

# ICARDA *Caravan*

Issue No. 16, June 2002



## *Review of agriculture in the dry areas*

***In this  
special issue to mark the  
International  
Year of Mountains:***

***Rebuilding Afghanistan's  
agriculture***

- *Future Harvest Consortium  
meets critical need for seed*

***Reclaiming ancient techniques***

- *Terrace rehabilitation in Yemen  
and Peru, and pitcher irrigation  
in Syria*

***Crops that fend for themselves***

- *Iranian cooperators help unlock  
the secrets of natural  
weed suppression*

***What gladiators ate for lunch***

- *Improving food barley through  
farmer participatory selection  
in the highlands*

***Why wait for spring***

- *Winter lentil for the  
highlands of Turkey*

***Goats, or scapegoats***

- *In search of the true cause of  
forest degradation in Peru*

***And more . . .***



# From the Director General

**T**he declaration of 2002 as the International Year of Mountains reaffirms the vision of ICARDA's founding fathers who, while developing the research mandate for the Center, had seen the importance of high-elevation areas in food production. In the West Asia and North Africa (WANA) region, which originally constituted the regional geographic mandate of ICARDA, highlands account for about 40% of the total agricultural land and contribute nearly 30% to the region's production. Highlands are found in Afghanistan, Algeria and Morocco (the Atlas mountain range), Ethiopia, Iraq, Iran, Pakistan, Turkey, and Yemen. The proportion of mountainous area in the region further increased when countries of Central Asia and the Caucasus recently joined the geographic mandate of the Center. Over 80 million people live in the highlands of Central and West Asia and North Africa (CWANA); the region is home to a rich genetic diversity; and is much more vulnerable than lowlands to natural resource degradation.

Since high-elevation areas are subject to harsh weather, are not easily accessible, and their soils are degraded, they have conventionally been marginalized in research and development programs. This is reflected in poor research infrastructure, shortage of food, and widespread poverty. However, in the ICARDA region, over 35% of the wheat produced comes from mountainous areas, as does a significant proportion of livestock. Food legumes, particularly chickpea and lentil, occupy an important place in the farming systems, and are an integral component in the diet of the mountain populations.

ICARDA has not only maintained its original research interest, but has strengthened its efforts in promoting agriculture in mountainous areas. The Center's Highland Regional Program, based in Turkey, undertakes collaborative research with national partners in Iran, Pakistan, Turkey, Afghanistan, Morocco and Algeria, and the countries in Central Asia and the Caucasus. In the highlands of Latin America, the Center's collaborative program

focuses on cereal (particularly barley) and food legume improvement, and natural resource management.

In Pakistan, a project on "Management of Agricultural Research and Technology" (MART) was conducted during 1985-1994 jointly by ICARDA and the Arid Zone Research Institute (AZRI), based in highland Balochistan. The MART Project strengthened the research capacity of AZRI through the acquisition of necessary infrastructure and the training of research staff. A dryland agriculture program was developed and implemented successfully, based on improved rangeland management, integration of crops and small-ruminant production, use of fodder shrubs as an additional feed resource, water harvesting for increased water-use efficiency, and identification and adoption of drought-tolerant cultivars of wheat, barley, lentil, and vetch.

Indeed, ICARDA's involvement in highland agriculture was put to best use when opportunity came to rebuild Afghanistan after long years of war and drought. The Center, during its early years, had collaborative projects in Afghanistan, which led to the release of new crop varieties. The precious germplasm collected from mountainous areas of the country during those years is still available in ICARDA's genebank both for repatriation and for use in developing new varieties suited for the agroclimatic conditions of Afghanistan. Based on these comparative advantages, ICARDA was, in January 2002, designated as the lead center in a multipartner initiative—the Future Harvest Consortium to Rebuild Agriculture in Afghanistan. The

Consortium receives financial support from the United States Agency for International Development. Glimpses of the progress made by ICARDA in rebuilding agriculture in Afghanistan are presented in this issue.

In Turkey, a project on "Sustainable Development of Small-scale Farmers of the Taurus Mountains," popularly known as the "Taurus Mountains Project (TMP)," was implemented during 1990-1998. A multidisciplinary team of researchers from Çukurova University and other Turkish institutes collaborated with ICARDA and with small-scale farmers in four villages of the Taurus Mountains to develop, test, and disseminate new, improved



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Cover: Mountain terraces in Yemen.

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crop varieties and technologies in the target region. TMP is estimated to have raised farm family annual income by 65% over the Project period.

The Iran-ICARDA collaboration, dating back to the early days of ICARDA, has greatly expanded with the initiation of a joint project on "Strengthening Agricultural Research for Dryland Farming in the High Altitude Areas of Iran" and the consequent posting of ICARDA staff in Iran, starting in 1996. The strong commitment and dedication of Iranian researchers has made it possible to make important achievements. Research facilities have been established at two major centers—one each at Maragheh and Sararood—and enhanced at several other centers in the country. New cultivars of wheat, barley, chickpea and lentil, along with associated production technologies, have been developed and are being adopted by farmers in the dry, rainfed areas of Iran, providing yield increases of up to 40% or more at the farm level.

Research on policy and property rights is an integral component of ICARDA's research agenda. A study in the highlands of Yemen, for example, is under way to understand why terrace farming in the country has lost its importance and why terraces are left to degrade, and how this trend can be reversed. Community participation in designing rehabilitation techniques for terraces is a key component of the project.

This issue of *Caravan* presents a sample of success stories from ICARDA's work in mountainous areas in CWANA. I hope it will add to the momentum generated by the declaration of 2002 as the International Year of Mountains to improve the welfare of the people, and the health of the environment, in mountainous areas.

**Prof. Dr Adel El-Beltagy**  
**Director General**

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## About ICARDA and the CGIAR



Established in 1977, the International Center for Agricultural Research in the Dry Areas (ICARDA) is governed by an independent Board of Trustees. Based in Aleppo, Syria, it is one of 16 centers supported by the Consultative Group on International Agricultural Research (CGIAR).

ICARDA serves the entire developing world for the improvement of lentil, barley and faba bean; all dry-area developing countries for the improvement of on-farm water-use efficiency, rangeland, and small-ruminant production; and the Central and West Asia and North Africa region for the improvement of bread and durum wheats, chickpea, and farming systems. ICARDA's research provides global benefits of poverty alleviation through productivity improvements integrated with sustainable natural-resource management practices. ICARDA meets this challenge through research, training, and dissemination of information in partnership with the national agricultural research and development systems.

The results of research are transferred through ICARDA's cooperation with national and regional research institutions, with universities and ministries of agriculture, and through the technical assistance and training that the Center provides. A range of training programs is offered, from residential courses for groups to advanced research opportunities for individuals. These efforts are supported by seminars, publications, and specialized information services.



The CGIAR is an international group of representatives of donor agencies, eminent agricultural scientists, and institutional administrators from developed and developing countries who guide and support its work. The CGIAR receives support from many country and institutional members worldwide. Since its founding in 1971, it has brought together many of the world's leading scientists and agricultural researchers in a unique South-North partnership to reduce poverty and hunger.

The mission of the CGIAR is to promote sustainable agriculture to alleviate poverty and hunger and achieve food security in developing countries. The CGIAR conducts strategic and applied research, with its products being international public goods, and focuses its research agenda on problem-solving through interdisciplinary programs implemented by one or more of its international centers, in collaboration with a full range of partners. Such programs concentrate on increasing productivity, protecting the environment, saving biodiversity, improving policies, and contributing to the strengthening of agricultural research in developing countries.

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 System with a Secretariat in Washington, DC. A Science Council, with its Secretariat at FAO in Rome, assists the System in the development of its research program.

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# ICARDA Celebrates 25th Anniversary: Future Holds Challenges, Opportunities

**H**.E. Dr Nouredin Mona, Minister of Agriculture and Agrarian Reform, Syria, addressing guests at ICARDA's 25th anniversary celebrations in May, pledged his country's continued "full support" to help ICARDA achieve its mission of poverty reduction and improved nutrition, working on behalf "not only of poor farmers in Syria, but farmers worldwide."

Using crop varieties developed in partnership with ICARDA, "Syria is now an exporter of wheat, barley, lentils, and sometimes chickpea," said H.E. Dr Mona. The commitment to "partnership" based on "common interest" for the good of the poor continues with Syria's President Bashar Al-Assad, the Minister said.



*H.E. Dr Nouredin Mona, Minister of Agriculture and Agrarian Reform, Syria*



*Dignitaries from all over Central and West Asia and North Africa and beyond joined ICARDA staff, management, and Board of Trustees members for Presentation Day 2002, which also marked the 25<sup>th</sup> anniversary of the Center's founding.*

Syria has joined the Consultative Group on International Agricultural Research, and has pledged an annual contribution of US\$500,000.

ICARDA Board of Trustees Chair, Mr Robert Havener, presented a history of ICARDA, in which he acknowledged the key role played by the late President Hafez Al-Assad in the establishment of the Center in Syria. The contributions made by the International Development Research

Centre (IDRC), Canada; the Rockefeller Foundation; the Ford Foundation, and others were also acknowledged. The Board Chair said ICARDA has achieved a great deal, but much remains to be done, a theme echoed by the speakers who followed him in the day-long symposium.

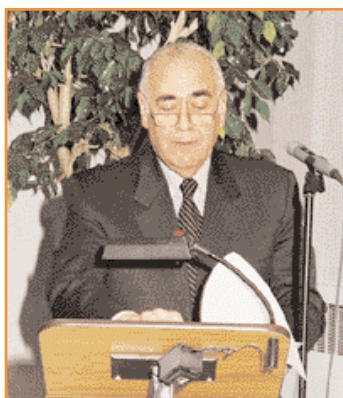
Gains have been made, but "hunger and poverty still loom" in many parts of the developing world, "threatening past achievements," said Dr Mervat Badawi, Director, Technical Department, Arab Fund for Economic and Social Development (AFESD), Kuwait.

"The food gap cannot be closed by expanding [production] area, but through increases in productivity achieved through science," said Dr Badawi. ICARDA has always enjoyed a special relationship with AFESD, "a relationship earned through its research record," she said.

Dr Peter Cooper, Director, Natural Resources and Environment, IDRC, flagged water and climate change as dominant issues. Water, he said, is becoming increasingly scarce and increasingly a matter of international concern, while climate change is already occurring, making dry areas of West Asia and North Africa hotter and drier.



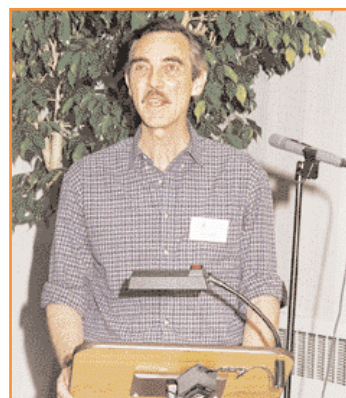
*Mr Robert Havener*



*Prof. Dr Adel El-Beltagy*



*Dr Mervat Badawi*



*Dr Peter Cooper*





*Left: Participants in the 25th anniversary celebrations took the opportunity to tour ICARDA's research facilities at headquarters. Listening to a presentation on livestock research are from left, in front, Prof. Dr Adel El-Beltagy; H.E. Mr Tursunboi Rakhmatov, Minister of Agriculture, Tajikistan; Dr B. Ghareyazie, Deputy Minister of Agriculture and Head of AREO, Iran; H.E. Dr Nouredin Mona, Minister of Agriculture and Agrarian Reform, Syria; H.E. Dr Mahmud Duwayri, Minister of Agriculture, Jordan; H.E. Dr Yousef Abu Safieh, Minister of Environmental Affairs, Palestinian Authority; Mr Robert Havener, Chair of ICARDA's Board of Trustees; and Dr Mouin Hamze, Secretary General, National Research Center, Lebanon.*

*Right: As part of the 25th anniversary celebrations, a plant pathology laboratory was dedicated to Dr Alfred Bronnimann, former Chair of ICARDA's Board of Trustees. From left, in front, H.E. Dr Nouredin Mona, Minister of Agriculture and Agrarian Reform, Syria; Prof. Dr Adel El-Beltagy; H.E. Mr Mustafa Ould Maouloud, Minister of Rural Development and Environment, Mauritania; Dr Enrico Porceddu (behind), former ICARDA Board Chair; Dr B. Ghareyazie (behind), Deputy Minister of Agriculture and Head of AREO, Iran; H.E. Dr Mahmud Duwayri (in front), Minister of Agriculture, Jordan; H.E. Mr Tursunboi Rakhmatov (behind), Minister of Agriculture, Tajikistan; Mr Amin Ali Al-Musaibi, from the Ministry of Agriculture, Yemen; and Mrs Alfred Bronnimann.*



As such, ICARDA's mandate is "increasingly relevant and deserving of increasing support from donors," said Dr Cooper, who worked at ICARDA for 11 years until 1989.

ICARDA Director General Prof. Dr Adel El-Beltagy briefed the gathering on the challenges facing the world's drylands, and pointed a way forward for the Center and the region through harnessing science. He said ICARDA would give higher priority to helping rural communities add value to their agricultural produce, and would make best use of new technologies, such as biotechnology, geographic information systems, remote sensing, and computer expert systems to increase agricultural productivity.

Everyone has a responsibility to promote respect for "human diversity and protect the natural wealth of our planet. ICARDA, for its part, is fully committed to the task of producing international public goods in agriculture, and is thus contributing to food security, protection of the environment, and poverty alleviation," said Prof. Dr El-Beltagy.

Dr Per Pinstrup-Andersen, Director General of the International Food Policy Research Institute, Washington, DC, said that efforts to achieve food security will be affected by globalization, which he said can be managed to help the poor;



*Dr Per Pinstrup-Andersen*

technological change, including use of biotechnology to improve agricultural productivity; and natural resources degradation, water scarcity, emerging health problems, and climate change, all of which pose a challenge to policy-makers and researchers.

At the World Food Summit in 1996, participating nations pledged to reduce by half the number of malnourished people in the world by 2015. To do this, research and policy initiatives must "target low-income people without access to sufficient food," said Dr Pinstrup-Andersen, winner of the World Food Prize in 2001.

Much hope is being placed in biotechnology, including development of transgenic plants, to help increase crop productivity. Dr Marc Van Montagu, Professor Emeritus, Ghent University, Belgium, said that biotechnology will benefit the poor, and lamented that much of the public debate surrounding genetically modified foods is ill informed.

"We have to learn how to use our emerging knowledge. We need to add genes conferring drought and salt tolerance to elite cultivars, and we need to improve the agronomic traits of drought and salt tolerant cultivars," said Dr Van Montagu, founder of the Institute for Plant Biotechnology for Developing Countries. ■



*Dr Marc Van Montagu*

## Future Harvest Consortium to Help Rebuild Agriculture in Afghanistan

**R**epresentatives of the international community began planning how best to restore food security and rebuild the agricultural sector in Afghanistan at a meeting convened by ICARDA in Tashkent, Uzbekistan, on 20-21 January 2002.

The meeting, supported by the United States Agency for International Development (USAID) and organized by ICARDA's Regional Office for Central Asia and the Caucasus, brought together 74 participants representing 34 organizations, including 10 of the 16 Future Harvest Centers of the Consultative Group on International Agricultural Research (CGIAR), non-governmental organizations (NGOs), United Nations agencies, United States institutions, various international agencies, and donors, including the Department for International Development (DFID), UK; the International Development Research Centre (IDRC), Canada; USAID, and



*Seventy-four representatives from 34 organizations gathered in Tashkent, Uzbekistan, in January to help plan the rehabilitation of Afghanistan's agriculture sector. The meeting was organized by ICARDA and supported by the United States Agency for International Development.*

others. ICARDA Director General Prof. Dr Adel El-Beltagy and USAID Senior Policy Advisor Dr Raymond Morton inaugurated the meeting.

The meeting decided to establish the Future Harvest Consortium to Rebuild Agriculture in Afghanistan, with financial support from USAID. Other donors are considering to join. Along with ICARDA, the other Future Harvest Centers represented were: the International Center for Tropical Agriculture (CIAT); International

Center for Maize and Wheat Improvement (CIMMYT); International Potato Center (CIP); International Crops Research Institute for the Semi-arid Tropics (ICRISAT); International Food Policy Research Institute (IFPRI); International Livestock Research Institute (ILRI); International Plant Genetic Resources Institute (IPGRI); International Service for National Agricultural Research (ISNAR); and the International Water Management Institute (IWMI).■

### Challenges Can be Overcome through Regional Cooperation

Researchers and research administrators from throughout Central and West Asia and North Africa (CWANA) met at ICARDA headquarters on 8-10 May to integrate regional agricultural research priorities into the agenda of the Consultative Group on International Agricultural Research. The group was working with recommendations reached earlier at five sub-regional priority-setting meetings organized by ICARDA in 2001-2002. The May meeting was held to broaden the outlook to come up with a plan of action for the entire CWANA region. ■





## Convoy Carries Seed to Afghan Farmers

A convoy of 200 trucks carrying some 3500 tonnes of certified seed of improved wheat varieties was sent to Afghanistan in mid-May, from Pakistan, as part of a seed relief effort being implemented by the ICARDA-led Future Harvest Consortium.

