- University of Queensland
- University of South Australia
- University of Sydney, Plant Breeding Institute
- University of Western Australia
- Australian Agency for International Development

Austria
- Landwirtschaftlich-chemische Bundesversuchsanstalt
- University of Natural Resources and Applied Life Sciences(BOKU)

Belgium
- University of Ghent
- University of Leuven

Canada
- Agriculture and Agri-Food Canada
- Agriculture Canada, Field Crop Development Centre
- CGIAR-Canada Linkage Funds
- University of Saskatchewan

Chile
- Institute of Agricultural Research (INIA)

China
- Chinese Academy of Agricultural Sciences

Denmark
- Danish Institute of Agricultural Sciences
- Ris National Laboratory, Plant Biology and Biogeochemistry Department
- Royal Veterinary and Agricultural University
- University of Copenhagen
- Danish Agricultural Advisory Service

France
- Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD)
- Centre National de la Recherche Scientifique (CNRS)
- Institut de Recherche pour le Développement (IRD)
- Institut National de la Recherche Agronomique (INRA)
- Université de Paris-Sud

Germany
- BASF Corporation
- Biologische Bundesanstalt für Landund Forstwirtschaft
- Bundesministerium für Wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)
- Deutsche Gesellschaft fur
- Technische Zusammenarbeit (Deutsche Gesellschaft für Internationale Zusammenarbeit)
- Deutsche Sammlung von Mikroorganismen und Zellkulturen
- Humboldt University of Berlin
- IPK-Gatersleben
- Leibniz Institute of Plant Genetics and Crop Plant Research
- University of Aachen
- University of Bonn
- University of Frankfurt am Main
- University of Giessen
- University of Goettingen
- University of Hannover
- University of Hohenhei
- University of Kiel

Italy
- Consorzio Ricerca Filiera Lattiero-Casearia, Regione Siciliana
- EC Joint Research Centre
- Germplasm Institute, Bari
- Istituto Sperimentale per la Cerealicoltura, Sezione di Fiorenzuola d'Arda
- Italian Research Agency for New Technologies, Energy and the Environment (ENEA)
- National Institute of Geophysics and Volcanology
- Institute for Agricultural and Forest Mediterranean Systems
- Udine University
- University of Bologna
- University of Tuscia, Viterbo

India
- Indian Council of Agricultural Research

Japan
- Japan International Research Center for Agricultural Sciences
- Research Institute for Humanity and Nature
- Tottori University
- Yokohama City University
- Japan International Cooperation Agency

Netherlands
- Alterra
- Vrije Universiteit, Amsterdam
- Wageningen University and Research Centre

Russia
- N.I. Vavilov Research Institute for Plant Industry

Spain
- Consejo Superior de Investigaciones Científicas
- Instituto de Agricultura Sostenible (IAS-CSIC)
- Instituto de Investigación y Formación Agraria y Pesquera
- Spanish National Research Council (CSIC)
- University of Barcelona
- University of Córdoba
- University of Lleida and Institut de Recerca i Tecnologia Agroalimentaries (UdL-IRTA)
- University of the Basque Country

Sweden
- Nordic Genetic Resource Center
- Swedish University of Agricultural Sciences

Switzerland
- North-South Forum (formerly Swiss Centre for International Agriculture)
- Station Fédérale de Recherches Agronomiques de Changins (RAC)
- Swiss Federal Institute of Technology
- University of Bern
- University of Zurich

United Kingdom
- Birmingham University
- British Society of Animal Science
- CABI Bioscience
- Centre for Arid Zone Studies, University of Wales
- Centre for Ecology & Hydrology, Wallingford
- Macaulay Land Use Research Institute
- Macaulay Research Consultancy Services Ltd
- National Institute of Agricultural Botany
- Natural Environment Research Council
- Natural Resources Institute
- Rothamsted Research Centre
- Scottish Crop Research Institute
- Department for International Development

United States of America
- Borlaug Institute, Texas A&M University
- Brigham Young University, Utah
- Busch Agricultural Resources Inc.
- Cornell University
- Kansas State University
- Michigan State University
- New Mexico State University
- North Dakota State University
- Oregon State University
- Purdue University
- Stephen Austin State University
- University of Arizona
- University of California, Davis
- University of California, Riverside
- University of Delaware
- University of Florida, Gainesville
- University of Hawaii
- University of Illinois at Urbana-Champaign
- University of St. Paul, Minnesota
- University of Vermont
- University of Wisconsin
- Utah State University
- Virginia Polytechnic Institute and State University
- Washington State University
- Yale University
- Michigan State University

