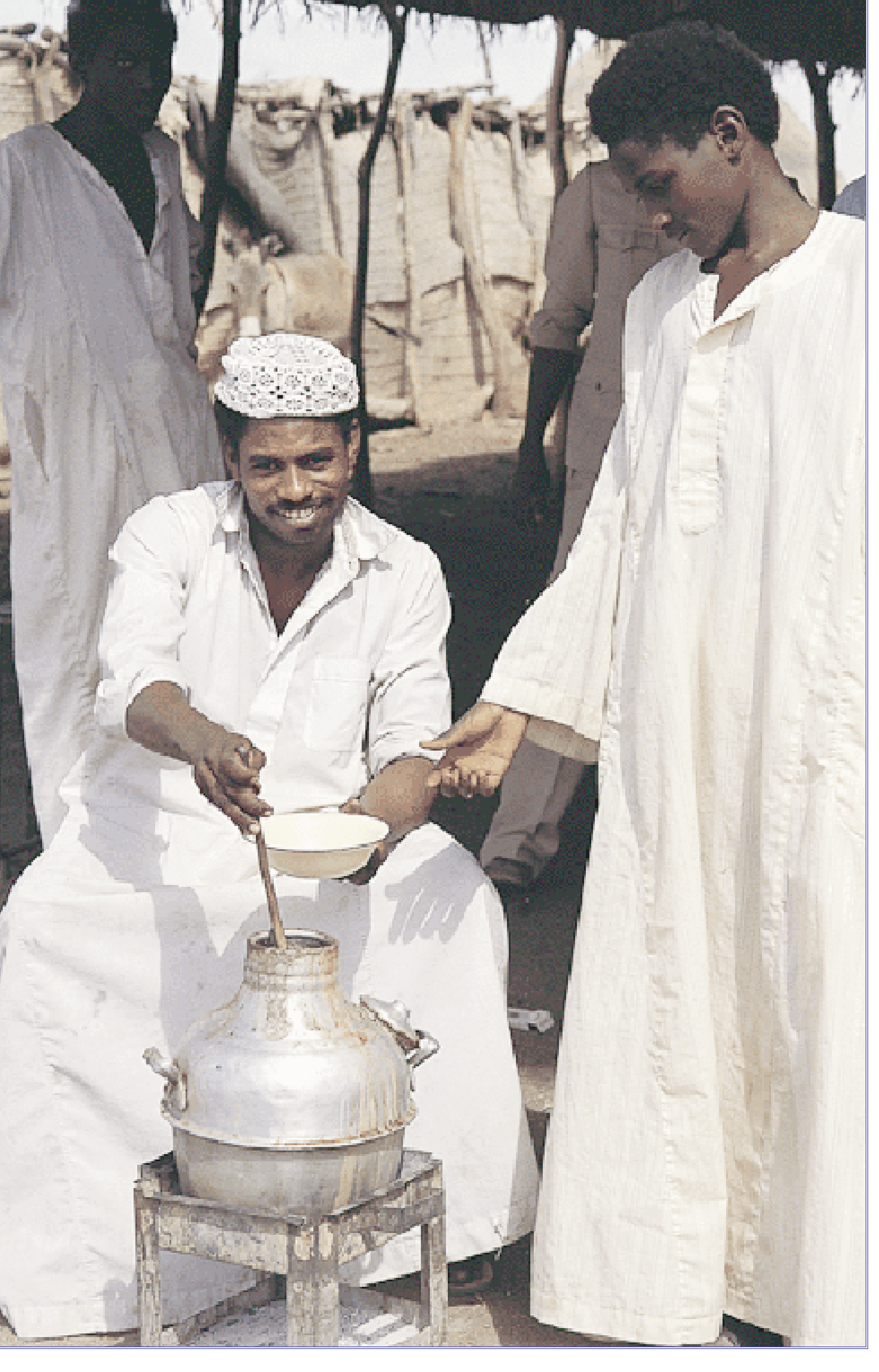
ICARDA Issue No. 9 Summer/Autumn 1998

Caravan

Review of agriculture in the dry areas



In this issue:

From the Director General

In our last issue of *Caravan* (No. 8), we shared with our readers ICARDA's philosophy of integrating natural resource management with crop improvement, and how the Center is striving to keep this equation balanced in its research agenda. We illustrated this balance with some of our success stories, but the focus of Issue No. 8 was on natural resource management designed to improve crop productivity. In this issue we present some examples of ICARDA's successes in crop improvement designed to protect and even enhance the natural resource base.

The story of faba bean improvement in Egypt (see page 7) is not just a story of achieving self-sufficiency in this crop in that country; it is also a story of how a carefully designed research program helped the country cut down the use of herbicides and fungicides and thus protect the environment. It is also a story of the role of biodiversity in food security and protection of the natural resource base. Above all, it is a story of the effectiveness of a tripartite partnership between ICARDA, donors, and national programs. This model of cooperation is now being applied to other crops, not only in Egypt but also in other countries.

In our research on combating desertification, we have found that vetch is one of our best allies. This forage legume not only feeds the livestock but it also "feeds" the soil through fixing atmospheric nitrogen. ICARDA's work on vetch/cereal rotations has amply demonstrated the benefits that can be reaped from this technology in protecting the marginal land from turning into desert, increasing the availability of feed for livestock, and harvesting higher yields of the cereal crop, usually barley, after the vetch phase. The article on page 19 describes the enthusiasm of Syrian farmers in adopting this technology. Our research on the underground vetch (see page 15), which produces pods both above and below the ground, is opening up new opportunities for greening the marginal land through natural regeneration of this species. These are just a few examples to illustrate how ICARDA's crop improvement research goes hand-in-hand with natural resource management.

The key question, however, is the adoption of new technology by farmers. Farmers would not accept any change in their systems unless they have first seen it work. For this reason, ICARDA makes farmers its partners early in the research process. Experience is our witness that this makes transfer of technology much easier. The key is the multiplier effect that the participating farmers set in motion in the village communities. The faba bean story in this issue (page 7), and the participatory barley-breeding story in *Caravan* 8, illustrate this point well.

Crop improvement integrated with natural resource management through farmer participation is, however, only

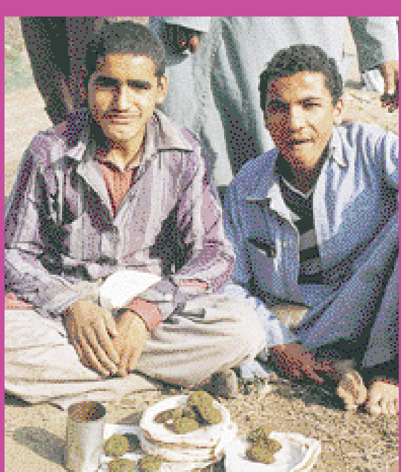
ICARDA
Caravan

Issue no. 9 Summer/Autumn 1998

Cover: *Foul muddamis*, the most common faba bean recipe, being sold on the roadside in Sudan. Underlying the challenge of increasing food production is the bigger challenge of access of the poor to sufficient food at prices they can afford.
Photo: M.C. Saxena.

one part of the story. Integration of new technology, which is acceptable to farmers, with policy is another important part. This is becoming even more important, given the changes taking place in the global agricultural sector. The shift from nationally focused markets, which often provide subsidies for the cultivation of crops used as staple food, to open global markets which are both competitive and do not offer subsidies, dictates a major change in policy at national, regional and global levels for agricultural research to succeed. To respond to this changing scenario, ICARDA is placing increased emphasis on this aspect. The Center is strengthening its program of research in socioeconomics, with a view to link its research agenda to the changing economic environment. Of particular interest are such areas of study as the management of land and water, which are both at serious risk in the dry areas, as well as biodiversity, which provides the raw material for crop improvement. These studies are intended to provide options to policy makers to make reforms in the agricultural sector with a long-term vision to stay competitive in the global market systems and, at the same time, achieve sustainable food security in their own countries. ICARDA is doing this through a network of researchers whose work would influence policy-making in their countries.

Prof. Dr Adel El-Beltagy
Director General



***Falafel* is delicious!** **See page 7.**

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 West and Central 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 extending 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 a wide variety of country and institutional members worldwide. Since its foundation 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 strengthening 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 United Nations Environment Programme (UNEP) are cosponsors of the CGIAR. The World Bank provides the CGIAR System with a Secretariat in Washington, DC. A Technical Advisory Committee, with its Secretariat at FAO in Rome, assists the System in the development of its research program.

Caravan is published four times a year, in spring, summer, autumn and winter, by the International Center for Agricultural Research in the Dry Areas (ICARDA), P.O. Box 5466, Aleppo, Syria.
Tel.: (963-21) 2213477, 2225112, 2225012.
Fax: (963-21) 2213490/2225105.
E-Mail: ICARDA@CGIAR.ORG
Telex: 331206/331208/331263.
Web site: http://www.cgiar.org/icarda

Editor: Surendra Varma

ISSN 1025-0972

DG Participates in the First International Agronomy Congress

Inaugural session: H.E. Mr K.R. Narayanan (third from right), President of India; H.E. Mr Sompal (fourth from right), Minister of State for Agriculture; Prof. Dr Adel El-Beltagy (right), DG, ICARDA; Dr Punjab Singh (second from right), President, Indian Society of Agronomy, and Vice-Chancellor, Jabalpur Agricultural University; Dr G.B. Singh (left), Chairman of the National Organizing Committee, and DDG (NRM), ICAR; and Dr Mukhtiar Singh (second from left), Eminent Agronomist and former Director of Central Potato Research Institute, India.

Prof. Dr Adel El-Beltagy, Director General, participated in the First International Agronomy Congress, held in New Delhi, 22-26 November 1998, as a member of the Governing Board of the Congress.

H.E. Mr K. R. Narayanan, President of India, was the Chief Guest at the inaugural session, which was chaired by H.E. Mr Sompal, Minister of State for Agriculture. Prof. El-Beltagy delivered a statement at the inaugural session, in which he highlighted the role of dry areas in contributing to increased food production and poverty alleviation. He also delivered a plenary lecture on "Central and West Asia and North Africa: A Regional Vision," emphasizing the role of agricultural research in ensuring food security and sustainable management of the fragile natural resource base in the dry areas. He illustrated his talk with examples of ICARDA's research work and its impact.