The trucks traveled from Lahore, via Peshawar, to the Afghan capital Kabul, where the seed was received by the Ministry of Agriculture and loaded on smaller trucks for transportation to outlying provinces, where roads are often not suitable for larger trucks.

The World Food Program arranged the transportation to Kabul, while the ICARDA Afghanistan program staff, led by Dr Nasrat Wassimi and Mr Abdul Rahman Manan, arranged onward transportation. Non-governmental organizations, working jointly with the Ministry of Agriculture, distributed the seed to about 70,000 farmers. Most of the seed arrived in time for spring planting.

The Future Harvest Consortium is a multi-partner initiative, financially supported by the United States Agency for International Development (USAID).

## Seed Workshop First in Afghanistan

ICARDA organized a workshop entitled "Guiding Principles for Regulatory and Seed Systems Support Interventions" in Kabul, 21-23 May 2002, on behalf of the Consortium, the Afghanistan Ministry of Agriculture and Livestock, and the Food and Agriculture Organization of the United Nations (FAO). Sponsored by USAID, this was the first scientific meeting on seed in Afghanistan, and brought together about 80 participants from international and Afghan institutions.

The purpose of the workshop was to develop guidelines, or a code of conduct, for effective coordination and monitoring of seed system support interventions, and define standards and procedures that should be followed by all assisting institutions. ■

## High-level Afghan Delegation Visits ICARDA

Plans for training 25 agriculturists and establishing six seed laboratories were set when a senior Afghan delegation visited ICARDA headquarters on 9-16 May.

In a meeting with Prof. Dr El-Beltagy and senior ICARDA management staff, the delegation leader, H.E. Mr

and reintroducing the country's native fruit and vegetable crops.

While the need in Afghanistan is urgent, and the help of the donor community is vital, "we don't plan to be dependent forever," said Mr Sharif in expressing optimism over the long-term prospects for his country. He



*H.E. Mr Mohammad Sharif (second from right), Deputy Minister of Agriculture, Afghanistan, and members of the Afghan delegation meet with ICARDA Director General Prof. Dr Adel El-Beltagy (right) upon arrival at ICARDA headquarters.*

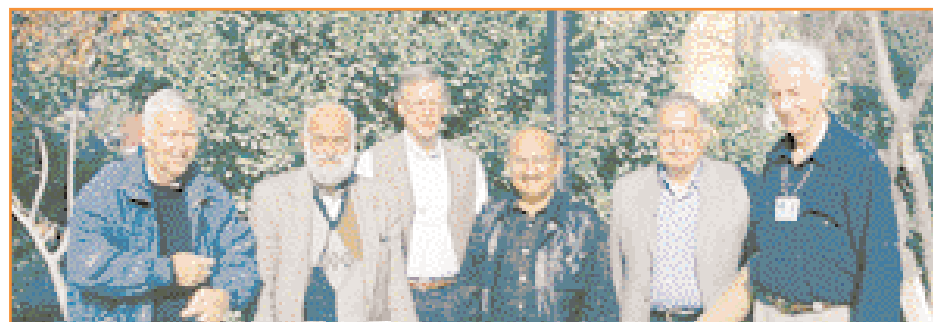
Mohammad Sharif, Deputy Minister of Agriculture, expressed appreciation for the work of ICARDA, which he said has had an ongoing, productive relationship with Afghanistan, despite years of war and instability in the country.

The Deputy Minister also praised the on-going efforts of the ICARDA-led Future Harvest Consortium to collect and deliver high quality seed in time for autumn planting, and other aspects of the plan of work, such as establishing an efficient seed production system; improving livestock nutrition and health; restoring soil and water management;

assured Prof. Dr El-Beltagy of his Ministry's full support in addressing the Consortium's four program areas.

In his welcoming remarks, Prof. Dr El-Beltagy briefed the delegation on ICARDA's role in the Consortium, and stressed that the Center is not a donor, "the Center exists to serve the needs of the world's dry areas." USAID is currently the principal donor to the Consortium. Other agencies, including the International Development Research Centre, Canada, have also made commitments for funding, and

*Continued on page 8*



*Seed relief operations organized by the Future Harvest Consortium to Rebuild Agriculture in Afghanistan are in full swing. From left, Dr Tony van Gastel, Head, ICARDA Seed Unit; Mr Abdul Rahman Manan, Chief Advisor, Future Harvest Consortium; Dr Larry Paulson, Agricultural Development Officer, United States Agency for International Development (USAID); Dr Nasrat Wassimi, Executive Manager, Future Harvest Consortium; Dr Mahmoud Solh, Assistant Director General, International Cooperation, ICARDA; and Dr Ray Morton, Senior Policy Advisor, USAID, were in Kabul to help organize the effort.*

## Iranian Minister Leads Mission to ICARDA

ICARDA received a high-level delegation from the Islamic Republic of Iran, headed by H.E. Mr Mahmoud Hojjati, Minister of Jihad-e-Agriculture, 18-19 May 2002.

In welcoming H.E. the Minister, Prof. Dr El-Beltagy recalled the history of the establishment and development of ICARDA and the role of Iran in enabling ICARDA to meet the agricultural research needs of the high-

Iran (ABRII) has been particularly close and fruitful. The strong support provided by the government of Iran to ICARDA has made this possible.

The delegation had an intensive tour of the research and training facilities and a thorough introduction to the research activities at the Center. The visit covered demonstration plots of cereals (barley, bread wheat, and durum wheat) and legumes (lentil,



*H.E. Mr Mahmoud Hojjati (right), Minister of Jihad-e-Agriculture, Islamic Republic of Iran, discusses the progress of joint research with ICARDA Director General Prof. Dr Adel El-Beltagy.*

elevation areas of the region. He highlighted the strong ties that have developed through the "Joint Collaboration Project for Strengthening Agricultural Research" conducted by the Agricultural Research and Education Organization (AREO) and ICARDA. Under the project, scientists from seven Iranian institutes are collaborating with ICARDA to develop solutions to the problems faced by farmers and to enhance the economic well-being of farm families. The collaboration with the Dryland Agricultural Research Institute (DARI), Seed and Plant Improvement Institute (SPII), and Agricultural Biotechnology Research Institute of

chickpea, faba bean, and forage legumes); multiplication of quality seed for use by national programs, particularly seed for Afghanistan; the genebank; livestock health and nutrition research and milk processing work; collection of fodder shrubs adapted to harsh conditions of rangelands in Central and West Asia and North Africa; application of water harvesting techniques and supplemental irrigation for enhancing productivity of rainfall; integrated management of pests and diseases and biocontrol measures to protect wheat from Sunn pest; screening of chickpea breeding material for ascochyta blight resistance; application of remote

sensing and geographic information systems (GIS) for agroecological characterization and for developing sustainable land and water-use options; library and information dissemination activities; the computer center; and training facilities.

The delegation also had the opportunity to visit farmer participatory barley breeding sites and to learn about the application of biotechnology for crop improvement for dry areas. H.E. the Minister and his two deputies had in-depth discussions with ICARDA scientists at each of the research sites visited. They were greatly impressed with the depth and diversity of research undertaken by the Center.

The discussions provided an opportunity to further strengthen linkages between work at ICARDA and in Iran, and to explore ways to maximize the benefits of these linkages for the benefit of farmers in Iran and in neighboring countries with similar agroecological conditions. In this connection, existing regional initiatives on wheat rust and Sunn pest, with Iranian researchers and institutions playing a lead role, are much appreciated.

In a wrap-up meeting, H.E. Mr Hojjati expressed his great appreciation for the opportunity to gain first-hand knowledge about work being done by the Center.

"The visit has been highly informative and the research work seen will be of great use back in Iran," H.E. the Minister said. ■

## *Afghan Delegation Visits ICARDA* *Continued from page 7*

still more donors are being sought.

The delegates and ICARDA management agreed on a proposal to have 25 Afghan agriculturists trained at ICARDA in seed production technology, including seed health, storage, and marketing. The agreement also envisages the establishment of six seed-technology and three seed-health testing laboratories in key locations in Afghanistan. The personnel trained at ICARDA will take charge of the operation of these laboratories starting in the 2002/2003 cropping season. ■



*The delegation from Iran is briefed on the medium-term storage of genetic resources held in the Center's genebank. ICARDA holds in trust some 128,000 accessions of crop and forage species and their wild relatives.*



# Seed for Afghanistan: A First Step in Restoring Food Security

*After years of armed conflict and drought, Afghanistan is struggling to get back on its feet. The ICARDA-led Future Harvest Consortium to Rebuild Agriculture in Afghanistan is there to help with emergency seed and longer-term programs designed to regain for the country its once thriving agricultural sector. Hope lies in the resilience and determination of the Afghan people and, for the time being, in the sustained commitment of donor countries.*



*Future Harvest Consortium members discuss plans for production of quality seed in Afghanistan.*

Afghanistan is a landlocked country bordering China, Iran, Pakistan, Tajikistan, Turkmenistan, and Uzbekistan. The Hindu Kush mountain range splits Afghanistan from east to west. The steep high peaks of the Wakhan Corridor are in the east, at 5500-7500 meters elevation. In east-central and central Afghanistan the mountains broaden into wide spurs fanning to the north and south at 3000-4000 meters elevation. In the west, the mountains end in the Safed Koh Range, north of Herat and close to the northwestern border, where the altitude is around 1100 meters.

The population growth rate is

currently more than 3%, average lifespan is just 40-46 years (estimates vary), and literacy is at 31.5% (percent of those aged 15 and older who can read and write).

"Afghanistan has no large ecological zones. Every valley or local place is different from its neighbors. Most regions are composed of an endless number of small areas with their own micro-climates," says Mr N. Tunwar from the Food and Agriculture Organization of the United Nations.

Only a small part (12%) of Afghanistan's land, mostly in scattered valleys, is suitable for farming, and most of this farmland requires irrigation. Water from springs and

**By A.J.G. van Gastel,  
S. Kugbei and N. Wassimi**

rivers is distributed through surface ditches and underground channels. However, less than one-third of the arable land is irrigated.

The topography has resulted in tremendous diversity of agriculture. This varies from arid pastoral systems and localized food production areas where irrigation is essential, to sub-mountainous areas where rainfed cereals and legumes are grown and tree fruits produced; from large valleys where crop productivity is constrained only by the availability of water, to narrow ravine zones where slopes limit the arable land.

Afghanistan once produced enough to feed its people and even exported some surplus. A long history of war and three consecutive years of drought have brought Afghanistan to its knees. One-third of the population fled the country, with Pakistan and Iran sheltering more than 6 million refugees. Agricultural productivity has declined sharply and food has become scarce in the country.

Today, with the situation relatively quiet, farmers are returning to their homesteads and villages to take up



*A healthy wheat crop near Kabul.*



agriculture again. Agriculture is the key occupation for a majority of the country's people, but getting agriculture back on its feet will not be easy, given the virtual collapse of supporting institutions, a halt in human resource development and the shortage of basic inputs, such as seed of appropriate varieties, fertilizer, and draft power. Two closely related needs must be addressed. The first is an immediate need for seed of food crops, and the second is a cessation of hostility to allow full return of farming communities. Then there is the longer-term need for technical assistance in developing sustainable agricultural production systems.

It was the desire to find the right balance between emergency and long-term efforts and engage partners with differing comparative advantages for fulfilling these needs that gave rise to the Future Harvest Consortium to Rebuild Agriculture in Afghanistan.

### The driving force

With funding from the United States Agency for International Development, the Future Harvest Consortium was formed at a meeting in Tashkent, Uzbekistan, in January 2002. Led by the International Center for Agricultural Research in the Dry Areas (ICARDA), the Consortium comprises international agricultural research centers of the Consultative Group on International

*Seed for on-farm testing and multiplication in Afghanistan is loaded on trucks at ICARDA headquarters.*



*Trucks loaded with seed depart ICARDA headquarters enroute to Sharjah and onward shipment to Afghanistan.*

Agricultural Research, other international research and development organizations, the Food and Agriculture Organization of the United Nations, United States universities, several international and local non-governmental organizations (NGOs) working in Afghanistan, and the Afghan Ministry of Agriculture and Livestock (MOAL). A project proposal discussed at the Tashkent meeting was soon begun and it continues to gather momentum. The implementing organizations have joined with Afghan partners to achieve quick and effective results.

### Delivering seed to meet immediate needs

Afghan farmers needed seed to sow their spring crop by mid-April to the beginning of May 2002, depending on elevation. Time was running out, and the Consortium needed to act fast. Within two weeks, or by 10 April to be precise, a total of 3500 tonnes of seed of adapted wheat varieties was delivered through NGOs and village *shurahs* (community groups). Seed was procured in Pakistan, transported by the World Food Programme via Peshawar and Kabul to NGOs in the provinces. All in all, seed was made available to about 70,000 farm families in the provinces of Badakhshan,

Bamian, Ghazni, Lowgar, Kapisa, Parwan, Wardak, and Uruzgan. This remarkable result was achieved through the diligence of Afghan partners, who worked around the clock and knew where to find those most in need. The International Fertilizer Development Center later supplemented the seed with fertilizer, through a voucher system. To minimize dependency, no inputs were given free to farmers.

The system worked, and was much appreciated. "Being able to get seed now, and pay for it with wheat grain after we harvest our crops is a wonderful idea," said one farmer from Wardak province.

"If I had not received this seed, I would not have sown any crop this season. We ate everything we had. Nobody could get a job to earn money and we could not buy seed," remarked another farmer, Chariaka Hamidullah, from Maidan District.

Several farmers expressed similar sentiments, while many remain concerned about what will happen next. Some ponder the fate of other farmers who were not fortunate enough to get seed.

"We received the ICARDA seed and could plant, but another village did not get this seed, and could not plant. We have to help them with what we will harvest," said a farmer in Bagram.



*A bag of certified wheat seed destined for Afghanistan.*



The Consortium has made arrangements for delivery of more than 5000 tonnes of seed, all produced locally, in time for fall planting. Leading farmers were contracted to produce the seed, and a rigorous program to ensure quality was put in place, which includes field inspections and removal of off-type plants, post-harvest treatment against disease, and proper packaging.

### Ensuring long-term stable agriculture

The development of a long-term viable agricultural sector will depend on a close link between the short-term emergency measures and the development of sustainable seed and agricultural production systems.

As part of the Consortium's activities, seed of a large number of varieties of wheat, barley, lentil, chickpea, and vetch has been provided to Afghanistan for evaluation and multiplication in cooperation with farmers. Included are landraces, which had been stored in ICARDA's genebank. These varieties and landraces will provide farmers with a broader range of production options.

### Needs assessments

The Consortium is assessing needs related to seed and crop improvement; soil and water; livestock, forage and rangeland; and horticulture. These four assessments will provide a long-term and holistic perspective on which to base the rehabilitation of agriculture in Afghanistan.

### Infrastructure support

The country's entire agricultural production system has been disrupted; local seed and crop improvement programs do not function; research stations have been extensively damaged, equipment has been looted and staff members have left the country or do not have the financial means to carry out research and development activities. Therefore, apart from seed and fertilizer, the Consortium will provide seed testing and seed health testing equipment to support measures that ensure seed quality, including seed quarantine at

ports of entry. Small-scale seed cleaning equipment and seed testing and seed health testing laboratories are already on the way to Afghanistan. The Consortium will also contribute to the rehabilitation of research stations; help initiate variety development and evaluation work; and support village-based seed production activities.

### A code of conduct for seed support

The crisis in Afghanistan has attracted considerable aid interest, and many international and national organizations and donor agencies are assisting in the rebuilding of the country's agricultural sector. Genuine as these efforts might be, such activities come with risks, such as the import and distribution of inappropriate varieties, or seeds that carry new diseases, pests, and weeds. There is, therefore, a clear need to coordinate activities and to agree on guiding principles for regulatory and seed system support interventions, including standards for seed production, seed quality, quarantine, importation, and distribution.

The Tashkent stakeholders meeting recommended that a workshop be held to develop a code of conduct to guide all those involved in seed provision in Afghanistan. The workshop was held on 21–23 May 2002, and was the first scientific meeting on seed in the country. It brought together over 80 participants from international and Afghan institutions working or interested in the area of seed to rebuild Afghanistan's agriculture. The Code of Conduct developed will form the basis for a much-needed national seed policy and regulatory framework for Afghanistan, as the country moves from dependence on emergency assistance to sustainable agricultural development.

