ICARDA Caravan

Issue No. 5 Winter/Spring 1997

Review of agriculture in the dry areas

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The earth... Washed and blown away

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These olive groves look fine, but runoff is damaging them. How can we help?

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Is it bad for the soil? And is money going up in smoke?

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Arabian Peninsula
New office, new initiative

From the Director General

Desertification is an environmental nightmare that has been worrying agricultural researchers and environmentalists for a long time. It is the most extreme form of soil erosion, and also causes loss of biodiversity. To think of erosion only in terms of encroaching desert is to lose sight of the damage that will have been done to the land long before its dangerous effects become visible. ICARDA believes that we must deal with the problem of soil erosion long before it gets to that stage.

Erosion by wind and water has already, quietly, done much damage to the land all over the region. It shows in improperly-used sloping land that is no longer as productive, because the topsoil is being eroded by runoff. It shows in silt which clogs dams and watercourses, ruining investment in construction that has been made just a few years before. It shows in exhaustion of nutrients from cereal monocropping. And it shows in the dust that settles over everything in the summer. It may not show itself to the casual observer, who passes by a field and sees something still growing there. But our scientists can see it clearly enough.

So can the farmers. But here we hit a practical difficulty with soil conservation. Some farmers *can* afford to take a long-term view, and sacrifice short-term income to long-term environmental protection. On the whole, however, farming communities—which are often economically marginalized—face economic and demographic pressures that force them to maximise output from the land by adopting techniques that eventually lead to loss of soil and biodiversity.

One might draw the conclusion, from this, that practical conservation measures are impossible until the land ceases altogether to be productive, and the farmer cannot use it anyway. ICARDA does not take this view. What we must do is

devise solutions that bring net benefits to farmers and pastoralists, so that they can implement them now. This was the rationale behind our cereal/feed legume rotation work; the weight-gain for sheep grazing the legumes fills the economic gap left by a year of no cereal produc-

ICARDA Caravan Issue no. 5 Winter/Spring 1997

The good earth...

...Or is it? Soil erosion is a step on the road to the desert. ICARDA means to stop it.

Sloping land is vulnerable to water erosion—and olive groves in the hills suffer. But farmers have short-term pressures that prevent them from taking long-term measures. ICARDA's response: a participatory approach.

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What is this man doing in a tree (above)? Find out on page 12

Can farmers help stop global warming? These ICARDA technicians are finding out. See page 20

Legumes can feed the soil; saltbushes can protect it against wind erosion. ICARDA brought Egyptian farmers to Syria to see how.

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Burning stubble may not be good for the soil. It may not be economic either. In fact, it may be money going up in smoke.

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Global warming—do farmers have part of the answer? Can agriculture in fragile environments make a difference?

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tion. The following year, cereal yields are up. So it is a solution that farmers can afford to adopt. ICARDA has demonstrated this in its El Bab project in Syria, and is continuing this work elsewhere. But the key point here is: farmers did not want to adopt this solution before these benefits had been demonstrated to them. They couldn't afford to take chances.

We accept this. Now we are working with farmers to devise solutions to the problem of runoff erosion in olive groves. We are doing it by tackling some of their immediate concerns and are getting, in return, cooperation on longer-term experiments.

ICARDA believes that this type of participatory research is highly cost-effective. Money spent on solutions which are not adopted is wasted. ICARDA and its partners will continue with participatory research. But we need to focus on solutions at some stage. We can talk to farmers, but unless the work does result in a feasible, transferrable technology that is adopted, we have wasted our time and theirs. It has to lead to improved income generation and therefore poverty alleviation, and a protected and enhanced natural-resource base—that is, soil, water and biodiversity. Participatory work can not be rushed, but it will lead us in the right direction.

Prof. Dr Adel El-Beltagy
Director General

Plus:

Working in the Arabian Peninsula, page 8

About ICARDA

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

In the context of the challenges posed by the physical, social and economic environments of the dry areas, ICARDA's mission is to improve the welfare of people in the dry areas of the developing world by increasing the production and nutritional quality of food while preserving and enhancing the resource base. ICARDA meets this challenge through research, training, and dissemination of information in partnership with the national agricultural research and development systems.

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 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.

Much of ICARDA's research is carried out on a 948-hectare farm at its headquarters at Tel Hadya, about 35 km southwest of Aleppo. ICARDA also manages other sites where it tests material under a variety of agroecological conditions in Syria and Lebanon. However, the full scope of ICARDA's activities can be appreciated only when account is taken of the cooperative research carried out with many countries in West Asia and North Africa and elsewhere in the world.

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.

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Director General meets Prime Minister of Jordan

On his recent official visit to Jordan, in December 1996, Director General Prof. Dr Adel El-Beltagy met H.E. Mr Abdul Karim El Kabariti, the Prime Minister of Jordan, at the Prime Minister's office. The Prime Minister and Prof. Dr El-Beltagy discussed the on-going cooperation between Jordan and ICARDA and its future direction.The meeting was also attended by H.E. Dr Mustafa Shuneikat, Minister of Agriculture, and Dr Nasri Haddad, ICARDA Regional Coordinator for West Asia. ICARDA runs regional activities for West Asia from its Amman office, which was established in 1989.