The DG was accompanied by Dr M.C. Saxena, ADG, who was a member of the International Organizing Committee of the Congress. A veteran agronomist, Dr Saxena is a Life Member of the Indian Society of Agronomy. He chaired a symposium on "Globalization of Agriculture and Policy Imperative," and delivered an invited lecture on "Symbiotic Nitrogen Fixation for Sustainable Agriculture in the Dry Areas," during the Congress.

Besides attending the Congress, Prof. El-Beltagy and Dr Saxena held extensive discussions with Dr R.S. Paroda, DG, Indian Council of Agricultural Research (ICAR) and Secretary, Dept. of Agricultural Research and Education, Govt. of India, to strengthen collaboration between ICARDA and ICAR. ICAR now has funds available for implementing the National Agricultural Technology Transfer Project, which opens avenues for ICARDA's collaboration with the Central Arid Zone Research Institute (CAZRI) in Jodhpur and the Central Research Institute for Dry Areas (CRIDA) in Hyderabad. It was suggested that scientists from these institutions and ICARDA exchange visits and develop specific research plans.

Text of Prof. Dr Adel El-Beltagy's Statement at the Inaugural Session

"Honorable President of India Shri Narayanan,

It is a pleasure and an honor for me to be in India, a country for which I have great admiration and respect. India's rich cultural and spiritual heritage has benefited the whole world. The agricultural scientists of India have been making a significant intellectual contribution to the agricultural research and development globally. This First International Agronomy Congress is an illustration of that.

As the new millennium approaches, the goal of ensuring food security remains as elusive as ever. We already have 840 million people going hungry and 2 billion malnourished. Most of the hungry are in developing countries: 37% in Africa, 20% in Asia and 13% in Latin America. Their number will continue to increase with the rapid population growth. On the other hand, natural resources essential for providing food, fiber and biomass are being lost or degraded.

Food security for the population today and for an additional 3 billion people in the next 20 years is truly a formidable challenge. But agricultural research—along with right policies and institutional support to the farmers—can help meet this challenge. India has already demonstrated this, through its Green Revolution. Our hope for the future, however, lies in areas that are considered less productive or unsuitable for agriculture, which the Green Revolution did not touch.

Over 3,000 million hectares of land in developing countries is considered marginal for agriculture, but much of it can be made more productive through appropriate technologies and policies. The low yield potential of this land makes the use of external inputs uneconomical. But if we can develop the right strategies for agricultural intensification in these areas, they can substantially contribute to increasing food production. These strategies must be built on four key elements: (i) improved technologies and farming systems, including the use of under-utilized crop species, (ii) secure property rights and effective institutions, (iii) effective risk management, and (iv) the right policy environment.

Poverty and the degradation of the natural resource base is a vicious cycle. If the poor do not have enough to eat, they would, unintentionally, neglect or overuse or even destroy the natural resource base. This is understandable because survival comes before anything else. But we must find ways to break the complex cycle of poverty and the loss of natural resources. The knowledge generated from agricultural research can help in identifying the factors that lead to the creation of such a cycle, and in developing appropriate solutions. We must put poverty at the heart of our research strategies and programs. We must develop technologies that will help not only in increasing production but also in generating increased income to the farming community. Through a participatory approach, we can integrate the poor in the research process.

On the other hand, hunger is not entirely a result of food shortages. Inadequate access to the food that is available is another important issue in poverty alleviation. Access to food, we all know, is highly unequal. World food stocks have dwindled to their lowest level in the past 20 years, and 60% of those stocks are now held by private companies which control their price, distribution and location. Seventy percent of world grain trade is carried out by just six companies. The question is whether economic liberalization will help achieve food security or widen the gap between rich and poor? This is where national governments have a very important role to play. Policies that penalize crops grown in marginal areas should be eliminated. Governments must make policy and institutional changes, invest in agricultural research in less-favored areas, rural infrastructure, education and health to develop human capital and involve local communities to address these issues. The objective should be for the rural people to take advantage of the market.

Prof. Dr Adel El-Beltagy delivering his statement at the inaugural session.

Prof. Dr El-Beltagy (second from right); Dr R.S. Paroda (second from left), DG of ICAR; and Dr Punjab Singh (right), being interviewed on Doordarshan (Hindi, meaning television)--the National Television Network of India.

New tools of research, such as remote sensing, GIS, biotechnology and computer science can greatly help accelerate our pace of increasing food production and alleviating poverty. Integrated gene management in harmony with the various disciplines of agricultural research can provide us with crop cultivars that can tolerate abiotic stresses, such as drought and heat, and can resist diseases and pests.

Modern information technology has turned what was considered as fiction, into reality. Speedy sharing and exchange of knowledge through information superhighways, and the use of computer programs and expert systems for research and extension have brought us to the cutting edge of technology. The gap between industrialized and developing countries in their knowledge capital and progress in research is increasing. No research and development strategy for a developing country would be complete without a strong information technology component.

Continued on page 20

ICARDA Scientists Honored

CGIAR Chairman's Science Award

Dr Imad Eujayl (center) receives the award from CGIAR Chairman, Dr Ismail Serageldin (right) and Dr Wally Falcon (left), Chairman of the Selection Committee.

Dr Imad Eujayl won the CGIAR Chairman's 1998 "Outstanding Locally-Recruited Support Staff," science award. This award is presented to a locally-recruited scientific support staff member of any nationality who, during his/her tenure at a center, has made an outstanding contribution towards achieving the CGIAR goals. The award consists of a plaque and a cash amount of US$5000. Imad received this award from the CGIAR Chairman, Dr Ismail Serageldin, during ICW 98 in Washington, D.C., in October 1998. The happy news makes the entire ICARDA family proud of Imad.

Imad joined the biotechnology group as a research assistant at ICARDA in 1993 to work on lentil genome-mapping project, after having had working experience in tissue culture in lentil. The project required the development of segregating populations for genetic linkage analysis, development of long-term mapping population for testing in different environments, and application of new genetic analysis tools (PCR-based markers) and extensive genotyping of individual lines of the population. Imad carried out all these responsibilities single-handed for four years.

The research problem he addressed was to identify DNA markers that are linked to *Fusarium* wilt resistance and frost tolerance in lentil. Imad developed a genetic linkage map for lentil on recombinant inbred lines (the most extensive lentil map to date) with RAPD, RFLP and AFLP. From this map he was able to identify DNA markers linked to *Fusarium* wilt resistance. For frost tolerance also, a DNA marker was identified. Having identified these markers, selection for these traits is possible even when the stresses are absent, which is not unlikely in the unpredictable dry-area environments of West Asia and North Africa. It is the first time that a DNA marker for an abiotic stress—frost tolerance—has been identified in lentil. His research efforts yielded a genetically characterized population that can be shared by investigators for long-term collaborative projects in lentil genetic mapping. This will help develop improved lentil cultivars with specific traits, and will contribute to increased food production.■

Oregon State University's Award

Dr Hugo Vivar, Barley Breeder and Regional Coordinator of ICARDA's Latin America Regional Program, based at CIMMYT in Mexico, won the 1998 James and Mildred Oldfield/E. R. Jackman Team Award of the College of Agricultural Sciences, Oregon State University (OSU), USA, as a member of the Barley Stripe Rust Resistance Team. The team consists of seven researchers, of which Dr Vivar is one. The award includes a certificate and an Oldfield medal to each team member and US$3000 for the team.

In his communication to the team members, Dr Thayne R. Dutson, Dean, College of Agriculture, OSU, said: "I wish to congratulate you and members of your team on being selected as the recipient of the 1998 James and Mildred Oldfield/E.R. Jackman Team Award. It is with great satisfaction that we provide this recognition to you."

The Barley Stripe Rust Resistance Team has, through individual and cooperative efforts, contributed to the development of a new value-added processing industry in Oregon.

The award was presented to the winners on the Faculty and Staff Day of the College of Agriculture of OSU on 17 September 1998.

ICARDA has a world mandate for the improvement of barley. In the Latin America region, stripe rust is one of the major diseases causing severe losses in barley production. Dr Vivar has been involved for several years in developing improved barley varieties resistant to stripe rust, in cooperation with OSU, national researchers and other partners.■

More Faba Bean, Less Pollution

Average annual faba-bean production in Egypt has risen from 269,000 tonnes in 1977 to 442,000 tonnes in 1998, with the yields per hectare now being the third highest in the world, after France and Germany. The use of fungicides and herbicides, earlier used to protect the crop from diseases and a parasitic weed, has also been drastically reduced to protect the environment. What made this possible?

By Shaaban Khalil and M.C. Saxena

In the Dilingat village of Bahaira Governorate in Egypt, Abu Ahmed (right) proudly displays his faba bean crop full of healthy pods, grown without using fungicides. In the past, he had to apply two or more fungicide sprays to save his crop from the chocolate spot disease. He is one of hundreds of farmers in the Upper Egypt to Delta area who are participating in large-scale demonstrations of the newly released high-yielding and disease-resistant varieties of faba bean, and improved production practices that bring them higher profits. These demonstrations are organized by ICARDA s Nile Valley and Red Sea Regional Program.

Faba bean is an important component of the staple diet in Egypt, the most common recipe being *foul mudammis* (see also page 10). *Falafel*, made with green or dry faba bean seeds mixed with chickpea, is another product commonly used for making sandwiches that provide nutritious food for the poor. In the 1970s, Egypt produced about 269,000 tonnes of faba bean per year, which was not enough to meet domestic demand. Two diseases, chocolate spot (*Botrytis fabae*) and rust (*Uromyces fabae*), and a parasitic weed known as broomrape (*Orobanche crenata*) were mainly responsible for causing production losses. Also, the yield potential of varieties used by farmers at that time was low.

Chocolate spot and rust are the main diseases in the Delta and New Lands. They can cause heavy yield losses and even wipe out the crop. Chocolate spot appears as brown spots on the leaves and stem. Aphid-transmitted viruses also pose a serious threat to faba bean. The Faba Bean Necrotic Yellows (FBNY) and the Bean Yellow Mosaic (BYM) are the most prevalent viruses, particularly in Middle Egypt. These viruses alone are known to have caused up to 90% yield losses in some years. Broomrape is common in Middle and Upper Egypt, as well as in the Delta. Depending on severity of infection, it can cause up to 80% yield losses. This parasitic weed sucks up nutrients from faba bean plants, which then wilt or fall over, and also competes with the faba bean crop for food and water. Broomrape is also a serious problem in Morocco, Portugal, Spain, Syria and Tunisia. Its seeds are tiny, among the smallest known, and therefore can be spread quickly over large areas by wind and water. The seeds can survive for over 10 years in the soil.