### Training Afghans for the tasks ahead

One of the bitter consequences of the long conflict in Afghanistan is the breakdown in educational systems,

*A Future Harvest Consortium worker talks with an Afghan farmer commissioned to grow quality wheat seed.*



which has resulted in an entire generation of young people going virtually without formal education. The consequences of this are obvious and permeate Afghan society, particularly among females.

As such, the Future Harvest Consortium has designed training programs as an integral part of its package of interventions. Training will be made available to farmers, technical personnel, extension agents, and university students. The program began with a field-based course on seed production practices for field crops. This course supported ongoing activities to upgrade grain fields, and made a start in training the younger generation.

Training is also envisaged in soil and water management, livestock and rangeland management, as well as in crop improvement and seed system development. Degree training will be an important component.

### The future

The rebuilding of Afghanistan's agricultural sector has only just begun. It will not be accomplished overnight. Instead, it will require long-term commitment. The Future Harvest Consortium has taken quick action to supply seeds and a range of support services to farmers. The next steps in addressing the overall longer-term needs of the agricultural sector will be crucial. ■

*Dr Tony van Gastel is Head of the Seed Unit and Dr Sam Kugbei is Seed Economist at ICARDA; and Dr Nasrat Wassimi is the Executive Manager of the Future Harvest Consortium to Rebuild Agriculture in Afghanistan, based in Kabul.*

## ICARDA's Contribution to Improving Wheat in the CWANA Highlands

*Highlands are known for their harsh environments and poor accessibility, which probably accounts for their relative neglect when it comes to research. From its inception, ICARDA recognized the importance of highlands and set about correcting this imbalance by establishing a research program to address the specific challenges encountered at high elevations.*



*Wheat crops cover a major part of the highlands in CWANA. In this photo, the local wheat cultivar 'Sardari,' widely grown in Iran, is seen heavily infected with yellow rust.*

Close to 40% of the wheat in Central and West Asia and North Africa (CWANA) is grown in mountainous areas (elevations above 900 meters) with typically cold winters. These include highlands in West Asia, primarily in Turkey, Iran, Afghanistan, and Pakistan; the Caucasus and Central Asia; and in parts of the Atlas Mountains in North Africa. Bread wheat is the major staple food crop in these areas, where it is grown on about 17 million hectares. The frequent stresses—cold, drought, diseases, and insect pests—affecting the wheat crop and the relative lack of improved technologies in these areas explain the low grain yield, 1 t/ha or less, and, to a

### By Habib Ketata and Moussa Mosaad

certain extent, the rural poverty in the highlands.

In 1980, ICARDA established the Highland Wheat Project, which in 10 years collected and developed diversified wheat germplasm, which it shared with national agricultural research systems (NARS). The material was in turn used effectively by partner NARS to develop improved wheat cultivars for the highlands. In 1991, the ICARDA project was merged with the winter wheat project of the International Maize and Wheat

Improvement Center (CIMMYT) in partnership with Turkey, to form a joint Turkey/CIMMYT/ICARDA program on facultative and winter wheat improvement. The program has two projects, one implemented at ICARDA in northern Syria, and the second in Turkey.

Although the joint program delivers improved wheat germplasm worldwide, the scientists at ICARDA focus their activities on CWANA research priorities. The work of breeders is complemented by contributions from pathologists, entomologists, genetic resources specialists, biotechnologists, and agronomists. In addition to regular breeding nurseries and trials, specific germplasm is provided to NARS throughout CWANA upon request, including germplasm pools for resistance/tolerance to various diseases and insect pests and to drought and thermal stresses. Research conducted at ICARDA has also enabled breeders from CIMMYT and ICARDA to develop wheat types (winter, spring, or facultative) for specific target areas in CWANA. It is found that wheat genotypes selected at ICARDA's station in Tel Hadya, northern Syria, are suitable for most of the agroecologies found in CWANA highlands; they are typically facultative



*When they occur simultaneously in wheat fields, drought and cold stress cause severe yield losses in susceptible cultivars, as shown here.*



types (with a low vernalization requirement, i.e., a moderate need for exposure to low temperature in the vegetative stage) with good cold tolerance. On the other hand, winter types selected in Turkey have a narrower range of adaptation within CWANA. Spring types, requiring no cold exposure to flower, are found to be suitable for lower elevations in CWANA.

International center scientists work hand in hand with NARS scientists to develop improved wheat cultivars and management technologies. As a result, a relatively large number of improved wheat cultivars have been released by NARS in the past decade for cultivation in the highlands. These cultivars are gradually replacing older, less productive varieties. Some of the new cultivars (e.g., 'Azar 2' in Iran, and 'Sanzar 8' and 'Dostlik' in Uzbekistan) are particularly tolerant to drought. A major achievement has been realized in the area of germplasm resistance to yellow rust, a devastating disease in the highlands, where the resistance level has been increased from less than 10% to over 40% in just six years. A



*Farmers, extension specialists and researchers visit adjacent, contrasting wheat fields that highlight the difference between improved and traditional production technologies, during a field day at Sarab in northwestern Iran, June 2002.*

Yellow Rust Research Network has been established for Central and West Asia to facilitate the exchange of disease information across countries, monitor disease development, and provide an early warning system for yellow rust epidemics. Hands-on training, workshops, and conferences

are held regularly to exchange scientific information and experiences in wheat improvement and related disciplines.

Newly bred wheat cultivars and associated improved production technologies are adopted by farmers through a participatory research approach involving researchers, extensionists, and farmers. The new technologies have been found to increase farm grain yield by 30% or more, and reduce production fluctuation, a typical characteristic of rainfed wheat. One supplementary irrigation at planting time was found to improve crop growth, reduce the risk of crop failure, and lead to substantial yield increases (more than 50% in some cases) in cold-winter highlands.

These wheat yield increases are relatively recent in the highlands and limited to certain countries or localities. Highlands generally remain disadvantaged in comparison to lowlands, and require further research and investment to make better use of their resources. ■

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*Left: Participants in a training workshop examine the performance of winter wheat 'Dostlik' in Uzbekistan.*

*Right: ICARDA and Uzbek scientists during a field survey on cereal diseases and insects in Syrdarya region of Uzbekistan.*



## Winter Lentils Promise Improved Nutrition and Income in West Asian Highlands

*By planting lentil in winter, when soil moisture is plentiful, farmers can enjoy a boost in yield and profit. ICARDA and its partners in West Asia are developing winter-hardy lentil lines and related production technologies to make winter production a widespread reality.*



*Spring-planted lentil in an experimental field in Ardebil, Iran, showing poor crop growth.*

Lentil has been an important food legume crop in the farming systems of West Asia since time immemorial. Its protein-rich seed is an important dietary component, especially for the poor. The seeds are eaten whole or dehulled and split. Small-seeded red lentil is usually used for soup, while large-seeded yellow-cotyledon lentil is often cooked with rice or broken wheat seed (*mujadarah* in Arabic). And lentil straw is a valuable livestock feed, particularly in dry years.

Like other legumes, lentil has a symbiotic relationship with soil bacteria belonging to the genus *Rhizobium*. The *Rhizobium* grows in root nodules and fixes nitrogen from the air, making it available to its host plant and subsequent crops. Apart from

**By A. Sarker, N. Aydin, A. Aydogan, S.H. Sabaghpour, H. Ketata, I. Kusmenoglu and W. Erskine**

improving the soil nitrogen status, lentil grown in rotation with cereal can break disease and insect pest cycles that build up in monoculture systems. Lentil can thereby contribute to the sustainability of cereal-dominated cropping systems.

Traditionally, lentil is grown in West Asia in winter in lowlands (<850 meters above sea level, <-10°C) and in spring in the highlands, where winter conditions are too severe for lentils (approaching -20°C). Therefore, in the highlands of Afghanistan, Iran,

Pakistan and Turkey, lentil is normally grown as a spring crop. In these areas ICARDA and its partners are working to shift lentil planting from spring to winter to exploit the benefits of winter rainfall and boost production and profits for farmers.

### Means of higher yield

First, lentil production in these areas can be increased substantially by replacing local landraces with improved spring varieties. The crop is grown on residual soil moisture at the end of the rainy winter season, so cultivars with early growth vigor, high biomass development, early flowering and maturity, which can escape terminal drought and heat stress, are best suited.

Second, production can be increased significantly by shifting planting from spring to early-spring or fall. This gives the crop the benefit of winter rainfall, and low evapotranspiration, because temperatures are low when the crop approaches maturity. This environment allows optimum vegetative growth, development of higher yield potential, and higher water-use efficiency. As well, the taller canopy allows for mechanical harvest. The increased biomass from the winter crop is highly prized for feeding small ruminants. It has been estimated that about 400,000



*The winter (background) versus spring (foreground) sowing of lentil in an experimental field in Ardebil, Iran. The winter-sown crop performed much better.*



hectares of spring crop could be replaced by winter lentil in the highlands of West Asia.

### Prerequisites for winter lentil

The question might be asked, "If the winter crop is so profitable, then why haven't farmers tried growing lentil in winter?" ICARDA and national program researchers have identified three prerequisites for a successful winter crop: (1) sufficient winter hardiness in cultivars to be grown, (2) weed control, and (3) resistance to ascochyta blight, a fungal disease. Investigations have revealed that farmers avoid winter sowing because of heavy or total crop loss due to cold stress, weeds, and blight.

There are three main scenarios observed in winter production, but in all cases sufficient winter hardiness is essential to produce a good crop without cold injury.

Fall-sown crops that receive rain right after sowing germinate and the young seedlings are subjected to cold spells and are eventually covered by snow. The snow insulates the seedlings from severe temperatures, and after the snow melts the seedlings resume growth with full vigor.

If there is no moisture in the soil after fall planting, the seed remains in the soil over winter. When the snow melts or the soil receives rain, the seed germinates and the seedlings grow. This is called "intezeri planting."

In some cases, seedlings are subjected to a cold spell without snow cover.

Of course, just as the lentil thrives on the good early moisture, so do weeds, which compete for moisture and nutrients. Farmers can fight back with an integrated weed control program using appropriate herbicide and mechanical control. Smallholder farmers can use hand weeding.

Farmers can counter ascochyta blight by growing resistant cultivars, and by including them as part of an integrated disease management strategy.

### First step: Find the right germplasm

The first step is to find plants that can survive the harsh winter cold. ICARDA has a rich collection (about 10,500 accessions) of lentil germplasm, including wild relatives. Evaluation of this material has revealed enormous variability in cold tolerance. These accessions are the raw material that ICARDA is using for breeding elite lines for winter cultivation.

### Decentralized breeding approach

ICARDA's main research station at Tel Hadya, Aleppo, in Syria, has mild winters, so research into winter hardiness is carried out with partners

elsewhere. Field screening is done in collaboration with the Central Research Institute of Field Crops (CRIFC), Ankara, Turkey, at Haymana and Sivas, areas prone to extreme cold. Information generated and selections made are sent to ICARDA and the material incorporated in the International Cold Tolerant Nursery, which is sent to national programs for evaluation. Also, any winter-hardy parents used in the hybridization program at ICARDA and segregating populations are sent to partners to select single plants suited to various agroecological conditions.

### Success stories

**Turkey:** Out of about 560,000 hectares planted to lentil in Turkey, about 130,000 hectares are in highlands of central Anatolia, in Ankara, Tokat, Konya, Yozgat, Çorum, Sivas, Karaman, and Nevsehir. These areas range in altitude from 608 to 1400 meters above sea level, and in the middle of winter the temperature varies from

–12 to –30°C. Working with ICARDA, Turkey has recently released three high-yielding winter-hardy (developed from its own germplasm) and two high-yielding spring varieties (developed from ICARDA-supplied germplasm). 'Kafkas' yielded 1705 kg/ha, 'Ciftci' 1558 kg/ha and 'Ozbek' 1730 kg/ha, representing a yield increase of 42%, 30%, and 44%, respectively, over the local check. The spring red lentil variety 'Ali Dayi,' produced an average of 1490 kg/ha compared with 1277 kg/ha obtained from the best check 'Emre 20.' The green lentil spring variety 'Meyveci-2001' produced an average of 1383 kg/ha, compared with 1290 kg/ha from the check 'Sultan 1.' These varieties are taller than the local checks and therefore more amenable to machine harvesting, an important consideration where labor is expensive and not readily available.

In addition, Turkey has identified several winter-hardy lines, which are now at various stages of evaluation. Some of them, ILL 7155, ILL 759, ILL 1878, ILL 8146, ILL 9832, and ILL 4400, are in advanced testing.



*Performance of spring- and winter-sown lentil in Eskişehir, Turkey. The winter-sown crop (right) reached maturity, while the spring-sown crop is vulnerable to terminal drought and heat stress.*

**Iran:** Lentil is grown on about 205,000 hectares in Iran, but with poor productivity of 464 kg/ha. The major constraints are non-availability of improved varieties for early-spring or winter planting, high weed pressure, poor agronomy, and lack of quality seed. To date, the only variety released in Iran for early-spring sowing is 'Garcharan' (ILL 6212), which originated from ICARDA material. Iranian farmers like the variety because of its higher yield and larger seed size.

The major lentil-producing regions in Iran are East Azerbaijan, Ardebil, Khorasan, Zanjan, Ghazvin, and Lorestan. In the peak of winter, temperatures can drop to  $-22^{\circ}\text{C}$ . Farmers grow winter lentil on about 10,000 hectares, but the local landraces have low yield potential and are vulnerable to a range of biotic and abiotic stresses. Scientists in Iran have been busy selecting winter-hardy material from ICARDA nurseries. Some lines, such as ILL 590, ILL 662, ILL 857 and ILL 975, are undergoing on-farm testing. The lines have a high level of resistance to cold and fusarium wilt, and are free from ascochyta blight. A simultaneous seed multiplication program is under way in anticipation of the lines' official release to farmers.

**Pakistan:** In the highlands of Balochistan province, lentil is planted in the spring and yield is low. Scientists at the Arid Zone Research Institute have identified and released 'ShirAZ-96' (ILL 5865) for winter cultivation. The variety, developed from ICARDA-supplied material, thrives in harsh cold and has larger seeds than the local varieties. Farmers have adopted the variety, which is now grown on about 300 hectares in the region.

**Afghanistan:** Traditionally, Afghan farmers grow lentils in spring in cold-prone areas. More than a decade of work led to the release in 1999 of improved cultivars for early-spring (March) sowing in Herat, Balkh, and Takhar provinces. ILL 5582, which has also been released in several countries, including Syria, is a yellow-cotyledon lentil with cream color testa and large seeds. ILL 7180 is a red lentil. Both



*ICARDA and Turkish scientists evaluate the performance of 'Kafkas,' a high-yielding and winter-hardy lentil variety in Turkey.*

were identified from ICARDA international nurseries and tested for several years across regions. On average, ILL 5582 produced 53% higher yield, and ILL 7180 gave 37% higher yield, than the local checks.

### **Making quality seed available to farmers**

Lack of seed is a major constraint to dissemination of improved varieties of lentil. However, in Turkey, the Mediterranean Seed Export Company has taken the initiative to multiply seed of released varieties. The company reports that about 70 tonnes of 'Kafkas' seed will be available for 2000/03 winter planting.

In some cases, ICARDA supplies bulk seed to meet demand from national programs. For example, about 2 tonnes of seed of improved cultivars is destined for Afghanistan. And breeder seed of 'Ali Dayi' and 'Meyveci-2001' have been shipped to Turkey for multiplication.

### **Application of biotechnology**

Progress in developing winter-hardy lentil cultivars has been slow due to the difficulty in identifying and transferring winter-hardiness genes using traditional field screening methods. ICARDA is working in collaboration with Prof. Fred Muehlbauer of Washington State University, USA, and CRIFC, to

identify the genes that confer winter hardiness and to tag them with molecular markers.

A student from Turkey was successful in identifying and tagging genes for winter hardiness. A number of major and minor quantitative trait loci (QTLs) have been assigned in the lentil genome, whose cumulative effects provide winter survival.