Appendix 7:

Senior Staff (as of 31 December 2010)

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Director General's Office
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Mr Ali Abu Hanish, Internal Auditor
Dr Elizabeth Bailey, Executive Assistant to the Director General; Board Secretary
Ms Amira Diab, Executive Secretary
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Mr Bashir Al-Khouri, Consultant Legal Advisor, Beirut
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Dr Kamel Shideed, Assistant Director General - International Cooperation and Communication
Dr Maarten van Ginkel, Deputy Director General - Research
Mrs Ourouba Zein el-Deen, Executive Secretary

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Ms Lama Aswad, Physical Plant Officer
Mrs Shirley Ann Davis-Phillips, Head, International School of Aleppo*
Ms Hiba Eimesh, Coordinator, Visitors Services
Mr Abdul Wahab Kabbani, Foreman Fabrication Workshop
Ms Mary Malki, Administrator - Reward Management
Ms Diana Moudares, Administrator - Resourcing
Ms Dalida Nalbandian, Purchasing and Supplies Manager
Mr Waheed S. Quader, Head, Physical Plant Unit
Ms Raghad Rahwan, Executive Secretary
Mr Nellooli P. Rajasekharan, Director, Human Resources
Mr Antoine Shomar, Assistant Farm Manager
Mrs Mary Street, Executive Secretary
Dr Ammar Talas, Medical Consultant
Mr Robert Thompson, Head, International School of Aleppo**
Ms Lina Yazbek, Administrator, HR Services

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Ms Nahla Assal, Accounts Associate
Mr Bruce Martin Fraser, Director of Finance**
Ms Anne Wambui Kabuthu, Finance Officer
Mr Mohamed Samman, Treasury Supervisor
Mrs Imelda Silang, Accounting Manager

Government Liaison
Dr Majd Jamal, Assistant Director General - Government Liaison
Mr Mohamad Nabil Traboulsi, Assistant National Research Coordinator

Project Development & Grant Management Unit
Mr Tareq Bremer, Grants Management Officer*
Ms Ilona Kononenko, Grants Management Officer**

Station Operations
Mr Colin Norwood, Farm Manager**
Mr Bahij El-Kawas, Senior Supervisor, Horticulture

Damascus Office, Syria
Ms Hana Sharif, Head

Beirut Office & Terbol Research Station, Lebanon
Dr Hassan Machlab, Lebanon Country Manager

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Biodiversity and Integrated Gene Management
Dr Michael Baum, Director
Dr Ahmed Amri, Head of Genetic Resources Section and Deputy Director
Dr Osman Abdalla El Nour, Bread Wheat Breeder
Dr Shiv Kumar Agrawal, Lentil Breeder
Ms Fida Alo, Research Associate
Mr Munzer Alnaimi, Research Associate
Ms Suhaila Arslan, Assistant Manager, International Nurseries
Dr Siham Asaad, Head, Seed Health Laboratory
Dr Abdullah Bari, Genetic Resources Scientist*
Dr Zewdie Bishaw, Head, Seed Section
Dr Mustapha El-Bouhssini, Entomologist
Dr Flavio Capettini, Barley Breeder
Dr Monika Garg, Research Associate
Dr Stefania Grando, Barley Breeder
Mr Samir Hajjar, Training Coordinator
Dr Aladdin Hamwieh, Associate Scientist Chickpea Breeding
Mr Fouad Jabi El-Haramein, Research Associate
Mr Hasan Al-Hasan, Research Associate
Mr Bilal Humeid, Research Associate, Genetic Resources
Dr Muhammad Imtiaz, Chickpea Breeder
Dr Masanori Inagaki, JIRCAS Scientific Representative
Mr Ali Abdullah Ismail, Research Associate
Mr Tawffiq Istanbuli, Research Associate
Mr Abdullah Joubi, Research Associate**
Mr Haitham Kayyali, Research Associate
Dr Seid-Ahmed Kemal, Pulse Pathologist
Mr Gaby Khalaf, Research Associate
Mr Jan Konopka, Germplasm Documentation Officer
Mr Adonis Kourieh, Research Associate
Dr Safaa Kumari, Plant Virologist
Mr Samer Lababidi, Geneticist
Dr Fouad Maalouf, Faba Bean Breeder
Mr Michael Michael, Research Associate
Mr Samer Murad, Research Associate
Dr Miloudi Nachit, Durum Wheat Breeder
Mr Hani Nakkoul, Research Associate
Ms Rita Nalbandian, Secretary - Executive
Dr Kumarse Nazari, Cereal Pathologist
Mr Abdul Aziz Niane, Seed Scientist
Dr Francis Ogbonnaya, Senior Biotechnologist
Mr Henry Pachayani, Research Associate
Mr Ali Shehadeh, Research Associate
Dr Ken Street, Legume Germplasm Curator and FIGS Specialist
Dr Wuletaw Tadesse Degu, Wheat Breeder*
Dr Izzat Sidahmed Ali Tahir, Wheat Breeder*
Dr Sripada M. Udupa, Senior Scientist, Biotechnology
Dr Amor Yahyaoui, Coordinator, ICARDA-CIMMYT Wheat Improvement Program
Mr Ala'a Yaljarouka, Research Assistant
Dr Adnan Al-Yassin, Barley Breeder*