The threats from diseases and parasitic weed to faba bean are worsened by the climate. In Egypt and other areas of the West Asia and North Africa region, the cool winter season, when the rain falls, is very short. It is preceded and succeeded by high temperatures. To avoid this, farmers traditionally delay planting by a couple of weeks, until after 15 November, to reduce the problem of chocolate spot and broomrape, both of which like humid conditions. But, if farmers delay planting, the crop faces the challenges of high temperatures, lack of water, and too much light in April and May when it is at a critical stage of its growth. Shortening the growing season in this way to by-pass diseases can reduce faba bean yields by up to 30%. The high temperatures also encourage the build-up of aphids, and therefore of viruses that they transmit to the crop.

To make up for the yield loss, farmers would apply up to 30% additional nitrogen and 15% phosphate to the crop—a practice encouraged by large subsidies on these inputs. With timely planting of the crop, the farmers needed to apply a fungicide to control chocolate spot, and a herbicide to control broomrape. This called for training in the use of these chemicals. And the practice also contributed to environmental pollution. Clearly, farmers were in urgent need of help in their efforts to improve faba bean production in the country.

In 1979, only two years after its establishment, ICARDA, in cooperation with Egypt and Sudan, and with financial support from the International Fund for Agricultural Development (IFAD), developed a Nile Valley Project (NVP) on Faba Bean. The NVP office was based in Cairo. The Project brought together the expertise of ICARDA and the national programs of Egypt and Sudan to tackle the problems of faba bean cultivation in the Nile Valley region.

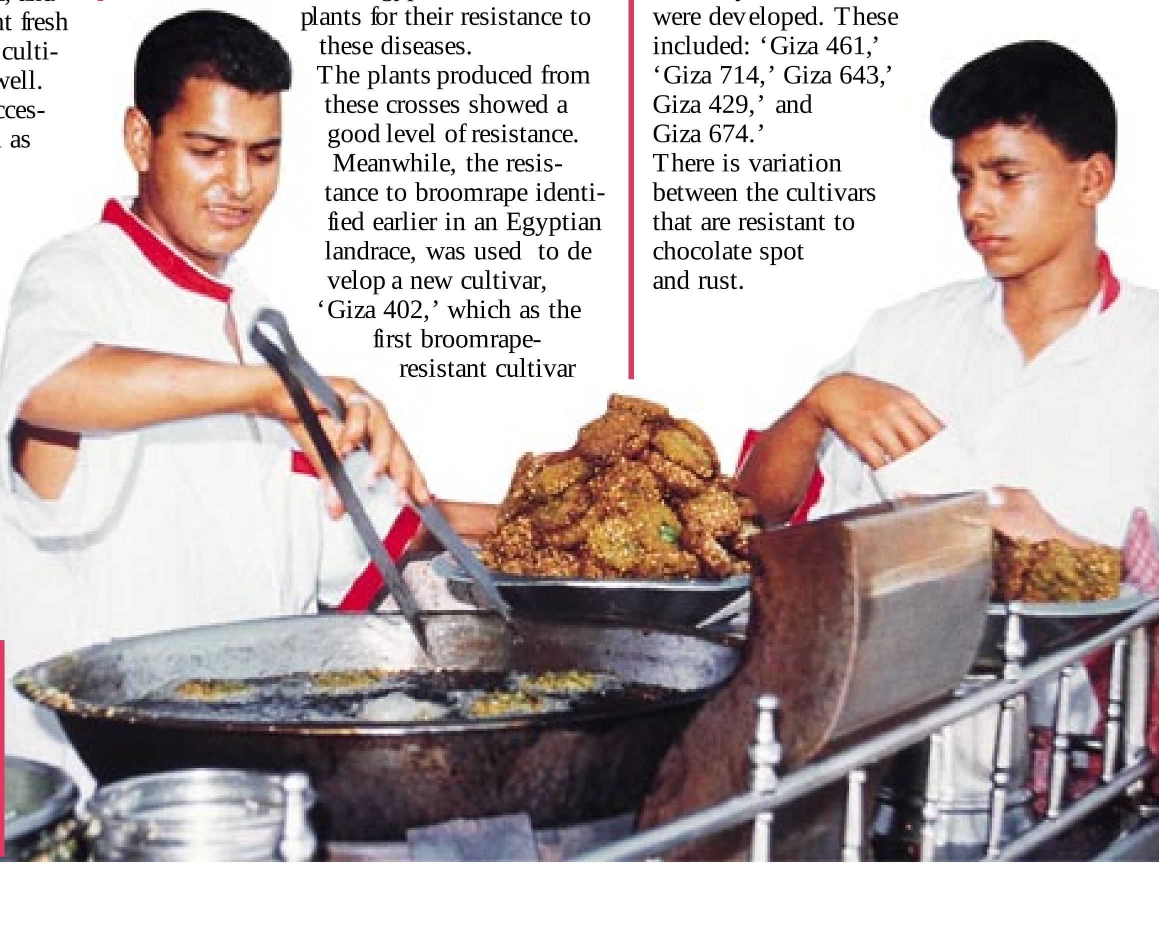
The Egyptian national program, in 1975, had identified a local landrace (farmer's variety) that had some resistance to broomrape. Collaboration with ICARDA, and use of its germplasm, brought fresh opportunities for identifying cultivars resistant to diseases as well. In the 1980s, a germplasm accession, ILB 938, was identified as highly resistant to chocolate spot. Researchers at the Agricultural Research Center (ARC), Egypt used this line in crosses with Egyptian material, including oneof the local varieties, 'Giza 3,' to develop new lines suitable for local conditions.

'Giza 461' was the first variety developed and released as a result of these joint efforts for use by farmers. It paved the way for the development of other resistant varieties, and attracted the attention of both the Egyptian government and farmers. Egyptian researchers then tested these crosses at Sakha and Nubaria Research Stations. The latter station is located in the newly-reclaimed lands. The program used the different types or strains of chocolate spot and rust found all over Egypt to test the plants for their resistance to these diseases.

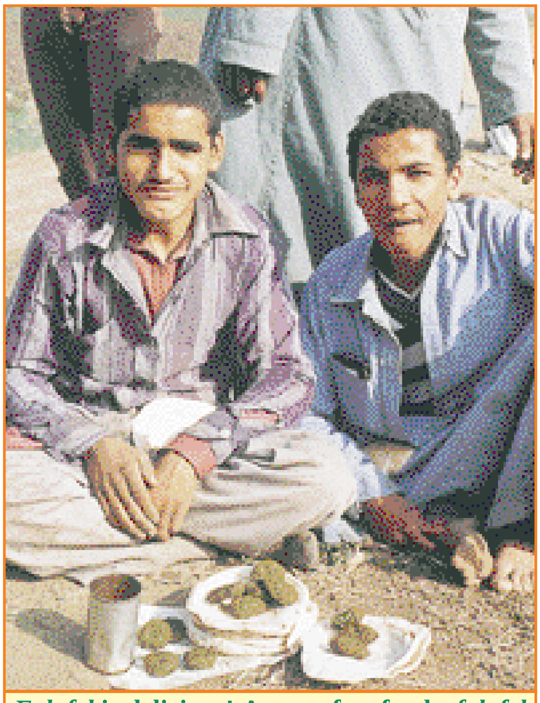
The plants produced from these crosses showed a good level of resistance. Meanwhile, the resistance to broomrape identified earlier in an Egyptian landrace, was used to develop a new cultivar, 'Giza 402,' which as the first broomrape-resistant cultivar ever released anywhere in the world. It was extensively used in on-farm demonstrations in the broomrape-infested areas in Egypt. The broomrape resistance from this cultivar was also incorporated into high-yielding faba bean lines resistant to fungal diseases.

Using this material in the breeding program, new cultivars with high productivity and disease resistance were developed. These included: 'Giza 461,' 'Giza 714,' Giza 643,' Giza 429,' and Giza 674.' There is variation between the cultivars that are resistant to chocolate spot and rust.

Nile Valley Faba Bean Project was initially funded by the International Fund for Agricultural Development (IFAD) for both on-farm and on-station research.



Falafel made with green faba bean seeds is used to make nutritious sandwiches for low-income groups both in villages and cities in Egypt.



Falafel **is delicious! Among fast foods,** ***falafel*** **sandwiches are particularly popular.**

Screening for **Orobanche** *resistance at Giza Research Station in Egypt.*

'Giza 717' and 'Giza 461' have a high level of resistance to both chocolate spot and rust and are now grown in the northern part of the Delta. 'Giza 714' is adapted to conditions in the east Delta and 'Giza 643' to those in the south Delta. The average increase in yield is 25%. 'Giza Blanca,' which requires less water, is widely adapted for planting in the newly-reclaimed lands. It produces over 36% higher yields than other cultivars. 'Giza 716' is early maturing and can be planted before cotton in the Nile Delta, and 'Giza 40,' released recently, in Middle and Upper Egypt. Of the varieties that are resistant to broomrape, 'Giza 402' is adapted to conditions in Middle and Upper Egypt, 'Giza 429' in Middle Egypt, 'Giza 674' in Upper Egypt, and 'Giza 843' in the north Delta.

In 1983, national faba bean production in Egypt rose to 295,000 tonnes per year, making the country self-sufficient in faba bean. By 1996, farm-level yields had increased by about 43.5%. In 1998, the production rose to 442,000 tonnes, providing Egypt with opportunities for export.

Doubling the production of faba bean in Egypt is a result of adoption of a series of improved production packages. These packages were developed jointly by ICARDA and the Egyptian national program. The key component of these packages is the use of new varieties, but they include other important factors, such as improved agronomic practices (for example, sowing date and tillage). The improved varieties, resistant to diseases and broomrape, helped in cutting down the use of chemicals drastically. The achievements of the NVP became a model to follow for other crops and in other countries.