### **The future**

Although spring lentil is the traditional crop in the highlands of West Asia, our goal is to facilitate the spread of winter planting with appropriate varieties and production technologies. Working with national program partners, successes have been achieved in identifying and releasing cultivars with high levels of winter-hardiness and better yield potential. Dissemination of winter planting technology will improve the incomes of farmers in the region. ■

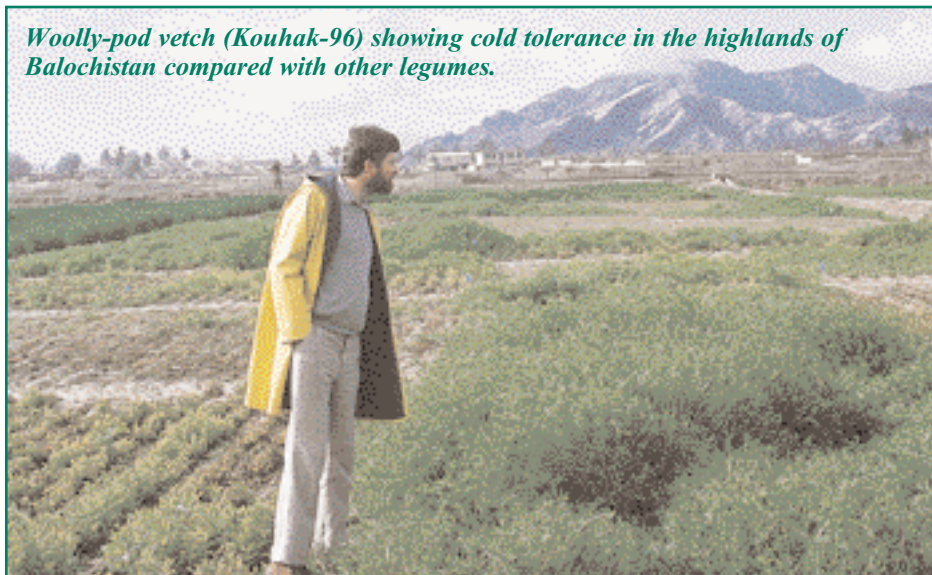
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# Vetch Makes a Comeback in the Highlands of Balochistan

*Long-time cooperation with the Arid Zone Research Institute, Pakistan, is generating benefits in the highlands of Balochistan, in the form of adapted forage varieties that increase the incomes of pastoralists and preserve the environment. Now, one of these same forage lines has been multiplied for shipment to war-torn Afghanistan.*

*Woolly-pod vetch (Kouhak-96) showing cold tolerance in the highlands of Balochistan compared with other legumes.*



**T**he marginal low-rainfall areas of the highlands of Central and West Asia have a very fragile agroecosystem, which is now subject to degradation and erosion because of increased cropping of barley in response to rising population.

Increasingly large deficits in forage production are forecast for the highlands of West Asia. To meet rising demand, productivity will have to increase, even on marginal land, particularly in the arid highlands, which will have to make a larger and more consistent contribution to the agricultural sector of national economies.

The vast highlands of Balochistan province (approximately 20 million hectares with elevations greater than

1000 meters above sea level), Pakistan, are typical of many areas in West Asia. They are marginal and underutilized, but with careful management they could help sustain the agricultural economy.

The Balochistan highlands have a mixed arid continental Mediterranean and arid sub-tropical monsoon climate. Rainfall is highly erratic and seldom exceeds 250 mm, and winters can be exceedingly cold.

The dryland farming systems are dominated by the production of small ruminants. Some 18.4 million sheep are raised on approximately 18 million hectares of rangeland, which amounts to a more than 10-fold increase in the sheep flock size in the past 50 years.

**By Ali Abd El-Moneim  
and Dyno Keatinge**

Livestock owners now face severe feed shortages.

Annual forage legumes, principally *Vicia* and *Lathyrus* spp., have been shown in other Mediterranean and highland environments to provide adequate and stable yields. Historical evidence suggests that *Vicia* and similar annual legume species were common in the highlands of Balochistan before severe overgrazing virtually eliminated them.

To address the problem of feed shortage, the Arid Zone Research Institute, in cooperation with ICARDA, has been evaluating forage legume germplasm for adaptability. Because the environment is unsuitable for sustained crop production, an unconventional germplasm evaluation strategy was adopted, which emphasizes the introduction of *Vicia*. The substantial risk of crop failure from either cold or drought, in any year, makes continuity of seed supply of selected lines a major problem. ICARDA helped by providing a ready supply of seed.

Germplasm evaluation has made tangible progress. Woolly-pod vetch



*Farmers and scientists inspect vetch grown in the Taurus Mountains in Turkey.*

*Continued on page 43*

## Participatory Barley and Lentil Breeding in Yemen

*In 1999, ICARDA began a participatory breeding program to improve barley and lentil on the terraced mountain slopes of Yemen. The work is carried out in collaboration with Yemen's Agricultural Research and Extension Authority and a growing team of local farmers eager to share their knowledge of the land and its agriculture.*



*A farmer addresses her neighbors at a lentil field day.*

The Kuhlan-Affar district in Hajja province of Yemen represents the traditional dryland farming systems in the country's northwestern highlands, characterized by subsistence agriculture. The area is essentially a steep mountain slope that descends, within a short horizontal distance, from an altitude of 2800 meters to about 800 meters at the wadi floor (Wadi Sharis). It could be divided into three major agroecological zones consisting of a mountaintop (zone III), terraced mountain slopes (zone II, middle slope), descending into the wadi bed (zone I, lower slope).

Agriculture in the highlands is supported by traditional methods of water harvesting on terraces made thousands of years ago by farmers who leveled the soil, removed the stones, plowed, manured, and built walls that helped trap the soil carried in runoff.

The size of the terraces varies, mostly in relation to the slope—the steeper the slope the smaller the terrace. Each farmer usually owns more than one terrace, with an average farm size of about 1.4 hectares.

Usually only one crop is planted in each terrace, but it is not uncommon to see terraces divided between lentil and

**By S. Ceccarelli, S. Grando,  
M. Martini and A. Lutf**

barley or between sorghum and faba bean.

The most important crops are sorghum, wheat, lentil, barley, millet, beans, fenugreek, and peas. The majority of farmers use traditional cultural practices. The relative importance of the crops vary from year to year depending on rainfall. For example, in the case of a late start of the rainy season the wheat area is decreased and the barley area is increased. A recent survey indicated that manual labor and the use of traditional tools is common.

All of the crops are planted to indigenous local varieties (landraces). Farmers in the area usually save part of their harvest as seed for the next year. This seed is frequently of poor quality. High quality seed is too expensive, and in many cases farmers cannot afford it. Farmers commonly use organic fertilizers. Urea is the only inorganic fertilizer applied.

Most of the farmers farm full-time, they make all of their farming decisions, and carry out most of the farming operations. There are slightly more female farmers than male farmers, most of the farmers are married, most are illiterate.

The average family size is about 11



*Farmers check the quality of barley selections.*



individuals. Large families are common, which is related to the large demand for labor in traditional agriculture. The average number of males and females per farm household is about the same.

### Choice of villages and farmers

Three villages were selected in the area (Hasan Azam, Beit al Wali, and Al Ashmor), based on the importance of the principal crops grown, barley and lentil.

In each village the implementation of the project was discussed in detail with the farm community. The following steps were used in every village to select participating farmers.

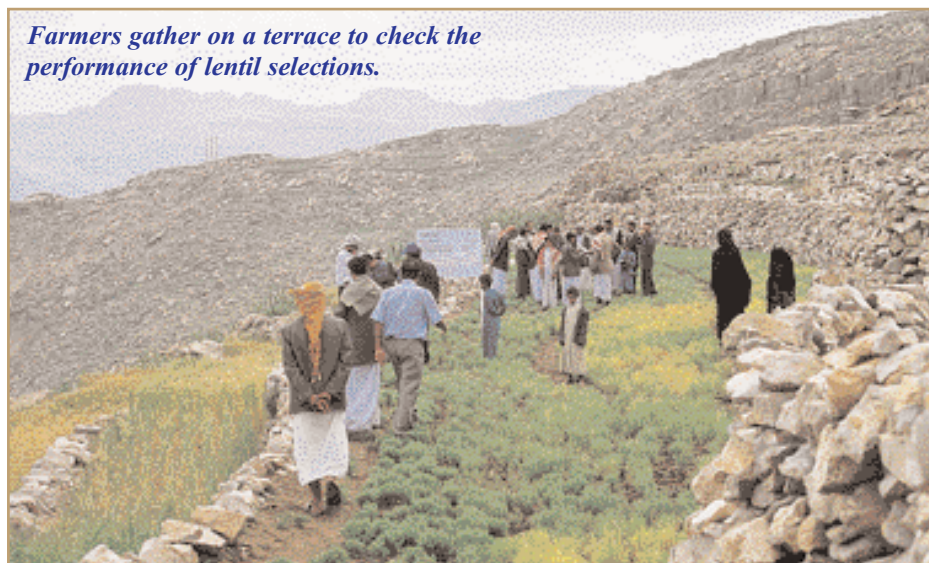
1. A meeting was organized with a group of farmers in the house of the leader of the village.
2. After a discussion on the agricultural farming system in the area, the nature of the problem, the farmers' practices, crop production and costs, we discussed with the farmers:
  - the objectives of the collaborative research and its potential benefits
  - the work plan and the methodology of the project
  - the responsibilities in terms of implementation, cost, evaluation, and other factors.

Five farmers were chosen in Hasan Azam and in Beit al Wali, and three in Al Ashmor. The farmers were typical of their village, willing to conduct the trial according to the agreed-upon design, were practicing farmers (not absent farmers) with experience in growing these two crops, were interested in changes and ready to adopt improved varieties, were willing to share their experience and provide all necessary information to research and extension workers.

### Material and selection

Fifty barleys (10 local landraces, 30 introduced lines, and 10 segregating populations), and 50 lentils (20 local landraces, 25 introduced lines, and 5 segregating populations) were planted in March 1999 (spring season) in two replications of a lattice design in Hasan Azam and Al Ashmor and in one replication in Beit al Wali. Because of the differences in the size of the terraces, the number of plots per

*Farmers gather on a terrace to check the performance of lentil selections.*



terrace varied, and the total number of terraces was 5, 4, and 17 in Hasan Azam, Al Ashmor, and Beit al Wali, respectively. The same terrace hosted two incomplete blocks as well as a plot with the farmer's cultivar. The plot size was 4 rows, 2.5 m long, and 25 cm between rows in Hasan Azam and Al Ashmor, and 4 rows, 2 m long, and 25 cm between rows in Beit al Wali. The agronomic management of the plots was left up to the farmer. The same genetic material was also planted in the research station at Al Erra using the same experimental design as in the villages, with the difference that each crop was planted in a separate trial.

In lentil, the breeder and farmers conducted the evaluation and the selection at the three villages and in the research station at three stages of growth; the first before flowering, the second at pod formation, and the third before harvest. A simple form was given to the farmers to record their observations, individually and as a group, on the most interesting characteristics. For barley, each farmer made his selection by tying numbered labels at the end of the selected plots. In Hasan Azam, selection of lentil and barley was also performed by a group of four women from the village.

The same process was repeated in 2000 and in 2001 using the lines selected in 1999 and 2000, respectively. At the end of the selection process, six new barley lines and 7-11 new lentil lines were identified by the farmers in the three villages.

One of the barley lines, 'Al Erra 60,' largely outyielded the local check

in all three villages, and a second line, 'Al Erra 58,' performed very well in two villages. The farmers have multiplied these lines, and the seed will be made available to other farmers in the same and neighboring villages.

The farmers identified at least two high-yielding lentil lines in each village, which often differed from village to village. Selection of lentil and barley was of great interest to the women participants, and the number of participants increased continuously over the course of the project. It is important to differentiate selection by gender, because preferences can differ considerably.

The project has generated a wealth of information on farmer preferences in some of the most remote areas of Yemen. It has also increased the awareness of the farmers about what plant breeding can offer, and thus has created a demand for this type of work in other crops. Although this project was one of the smallest handled by the Agricultural Research and Extension Authority, it had a conceptual and cultural influence on the entire institute. As a consequence, other projects have started to incorporate participatory components, and participatory research is likely to become a common conceptual platform for AREA's activities. ■

*Dr S. Ceccarelli and Dr S. Grando are Barley Breeders at ICARDA; Dr M. Martini is a Research Associate, Socioeconomics and Gender Analysis; and Mr A. Lutf is National Coordinator of the Project.*

## Food Barley Gains Long-overdue Attention

*Barley is best known as a feed crop and the principal ingredient of beer, but it is also an important food crop, especially for people living in remote highlands. ICARDA and its research and development partners have joined forces to correct the relative neglect of this ancient dietary stalwart.*

### Food of the gladiators

Barley grain is used as feed for animals, malt, and human food. It was a staple food as far back as 18,000 years ago. It was the energy food of the masses, and it had a reputation for building strength. Barley was awarded to the champions of the Eleusian games. Gladiators of the Roman Empire were called *hordearii*, barley-men, because barley was the main component of their training diet.

Barley remnants from ancient Mesopotamia and Egypt are much more abundant than those of wheat, and the earliest literature suggests that barley was more important than wheat for human food. The Sumerians had a god for barley but none for wheat. In the Near East and Mediterranean, the shift to wheat as human food came in classical times, and by the first century A.D. barley was already mostly fed to animals. In northern Europe barley remained the main food cereal until the 16<sup>th</sup> century.

Barley is still an important staple food in several regions, generally in places where other cereals grow poorly due to altitude, low rainfall, or soil salinity. It remains the most viable option in dry areas (< 300 mm of rainfall annually) and in production systems where alternatives for food crops are very limited or absent, such as the highlands and mountains of



*Farmers meet to inspect and select barley lines in Yemen.*

Central Asia and the Horn of Africa, the Andes, the Atlas Mountains of Morocco, and several other areas. These regions are characterized by harsh living conditions and are home to some of the poorest people in the world. Sustainable production of barley could play a significant role in improving food security at the household and community level.

### Food barley status

Morocco is the largest consumer of barley as food. There the crop has played a significant role in food security of households throughout history. Since the beginning of the second millennium, succeeding dynasties have relied on large barley grain storage facilities as bulwarks against hunger. About 20% of barley grain in Morocco is used as food, mainly in the mountainous and southern parts of the country. Consumption is higher in dry years. Rural dwellers consume annually an average of 54 kg per person, compared to 5.5 kg per person in the cities. A large variety of dishes, including soups, bread, potages, and couscous, are made from barley grain products.

Barley grain accounts for over 60% of the food of the people in the

### By Stefania Grando

highlands of Ethiopia. It is used in diverse recipes that have deep roots in culture and tradition. Some recipes, such as *Besso*, *Zurbegonie* and *Chiko*, which have long shelf life, can only be prepared from barley grain. Other recipes, such as *Genfo*, *Kolo* and *Kinche*, are most popular when made from barley grain, but can be prepared from other cereals. Barley is the preferred grain, after tef, for making the traditional bread called *Injera*. Barley can be used on its own or in combination with tef or some other cereal. Other recipes, such as *Dabbo* (bread), *Kitta* (or *Torosh*), *Atmit* (or *Muk*), and *Wot*, can be prepared from pure barley flour or from blends. Among local beverages, *Tella* and *Borde* are prominent, and best made from barley grain.

Barley spikes at milk or dough stage are also roasted over flame and the grain is eaten as a snack called *Eshete* and *Wotelo*, or *Enkuto* if the barley spikes are roasted dry.

In Yemen, barley is grown at 1800-3000 meters above sea level, and the grain is used in various dishes and local drinks. *Maloog* and *Matany* are two kinds of bread made from a blend



of barley flour and bread wheat flour, and barley flour and lentil flour, respectively. *Nakia* is a local drink made from boiled barley grain.

In the Andes of Colombia, Ecuador, Peru and Bolivia, barley is the staple food of farmers at altitudes between 2200 and 4000 meters above sea level. It is the crop best adapted to high altitudes, drought, salinity, and aluminum toxicity. Its earliness and cold tolerance make it suited to the short frost-free growing seasons in the high altitudes. In this area barley is finely ground and roasted into *Machica* or *Pito*; barley 'rice,' coarsely broken grain, is used for soups; and barley flakes, a relatively recent product, are eaten for breakfast. Hull-less barley is preferred, and earns a higher price than regular barley. For example, in Ecuador, variety 'Atahualpa,' with its larger and lighter hull-free kernels fetches 10% more than other varieties.

In Nepal, barley occupies only 1% of the cultivated area, but makes a significant contribution to the food security of the poor living in the inaccessible mountainous areas. And barley is indispensable in virtually every Hindu ritual. Early maturing naked (hull-less) barley is more common in the higher altitude range of east and west Nepal (Solukhumbu and Mustang districts). But in the mid-west (Karnali) regular barley is preferred over naked barley, which is also due to the food habit of different ethnic groups in these areas. Most barley product is used for food.

## Barley improvement

Most efforts in barley breeding have focused on feed and malting cultivars. International agricultural research has almost completely neglected the improvement (quantity and quality) of food barley. So, in response to requests from a number of national agricultural research systems, the barley project at ICARDA initiated a program to rectify this situation.

An international workshop on food barley improvement, jointly organized by ICARDA, the Food and Agriculture Organization of the United Nations, and Institution de Recherche et Enseignement Supérieur Agricole, Tunisia, and supported by the OPEC



*Farmers and researchers meet in Ethiopia.*

Fund for International Development, was held in Hammamet, Tunisia, 14-17 January 2002.

The workshop brought together more than 30 participants from 13 countries, representing most of the area where barley is largely used as food, from as far away as Ecuador, Peru, and Nepal.