Diversification and Sustainable Intensification of Production Systems
Dr Rachid Serraj, Director*
Dr Hafid Achtak, Post Doctoral Visiting

Scientist-CIRAD*
Mr Fahim Ghassali, Research Associate
Dr Atef Haddad, Research Associate - Agronomy
Mr Haitham Halimeh, Research Associate**
Ms Sawsan Hassan, Associate Project Coordinator
Dr Muhi El-Dine Hilali, Research Associate
Mr Yaseen Khalil, Research Associate
Dr Asamoah Larbi, Pasture and Forage Production Specialist
Dr Mounir Louhaichi, Range Ecology and Management Research Scientist
Dr Colin Piggin, Project Leader, ACIAR/AusAID Iraq Project
Dr Barbara Ann Rischkowsky, Senior Livestock Scientist
Mr Mohamad Amin Khatib Salkini, Research Associate
Dr Ravi Gopal Singh, Cropping Systems Agronomist*
Dr Markos Tibbo Dambi, Small Ruminant Scientist**
Ms Monika Zaklouta, Research Associate

Integrated Water and Land Management
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Mr Pierre Hayek, Research Associate
Dr Fadi Karam, Irrigation and Water Management Specialist
Dr Mohammed Karrou, Water and Drought Management Specialist
Dr Zuhair Masri, NPO, Soil Conservation & Land Management**
Dr Manzoor Qadir, Project Manager-ACIAR Iraq Salinity Projects
Dr Rolf Sommer, Soil Fertility Specialist
Dr Ahmed Mohammed Al-Wadaey, PDF; Soil and Water Conservation
Dr Feras Ziadat, Soil Conservation/Land Management Specialist

Social, Economic and Policy Research
Dr Aden Aw-Hassan, Director
Dr Mohamed Abdelwahab Ahmed, Agricultural Policy Specialist**
Dr Ihtiyor Bobojonov, Agricultural and Policy Economist**
Dr Simeon Kaitibie, Applied Agricultural Economist**
Dr Malika Martini Abdelali, Community and Gender Analysis Specialist
Dr Ahmed Mazid, Agricultural Economist
Dr Farouk Shomo, Socio-economics Researcher
Dr Yigezu Yigezu, Post Doctoral Fellow*

Support Services

Capacity Development Unit
Dr Iman El-Kaffas, Head*
Ms Laurice Abdul Majid, Officer - Administrative Material & AV. Services
Mr Afif Dakermanji, Training Officer

Communication, Documentation, and Information Services
Ms Elizabeth Ann Clarke, Head**
Ms Siba Darouzi, Library & Information Services Manager
Mr Bernhard Hack, Visiting Scientist*
Mr Muhammad Manaf Hamam, Electronic Publishing Associate
Mr Majdi Kebbe, Translator
Dr Nihad Maliha, Library and Information Services Manager**
Mr Nicholas Martin Pasiecznik, Science Writer/Editor**
Mr Ajay Varadachary, Communication Specialist