On the other hand, the NVP continued to evolve. Increased funding became available for its work from other donors, including Italy, the European Union, the Netherlands and Sweden. Also, more countries joined NVP, which has today expanded into the Nile Valley and Red Sea Regional Program (NVRSRP), with Egypt, Sudan, Ethiopia, Eritrea and Yemen as its partners. NVRSRP is now also working on other cool-season food legumes and cereals, as well as farm resource management with its partner countries.

The faba bean story is not only about higher yields and reduced use of chemicals; it is also a story of producing more with less land area. If the yield level had remained the same as in 1977, the area needed to produce 442,000 tonnes of faba bean in 1998 would have been 188,000 hectares, against the actual 138,000 hectares. This represents a 36% saving in the land area used in 1998. Above all, it is a story of harmonizing food production with the environment. ■

Dr Shaaban Khalil is Faba Bean Breeder, and Dr M.C. Saxena is Assistant Director General, at ICARDA.

Screening faba bean lines for rust and chocolate spot resistance at Nubaria Research Station in Egypt.

Going Global for Better Beans

Faba bean is one of the most important crops in the developing world, not just in the Middle East but also in South America and China. It provides the staple diet for millions of people as well as animal feed and green manure.

By Joop van Leur, Larry Robertson and Mike Robbins

It's dinner time in Sudan, and you might decide on a takeaway meal of *foul* beans—the staple diet of the country. If you live in a town, the chances are that, dotted around the *souk* (market), there will be *foul*-sellers standing beside great steel vats that rather resemble milk-churns (see cover photo).

In these are the hot beans, carefully cooked and ready to eat. If money is short, you may decide on a plastic bowl full of plain *foul*, sprinkled perhaps with a little cumin. If the pocket will bear it, you might prefer a luxury *foul*. In this case, the vendor, having dispensed a few ladles of beans into the dish, will grate some cheese over the surface. He will follow this with a sliced egg or two and some salad. He will then take a soft-drink bottle, grasp it firmly by the neck and pulverize the ingredients. The resulting purée, eaten with bread, is an excellent meal.

It is also highly nutritious. *Foul* beans are faba beans. They are a first-class source of protein, essential in countries where the poorer section of the population cannot afford meat. Moreover, they contain lysine, an animo-acid essential for human health and especially for growth. This can be obtained from meat and dairy products, but if these are not available, deficiency can occur, especially in cereal-based diets like those of the West Asia and North Africa (WANA) region. It is thus an important staple for the poor, but not only for them; in some of the better restaurants of Cairo and Damascus, cooking with *foul* is high art.

Faba bean is an important part of the farming system, too. It is good for the soil and ideal for rotation with cereal; indeed the crop is so soil-friendly that, in some parts of the world where *foul* is not eaten, the crop is grown anyway and plowed under as green manure. It can also be a valuable source of animal feed.

But faba bean has an Achille's heel: it is seriously prone to disease, and yields can be highly unstable. As already mentioned in the earlier article (page 7), its chief enemies are rust, chocolate spot and ascochyta blight. Broomrape, a parasitic weed, is also a serious threat to it. A serious attack of just one of these can devastate the crop. Moreover, plant pathogens have the potential to adapt to new varieties that initially show resistance. Screening germplasm for resistance is, therefore, a never-ending process, as new genes for resistance are constantly needed.

But researchers need plant genetic resources to work with, if they are to find sources of resistance.To this end, ICARDA is collaborating with two

An Ecuadorean farmer winnows her crop to provide clean seed samples of faba bean to a member of the collection team.

Larry Robertson

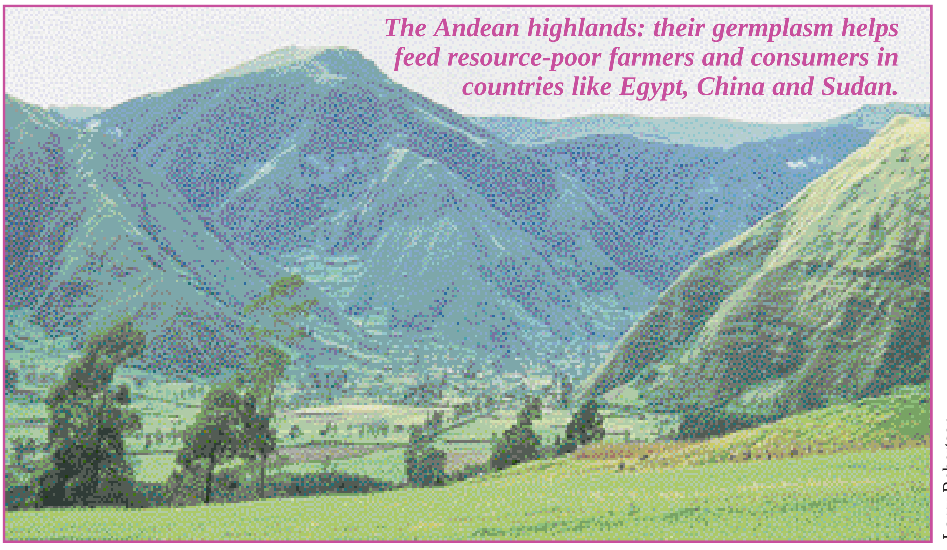
Australian organizations, the Australian Center for International Agricultural Research (ACIAR) and the Grain Research Development Corporation (GRDC).

Reliable screening of resistance to chocolate spot and ascochyta blight is only possible by inoculating faba beans with these pathogens and growing them in nurseries in an environment in which the diseases will develop. With special funding from GRDC and ACIAR, ICARDA has established a research site at the Mediterranean coast near the Syrian city of Lattakia. The mild winters and high humidity in this region help the development of diseases and viruses.

ACIAR is part of Australia's overseas development program, and is also taking part in important work on faba bean with ICARDA and the Chinese national program. GRDC is a venture supported by Australian farmers through a levy on all agricultural production; this contribution is then matched by the Federal Government.

Australian farmers need a rotation crop to fight falling wheat yields. Legumes are good for this, and ICARDA has done a lot of work on these rotations. The Australians are rotating wheat with faba bean, which they use for fodder. However, the full potential has not been reached because there are no locally-adapted faba bean varieties. GRDC is doing considerable, and far-sighted, research on this in northern New South Wales and southern Queensland. It is possible that the ICARDA screening operation will eventually help this research. The products of GRDC's research will be available to everybody, not only Australian farmers.

Meanwhile, at its research site on the Syrian coast, ICARDA is working on resistant varieties for the developing world. It is screening germplasm from many regions. Faba bean originated in West Asia and has been cultivated there for 3500 years. This makes the faba-bean gene-pool in WANA a rich one, but the diseases are so virulent and fast-mutating that sources of resistance must be found in unrelated germplasm. For example, previous work at ICARDA showed a high level of disease resistance in germplasm originating from the high-altitude (and high-rainfall) areas in the Andes of South America. So ICARDA organized a new collection mission in Ecuador and a large number of samples collected there were tested at Lattakia. A high level of resistance to chocolate spot was found.



The Andean highlands: their germplasm helps feed resource-poor farmers and consumers in countries like Egypt, China and Sudan.

Larry Robertson

The process does not end there, however. The Ecuadorean material seemed also to have a good level of resistance to rust and ascochyta blight, but it tended to mature rather late for the growing environment in the WANA region. Therefore, individual selections were made from the material that matured earlier, but still had high level of resistance. Through intensive disease screening at Lattakia a number of highly-resistant lines were identified from other countries as well, especially Morocco, Spain, Portugal and Greece.

The Ecuadorean material demonstrates both the problems and potential of working with faba bean. The crop has a very high degree of cross-pollination by bees; to keep them out, screenhouses with mesh have to be used to protect the breeding lines and keep them pure. However, because of cross-pollination before collection, the germplasm varies widely within a single accession. This applies to most of its characteristics, including disease resistance. Canadian researchers working on rust have identified both disease-resistant and susceptible strains within the same accession. This means that the charactistics you want may be found in a variety that, in general, does not have them. This is like looking for a needle in a haystack, but it works.

The genes we need, and thus the answers, will be found. It is a long process. For the researcher, collecting germplasm is only the beginning; the material collected must be evaluated. There are countless accessions in the world's genebanks that may contain genes that could prevent famine and raise rural incomes in the developing world. But we need to find them.

Even so, the fight to protect faba bean demonstrates how international linkages within agricultural research can bring huge benefits. Through this work, researchers are learning from each other all over the world; it is about cross-pollination of intellects, as well as germplasm. But it is also an example of the benefits brought by the free exchange of genetic resources. Germplasm is being exchanged around the world from Spain to Egypt to Syria to Ecuador to China. The products will be used to benefit people of limited means. For ICARDA, it involves the man wielding the neck of a soft-drink bottle in the *souk*. We want better food security for his customers, and that is what germplasm exchange is all about.■

Joop van Leur, formerly Barley Pathologist at ICARDA, is now Senior Plant Pathologist, New South Wales Agriculture, Australia. Dr Larry Robertson, previously ICARDA's Legume Germplasm Curator, is now Vegetable Crops Curator, USDA ARS PGRU, Cornell University, Collier Drive, Geneva, New York, USA. Mike Robbins was previously Science Writer/Editor at ICARDA.

We Fixed Rust! Next, Wilt and Root Rots

By Geletu Bejiga, Negussie Tadesse and Willie Erskine

Lentil is essential to nutrition in subsistence farming in Ethiopia. But it is prone to diseases which can wipe out the crop. Ethiopia's Debre Zeit Agricultural Research Center is fighting back—and winning.

Lentil at Debre Zeit Agricultural Research Center.

M. C. Saxena

Lentil is an important part of the farming system in Ethiopia. Farmers and their families use it to make *wot*, a soup, which supplements their diet with lysine, an amino-acid essential for the human body. The diets in Ethiopia, where barley and *tef* are the staple food, are often deficient in lysine.