The workshop was organized to review food-barley-based systems and identify bottlenecks in production; review present and past research efforts addressing food barley improvement; identify and describe major cultivated food barley varieties, including uses and growing environments; identify quality characteristics desired by consumers; identify constraints and research needs; and discuss and define a regional and global plan of action for research and collaboration.

Participants presented the status of food barley in their respective countries. Their talks included descriptions of traditional and new uses of barley, varieties, research activities, and the importance of food barley as compared to feed and malting barley.

All participants agreed strongly on the need to establish domestic and international networks of researchers with a common interest in food barley. They also contributed to the preparation of a global project on food barley improvement with the following components:

- Collection of baseline information and filling of gaps

- Breeding local food barley for quality and sustainable productivity
- Establishment of optimum crop management for sustainable production
- Improvement of storage
- Improvement of food barley's nutritional quality
- Development of small-scale food barley industry, and
- Seed production and multiplication.

It was also agreed that barley recipes would be collected from diverse regions and compiled in a book to promote food barley and to document local knowledge.

## The future

There is scope for the development of food barley varieties with higher and stable yield, better grain quality, and higher nutritive value. Eventually, food barley research will have a direct impact on the livelihoods of the rural people in the regions where barley is a staple food, not only by increasing sustainable crop productivity, but also by improving nutritional quality and developing barley-based local industry. ■

*Dr Stefania Grando is a Barley Breeder at ICARDA.*

*The author would like to thank all participants in the Food Barley Workshop for providing valuable information on the status of the crop.*

## Protected Agriculture Earns More Income from Less Water for Terrace Farmers in Yemen

*The rainfed terraces of Yemen are major producers of the country's food crops, but the income they earn for farmers is low. The terraces now suffer from neglect, the result of lack of investment and a scarcity of labor due to migration of young men to the cities. ICARDA and its partners are investigating protected agriculture with efficient irrigation systems as a means to boost returns in order to save the terraces and the rural way of life they support.*



*A plastic greenhouse installed on a mountain terrace in Yareem District, Ibb Province, Yemen.*

Almost 70% of Yemenis live in rural areas, growing rainfed crops of mainly sorghum, millet, maize, and pulses. The major growing season coincides with the rains from May to October. The period November–April is considered a closed season, but at low elevation, when frost does not occur and water is available, some vegetables are grown under irrigation to generate additional income. Vegetable production in open fields consumes a lot of water, so utilization of the land is limited.

Low return from farming has led to deterioration of terraces, and has contributed to a rural exodus—much of the countryside is inhabited only by women, children, and the elderly. Attempts to encourage farmers to stay have been successful only where irrigation water is available and cash crop cultivation is practiced.

Cultivation of high value crops, combined with traditional subsistence crops, might improve farmer income and reverse this trend. With this in mind, ICARDA, through its Arabian Peninsula Regional Program (APRP), and in collaboration with the Agricultural Research and Extension Authority (AREA), Yemen, initiated a research and development project to introduce greenhouse cultivation of winter cash crops in the country's terraces. The objectives were:

- Create additional income for farmers through cultivation of cash crops in the closed season.
- Introduce new techniques of cultivation and irrigation for rational use of resources.
- Intensify the use of terrace lands through the cultivation of cash crops in winter.
- Raise the return from terrace farming so that farmers will be encouraged to better manage and maintain the terraces.
- Create additional jobs for the rural population so young farmers will stay on (or return to) the land, and thereby reduce the pressure on urban centers.

### Why protected agriculture

In protected agriculture, growth environment and production timing are controlled for improved yield. Compared with open-field agriculture, it can produce high value fresh produce using less water and fertilizer, and the total yield from protected agriculture can be three times that of open-field cultivation.

Greenhouse cultivation of high value crops was introduced to farmers through a participatory process involving researchers, extension agents, and the farming community. ICARDA–APRP and AREA paid for

**By Ahmed T. Moustafa and Abdul Wahed Mukred**

construction materials and provided technical guidance, while the farmers provided the sites and constructed water reservoirs. The farm families and their neighbors participated throughout the construction process.

Plastic houses were constructed from locally purchased galvanized pipes at three sites, in Al-Mahweet, Dhela'a area—Bait Fakhr Al-Deen; in Yareem District, Ibb Province; and in Taez (southern upland area). The houses have side windows for ventilation, and doors and windows fitted with insect-proof netting purchased locally. The fertigation system consists of polyethylene drip lines fed by a plastic barrel, fitted with a filter and water meter. The barrel is fed by a small reservoir built of stone and cement 3 meters above the greenhouse level. The small reservoir is in turn fed by a pipe from a nearby dam constructed to harvest runoff during the rainy season.

The first trial was encouraging, especially at Al-Mahweet, where yield reached 9.18 kg/m<sup>2</sup> in four months.

Integrated production and protection management (IPPM) was practiced, which involved keeping the relative humidity low, and using irrigation



water sparingly. Plants were strong and healthy, and suffered low incidence of pests and disease. The crops were sprayed twice with a safe chemical, compared with the six applications typical in plastic houses without IPPM.

### Linking with the community

Field days were held in the middle of the season. Farmers from the nearby villages were invited to visit the site and discuss their views about the technology, and to comment on the likelihood of their adopting it. The following conclusions were derived from discussions among the farmers:

- Plastic house cultivation using drip irrigation to produce cash crops fits farmers' need for income diversification.
- The technology should be expanded to meet the large demand for cucumbers in the capital, Sana'a, and in nearby markets.
- Farmers are now convinced that water from open wells can be used more rationally to produce cash crops. The current methods of irrigation, e.g., furrow and spate irrigation, are wasteful and allow for only limited areas to be planted.
- Farmers showed interest in expanding the crops grown under plastic houses, which could diversify income and allow adoption of a suitable cropping pattern adjusted to local circumstances and market needs.
- The expansion of plastic house construction and management in rainfed terraces in Al-Mahweet, or similar areas, should go side-by-side with the outputs of APRP in IPPM, to avoid overuse of agrochemicals. IPPM could be adopted if proper training and materials were made available to farmers.



*Children, just back from school, with an elder in front of a newly constructed plastic greenhouse.*

### Conclusions and recommendations

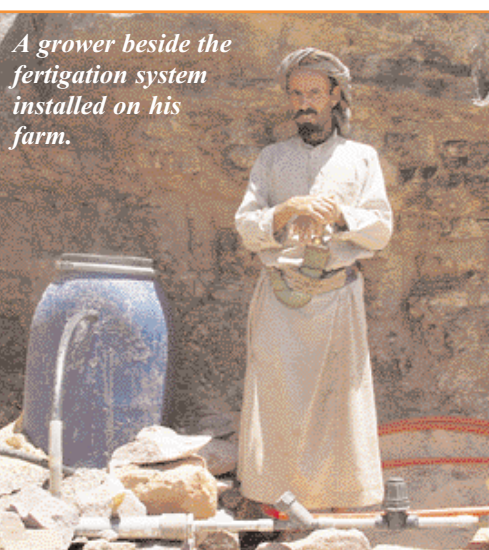
- Income from cucumbers in the first season was sufficient to cover the cost of materials and construction.
- IPPM produced high quality crops without excessive use of agrochemicals.
- The introduction of drip irrigation contributed significantly to the concept of rational use of water in the terraces of Yemen.
- There is ready demand for cucumbers produced in plastic houses, and farmers had no problem marketing their produce.
- It would be in the farmers' interest, and in the interest of the market, to increase the number of crops grown in plastic houses. Some potential crops include tomatoes, sweet melon, peppers, and cut flowers.
- The export potential of cash crops grown in plastic houses was not

explored, but the terraces in Yareem and Al-Mahweet might prove ideal for cultivation of high value, high quality crops for export.

- Farmers who participated in the pilot activity should be supported in diversifying crop cultivation. This could be supported by ICARDA-APRP and AREA.
- Protected cultivation in terraces should be given high priority by policy makers. The Agricultural and Fisheries Promotional Fund and the Credit Bank, as well as other donor agencies, should be encouraged to support terrace farmers to expand protected agriculture and the use of modern methods of IPPM in cultivation of high value crops.

### The future

ICARDA-APRP and AREA will expand this project to other terraces. A proposed project would facilitate specialized training for growers and extension staff. Different plastic house designs should be tested for their cost-effectiveness, simplicity, and suitability to the topography. A workshop will be held to promote the local manufacture of simple greenhouses to reduce the initial capital cost to farmers. In time, maybe plastic greenhouses will bring prosperity to rural Yemen, and save the country's terraces in the process. ■



*A grower beside the fertigation system installed on his farm.*



*Left: Greenhouse cultural techniques were adopted easily by growers.*

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## The Yemeni Mountain Terraces Project: Institutionalizing Community-based Integrated Natural Resources Management Research

*The terraces that cover the steep slopes of Yemen afford an incredibly beautiful view, but life in the mountains is extremely harsh. The terraces depend on scanty rainfall augmented by runoff from the rocky slopes. An old farmer, bent over his hoe, scratches and pounds the soil. A closer look reveals that the green of his terrace is cast by sparse sprigs of thinly planted sorghum. Young girls walk up and down the slope, carrying pans of water on their heads. A donkey, with dripping jerry-cans roped to its back, slowly follows. Shoeless boys in rangy jackets throw stones to guide their flocks of small mountain sheep. Groups of women, completely hidden in their black garb, balance large bunches of fodder as they trudge slowly upward. Young men, their cheeks bulging with the chewed-up leaves of the mildly stimulating qat plant, huddle in the back of a pickup truck as it bounces and pitches down a rough track along the edge of a cliff. Girls sit at a spring washing clothes in pans of muddy water. A large reservoir, hewn in the rock, is left with just a little greenish water.*

The applied natural resources management research conducted for the last four decades in developing countries by centers of the Consultative Group on International Agricultural Research, advanced institutions, and national agricultural research systems has generated numerous research outputs. These include improved techniques for water, soil and land management, rangeland management, conservation of biodiversity, and livestock improvement. Similarly, the socioeconomic research has determined factors that influence resource users' behavior and has suggested policy and institutional measures that might lead to more rational and sustainable use of natural resources.

The need for converting the results of this research into positive impact in communities has led to the emergence of a new approach to applied natural resources management. We call this approach community-based integrated natural resources management (CB-INRM) research.

Because it can identify priority problems, CB-INRM offers a much higher chance of success in developing technologies and knowledge that can solve users' real problems. This requires (1) direct and effective participation of the beneficiaries, (2) a holistic approach that takes into consideration the critical elements of



*A farmer processes his crop by hand on a mountainside in Yemen.*

the system, be they biophysical, socioeconomic, institutional or organizational, and (3) a deliberate and proactive agenda to expand the use of research results by a larger number of beneficiaries, achieved by building effective collaboration with policy makers and development organizations.

### Application of CB-INRM in the mountains of Yemen

This approach is being implemented in three small watersheds, each with 7 to

**By  
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12 communities, through a project supported by the International Development Research Centre, Canada. Participatory rural appraisals (PRA) were conducted to identify problems and suggest possible research and development interventions. Land information databases, which include



biophysical and socioeconomic data, are being developed. Comprehensive household labor data that allow disaggregated analysis by age and gender is being collected. Efforts are made to link research with non-governmental organizations, credit organizations, and farmer cooperatives. Farmer training, through traveling workshops and farmer participation in research, is an integral part of the project.

### Sources of livelihood

In surveys, farmers described the poorest households as having very few assets and mainly working for others, or sharecropping with other land users. The poorest households, with no or very small productive agricultural land, depend less on agriculture as a source of livelihood and more on their wage labor and on non-agricultural income. This means that crop-based technologies will not take the poorest households out of poverty. Other asset-building interventions, such as enabling the poor to acquire livestock, would be more appropriate.

### Water management: The first priority

Surveys and discussions with farmers have revealed that water scarcity is the most critical issue in the study areas. Communities have developed complex water management structures built through local knowledge. These include networks of channels that carry



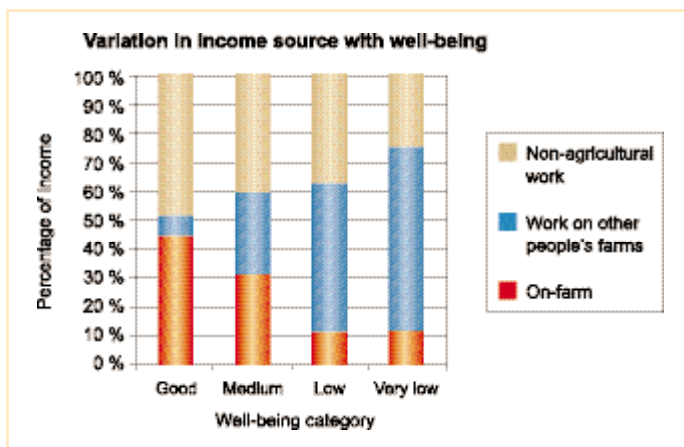
*Children bathe and play in a mountain reservoir.*

harvested surface runoff to distant fields in the rainy season, and seasonal springs with a network of diversion channels that carry water to small reservoirs and cisterns. This supports the limited irrigated agriculture. High value crops, such as coffee, *qat* and vegetables, are irrigated with this precious water. Cisterns are used to store runoff, mainly for domestic consumption. Water sharing mechanisms are based on traditional institutional arrangements, which are working well. However, several limitations were identified. Population growth, increased interest in off-farm employment, and male out-migration strain traditional institutional arrangements, which no longer provide adequately for the repair and maintenance of these water systems. Farmers cited help for water system improvements as their first priority.

information available and organizational capacity at the local level on the other. Development of community organizations that could increase awareness about available resources and reduce the related transaction costs is critical to improve the welfare of these rural communities. Such organizations could also serve as liaison for research and extension.

Water productivity in the watersheds could be improved in various ways. More surface runoff could be caught in small reservoirs. This water could be used for supplemental irrigation at critical times. Earthen irrigation channels, which guide water over long distances along the terraced slopes, could be improved to reduce leakage. Crop selection is an important issue. Due to the uncertainty of the water resources and the traditional water sharing system, water is not always given to the highest value crop. There is also potential for the use of drip irrigation for high value crops grown in plastic tunnels. All water management options need to be carefully planned and discussed with the farmers, so that downstream farmers will not be adversely affected by improved water-use efficiency upstream.

The development of cisterns for domestic and agricultural use could have an enormous impact on livelihoods in these communities. Availability of domestic water is a major problem, and women spend much of their time fetching water. However, farmers need technical help and advice on the design of cisterns,



*Farmers who earn more of their income from their own land are better off than farmers working on other people's land.*

Interest-free loans for developing water resources are available, but farmers are neither fully aware of the service nor effectively organized to access these loans. There is a big gap between resources available for community development in different national and provincial institutions on one hand and the

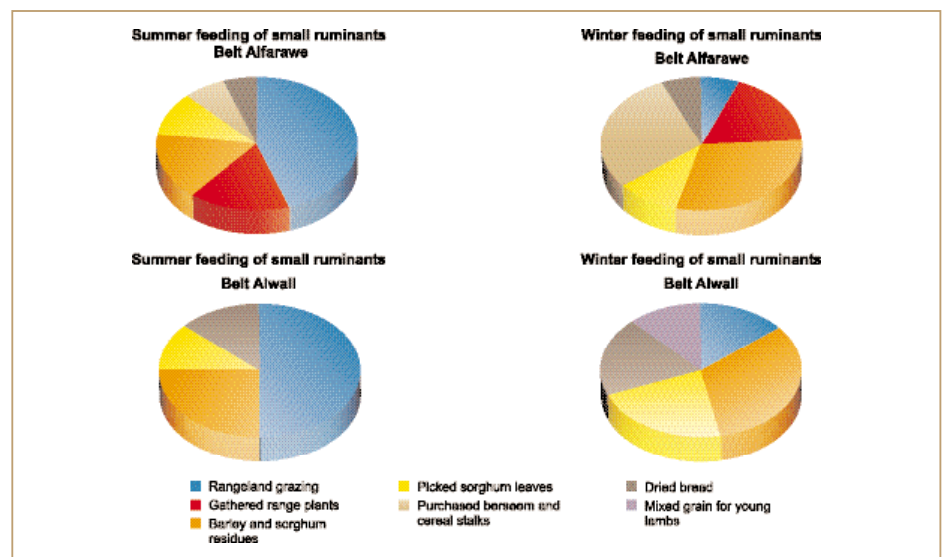
and on the optimal use of water for agriculture. Improved access to development loans through community organizations, and farmer visits to areas where such systems are used, could improve adoption.