Information Technology Unit
Mr Colin Webster, Acting Manager
Dr Zaid Abdul-Hadi, Head**
Mr Hashem Abed, Senior Coordinator, Software Development
Mr Mohy-el-din Ammouneh, MIS Database Administrator
Ms Malake Ballouz, MIS Applications Analyst
Ms Samira Maksoud, Executive Secretary
Dr Fadil Rida, MIS Applications Specialist
Mr Michael Sarkisian, Senior Systems Engineer

Geographic Information Systems Unit
Dr Eddy De Pauw, Head GIS Unit
Mr Wolfgang Goebel, Visiting Scientist
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Dr Abdul Wahid Jasra, Range Ecology and Management Specialist**

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Central Asia & Caucasus Regional Program

Tashkent, Uzbekistan
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Nile Valley & Sub-Saharan Africa Regional Program

Cairo, Egypt
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South Asia & China Regional Program

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Highland Regional Network

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Appendix 8:

Abbreviations

AAAS	American Association for the Advancement of Science
ACIAR	Australian Centre for International Agricultural Research
AFESD	Arab Fund for Economic and Social Development
ARC	Agricultural Research Center (Egypt), Agricultural Research Corporation (Libya)
AREEO	Agricultural Research, Education and Extension Organization (Iran)
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
AVRDC	Asian Vegetable Research and Development Center (Taiwan)
BMZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (Germany)
BOKU	University of Natural Resources and Life Sciences (Austria)
CAAS	Chinese Academy of Agricultural Sciences
CAC	Central Asia and Caucasus
CGIAR	Consultative Group on International Agricultural Research
CIMMYT	International Maize and Wheat Improvement Center (Mexico)
CIP	International Potato Center (Peru)
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement (France)
CpCSV	Chickpea chlorotic stunt virus
CWANA	Central and West Asia and North Africa
DARI	Dryland Agricultural Research Institute (Iran)
ENEA	National Board for New Technology, Energy and the Environment (Italy)
ETH	Swiss Federal Institute of Technology, Zurich
FAO	Food and Agriculture Organization of the United Nations
GAP	Southeast Anatolia Regional Administration (Turkey)
GCC	Gulf Cooperation Council
GCSAR	General Commission for Scientific Agricultural Research (Syria)
GIS	geographic information systems
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (Germany)
ICAR	Indian Council of Agricultural Research
ICARDA	International Center for Agricultural Research in the Dry Areas
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
ILRI	International Livestock Research Institute (Kenya, Ethiopia)
INRA	Institut National de la Recherche Agronomique (Algeria, Morocco)
IPCC	Intergovernmental Panel on Climate Change
IPM	integrated pest management
IPPM	integrated production and protection management
IRRI	International Rice Research Institute
IWWIP	International Winter Wheat Improvement Program
LARI	Lebanese Agricultural Research Institute
MARA	Ministry of Agriculture and Rural Affairs (Turkey)
MoU	memorandum of understanding
NARS	national agricultural research systems
NCARE	National Center for Agricultural Research and Extension (Jordan)
NGO	non-governmental organization
ODAP	oxalyl diaminopropionic acid
PCR	polymerase chain reaction
RIL	recombinant inbred line
SBL	synthetic backcross derived line
SI	supplemental irrigation
SPII	Seed and Plant Improvement Institute (Iran)
UAE	United Arab Emirates
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
VBSE	village-based seed enterprise
WANA	West Asia and North Africa
ZEF	Center for Development Research (Germany)

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About ICARDA and the CGIAR

Established in 1977, the International Center for Agricultural 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 and West Asia and North Africa (CWANA) region, ICARDA contributes to the improvement of bread and durum wheats, kabuli chickpea, pasture and forage legumes, and associated farming systems. It also works on improved land management, diversification of production systems, and value-added crop and livestock products. Social, economic and policy research is an integral component of ICARDA's research to better target poverty and to enhance the uptake and maximize impact of research outputs.

The Consultative Group on International Agricultural Research (CGIAR) is a strategic alliance of countries, international and regional organizations, and private foundations supporting 15 international agricultural Centers that work with national agricultural research systems and civil society organizations including the private sector. The alliance mobilizes agricultural science to reduce poverty, foster human well being, promote agricultural growth and protect the environment. The CGIAR generates global public goods that are available to all.

The World Bank, the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP), and the International Fund for Agricultural Development (IFAD) are cosponsors of the CGIAR. The World Bank provides the CGIAR with a System Office in Washington, DC. A Science Council, with its Secretariat at FAO in Rome, assists the System in the development of its research program.