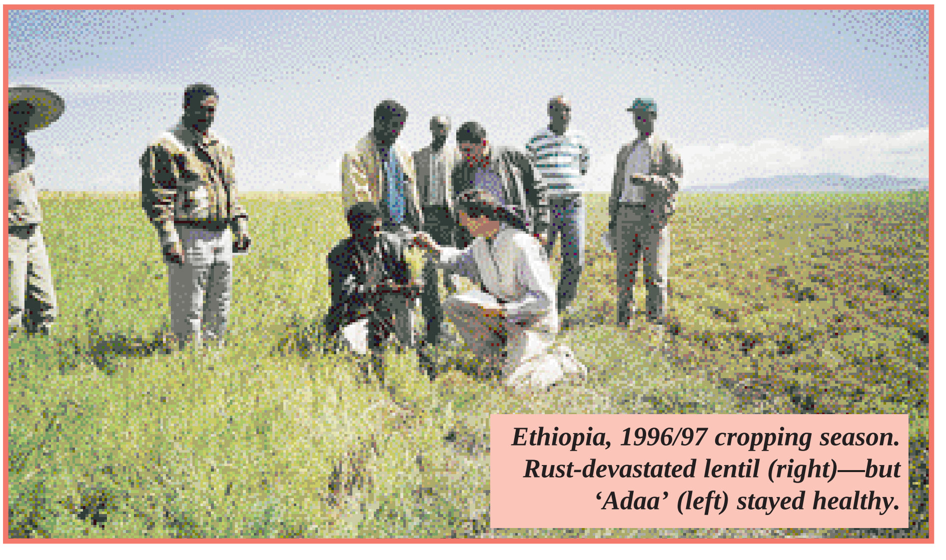
Fluctuations in yield of lentil therefore can have serious implications for food security. The lentil crop is menaced by a number of diseases—one of the worst being rust (caused by *Uromyces fabae*). Ethiopia's researchers have long been fighting this, and released their first rust-resistant variety, 'R-186,' in 1980. But it was severely hit by frost in the highlands—an illustration of how difficult it is to fulfill all the criteria!

The next step was to release the first ICARDA variety, 'ILL-358,' under the name 'Chalew.' This was a high-yielding variety with good disease resistance, but consumers did not like its yellow seed coat and cotyledon; their preference is for a grey seed coat and red cotyledon. So new varieties 'Adaa' (derived from an ICARDA line, FLIP86-41L) and 'Gudo' (FLIP84-78L) were developed in collaboration with ICARDA and released in 1994. Another variety, 'Alemaya' (FLIP88-63L), which is highly resistant to rust, was released in 1997. The involvement of farmers in evaluating advanced materials, as part of ICARDA's Nile Valley Regional Program activities, was found to enhance the identification of suitable materials for release.

'Adaa' has become the most popular lentil variety, due to its large grey seed coat and red cotyledon, and its resistance to rust . In November–December 1997, a rust epidemic wiped out all the local landraces (farmers' varieties), and the only unaffected varieties both in research centers and farmers' fields were 'Adaa,' 'Gudo,' and 'Chalew.'

However, rust is not the only serious disease of lentil. Work is being carried out to identify and develop lines with multiple resistance to rust, wilt, and root rots. Ethiopia, in collaboration with ICARDA, has already developed uniform and effective "sick-plots" for wilt, where landraces and introductions are evaluated. Indeed, the National Lentil Improvement Program has found 57 lines with rating 1 (highly resistant) under a high level of disease pressure, and a further 6 and 34 with ratings 2

Continued on page 14



Ethiopia, 1996/97 cropping season. Rust-devastated lentil (right)—but 'Adaa' (left) stayed healthy.

Harvesting Profits in Lentil Fields

Lentil growers in Syria and Turkey are seeing their average income rise by about US$1,800 per farm by adopting new varieties and harvest technology. A new report traces this success back to one of ICARDA's first lentil improvement programs.

By Ashutosh Sarker and Willie Erskine

A seed-to-harvest package for lentil growers in West Asia is increasing yields, reducing harvest costs, and returning extra money to growers.

In just the two areas that have so far adopted the system, annual farm revenue has shot up by US$13.3 million.

In West Asia and North Africa (WANA), lentil is an important source of protein in the cereal-based diets of the population. Lentil may be consumed whole, decorticated, decorticated and split, or ground into a flour. The most common method of preparing lentil is boiling, for example, the Indian *dal*, and the Middle Eastern *Mujaddarah* and lentil soup. It may also be deep fried and consumed as a snack, or combined with cereal flours in the preparation of such foods as breads and cakes. The crop also provides high-quality straw for animals, and helps to increase soil fertility through nitrogen fixation. Often it is a cash crop for farmers in the low-rainfall areas.

The costs of growing lentils in the WANA region have been rocketing because of an increasing population drift from the farmland to cities, which has created a tremendous shortage of agricultural labor in the region. Lentils have hitherto depended on hand labor, which is now so costly that the economics of this major cash crop were under threat.

ICARDA decided early in its first decade to tackle the difficulties imposed by these labor constraints and to encourage the expansion of this environmentally sustainable legume-cereal rotation in the dry areas.With financial support from the German Agency for Economic Cooperation, low-cost machine harvest systems were developed and introduced for use by farmers in Syria and Turkey, but further research stopped until an assessment could be made of take-up and success of the different harvesting machines that had become available.

Yaahya El Saleh, a postgraduate student from Syria, who is working on harvest mechanization for his Ph.D. research, has now carried out this survey. With assistance from ICARDA, and the University of Aleppo and the General Organization of Agricultural Mechanization in Syria, and the universities of Cukurova and Adana in Turkey, he found that farmers have largely adopted the new mechanical harvest methods as well as the improved lentil varieties from ICARDA's breeding programs. There are, however, regional differences in the type of machine used.

For mechanical harvesting to work best, planting method is important, as is levelled and stone-free land. Of the 171 lentil growers surveyed in Syria and Turkey, it was noted that about 90% of them grew lentil on flat, deep soil free of stone problems. Nevertheless, in some parts of Syria farmers are still using their traditional method of ridge planting which now needs to be changed

The combine harvester provides faster harvest but with some loss of straw.

to drilling into levelled land for easy use of the harvester.

The harvesting options for these lentil growers are a double-knife cutter bar, a self-propelled mower, or a combine harvester. In Syria, farmers have mostly adopted the combine, while the double-knife cutter bar is dominating in Turkey. Harvest loss studies show that the double-knife cutter bar gives higher straw yield than the combine or self-propelled mower, and is therefore preferred by those growers who wish to use their lentil straw for animal feed. Mechanization alone was not the total answer to improving output from the lentil crop in West Asia. Traditional lentil varieties had low stem strength and fell down, becoming unsuitable for mechanical harvesting where useable straw was an important by-product for farmers. ICARDA, in collaboration with national partners, produced new varieties, including Idlib 1 in Syria and Sayran 96 in Turkey, which meet the twin aims of good standing ability and resistance to mechanical damage. More lentil lines with good standing ability await release in both Syria and Turkey.

A side-mounted, tractor-operated, double-knife cutter bar in operation in Urfa, Turkey.

The combination of improved varieties and the replacement of scarce and expensive hand labor with mechanized harvesting was shown in the survey to be worth 17–20% off harvest costs. For the grower, this is worth an extra US$100 per hectare, but for the local economy in the two areas surveyed, it is worth a substantial US$13.3 million a year.

Mechanization Adoption

Where	Lentil Area (ha)	% Adoption by growers
Urfa, Antep provinces (S.E. Anatolia, Turkey)	150,000	78
Hassakeh province (Syria)	24,000	65

Dr Ashutosh Sarker is Lentil Breeder, and Dr Willie Erskine is Leader of the Germplasm Program, at ICARDA.

Continued from page 12

and 3, respectively. This gives a good chance of finding lines, or combinations of lines, which have both the resistance needed and other characteristics essential for farmer acceptance. Researchers were particularly happy that most of the released varieties showed tolerance to *Fusarium* wilt.

Once again, farmers are involved. After they had selected materials from the trials and evaluated performance of released varieties, they requested seed of the improved varieties; they also suggested that the seed be multiplied both off-season, under irrigation if possible, and in the main season. There are now lines at Debre Zeit Agricultural Research Center that are resistant to wilt, rust and frost, and are tolerant to drought, and these will be released soon.

The driving force for this success was the strong linkage between Debre Zeit and ICARDA's lentil-breeding program. Good progress has also been made in breeding for resistance to wilt and root rots in chickpea.

Farmers are pleased with this; indeed they have been congratulating Debre Zeit Agricultural Research Center on its achievements. For the scientists, technicians and others who work there, these are perhaps the most welcome congratulations of all.

Dr Geletu Bejiga is National Lentil and Chickpea Program Coordinator, and Dr Negussie Tadesse is Pathologist, Lentil and Chickpea, Debre Zeit Agricultural Research Center, Alemaya University of Agriculture, Alemaya, Ethiopia. Dr Willie Erskine is Leader of the Germplasm Program at ICARDA.

Bringing Hidden Feed to Surface

Nature is a vault of secrets, its proportions unimaginable. Some of these secrets have been discovered, yet many remain to be unlocked. An interesting creation of nature is a feed legume, called underground vetch (*Vicia sativa* subsp. *amphicarpa*) or *Bekia* in local language in the West Asia and North Africa (WANA) region. The most striking characteristic of this vetch is that it flowers and produces pods both above and below the ground (hence *amphi*, meaning both sides; *carp*, meaning fruit). ICARDA is using this characteristic in its research on sustainable agriculture for the drylands.

By Ali M. Abd-El Moneim and S. Varma

Specific to the Mediterranean region, the underground vetch is prevalent in Central Anatolia of Turkey, western Asia, Europe, and northern Africa. It grows in areas with poor soils mixed with stones, usually referred to as marginal lands, and is more common in hilly areas. The ability of this underground vetch to survive the harsh conditions of marginal lands with low rainfall (about 250 mm per year), and to produce herbage and pods, which provide nutritious feed for livestock, are both important characteristics which ICARDA is harnessing to rehabilitate degraded rangelands and increase feed production for small ruminants (sheep and goats).

The WANA region is facing an ever-increasing pressure on its land resources due to rapidly growing human population. The demand for meat and dairy products is outstripping the supply. Desperate to meet feed shortages, the livestock farmers are forced to graze their animals on land that has very little vegetation left. This is causing degradation of grazing lands through soil erosion and loss of native, naturally-growing plant species. Since barley is used as animal feed in WANA, the shortage of other kinds of feed, including forage legumes, has triggered continuous barley cultivation in marginal lands by farmers. This practice is not eco-friendly because it is leading to depletion of nutrients in the soil and, consequently, low yields of barley. Overgrazing and continuous barley cultivation are aggravating the threat of desertification.