### Introduction of livestock improvement technologies

Livestock is one of the most important sources of livelihood for the communities in the research sites. The PRA determined that feed shortage is the most important problem facing livestock producers. Children, mainly girls, spend a lot of time and effort herding sheep and goats on degraded mountain slopes. Cows are handfed, mainly by women. Farmers graze their animals on farm residues, fodder crops, and forage collected by women from different places. This subsistence practice limits the productivity of livestock. Researchers, therefore, must develop innovative and practical ways to improve livestock feed, reduce the cost of feed, and increase livestock productivity. Assessing market opportunities and farmers' ability to take advantage of these opportunities is an integral part of the livestock improvement program.

### Role of women

The role of women is critical in the mountain communities. In terms of labor, women's contribution to sustainable livelihood is substantially higher than that of the men. Women



*Feed sources of small ruminants in winter and summer.*

handle most the jobs related to livestock, including herding (done mainly by girls), rearing, feeding, collecting feed from fields and wadis, milking, and cleaning animal yards. Women and girls account for about 88% of this labor, while boys provide the remaining 12%. Women are responsible for preparing animal dung for fuel, fetching fuel wood and water, taking care of the children, and handling all domestic work. Women and girls also contribute about 31% of the labor supply for crop production and terrace repair. Groups of women travel long distances carrying collected fodder, wood, and water over steep slopes. Research and development interventions should address the drudgery that is a regular and obvious aspect of women's lives.

### Institutionalizing the approach at AREA

The CB-INRM approach requires that agricultural research institutions adapt to allow effective client-responsive research, but with agricultural research already seriously under-funded it is hard to see how such institutional change might occur. This project, however, is contributing to institutional evolution toward an impact-oriented, client-responsive agricultural research system in Yemen. The enthusiasm of Yemen's Agricultural Research and Extension Authority (AREA) researchers is already making a mark on their selected watersheds. It is important to note that successful CB-INRM research requires the support of a well funded and managed research system. This project provides AREA the opportunity to experience and evaluate CB-INRM approaches, and judge their value in improving the livelihoods of the rural poor. ■

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*Terraces sustain the high mountain communities of Yemen.*



# Oilseed Crops for the Highlands of CWANA

*Among oilseed crops (soybean, sunflower, rapeseed, groundnut, etc.), rapeseed has recorded the highest percent increase in both area (125%) and production (230%) over the past 20 years worldwide. Presently, world rapeseed production is about 36 million tonnes, from an area of 24 million hectares; China, Canada, India, Germany, France, and Australia are major producers. While the world yield average is 1.5 t/ha, the yield average in Germany is the highest among leading producers (about 3.7 t/ha), and in India the lowest (about 0.9 t/ha).*



*Rapeseed grows well under irrigation near Mashhad city, northeastern Iran.*

**T**he Central and West Asia and North Africa (CWANA) region is a major importer of vegetable oil. Yet, growing conditions in CWANA highlands, where a Mediterranean climate predominates, are generally suitable for most oilseed crops. In addition to vegetable oil production, the adoption of such crops offers the potential to introduce a beneficial diversity to the crop rotations practiced in the region.

## Rapeseed and canola

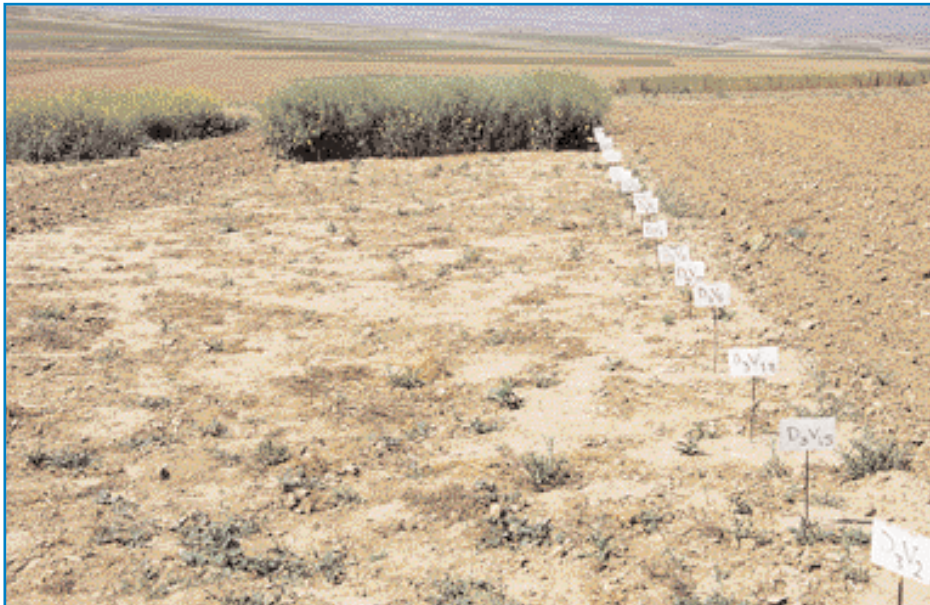
Rapeseed, also called rape or colza, is a cruciferous plant of the genus *Brassica*, and belongs to one of two main species: *Brassica rapa* and *Brassica napus*.

**By Abdul Rashid,  
Akhtar Beg, Ahmed A.  
Attary, Habib Ketata, Naazar  
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K. Alizadeh Dezaj**

*Brassica rapa*, commonly known as “turnip rapeseed,” is a diploid, self-incompatible species with small (1 mm diameter) round seed, yellow or brownish in color. This species is generally more cold tolerant and has a shorter growing season. A considerable area is grown to the species in Canada, China, and South Asian countries. In contrast, *Brassica napus*, known as “common rapeseed,” is an amphidiploid, self-compatible species

with darker and slightly larger seed. Yields are higher in temperate, humid climates conducive to a longer growing season, such as in western Europe.

Although traditionally grown in China and South Asia, rapeseed increased in importance in North America and Europe some 50 years ago with the breeding of higher quality types. The new cultivars, first in the form of open pollinated varieties (OPV), and thereafter as hybrids (HV), produce an edible oil low (<2%) in erucic acid, an undesirable fatty acid, and a seed meal low in harmful sulfur compounds known as aliphatic glucosinolates (with concentration of < 30  $\mu\text{mole/g}$  of oil-free meal). The name “canola” was coined for these improved rapeseed types. Canola oil



*At Shirvan, a highland site (1150 meters elevation) in northeastern Iran, winter temperatures drop to  $-14^{\circ}\text{C}$  or below. Rapeseed cultivars tolerant to cold might survive the winter if the crop is well established before the onset of cold weather. In this photo, rapeseed plots (background) irrigated at planting in the fall developed well and survived the winter, in contrast to the non-irrigated plots (foreground) in which the same cultivars were killed by cold.*

has a beneficial effect on blood cholesterol, and canola meal is a suitable feed for livestock and poultry, because of its high protein content (36%–40%) and balanced amino-acid composition. The nutritive value of canola rapeseed meal was further improved by the recent reduction of hull content in yellow-seed types.

Both spring and winter growth habit are found in both species. Winter types have a moderate vernalization requirement, a longer growing season, and are generally more cold tolerant than spring types. However, rapeseed does not possess the level of cold tolerance found in wheat. Very young seedlings, at two- to three-leaf stage, are particularly vulnerable to cold damage, and are usually killed by exposure to temperatures below  $-5^{\circ}\text{C}$  for a short period. In contrast, young plants that reach the rosette stage (6–8 leaves/plant) can survive winter temperatures of  $-15^{\circ}\text{C}$  or below. In rainfed highlands of most of CWANA, good stand establishment, with 6–8 leaves/plant of about 15–20 cm height prior to the onset of cold weather, is a prerequisite for rapeseed survival through the winter. Because in the CWANA highlands moisture can be lacking at the time of fall planting, the application of irrigation at this stage

can guarantee good plant establishment and prevent total crop loss. The photo above shows the “life-saving” effect of such irrigation at Shirvan, a highland site in northeastern Iran, where the temperature dropped to  $-10^{\circ}\text{C}$  during winter 2002. In irrigated, higher-elevation, colder sites at Zanjan (1660 meters elevation) and Hamadan (1640 meters) in northwestern Iran, rapeseed suffered little cold damage, although the temperature dropped to about  $-20^{\circ}\text{C}$ . In dryland, high-elevation areas ( $>1400$  meters elevation, latitude  $>30^{\circ}\text{N}$ ), where winter temperature drops to  $-15^{\circ}\text{C}$  or below, spring rapeseed types are recommended, with planting done as soon as field conditions allow, i.e., generally in early March. However,

winter-planted rapeseed yielded much higher than spring-planted rapeseed, i.e., about 5–6 t/ha compared with 1–1.5 t/ha under irrigation. Similarly, in the Mediterranean conditions of the CWANA highlands, with a seasonal rainfall of 350–450 mm, a rainfed rapeseed crop might yield 2 t/ha or more when sown in winter, but only 0.7 t/ha when sown in spring. Among winter rapeseed cultivars with superior performance in highlands of Iran are the open-pollinated varieties ‘Okapi,’ ‘Orient,’ ‘SLM-046,’ ‘Licord,’ and ‘Fornax.’ Among the spring types, the hybrid varieties ‘Hyola 401,’ ‘Hayola 308,’ and the OPV ‘Option 500’ produce good yield, particularly under irrigation.

## Mustard

Another, amphidiploid, self-compatible species, *Brassica juncea*, commonly known as Oriental mustard, is widely grown in South Asia and China for its oil, and more recently in Canada, Australia and the USA, where it is mainly used as condiment. However, progress has been made recently in developing canola-quality mustard cultivars, which makes it possible to also use this species for its oil. Compared to rapeseed, mustard is taller, more resistant to lodging and shattering, and more tolerant to drought and heat. New, improved mustard cultivars, therefore, might be more suitable in drier and milder-climate highlands of CWANA, with elevations no higher than 1000 meters.

Proper cultural practices are required for the establishment and development of a good rapeseed or mustard crop. Because the seeds are



*A farmer looks over a field of mustard, which is much taller than the adjacent rapeseed plants at left. Mustard is better adapted to drier conditions than canola. Both grew well at Kermanshah, Iran (1400 m elevation), in 2001.*



small, a good seedbed with fine soil texture, an even seeding depth of 2-4 cm, and a proper seed rate, i.e., 6-9 kg/ha, are essential. Adequate application of N-P-K and S fertilizers, and a sound integrated disease and pest management program are also needed.

### Soybean and sunflower

While soybean (*Glycine max*) is grown in summer and is generally confined to well-watered lowlands, sunflower (*Helianthus annuus*) can be grown in CWANA highlands (e.g., Central Anatolian plateau in Turkey) as a summer crop, but it lacks the cold tolerance necessary for a successful winter crop. The sunflower seed produces over 40% high-quality edible oil with 89% unsaturated fatty acids. However, sunflower yield in most of the CWANA highlands is low, in comparison with other competing summer crops. This explains the trend of reduction in area grown to sunflower in CWANA.

### Safflower

Safflower (*Carthamus tinctorius*) offers better attributes as an oilseed crop for the CWANA highlands. It is much more drought tolerant than all other oilseed crops and most other cultivated crops. It is also more tolerant to combined cold and drought stress at the seedling stage than is rapeseed. In rainfed cultivation at Shirvan, in northeastern Iran, safflower survived cold and drought stress (with no appreciable rain during the first six weeks following planting, and a minimum winter



*Sunflower is sown in spring and grows relatively well in the highlands.*

temperature of about  $-10^{\circ}\text{C}$ ) while all rainfed rapeseed seedlings in neighboring plots were killed. However, safflower is not as cold tolerant as wheat, and in colder ( $<-15^{\circ}\text{C}$ ) highlands it might best be planted in late February and early March as a spring/summer crop. Its deep taproot system enables it to grow on residual moisture for the whole season.

Safflower has been cultivated for its colorful flowers, the pigment of which is used as a natural food colorant. However, its seed oil is also of

excellent quality, good for cooking and frying, for margarine making, and in salad dressing. The major shortcomings of safflower are (1) its low yield potential ( $\leq 4$  t/ha, 20%–45% oil content), (2) its long (10-month) growing season if winter sown, and (3) its ability to sap soil moisture, leaving none for the following crop. Until these attributes are modified, safflower will continue to be relegated to marginal areas, including certain highlands, where other cultivated crops cannot grow. ■



*Safflower is another oilseed crop that is particularly well adapted to dryland conditions in both lowlands and highlands. The photo above shows a young crop of safflower, and the photo at left shows the same crop 2 months later, at Kermanshah, Iran. Safflower is also more tolerant to cold than other oilseed crops.*



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## Versatile Barley Varieties Help Highland Mexican Farmers Cope with Globalization

*Barley production in the highlands of Mexico dates from the time of the Spanish conquest. Today, all of the barley planted in the region is used for malting to produce beer.*

*Globalization, most notably the North American Free Trade Agreement, is prompting farmers to look for new crops, such as forage barley, which appears to offer an economically viable alternative to malt barley production.*



*Barley trials at Toluca Experiment Station, over 2600 meters above sea level.*

**B**arley has been grown in the highlands (over 2200 meters above sea level) of Mexico since the Spaniards introduced the crop about 500 years ago. It is mostly used to make beer, production of which has increased significantly in the country in the last few years due to an increase in exports. In some Mexican states, such as Hidalgo, where 120,000 hectares are grown annually, barley is the main crop. In other highland states, such as Mexico State, barley is the best alternative in years when the maize crop fails or cannot be planted due to

**By  
Flavio Capettini**

adverse weather conditions. Despite the success of Mexican beer worldwide, new trade agreements, specifically the North American Free Trade Agreement, have led to an increase in imports of malting barley from the United States of America and Canada. In response, barley growers are looking for new opportunities, and forage barley appears to be a good

alternative to malting varieties. Although it cannot fetch a premium price for quality, high-yielding forage barley developed by the ICARDA/CIMMYT (International Maize and Wheat Improvement Center) Latin American Regional

**Table 1. Barley grain yield from trials in drought conditions in the State of Mexico.**

Genotype	Yield (t/ha)
Line 12	5.0
Line 10	4.8
Line 37	4.4
Line 33	4.3
Line 52	4.2
Line 39	3.3
Line 64	3.2
<b>Galeras/PI6384//ESC.II.72</b>	<b>2.8</b>
<b>Weebill 1 (wheat)</b>	<b>3.4</b>

Varieties in bold are the drought-resistant checks.

*Crossing block of the ICARDA/CIMMYT barley breeding program.*





*Field day at Almoloya, State of Hidalgo.***Table 2. Grain yield, protein and reaction to main diseases of promising varieties tested for more than two years in the State of Hidalgo.**

Variety	Grain yield (t/ha)			Grain protein (%)	Rust		
	Tecoco-mulco	Almo-loya	Mean		Yellow	Leaf	Scald
Arupo//K8755/Mora	3.6	5.5	4.5	11.4	MS	R	R
Zig Zig	3.5	5.1	4.3	12.1	R	R	R
Capuchona 20	3.7	4.7	4.2	13.5	R	R	R
Tocte	2.3	4.8	3.6	12.3	R	R	R
Sen	1.9	4.2	3.0	15.7	MS	R	R
Esmeralda (local cultivar)	2.5	3.3	2.9	13.0	MS	MR	MS

R=Resistant MS=Moderately susceptible.

*Hooded barley cultivar 'Capuchona' released in the State of Mexico.*

Program has been proven to deliver a higher total income for growers than does malting barley. Farmers are able to sell the grain when the price is good, or use the barley to feed their lambs and goats when the grain price is low.

The environment in the Mexican highlands is diverse and variable, ranging from very dry, with less than 200 mm of precipitation in some years, to areas where annual rainfall reaches 500 mm. The ICARDA/CIMMYT program is helping in the development of barley varieties adapted to drought (Table 1), as well as varieties adapted to more favorable environments.

In order to achieve success, the program has signed research collaboration agreements with the Agriculture Secretariats of Hidalgo and Mexico State. The strategy includes the generation of variability through targeted crosses at research stations, followed by selection under target conditions, and extensive on-farm testing throughout the target area. The experiments and variety demonstration plots are presented to farmers during field days, which also afford an opportunity to discuss aspects of barley production and market preferences. In Mexico State, a hooded barley variety, 'Capuchona,' has been released and is generating excitement among growers because of its versatility. The cultivar is grazed, cut for silage, or harvested for grain. In Hidalgo, three new cultivars are expected to be released within the first three years of the project.