The Prime Minister emphasized the importance of research in achieving development objectives, and stressed the Government of Jordan's keen interest in strengthening this area to achieve better agricultural production. He said that ICARDA could play an important role in cooperation with the major institutions in the country, to assist Jordan realize these goals.

The Director General took the opportunity to thank the Prime Minister for the recent decision to award ICARDA full diplomatic status in Jordan. He also gave an overview of the CGIAR system and of the role the CG centers are playing in agricultural development.

He emphasized both ICARDA's global mandate and its role in WANA region, and the major achievements of ICARDA in the development of improved cultivars of the major crops, biodiversity conservation, in improvement of sustainable production systems, in irrigation management and in human resource development. He stressed the region's food needs in the coming 20 years, which could not be met without consolidated efforts by all concerned.

Dr Haddad gave a briefing on Jordan/ICARDA cooperation and on the on-going activities, which cover

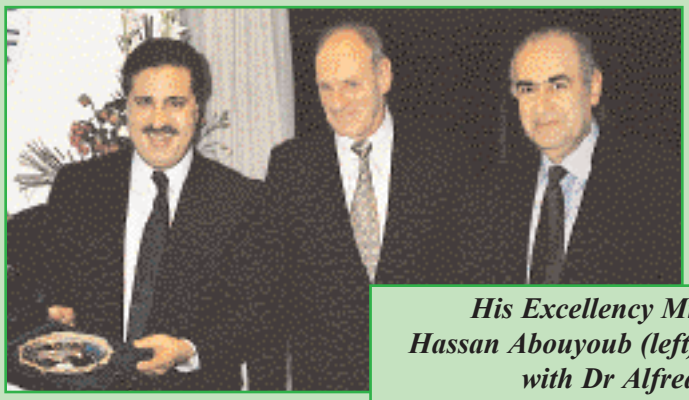
Minister praises joint work with Morocco

His Excellency Mr Hassan Abouyoub, Minister of Agriculture of Morocco, has paid generous tribute to ICARDA's collaboration with Morocco.

"We have a highly positive assessment of ICARDA's work in Morocco and of our cooperation with you," he told Board of Trustees Chairman Dr Alfred Bronnimann and Director General Prof. Dr Adel El-Beltagy. "We have high respect for your scientists. We need you, and hope our cooperation will grow stronger every day. There is no alternative but working together to face the challenges of dry-area agriculture."

Dr Bronnimann and Prof. El-Beltagy were paying a courtesy call on the Minister in Rabat during ICARDA's Program Committee and Board of Trustees meetings in the city from 17 to 23 February. They were accompanied by ICARDA's North Africa Regional Coordinator Dr Mohamed Mekni and by Dr Abdul Aziz Arifi, Director General of Morocco's national research organization, INRA (Institut de la Recherche Agronomique).

Prof. El-Beltagy described ICARDA's growing emphasis on water-use efficiency, and His Excellency strongly endorsed the need for more attention to this important area of research throughout the region. Trade balance, he argued, should be assessed in terms of water-use efficiency and cost. By exporting fruit and vegetables, the countries of the region were, in effect, exporting scarce water to developed countries, and any gains in export were artificial because this element was not being taken into account.



Surendra Varma

His Excellency Mr Hassan Abouyoub (left) with Dr Alfred Bronnimann (center) and Prof. Dr Adel El-Beltagy.

The Minister also endorsed ICARDA's vision and its new Medium-Term Plan, on which he was briefed by Prof. El-Beltagy during the meeting. Prof. El-Beltagy also explained the concept of ICARDA research affiliates in the region who will be the focal points of scientific networks in the region. They would thus be working for the betterment of their own NARS as well as others.

ICARDA's relationship with Morocco dates back to the Center's inception in 1977. Collaboration started with exchanges of germplasm and visits. Since 1986, several ICARDA scientists have been posted to work in Morocco in different areas of research. Between 1986 and 1996, ICARDA also supplied 654 germplasm nurseries, each containing large numbers of improved lines of various crop species, to Moroccan researchers.

From these beginnings, the relationship has developed into a full collaboration, with Moroccan scientists taking responsibility for

such areas as the development of sustainable integrated crop/livestock production systems, improvement of cereal and food-legume crops, water harvesting and management, rangeland policy and property rights, biodiversity and genetic resources, seed production and human resources development.

The Prime Minister enquired about ICARDA's work on drought-resistant crop varieties, especially for strategic crops like wheat. Prof. El-Beltagy gave a briefing on the ICARDA breeding program on wheat, which is carried out in collaboration with CIMMYT, and its efforts in this direction that bear future promise—especially in the area of biotechnology.

The discussion then focused on issues relating to water and its critical importance in the WANA region. The Prime Minister proposed that ICARDA cooperate with Jordan on the use of effluent water and brackish water in irrigation. Prof. El-Beltagy assured the Prime Minister that ICARDA would consider this in its future work in Jordan.