Vicia sativa subsp. amphicarpa plants with aerial and underground pods.

In marginal lands, expansion of underground vetch cultivation can augment feed supply. Being a legume, vetch helps in enriching the soil by fixing nitrogen from the atmosphere. A vetch/barley rotation can help to break the cycle of continuous barley cropping. The nitrogen added to the soil in the vetch phase helps increase barley yields.

The aerial flowers of vetch are blue-purple, while the underground flowers are white and much smaller. The underground flowers are more fertile than their exposed counterparts. About 80% of underground flowers produce pods. In the case of aboveground flowers, less than 50% develop into pods. The location of the underground flowers probably protects them from environmental factors harmful to pollen formation and fertility. The underground pods are white, in contrast to the chlorophyll-containing green pods found above the ground. Underground pods have fewer, larger seeds than aerial pods (2.0 *vs* 5.5 g/100-seed weight), and the seeds are usually pale compared with greenish-black in aerial pods.

Because little is known about the productivity, agronomy, and ecology of amphicarpic vetch species, ICARDA, in cooperation with its national partners, organized several collection missions to gather samples of vetch species from their natural habitats in Central Anatolia region of Turkey, where drought and heavy grazing are common, as well as from other countries. The Center's gene bank now holds about 150 accessions of underground vetch and 3572 of other *Vicia* spp., collected from Afghanistan, Algeria, Ethiopia, Jordan, Lebanon, Morocco, Pakistan, Syria, Tunisia, and Turkey. This is the largest collection of these species in any gene bank in the world.

Several studies have been carried out at ICARDA to assess the productivity of herbage and seed of the underground vetch, its ability to grow in rotation with barley in the marginal, low-rainfall areas, and its capacity to regenerate after heavy grazing. The results show that the ability of underground vetch to produce both aerial and underground seeds increases under heavy grazing. Over 90% of the aerial seeds are soft and germinate within 10–15 days. In the same period of time, only 2% of underground seeds germinate, because they are hard. Under natural conditions, the underground flowering takes place two weeks earlier than the aerial one. This ensures priority in the development and allocation of nutrients by the plant to the underground fruits.

A single **Vicia amphicarpa** *plant, improved through breeding for increased herbage.*

Drier conditions favor earlier underground flowering; consequently, the number of underground pods is higher than that of aerial pods in a dry year. When growing season is too short due to unfavorable distribution of rainfall and prolonged drought periods in the early spring, a high proportion of plants produce only underground pods. Clipping of aerial shoots stimulates basal branching both above and below the ground, decreases the number of aerial pods, and increases the number of underground pods.

Under heavy clipping, the plants maintain themselves on underground pods only. The two types of pods represnt the ingenuity of nature in protecting this species: the aerial pods increase the distribution of the species to suitable habitats, while the underground pods increase the probability of its survival under heavy grazing and drought.

The potential of this vetch was studied under natural grazing by sheep in rotation with barley. It was grown in large experimental plots and allowed to be grazed by sheep at the end of February, end of March, and end of April. Plots were left without grazing along with barley plots during the year of establishment. During the grazing year, the herbage grazed by sheep was 730, 830, and 900 kg/ha compared to 2000 kg/ha obtained from non-grazed plots. The underground seed yields were 210, 1000, and 1380 kg/ha, respectively, compared to 3800 kg/ha from non-grazed experiments.

Barley variety 'Atlas 46' was planted on the same plots where vetch grew before. It was found that barley after barley produced significantly less biological and grain yields than barley after underground vetch. Grain yield of barley after underground vetch was 2.2 t/ha, whereas, after barley, it was only 1.4 t/ha. Grazing underground vetch had no effect on the productivity of barley. During the barley phase, the seed bank of underground vetch was monitored. The seed bank at the end of the barley phase was around 300 kg/ha. After the barley phase, the underground seeds germinated (self-regeneration) after the first rain. The result was a dense pasture without any external inputs. The productivity of the self-

Continued on page 18

Above: The yield of barley after barley is lower (foreground) than after vetch (background).

Right: Even after extensive grazing, **Vicia amphicarpa**, ***left to nature, regenerates into a dense pasture.***

Harvesting Wheat, Not Wild Oats

In 1992, Egyptian scientists, working with ICARDA, pledged to tackle the problem of wild oat infestation in their wheat fields. The European Union donated over US$ 600,000 to help them do it. Six years on, Egyptian farmers are saving US$ 10.6 million a year just from reduced use of pesticides to control wild oats. And that's without counting the higher yields of wheat.

By El Hassanein El Sherbini Hassanein

Wheat became a profitable crop in Egypt in the 1980s. In those years, the Egyptian Government freed agriculture from a number of regulations to make it financially rewarding for farmers. The result was a gratifying upsurge in both wheat production, and productivity—a process assisted by ICARDA's Nile Valley Regional Program, working with Egypt's national scientists.

But many farmers turned to growing wheat year after year. The result was infestation with wild oats. The chief culprits were *Avena sterilis* and *A. fatua*, and, to a lesser extent, *A. sativa*. New dwarf-wheat varieties adopted in Upper Egypt were particularly heavily infested. By the early 1990s, the Egyptian authorities estimated that about 100,000 ha were moderately or heavily infested, and that wheat yield losses were over 100,000 tonnes nationwide.

Finding a wild oats control strategy was difficult. The morphology, or physical appearance, of wild oats make them hard to distinguish from wheat, particularly in the early growth stages, so hand-weeding entailed a serious risk; moreover, the labor was not always available, particularly in the New Lands. Herbicide has become very expensive in the last few years; agriculture is being deregulated, and it is no longer subsidized. Besides, the Government discourages more than one application of herbicide for environmental reasons, and a single application was not enough. The answer had to be found in a package of different control strategies, including cultural practices, suitable for the various regions of Egypt.

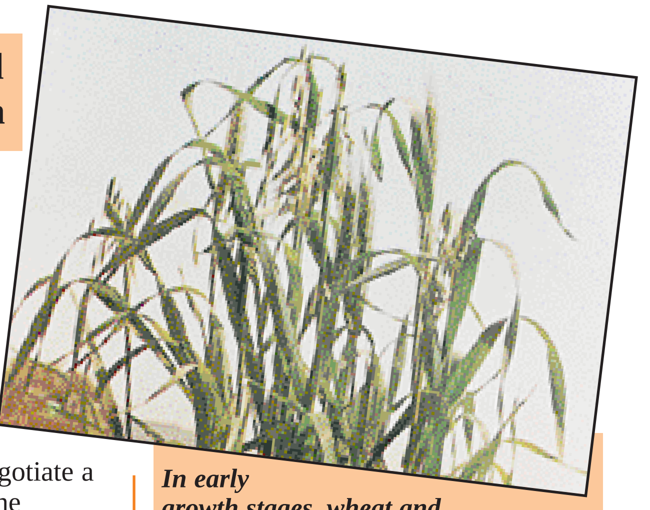
To find a solution, the Weed Control Section at Giza, part of Egypt's Agricultural Research Center (ARC), joined forces with the Nile Valley Regional Program of ICARDA. ICARDA's role was to provide technical support and backstopping, and administrative assistance. It also helped ARC negotiate a grant of US$ 617,000 from the European Union to fight wild oat infestation—and used part of this to train 30 researchers in weed control.

That was in 1992. Six years on, everyone involved has reason to be proud of their efforts.

In the beginning, the project had three basic activities. First, demonstrations took place in farmers' fields of the technology that was available. Second, on-farm experiments took place with farmers' participation, to try to develop suitable technology. During the first year alone, about 30 such experiments took place, testing each measure by itself. Third, back-up research experiments took place to find suitable packages.

The first component included briefing extension agents on how to monitor infestation and apply the herbicides correctly. They were also trained in identifying wild oats in their early growth stages.

Meanwhile, the development of a package took place mainly at Shandaweel and Mallawi stations in Upper and Middle Egypt. Part, at least, of the answer seemed to lie in rotation with berseem. Berseem is a forage legume which is cut four times a year—which means that the wild oats are cut as well. In any case, farmers need berseem for their animals, which helps to make the loss of a year's wheat production economic. It accounts for about half the winter crop in some areas, and is often followed by cotton or maize; it is good for the soil, raising subsequent cereal yields.



In early growth stages, wheat and wild oats are difficult to distinguish, but the differences become clear during later growth stages; the wild oat leaves droop over.

Four years' trials with berseem rotation showed that it was a better option for cutting wild-oat infestation than hand-weeding or herbicide application.

The researchers also tried the *Herrati* sowing method. Under this method, farmers irrigate to raise the weeds and then plow them under before they sow the wheat. This met with 60–70% success—good, but not enough. Even 10 wild-oat plants per square meter were enough to damage the wheat crop.

Next, there were seed rate trials. Raising the seed rate, from 120 to 150 kg/ha, helped the wheat fight the oats. This proved about 25% effective.

Hand-weeding was also looked at. Given the high cost of labor, it is difficult, but it can work, and the wild oats can be fed to animals if taken in their early growth stages. The researchers found that in areas where the labor was available, and where workers had been taught to identify the wild oats, up to 80% success was possible.

Then, there were herbicide trials. The researchers' knew that it was not possible to eliminate the use of herbicide entirely because in some areas, such as the New Lands, hand-weeding is impracticable due to labor shortages. The researchers came up with a number of recommendations using Grasp, Suffix, Topic and Puma-S, and found them very effective. But the cost—around US$ 80 per hectare—was high, and even if 90% of the wild oats were destroyed by one application, the remaining 10% were still enough to cause damage. And, a second application, as stated above, was both uneconomic and discouraged by the Government for environmental reasons.

Finally, roguing of wild oats in lightly-infested areas and the use of clean wheat seeds were also considered.

None of these strategies was adequate on its own. But all were potential weapons in the war against wild oats. Having tested the weapons, it was time to decide on the battle order! From 1993 to 1996, work took place on defining suitable packages. It was a lot of work; combinations of components were tested at 66 on-farm sites in five Governorates. Using all the components together, certainly, was effective, but so was a combination of three; and, in some circumstances, just two. It was also found that hand-weeding, although expensive and ineffective against heavy infestation, could work on its own in the case of light infestations.