Results after two years are encouraging, in terms of yield and quality of tested varieties (Table 2), when compared with 'Esmeralda,' the only malting cultivar grown in the region. Besides the increase in production, additional benefits more difficult to measure include the change in attitude among growers, as they become less dependent on the large malting companies and less vulnerable to market fluctuations. ■

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## Rehabilitation of Pre-Hispanic Terraces in the Peruvian Andes

*Over half a million hectares of agricultural terraces still exist in Peru, providing striking evidence of the achievements of ancient civilizations. Terraces formed the foundation of Incan food security, providing soils of good quality and moisture retention for the cultivation of maize, potatoes, and other crops. Combined with efficient gravity irrigation systems, they produced large amounts of food for populations comparable to those of the Andes today. Food surpluses were kept in specially designed storehouses, which still impress visitors.*

Many people who marvel at the rows of mostly abandoned terraces, some in the most remote mountainous locations of Peru, are inspired to consider rehabilitation as an answer to current problems of soil erosion, low agricultural yields, and rural poverty. It is also argued that rehabilitation will redirect a share of investment to the neglected Peruvian highlands, away from the more prosperous coastal areas. For, sadly, the descendants of the ancient terrace builders are now the most marginalized and poorest people in Peruvian society.

The Cusichaca Trust (CT), a Peruvian non-governmental organization that has worked for rehabilitation of irrigation infrastructure and terraces for many years, and which has pioneered the re-establishment of pre-Hispanic irrigation technology, was first to approach ICARDA regarding the terraces. CT was working in the Chicha-Soras Valley in the Departments of Apurimac and Ayacucho, and was searching for answers to a number of questions. Why, if there is a supposed shortage of agricultural land, are terraces seldom rehabilitated by farmers? Why is it so difficult to mobilize voluntary community labor for irrigation and terrace rehabilitation? How can support for poverty alleviation and terrace rehabilitation best be combined?

ICARDA encouraged further networking with other organizations involved in soil conservation and terrace rehabilitation. A consortium of five institutions was formed to coordinate actions with PRONAMACHCS (Programa Nacional



*Terraces in the Chicha-Soras Valley. Twenty-five percent of terraces are used for crops, while other areas lie fallow, but over half of terraces are abandoned, and most, including those in use, are poorly maintained.*

**By  
Abelardo Rodríguez and  
Thomas Nickalls**

de Manejo de Cuencas Hidrográficas y Conservación de Suelos), the government institution in Peru responsible for watershed management and the largest of its kind in Latin America. Socioeconomic studies were commissioned and coordinated by ICARDA; CT staff undertook participatory rural appraisals in eight districts in the Apurimac and Ayacucho regions, and inter-institutional seminar-

workshops were conducted with farmers taking an active role.

An often-asked question is why terraces were ever abandoned in the first place. A massive abandonment of terraces occurred just after the Spanish conquest due to the decimation of the native population brought about by enslavement and epidemics. Structures simply deteriorated due to a lack of labor for maintenance. Other reasons offered include climate change and seismic activity. Many blame heavy-footed cattle, which replaced the more dainty footed *llamas* and *alpacas* (South American camelids).



Rather than focus on a debate over abandonment in the distant past, ICARDA and CT chose to concentrate on questions surrounding more recent abandonment and deterioration. Why weren't farmers maintaining the terraces that were still in reasonably good shape? And why had some old irrigation systems apparently been abandoned in the last few decades?

Results of preliminary studies revealed that there has been a shift of focus in the Andean economy. In the past, crop production was the main economic activity; now it is just one of a range of survival strategies poor farmers adopt, which also include livestock production and temporary migration to cities for employment. Subsistence crops are still produced for food security, barter, and for sending to the capital, Lima, as part of reciprocal family relationships, but it is livestock production that provides farmers with cash income. While the equivalent monetary value of subsistence crops in the Chicha-Soras Valley averages a mere US\$380 a year per family, livestock production provides an average family with more than US\$530 in cash income.

Irrigation systems, on which terrace agriculture depends, have also fallen victim to poor coordination among users and insufficient maintenance. Communities in the Chicha-Soras Valley are now more fragmented and less homogenous than in the past. Traditional authorities, once central to a rigid system of communal resource management, are now weaker. Traditional systems of land management, such as the *layme* system, have been largely abandoned. The *layme* system involved the sectoralization of cropping rotations,



*Returns to labor from terrace agriculture are low due to low yields, and high transportation and maintenance costs.*

with particular sectors assigned by community authorities for cultivation or fallow each year, with the fallow sectors being used for communal grazing. Cultivation is now uncoordinated. Cultivated and fallow plots are scattered over various sectors, which results in animals grazing in cultivated areas, and thereby damaging crops.

An economic analysis of terrace cropping confirms the view that low yields and lack of access to markets mean little economic incentive for terrace improvement. Yields will not

cover the costs of rehabilitation unless combined with other improvements in linking agricultural production with markets. After family food requirements have been met, crops need to be sold, which farmers find difficult or impossible due to their remote location and inadequate roads.

The information collected in the Chicha-Soras Valley painted a rather bleak and depressing picture. Was this yet another case of outsiders hitting on a development idea that farmers would never take up? And the question still remained; why should they?

Through contacts with the Peruvian Ministry of Agriculture, ICARDA had previously visited the district of Andamarca, Ayacucho, which provides a contrasting positive example of terrace management. This was followed up by further visits by CT. On arrival in Andamarca one is immediately struck by the rows of well-maintained terraces



*Terraces in Andamarca, Ayacucho, are in spectacularly good condition.*





rising up from the rivers to the mountains above. The community is organized; it carries out annual maintenance, and still uses pre-Hispanic irrigation systems to irrigate most of the terrace plots. Water *fiestas* and traditional systems of management elaborately combine religion, myth, and ritual with regular maintenance activities. Large areas of alfalfa are grown on the terraces, the revenue from which pays for irrigation repairs. Special ramps have been constructed so that cattle can climb from one terrace to another without stepping on the terrace walls.

The complete explanation as to why terraces are so well managed in Andamarca compared to other areas is still not available. One factor is, obviously, that Andamarca's community institutions are stronger and are better able to organize collective actions. Other factors might be principally economic, such as better integration of livestock production, or they might be more associated with the conservation of a traditional way of life. Whatever the reasons, it is clear that there is a lot to learn from the farmers of Andamarca. CT has used this positive example as a focus for farmer-to-farmer visits, support for institutional strengthening, and the exchange of technical know-how. It is hoped that the lessons learned in Andamarca can be used to promote terrace rehabilitation in the Chicha-Soras Valley and other areas.

The evidence suggests that livestock production can be integrated with terraces successfully and can provide revenue for terrace maintenance. For other communities, livestock production might be the best entry point for terrace rehabilitation programs if integrated with the rehabilitation of irrigation systems and initiatives focused on the production of irrigated fodder crops. Andean farmers care most about livestock production, and the link to terraces through irrigated fodder needs to be demonstrated and promoted. The sustainability of irrigation depends on how well communities can coordinate irrigation operation and maintenance. As with so many other issues related to resource management, we keep coming back to community organization, which is of fundamental importance.



*Strong community cohesion and community institutions in Andamarca provide for effective resource management and regular maintenance of terrace and irrigation infrastructure.*

The community management of grazing has been flagged as a major issue in the Chicha-Soras Valley and, with facilitation from ICARDA and CT, local community leaders are already planning to reintroduce the *layme* system of land use. Community initiatives of this type need to be supported and community institutions strengthened for sustainable resource management. Community organizations need to be sufficiently powerful, but they also need to be accountable to the communities they serve and be bound by democratic processes.

Crop production also has to improve by other means, so that the benefits of terraces can be maximized. Improved crop rotations, increased use of manure, more efficient use of irrigation water, and an improved portfolio of crops linked to markets all have a part to play.

In many areas of Peru, tourism might support terrace rehabilitation. The community authorities in Andamarca are trying to improve local hotels and are providing information on local archeological sites, but interest seems to have increased most from a poster showing rows of its pristine terraces stretching into the distance. Tourists are not only attracted by the terraces, but also by the traditional livelihoods and local culture encompassed in this dynamic landscape.

Of course there is no magic wand.

The economics of terrace agriculture are marginal. The returns to farmers' labor are very low due to low yields, distance, and non-articulated markets. Poverty is a central problem in the Andes, and any initiative aimed at terrace rehabilitation must address this issue. We cannot impose solutions, but can only facilitate change by information sharing, appropriate extension and training, and through the collaborative efforts associated with participatory research.

Most Andean farmers are immensely proud of the achievement of their ancestors. While the institutional and economic conditions today are totally different from those of ancient Peruvian societies, the unchanged requirements of water and soil for crop and fodder growth make the technology of terraces ever applicable. Rising Andean populations, the need to use land more intensively, and the need to preserve soil fertility for future generations means that terrace rehabilitation will continue to be part of an integrated national strategy for poverty alleviation. ■

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# Goats, or Scapegoats for Desertification: Time to Take Another Look at Firewood Demand in Peru

*Goats have been turned into scapegoats when it comes to explaining desertification in Peru's northern dry forest, but ICARDA and its national program partners are trying to set the record straight. Strong demand for firewood and charcoal is the more likely cause of forest degradation, and alternative livelihood options for pastoralists and diminished demand for wood are the most reasonable solution.*

**T**he tropical dry forest of northwestern Peru, which once covered an area of 20,000 km<sup>2</sup>, has suffered severe desertification mainly during the last 50 years. While few disagree that desertification is occurring, there is disagreement on the relative impact of different human activities and on the measures necessary to stop desertification.

Many Peruvian officials and some scientists blame desertification on goats, whose uncontrolled access to the dry forest allows them to feed on young plant shoots. Agropastoralist communities in the dry forest have bred goats since the time of the Spanish conquest and 20% of the Peruvian goat population is raised in the region. At present there are 25,000 families of agropastoralists in the dry forest, mainly goat-keepers, typically owning about 40 animals.

Other scientists argue that numbers of animals are still low compared to forage production rates and that damage is limited by the agropastoralists' lack of ability to increase herd size during brief periods of intensive rainfall. The climatic phenomenon known as 'El Niño' causes very high annual rainfall (2200 mm–3000 mm in two to three months) approximately every five to eight years, while long-term average annual rainfall is low at 100 mm–400 mm. It is argued that goat-keepers cannot buy extra goats during years of abundant forage because of lack of



*To cut or not to cut; this is the dilemma faced by the inhabitants of the dry forest.*

**By Abelardo Rodríguez and Margarita Uhlenbrock**

credit and because all goat-keepers wish to keep their goats during this time, rather than sell them. With no livestock added to the system, the numbers cannot increase fast enough to have an impact on seedling establishment production during the critical 2–3 month period after the 'El Niño' rains. Only a successive number of years of high rainfall, during which stocking rates could build up, followed by a dry year would cause overgrazing, but this happens very infrequently.

To explain why goats and their keepers are blamed for deforestation, it should be remembered that goat-keepers have a very low social and economic status and that they have little lobbying capacity with government institutions. In Peru, goats are associated with poverty, destitution, and traditional practices. Goat-keepers are not included in forest

policy and receive minimal support from the government.

ICARDA has undertaken research in the region to fill some of the gaps in the knowledge related to this debate. The aim of the research has been to understand the human–environment interactions that might affect desertification and to find ways of alleviating poverty and supporting sustainable livelihoods for this marginalized group of agropastoralists.

One-hundred and sixty families were interviewed, distributed over six localities over four ecological zones in the region. Information was collected on family size, household consumption, levels of education, animal ownership, access to credit, domestic water supplies, access to irrigation, and on household income derived from agriculture, livestock and cheese production, firewood collection, and other on- and off-farm activities.

The estimated per capita income in 2000 was less than US\$0.80 per day. The poorest 25% of agropastoralists have a per capita income of US\$0.23 per day. Although almost 95% of families own goats, livelihoods are diverse. In four out of the six localities, firewood extraction provides more income than livestock and cheese production. Respondents gave figures for household consumption and for firewood sold in markets. They reported that 2000 kg/month/household was used for domestic use, representing 60% of total firewood extraction. This figure is

three-times the domestic firewood consumption rate typical in other similar parts of the world, and is probably inflated because householders do not want to admit to over-exploitation of firewood for commercial gain. Because an unknown proportion of the firewood reported as being for domestic consumption is probably sold for income, the total rates of extraction need to be considered. Domestic and commercial extraction combined averages 3400 kg/month/household. Much is sold to nearby villages, but a significant proportion is consumed as charcoal in the coastal cities. For instance, the dry forest supplies 34% of the charcoal consumed in Lima.

ICARDA's research shows that the principal reason for desertification is not goats, but the overexploitation of the forest for firewood and charcoal. Previous studies have suggested that agropastoralists are not excessive in their extraction of firewood, a finding that is drawn into question by this most recent study. This has important ramifications when it comes to devising strategies to arrest desertification. If agropastoralists can find alternatives to firewood extraction to supplement their income, then they might be encouraged to manage the forests more sustainably. Ironically, goats and goat products might provide their best livelihood alternatives, and, therefore, the best hope for alleviating further environmental damage.

Generally there is a negative correlation between income derived from firewood extraction and income derived from goat production, and a particularly strong negative correlation between the extraction of firewood and the production of goat cheese. The locations of Cañas and Pampa Larga have the most cheese production, while

**Right: Small ruminants live off the annual and perennial vegetation. Below: Water is the main factor limiting livelihoods in the dry forest of Peru's north coast.**



Both agropastoralists and urban consumers of charcoal have an interest in the preservation of the forest. Awareness campaigns to publicize the link between deforestation and the charcoal industry might persuade urban dwellers

they are also the areas of least firewood extraction.

Proper control of commercial firewood extraction requires more efficient and better-resourced local regulatory mechanisms and law enforcement authorities. But, it is unlikely that the extraction of firewood can be controlled by edict alone.

Aside from finding profitable alternatives to firewood extraction, desertification might be reduced by reducing the need for firewood for cooking in households and restaurants. High-efficiency stoves and bio-digester systems need to be further investigated. At present, because people take their water mainly from contaminated open wells, large quantities of firewood are used to boil water to make it safe for drinking. Improved water supplies would reduce firewood extraction for domestic purposes.

to buy charcoal from forests managed sustainably. At the same time, agropastoralists need to be supported in efforts to diversify livelihoods away from firewood extraction and to preserve forest resources to sustain future livestock and cheese production. Rather than being part of the problem, goat-keepers can be part of the solution. They have already developed livelihood strategies that are alternatives to excessive firewood extraction.

There is often a tendency for marginalized rural groups to be blamed for environmental degradation, as they have little public voice and their interactions with the environment are more obvious, compared for instance with an urban consumer of charcoal. The main culprits of desertification are failure of the market to reward restraint in firewood extraction, institutional failure to manage forests sustainably, and lack of livelihood alternatives. Solutions can only be found by treating goat-keepers as partners in resource management and in the socioeconomic development of the region. And the sustainable policy decided upon might well involve goats. ■

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**Small ruminants graze in an area being assessed for productivity and forage utilization. ICARDA and its national program partners are working to reveal the true causes of desertification and are helping to devise strategies to stop it.**



## Integrated Management of Sunn Pest: A Safe Alternative to Chemical Control

*ICARDA scientists and their partners in research for development have come up with integrated management approaches to combat Sunn pest, a very damaging insect affecting wheat and barley production, especially in the highlands. Some options for Sunn pest integrated management are ready for extension to farmers, but success will depend on a policy move away from reliance on chemical pesticides.*

**S**unn pest (*Eurygaster integriceps*, Puton) is a very destructive insect pest of wheat and barley in Syria, Iraq, Iran, Turkey, Afghanistan, and Lebanon, as well as in Central Asia and the Caucasus, Bulgaria, and Romania. Both nymphs and adults cause damage to plants and reduce yields and quality by feeding on leaves, stems, and grains. Apart from the direct reduction in yield, the insects also inject chemicals that greatly reduce the baking quality of the dough. If as little as 5% of the grain is affected, the whole grain lot might be

By  
**M. El Bouhssini, R. Canhilal  
and A. Aw-Hassan**

rendered unacceptable for baking.

Sunn pest infestations, which can lead to 100% crop loss in the absence of control measures, affect about 15 million hectares annually. About US\$40 million is spent each year on pesticides. For example, about 1.5 million hectares in Turkey and Iran, 240,000 in Afghanistan, and 200,000 in Syria are sprayed against the pest. In addition to the high cost of chemical control, insecticides pose a risk to nature's balance, human health, water quality, wildlife, and the environment as a whole. The present insecticide-based strategies must be replaced with multi-dimensional integrated pest management (IPM) approaches. In collaboration with its partner national agricultural research systems, along with the University of Vermont, USA; CABI Bioscience; and the Natural Resources Institute, University of

Greenwich, UK; and with support from the United States Agency for International Development; the Conservation, Food and Health Foundation, USA, and the Department for International Development, UK,

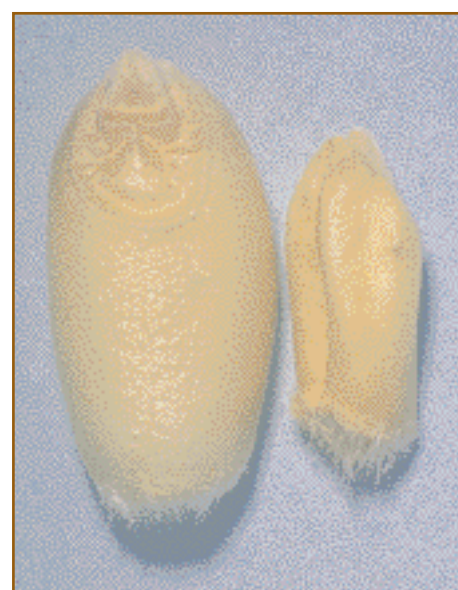


*Sunn pest adults feeding on a wheat spike.*



*Above: Sunn pest damage on leaf.*

*Right: Sunn pest damage on shoots.*



*Sunn pest damage on grain. Compare the shriveled infected grain on the right, to the healthy grain on the left.*





*Bread made from dough tainted by Sunn pest. The bread on the right, made from grain with a higher level of Sunn pest damage, is of unacceptable quality.*

ICARDA is developing IPM options for the management of Sunn pest making use of egg parasitoids, entomopathogenic fungi, host plant resistance, sex pheromones, and cultural practices, such as adjusting planting date and use of early maturing varieties.