The next step was to transfer this information to farmers. This is always easier when the technology has been developed in farmers' fields; their neighbors get to see it. The techniques were used in 100 demonstration plots every year, spread over 11 Governorates; in the course of five years, about 500 demonstration plots were run in collaboration between farmers, researchers and extension agents. About 600 extension agents were trained in identification and control of wild oats. Publicity tools were used: posters, leaflets and booklets, plus popular media. It was found out later that the sources of farmers' knowledge about wild oats control were multiple: weed scientists and extension agents (80%), television (71%), demonstration plots (59.5%), seminars (63.4%) and printed materials (44.3%).

Researchers were pleased that 61% of farmers adopted the complete package of recommendations for their area; if one includes those who did so partially, the figure would be 68%.The whole project has followed the model for technology transfer devised by ICARDA's Nile Valley Regional Program (NVRP), which has been active in the region since 1979. Generous initial support from IFAD (International Fund for Agricultural Development) effectively leveraged considerable support for NVRP from other donors, including the European Union, Italy, the Netherlands and Sweden.

What has been the impact of the wild-oat control package? Researchers managed a yield increase in previously infested plots of 2.01 t/ha. Farmers could not quite do this, but there has been a yield increase of 0.5 t/ha in infested plots nationwide, and, in the last year alone, extra wheat production is calculated at 54,132 tonnes. Savings to farmers from reduced use of herbicides are calculated at LE 36 million—about US$ 10.6 million. These two factors together far outweigh any extra costs incurred through, say, hand-weeding. Now the methodology is being transferred to other crops in Egypt. The project is offering environmental benefits, increasing food security, and putting more money into farmers' pockets. ■

An extension booklet to help farmers eliminate wild oats.

Dr El Hassanein El Sherbini Hassanein is Head of Weed Control Research Section, Agricultural Research Center, Giza, Egypt; he is also Coordinator of the Wild Oat Program.

Underground Vetch

(Continued from page 16)

regenerated pasture was around 4 t/ha, and it could be grazed by sheep in the spring.

ICARDA's work on unlocking the potential of this vetch for reseeding degraded rangelands and increasing feed production is attracting the attention of farmers in several countries. National partners have intensified their research on this vetch, using ICARDA-improved lines to increase the marginal land productivity in Egypt (the Mersa Matrouh Project), Pakistan, Turkey, and Syria. This pasture legume has potential to be grown elsewhere in the world where agroclimatic conditions are similar to the Mediterranean region, for example, in South Africa, southern Australia, North Africa, and Chile.

The naturally-occurring accessions of underground vetch have low herbage yield. A crossing program at ICARDA is making progress in increasing the herbage yield of this vetch by crossing it with promising, high-yielding lines of common vetch.

The underground vetch can help make dry areas greener, with substantial benefits of preventing soil erosion and increasing livestock production, and can be used in ley farming in rotation with barley. It benefits the barley crop through its nourishment of the soil with nitrogen fixation and, even more importantly, it can withstand tillage during the cereal phase.

Working with nature, not against it, for a better tomorrow for the people living in the dry areas, is the key component of ICARDA's strategy. ■

Dr Ali M. Abd-El Moneim is Senior Forage Legume Breeder and Dr S. Varma is Head of Information Services at ICARDA.

Critical Mass: ICARDA's Technology Takes Off

How do you know when a technology has been successfully transferred to farmers?

By Akram Semaan, Faik Bahhady and Mustapha Bounejmate

When they start investing in it themselves. ICARDA's cereal/vetch rotation technology in the El-Bab area of northwest Syria has proved it.

Rotation of cereal with vetch—*Vicia sativa*—has enormous potential for raising cereal yields and better sheep-feeding. It also ensures long-term sustainability of the land, and there is even evidence that it may reduce fertilizer and herbicide use.

The technology trials started in 1986 with a core group of eight farmers. Now 200 farmers are using it in the area. But the farmers wanted mechanical harvesting, as this can significantly increase the profitability of the technology. So ICARDA brought a cutterbar mower to the area and demonstrated it. This spring, a farmer has invested in three similar mowing machines to harvest the vetch. Besides using the machines himself, he rents them out to neighbors. A mower costs about US$2,600.

The rotations were introduced partly for environmental reasons. Technologies devised for this reason will not be taken up by farmers if they can't afford them. But this one pays from year one.

Use of feed legumes also helps increase soil organic matter, and thus soil carbon. There is a need to increase carbon sequestration globally to combat the 'greenhouse effect.'

ICARDA started to develop the rotation technology because continuous wheat and, especially, barley cropping was exhausting the land, and causing an unbroken cycle of pests and diseases. Both were hitting yields. Vetch is a feed legume. It not only feeds sheep; it also "feeds" the land, raising nitrogen content. This leads to better barley and wheat yields and reduces the need for fertilizer.

Although vetch is good for grazing and harvested feed and can replace barley as a source of nutrition for sheep, it has to be harvested if seeds are to be available and fodder is to be kept for lean seasons. Seed supply was a particular bottleneck. Hand harvesting is possible, but is uneconomic in the area. Farmers wanted a way of harvesting mechanically. So ICARDA brought in a cutterbar mower. It worked, and the idea caught on.

Farmer Mr Abou Hassan bought three of the imported mowers. One has been sold on to a farmer in Idleb Governorate, where it will be used for faba bean (*foul*) as well as vetch. The other two have been used to harvest Mr Hassan's vetch and are now being rented out for the equivalent of US$37–47 per hectare. According to Mr Amin Yagen, who has rented Mr Hassan's machines, hand-harvesting costs could be up to US$150–200 per hectare. Both win. "If I had the funds, I would have bought 20 of them," says Mr Hassan. "I will get the cost back in a year or two. And I will use it for other crops, such as coriander. I will buy my own next year," he says.

The machines are not depriving local people of jobs. There is not enough labor available in the area to harvest vetch economically.

Mr Yagen says that mechanical harvesting is better than grazing. The feed is available all year, including winter. This means that besides better weight gain, earlier lambing and higher twinning rates, he has healthy lambs for sale in the spring, when there are few available and the price is at its highest.

Mr Robert Havener (second from right), Member of ICARDA's Board of Trustees; Prof. Dr Adel El-Beltagy (third from right), Director General of ICARDA; Mr Ghassan Emish (left), Director of Agriculture, Aleppo Province; and Dr Ali Abd El-Moneim (second from left), Senior Forage Breeder of ICARDA, visited the El-Bab site recently to see the vetch/barley rotation technology adopted by the farmers in that village. Several farmers and local government officials were present on this occasion.

Moreover, mechanical harvesting leaves the field clear of weeds; this, plus the better soil-nutrient content, means he uses 30% less nitrogen on the wheat that follows vetch. In some fields, he would have been growing less profitable barley instead of wheat had there not been vetch before. Best of all, there is a plentiful supply of seed for further vetch production.

The machinery has clearly helped, and the local farmers' cooperative is planning to buy three cutterbar mowers itself next year. It has been an encouraging experience in two respects: first of all, the vetch rotations were developed at least partly for environmental reasons—but have also proved profitable. Second, it has reached critical mass. The farmers are investing themselves.

A farmer in El-Bab harvests vetch for seed, using a cutterbar mower. The availability of mowers has added to farmers' enthusiasm for growing vetch.

During a field visit to the El-Bab site by senior officials of ICARDA and the government of Syria, Mr Ghassan Emish, Director of Agriculture, Aleppo Province, thanked ICARDA for introducing this technology. "The rotation of cereal with vetch has enormous potential for raising cereal yields and better sheep-feeding. But it also ensures long-term sustainability of the land," he said. "I fully support ongoing efforts to expand this technology. I will urge the Agricultural Bank of Syria to provide farmers with medium-term loans to acquire mowers. The Directorate of Agriculture in Aleppo will join hands with ICARDA to expand this successful experience to new districts such as Menbedg and Jrablous," he added. Mr Khalaf Essalloum, Head of the Farmers' Union at El-Bab, ensured that he would fully support the proposals for purchasing mowers.

Akram Semaan, Faik Bahhady, and Dr Mustapha Bounejmate are Consultants in the Natural Resource Management Program at ICARDA.

International Agronomy Congress *(Continued from page 5)*

Mr President, the Indian Society of Agronomy has shown great foresight and wisdom in calling for this First International Agronomy Congress, focused on environment and food security for the 21st Century. It is an important landmark in meeting the challenge that researchers, policy makers, and the general public face today. This challenge cannot be met alone. The key to success lies in partnerships and in working together globally.

Your presence, Mr President, reflects the highest political will to enhance agricultural production by strengthening the agricultural research system in India. As part of the Consultative Group on International Agricultural Research (CGIAR), we have great admiration for India's achievements in the agricultural sector, and we commend the exemplary commitment of the Government of India to agricultural research. The active and ever-growing involvement of India in the CGIAR System is highly appreciated. On behalf of the System, I would like to emphasize, Mr President, that we have had a fruitful and synergistic relationship in the past with the agricultural research system in India, and we would like to continue and further expand this collaboration in meeting the formidable challenges of the next millennium." ■

Investment Opportunities for Donors

ICARDA has developed one-page concept notes on the projects listed below. Each concept note briefly describes the problem, objectives, activities, beneficiaries and expected impact of the work. It also provides a tentative figure of the funding required and the proposed life of the project. An ICARDA code number follows the title of each project in the list. The Director General of ICARDA will be pleased to provide a fuller version of any of these projects that donors may identify to support.

Natural Resources Management and Conservation

Optimizing soil-water use in the dry areas, ICARDA/16
Sustainable management of shallow groundwater aquifers, ICARDA/25
Planning water-harvesting systems in the drier environments, ICARDA/30
Methods, systems and guidelines for controlling wind erosion, ICARDA/46
Methodology for erosion hazard assessment in rainfed dryland, ICARDA/47
Mapping susceptibility to soil salinization in the dry areas, ICARDA/60
Resource mapping and remote sensing techniques in the dry areas, ICARDA/61
Modeling the recovery of marginal drylands in Mauritania, ICARDA/63

Biodiversity Conservation

Mapping the adaptation of landraces to cope with calamities, ICARDA/06
Increasing biodiversity through decentralized-participatory plant improvement, ICARDA/21
Characterization of barley and wheat *ex situ* collection from center of origin and diversity, ICARDA/52
Database of genetic resources of Central Asia, ICARDA/56

Sustainable Production Systems Development

Anticipatory research for sustainable productivity, ICARDA/01
Using forage legumes for productivity and sustainability, ICARDA/08
Increasing production of oilseed crops in the WANA region, ICARDA/13
Optimizing supplemental irrigation in the rainfed areas of WANA, ICARDA/31
On-farm water husbandry in WANA, ICARDA/32
Farmer participation in land-quality evaluation, ICARDA/35
Community participation to develop mountain-terrace agriculture, ICARDA/38
Safety nets for farmers and herders in marginal areas, ICARDA/45
Optimal rates of fertilization in the farming system in WANA, ICARDA/66
Management and conservation of Andean grazing swamps and camelids, ICARDA/68
Integrating market-oriented production strategies to enhance small-ruminant productivity, ICARDA/69
Market-oriented management and breeding strategies for small ruminant production in Central Asia, ICARDA/70
Improving production of small ruminant cheese and milk derivatives to enhance productivity, ICARDA/71
Improvement of crop production in the oasis system, ICARDA/72

Crop Improvement and Biotechnology

Development of biosafety regulations for countries in West Asia and North Africa, ICARDA/02
Interspecific hybridization in chickpea to introgress biotic and abiotic stress resistance, ICARDA/04
Improving drought resistance with molecular techniques, ICARDA/05
Genetically-engineered stress resistance in crops in WANA, ICARDA/09
Grasspea and lathyrism: safer food for subsistence farmers, ICARDA/10
Pathogenic variability in *Ascochyta rabiei* of chickpea, ICARDA/12
Breeding for resistance to drought to combat desertification, ICARDA/22
Biotechnology as a tool for detoxification and enhancement of nutritive value of grasspea, ICARDA/23
Development of low-toxin/toxin-free grasspea cultivars for Bangladesh and Nepal, ICARDA/24
Stability through biotechnology: changing floral biology of barley to exploit heterosis under drought, ICARDA/27
Alleviation of malnutrition and poverty by improving quantity and quality of food barley, ICARDA/28
Supporting farmers' breeding: improvement of barley landraces by farmers in the Andes, ICARDA/29
Improvement of disease resistance in lentil in Nepal, ICARDA/33
Exploiting BYDV resistance in cereals, ICARDA/36
Experimental mutagenesis in barley breeding, ICARDA/40
Winter barley for malting and brewing industry, ICARDA/41
Barley germplasm enhancement for cold tolerance, ICARDA/43
Broadening wheat genetic base using wild diploid relatives, ICARDA/51
Exploitation of genotype ¥ environment interaction studies in crop germplasm in WANA, ICARDA/65
Adaptation and enhancement of barley germplasm in Central Asia and the Caucasus, ICARDA/73

Integrated Pest Management

Diagnostic reagents for cereal and legume viruses detection, ICARDA/03
Exploiting legume virus diseases resistance, ICARDA/07
Integrated management of Ascochyta blight of chickpea, ICARDA/11
Integrated pest management of Sunn pest in West Asia, ICARDA/17
Use of botanical insecticides for the control of food-legume insect pests in WANA, ICARDA/20
Integrated management of cereal and food-legume insect pests in West Asia and North Africa, ICARDA/48
Integrated management of Hessian fly through host-plant resistance and biological control in North Africa, ICARDA/49
Integrated disease management in cereal and legume cropping systems of the West Asia and North Africa region, ICARDA/75

Seed Production Technology

Seed security: helping farmers to cope with disasters, ICARDA/15
Boosting seed use through small-holder enterprises, ICARDA/26
Forage and pasture seed: on-farm promotion of an informal seed sector, ICARDA/37
Facilitating the development and liberalization of national seed programs through a regional seed network, ICARDA/55
Improving the seed technology capabilities in the region through a new training initiative, ICARDA/57
Promotion and support to informal seed production systems in West Asia and North Africa, ICARDA/58

Socioeconomics and Policy

Policy, institutional and technology options in the drylands of Central Asia, West Asia and North Africa (CWANA), ICARDA/34
Property rights institutions, collective action and management of common resources, ICARDA/39
Micro-credit for sustainable resource management in dry lands, ICARDA/53
The policy economics of biodiversity use and conservation, ICARDA/54
Coping with a new national and international environment: the fate of dryland agriculture in CWANA, ICARDA/59

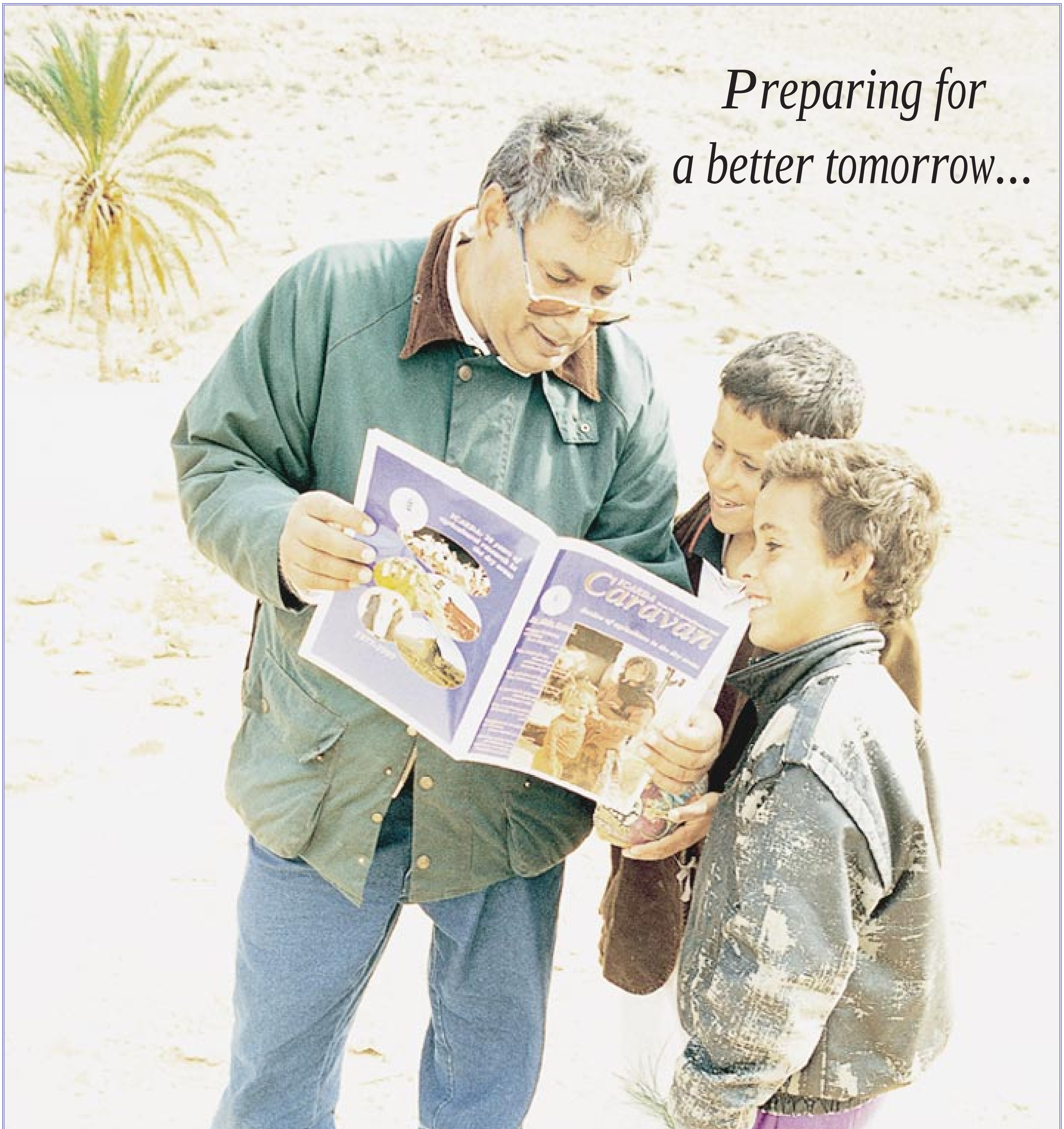
Information Technology

RAIN—Rainfed Agriculture Information Network, ICARDA/14
Use of IT for training agricultural researchers and extensionists, and for information dissemination, ICARDA/18
Soil resource information system for Syria, ICARDA/19
Preservation and dissemination of agricultural literature through a regional cooperative network in West Asia and North Africa, ICARDA/42
Improving variety description capabilities using an expert system, ICARDA/44
Enhancing the quality of data and scientific information in agricultural research in the WANA countries, ICARDA/50
"What is there and where is it"? - Spatial data in Central Asia, ICARDA/62
Barley expert system, ICARDA/64
Development of an interactive CD-ROM for practical training in seed testing, ICARDA/67
Strengthening access to, and dissemination of, information in developing countries, ICARDA/74

Donors to ICARDA

Since its inception to date (*listed in a descending order of the donation amount*)

1. World Bank
2. United States of America
3. Germany
4. Italy
5. The Netherlands
6. IFAD (International Fund for Agricultural Development)
7. United Kingdom
8. Arab Fund
9. European Union
10. Canada
11. Sweden
12. Australia
13. Norway
14. UNDP (United Nations Development Programme)
15. OPEC (Organization of Petroleum Exporting Countries)
16. Iran
17. IDRC (International Development Research Center)
18. Denmark
19. Ford Foundation
20. France
21. Japan
22. CGIAR (Consultative Group on International Agricultural Research)
23. Spain
24. Saudi Arabia
25. Egypt
26. Yemen
27. Austria
28. China
29. Finland
30. Syria
31. Belgium
32. India
33. UNEP (United Nations Environment Programme)
34. FAO (Food and Agriculture Organization of the United Nations)
35. Near East Foundation
36. Switzerland
37. Mexico
38. African Development Bank
39. Rockefeller Foundation
40. IMPHOS (Institut Mondial du Phosphate)
41. South Africa
42. AOAD (Arab Organization for Agricultural Development)
43. ANERA (American Near East Refugee Aid)
44. CIHEAM (Centre International de Hautes Etudes Agronomiques Mediterraneennes)
45. IFAR (International Fund for Agricultural Research)


Preparing for
a better tomorrow...
Caravan