Work on egg parasitoids has involved surveys to identify parasitoid species in Sunn-pest-prone areas and estimating the level of parasitism. Several species have been identified that seem to have a big role in reducing Sunn pest populations. The level of parasitism can reach 90% or more by the end of the growing season. Conserving these natural enemies is our challenge, and one way to achieve that is through the rational use of pesticides. Pesticides that are less harmful to natural enemies are used, and only when necessary, once the economic threshold is reached.



*Egg parasitoids of Sunn pest.*

More than 300 fungal isolates have been collected from Sunn pest overwintering sites in West and Central Asia; this represents the largest collection of Sunn pest entomopathogenic fungi worldwide. Based on laboratory and

greenhouse bioassays and preliminary fieldwork, several isolates have shown great potential for use as biocontrol agents. Work on formulation is underway and more field tests will be conducted next season, including some limited tests of these materials at IPM pilot sites to be established in farmers' fields in Syria, Iran, and Turkey.

A methodology for screening germplasm for resistance to Sunn pest using artificial infestation in field cages has been developed. Several bread and durum wheat lines and wild relatives have been found that are resistant at the vegetative stage. These sources of resistance have been given to breeders for use in their programs.

The IPM options will be extended to farmers through a participatory approach using farmer field schools formed around each of two IPM pilot sites in Syria, Iran, and Turkey starting next season. The biggest challenge in implementing IPM for Sunn pest management is national agricultural strategies that rely on



*Fungus-infected Sunn pest.*

progress in IPM. Public awareness and education at the level of public institutions, farmer organizations, and farmers are crucial for the success of



*Wild relatives of wheat: susceptible (in the middle) versus resistant.*

chemical control. The cost of chemical control is borne by governments. So faced with Sunn pest infestation, farmers apply pressure to their political representatives, who in turn request the government to spray. Until policy is changed to devolve the insect control responsibility to farmers and remove the disincentives for adopting IPM as an alternative to agrochemicals, it will be very difficult to make significant

such policy change. Studies assessing the potential impact of IPM options are an integral part of this research. The results should provide policy makers with important information on which to base their decisions. ■

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## Time-tested Pitcher Irrigation Helps Green the Slopes of Khanasser Valley

*Khanasser Valley in northern Syria has much in common with dryland areas throughout Central and West Asia and North Africa. The Valley's 11,000 residents rely mostly on the land for their survival, yet find it harder and harder to maintain a balance between resource utilization and conservation. The result is land and water degradation that threatens the long-term productive capacity of the Valley. In response, some ICARDA researchers have taken a fresh look at an ancient technology, pitcher irrigation, which could lead to the re-greening of Khanasser's barren slopes.*



*Women in Serdah plant an olive tree beside clay pots that will seep water to sustain the plant through the hot, dry summer.*

In its simplest form, pitcher irrigation entails burying an unglazed, porous clay pot next to a seedling. Water poured into the pot seeps slowly into the soil, feeding the seedling's roots with a steady supply of moisture. It is one of the most efficient and least costly irrigation systems ever devised, ideal for small farmers trying to eke a living out of dry marginal

**By Zuhair Masri**

land. In fact, it is even recorded in Chinese texts dating back more than 2000 years.

Since 1997, ICARDA has been working with farmers in Khanasser to test the potential of pitcher irrigation to

grow olive trees, and other fruit trees, on the barren valley slopes. Ten small farmer-participatory applied research sites now flourish, and the success has caught the interest of neighboring farmers.

It is hoped that the pitcher technology can help reverse some of the severe degradation that has occurred in recent years in Khanasser, which has seen trees felled, slopes overgrazed, and soil used up and eroded due to unsustainable land-use and irrigation practices.

### Farmer participatory research

Among the established sites, two trials were set up to compare pitcher irrigation with the farmers' regular practice of hand watering without pitchers. Olive trees were established in Serdah, a village in the foothills of Jebel Shbeith, and Qura'a, in the foothills of Jebel Al Hass. In each village, Roman style cisterns had recently been built to collect and store water, 12.5 m<sup>3</sup> and 27 m<sup>3</sup>, respectively.

The farmers prepared the plantations themselves. They built simple stone bunds, earthen graded bunds, diversion ditches, and retention



*Farmers learn about the benefits of pitcher irrigation, cisterns, and water harvesting in Khanasser Valley.*





*Left: A young olive tree is fed by pitcher irrigation on a Khanasser Valley hillside.*

*Below: Farmers gather around a cistern to learn more about pitcher irrigation and other water-efficient dryland technologies.*

ditches to collect and concentrate runoff around the trees. During the dry season, the trees without pitchers were watered using buckets four times per month. At the same time, the pitchers were filled with water from the cisterns as needed.

The pitcher irrigation used less water, and all the trees survived the dry period. A number of farmers in neighboring villages have decided to try growing fruit trees using pitcher irrigation, which is a breakthrough considering that fruit trees entail a

relatively long-term investment—5-7 years before they bear a good crop.

### Community involvement

ICARDA's soil conservation and land management project works closely with communities and groups to create a range of practical options through farmer-led and down-to-earth experimental study. A survey of farmers in Khanasser Valley has suggested that:

- Any land rehabilitation measures in the valley must be adapted to fit the land utilization and life patterns of the farmers.
- The conservation of the natural resources in the area—the establishment and maintenance of the conservation measures—should require only minor financial and labor input from the farmers.
- The major activities should be in winter, after the sowing of the rainfed fields, when the farmers are present in the village.

Tree plantations on the mountain slopes can conserve soil and prevent erosion. Trees, such as olives, require only minor inputs, and only when the plantation is being established. Olives are harvested in November, when most of the farmers have returned to the village.



### Just the beginning

By working with farmers to find and improve practical technologies, ICARDA can hope to improve livelihoods and conserve natural resources in Khanasser Valley, and then help spread that success to other dry areas around the world. ■

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#### Benefits of pitcher irrigation:

- Efficient—water is delivered directly to the root zone, and less water is lost to evaporation
- Inexpensive—makes use of local materials
- Easy to use
- No need for water pressure
- No need for water filters



*The water gradually seeps out through the porous walls into the root zone under hydrostatic pressure and/or suction, to maintain plant growth around the pitcher.*



## In Search of a Natural Alternative to Herbicides in the Highlands

*The use of agrochemicals in fragile highland environments can have far-reaching, harmful effects. Herbicides, including those of the bipyridinum and organophosphorous groups, are particularly harmful to humans and domestic animals. They also pollute the environment, and become ineffective when weeds develop herbicide resistance. Scientists in the highlands of Iran are investigating ways to make use of the natural growth inhibiting ability of some plants to reduce weed competition, boost yields, and reduce the need for herbicides.*

**T**he observation that some plants have the ability to depress the growth of neighboring plants led to the discovery of allelochemicals—naturally occurring growth-inhibiting chemicals released into the environment by living plants, through volatilization or exudation, or by decomposing plant residues. These chemicals only temporarily suppress plant growth, and, therefore, regulate species diversity without causing species extinction. Unlike synthetic herbicides, they rapidly degrade into non-toxic compounds and exert less toxic or pollutive effects on non-target species and the environment.

In the past few decades, the allelopathic suppression of weeds has received considerable attention as a possible alternative to weed control based on synthetic chemicals. The allelopathic properties of crop plants might be exploited by: growing specific crop varieties, mixing certain crop residues with the soil, or by using isolated allelochemicals as natural herbicides.

Apart from allelopathic properties, certain plants are better able to compete for available growth resources, such as moisture, nutrients, or light, than their neighbors.

Researchers in lowlands have found that certain rice cultivars (e.g., 'Taichung Native 1,' 'Johna 349,' 'Masrai,') are able to suppress weeds by 60% to 90%. Recent research by ICARDA and Iranian scientists has shown that specific wheat cultivars can effectively control weeds under field conditions in highlands of western Iran. The level of weed control is about 50% under rainfed conditions and 40% under irrigation. Among the identified



*The wheat cultivar on the left was able to inhibit weed growth, while the other cultivars could not.*

**By S.J.H. Rizvi, Dariush Bazzazi, Mozaffar Roustii and Habib Ketata**

weed-suppressing wheat genotypes are the cultivars 'Azadi,' 'Karaj 1,' 'Alborz,' and 'Sabalan.'

Although this weed-suppression ability might be due to both the allelopathic and competitive properties of those cultivars, it remains, nonetheless, a genotypic characteristic that might be used for effective weed control in wheat fields.

Other results by ICARDA and Iranian scientists show that residues of certain crops, such as sunflower and barley, when mixed adequately with soil can control weeds in chickpea crops to the same level achieved by proven chemical herbicides.

Several allelochemicals (e.g., ajoene, caffeine, citral, citronellol, geraniol, and lawsone) have been found to be effective in controlling

plant pathogenic fungi, such as *Aspergillus flavus*, *Fusarium oxysporum*, *Phytophthora cajani*, and others. In our experiments, we tested a gum collected from the plant *Asafoetida* and found it to control the chickpea disease *Ascochyta* blight by 70% compared to a check.

There is indeed a real potential for the use of certain crop species or varieties to control weeds or diseases without jeopardizing the ecosystems or the natural resources in the fragile environments of the highlands of Central and West Asia and North Africa. Such an alternative approach would be environment-friendly and cost effective. ■

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# Durum Production Shortfalls in North Africa: Some Facts

*New varieties are contributing to an increase in durum production in North Africa, and work in variety improvement is proving to be a sound investment. However, population growth in North Africa is outpacing production increases, so dependence on imports continues.*

**D**urum wheat is an important crop in North Africa. It is grown mainly in environments characterized by relatively low (250–450 mm) and uncertain rainfall causing large inter-annual fluctuations in production. Less than 50 years ago, countries here (such as Algeria and Morocco) produced surplus durum. The situation has changed dramatically. Now the West Asia and North Africa (WANA) region experiences durum shortfalls, due mainly to underproduction in North Africa. (Together, Turkey, Algeria, Morocco, Tunisia, and Syria account for more than one-third of world durum consumption.)

High population growth is the major force driving demand for food in North Africa. As domestic demand has outstripped domestic supply, many countries in the region now rely on imports. World trade in durum wheat has increased considerably over the past few decades, rising to an average of 6.2 million tonnes annually during the 1990s—approximately 20% of world durum wheat production, compared to about 17% in the case of bread wheat—from an average of less than 2 million tonnes in the 1960s. The increase in durum trade is largely due to the increasing import requirements of North Africa, which more than doubled between the period 1975–86 (average of 1.4 million tonnes) and 1988–97 (average of 3.0 million tonnes). Over three-quarters (77.4%) of North Africa's durum imports during the period 1988–97 went to Algeria.

A review of durum production per capita, computed over three periods, 1985/88, 1989/92, and 1993/96, shows that:

- Algeria had the lowest production per capita, regardless of time period. Despite a steady



*Making durum-based flat bread.*

improvement over time, which implies that production has been growing at a higher rate than population, durum production per capita did not exceed 41 kg.

- Production per capita in Morocco and Turkey declined steadily. In Morocco, production per capita declined from 67 kg in 1985/88 to 62 kg in 1989/92, then to 53 kg in 1993/96, i.e., a 21% decline, in absolute terms, between the first and last period. In Turkey, the decline was even sharper, from 101 kg in 1985/88 to 64 kg in 1993/96, a decline of nearly 37%. Turkey achieved the highest production per capita in the first period, but ranked third in the third period after Syria and Tunisia.
- Tunisia succeeded in keeping its production per capita at a relatively high level, especially in the second period when it surpassed not only Algeria and Morocco, but also Syria and Turkey, with average per capita production of 121 kg. Production declined in the last period, when it ranked second after Syria.

## By Abderrezak Belaid

- Syria achieved an unprecedented annual production growth rate of 14% between 1985 and 1996, and more than doubled its production per capita to almost 200 kg in the last period.

The low durum production per capita in Algeria and the declining trend observed in Morocco is mostly due to:

- Relatively high population growth in the 1980s and 1990s in both countries;
- A declining trend in durum area, partly due to the implementation in the 1980s of a policy aimed at expanding bread wheat area, very often at the expense of durum;
- Recurrent and severe drought in the late 1990s;
- Lagging investment in research (both breeding and crop management) targeted at less-favored areas;
- Poor targeting of extension



**A few sellers dominate the durum world market: Canada, the United States, and the European Union. Together they account for nearly all durum exports. Between 1975 and 1986, the world market share of the United States and Canada averaged 43.1% and 50.1%, respectively. In the following decade, Canada remained the major exporter, with a share of 48%. The market share of the United States, however, was halved to 20% (average) in the same period.**

programs and inadequate seed production and distribution systems, which have hampered the productivity gains expected from newly released varieties.

These causes suggest that in order to achieve significant productivity

gains, the national agricultural research systems in these countries should not only initiate (or reinforce) strong research efforts that target drought-prone environments, but also focus on extension programs and establish adequate seed multiplication and distribution systems.

Over the past few decades, the consumption–production gap in Algeria has widened, and the country is now the world's leading durum importer. Algeria imported an average of 80 kg/capita of durum annually in 1990-1997. The durum production-to-consumption ratio has declined at an average annual rate of nearly 2% over the past two decades. Even during record production years (e.g., 1996) the ratio was just slightly over 50%, while during bad production years (e.g., 1987) it fell to less than 15%, implying that domestic production covered only 15% of domestic demand for durum and durum products. Algeria imports about 5 million tonnes of wheat (durum and bread wheat) annually,

which represents about 167 kg/capita.

Sustainable food security is a fundamental objective of most developing countries. In North Africa, maybe more than any other region, food security is closely linked to grain production, especially durum production. (Durum consumption per capita in North Africa is among the highest in the world.) Increased reliance on imports to meet domestic durum production shortfalls is inflicting considerable damage on national economies in the region, especially in Algeria. Unless more effective strategies can be devised to improve durum productivity, food security will remain elusive. Production area could be expanded, but considering the importance of fallow area, which represents nearly 40% of cultivated area, sustained growth in domestic output will require significant productivity growth. ■

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## **Vetch Makes a Comeback**

*Continued from page 17*

(*Vicia villosa* ssp. *dasycarpa*) line IFLVD#683 was found to be sufficiently cold tolerant for autumn sowing and is highly productive. Line IFLVE#2542, a *Vicia ervillia*, has shown potential in drought conditions, and could be used for spring sowing.

After identifying the most adaptable lines, field trials were undertaken at three sites, Quetta, Khuzdar and Kan Mehtarzai, for two years, autumn and spring planting. IFLVD#683 grew slowly in the autumn, which enabled it to survive extreme cold, and given warm spring temperatures and adequate precipitation, proved a highly productive forage crop, producing 8.3 t/ha of dry matter and 1.1 t/ha of seed, with a protein content of 19% and 32%, respectively, in Quetta. The line also proved to be highly versatile. It was the highest yielding line in five out of six sowing-season-by-location combinations.

IFLVD#683 was the ideal forage crop for the highlands of Balochistan. Seeds were multiplied for three years and officially released as 'Kouhak-96,'



**Multiplication of 'Kouhak-96' seed destined for Afghanistan.**

named after a city at the border with Afghanistan.

The work, begun more than a decade ago in Pakistan, is still paying off. During 2001/2002, seeds of 'Kouhak-96' were multiplied at ICARDA's research farm at Tel Hadya, Syria, and 11 tonnes were produced for shipment to Afghanistan. ■

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*"Since its founding in 1977, ICARDA has had a strong interest in research for development in high-elevation areas, which are home to populations in the grip of severe poverty, attempting to eke a living from a highly fragile ecosystem. The International Year of Mountains is a good opportunity for us to reflect on our work and raise awareness about the importance of improving incomes, improving nutrition, and conserving the environment in mountainous areas."*

*Prof. Dr Adel El-Beltagy  
Director General, ICARDA*