The Prime Minister thanked Prof. El-Beltagy for ICARDA's efforts and cooperation and reiterated Jordan's interest in strengthening this cooperation.

H.E. Mr Abdul Karim El Kabariti, the Prime Minister of Jordan (left), with ICARDA Director General Prof. Dr Adel El-Beltagy at the Prime Minister's office.

important components of ICARDA's research. ICARDA and Morocco have a joint program for participatory barley breeding, and have made substantial progress in incorporating genetic resistance to diseases and pests in wheat. A particularly important Moroccan success has been the breeding of wheat varieties that are resistant to Hessian fly, a pest that causes devastating damage to the crop in several parts of ICARDA's region.

Collaboration has extended to other crops. Morocco has been testing and refining the winter chickpea technology developed by ICARDA in partnership with its sister Center, ICRISAT. INRA has taken this a step further by applying this technology to advance sowing dates of other crops, such as mustard, sunflower and maize. Morocco has been coordinating the faba-bean research network for the Maghreb countries since ICARDA transferred faba-bean improvement research to Morocco in 1991.

Morocco and ICARDA have worked together to preserve plant genetic biodiversity, saving it for future generations. Joint collection missions have so far resulted in a total of 2,656 new accessions.

There has been important collaborative work on pasture, forage and livestock. This dates back to 1978 and includes a very wide range of work. There have also been joint efforts in the field of biotechnology, agroecological characterization and farming systems research.

Training in particular has been a key element in ICARDA's technology delivery strategy. Therefore, 614 young Moroccan researchers and technicians have been trained in a variety of courses at ICARDA headquarters and elsewhere since 1979. ICARDA scientists have guided the M.Sc. and Ph.D. thesis research of several Moroccan students. Moreover, ICARDA has supported Moroccan scientists in a large number of international scientific events, where advances in collaborative research were presented. ICARDA has also deputed its Sation Operations Manager to help INRA by advising on the improvement of the physical infrastructure and operation of its research stations.

The high quality researchers and technicians available today in Morocco are benefiting the whole ICARDA region in a variety of scientific fields, ranging from Hessian fly resistance breeding to agroecological characterization, rapid rural appraisal, and technology transfer methodologies.

"I am delighted that H.E. the Minister is pleased with the relationship between ICARDA and Morocco," says Prof. El-Beltagy. "We are happy with it too. ICARDA can only succeed in its mission to raise food production and, at the same time, protect the natural-resource base if it works together with the national systems.

"We are certainly getting that collaboration from Morocco. ICARDA's efforts in strengthening agricultural research and training in Morocco since 1977 has come back in the form of a lively and committed research partner. Indeed, today ICARDA has several Moroccan scientists on its own senior research staff at its headquarters, working on topics from rangeland to crop breeding. It is a partnership that will continue to grow."

Errata

ICARDA staff have pointed out that, in our item on the Dryland Resource Management Project (Caravan No. 4), we did not mention the valuable support given to this project by the United Nations Environment Programme (UNEP).

Also, on page 4 of that issue, we wrongly identified Dr John Burns as Vice-President of Texas A&M; he is actually VP of Texas Tech. Apologies to all concerned.

Preserving Central Asia's genetic heritage

Genetic erosion is as frightening a prospect in the newly-independent republics of Central Asia as it is elsewhere. But the international research community is taking action.

By Jan Valkoun and Larry Robertson

ICARDA and its sister Center the International Plant Genetic Resources Institute (IPGRI), and their partners, have established a plant genetic resources network to coordinate conservation of Central Asia's genetic heritage. Known as the *Central Asian Plant Genetic Resources Network*, it emerged from a meeting in Tashkent in late October 1996.

And it looks as if, through its long-standing contacts, ICARDA has managed to find a donor to strengthen this network further. This assistance would take the form of a project, *Preservation and utilization of unique pulse and cereal genetic resources of the Vavilov Institute*.

Conservation of agrobiodiversity—the raw material of tomorrow's future food crops—is of particular importance in harsh environments. The subject was covered in some depth in *Caravan* No.4. This is as true of Kazakhstan, Kyrgyzstan, Tadjikistan, Turkmenistan and Uzbekistan as it is of anywhere else. The region has undergone decades of monocropping for high cereals and cotton output, reflecting its role as a commodity supplier for the old Soviet Union, and this, along with environmental damage through lavish water use (which led to the draining of the Aral Sea), overgrazing and rangeland degradation, can lead to serious loss of wild relatives of crops as well as locally-adapted farmers' varieties.

The October meeting was attended by three-member delegations from each of the five Central Asian republics, along with participants from the prestigious Vavilov Institute of Plant Industry (VIR), based in St. Petersburg. ICARDA was represented by senior staff from its Genetic Resources Unit. The other body at the meeting was IPGRI; this has a regional program based at ICARDA's Aleppo headquarters, but IPGRI's European operation is also involved in this through its forestry network, FORAGEN.

It's an exciting new collaboration, because the potential for swapping germplasm could be excellent. There is quite a similarity in the environments of the Central Asian and West Asia/North

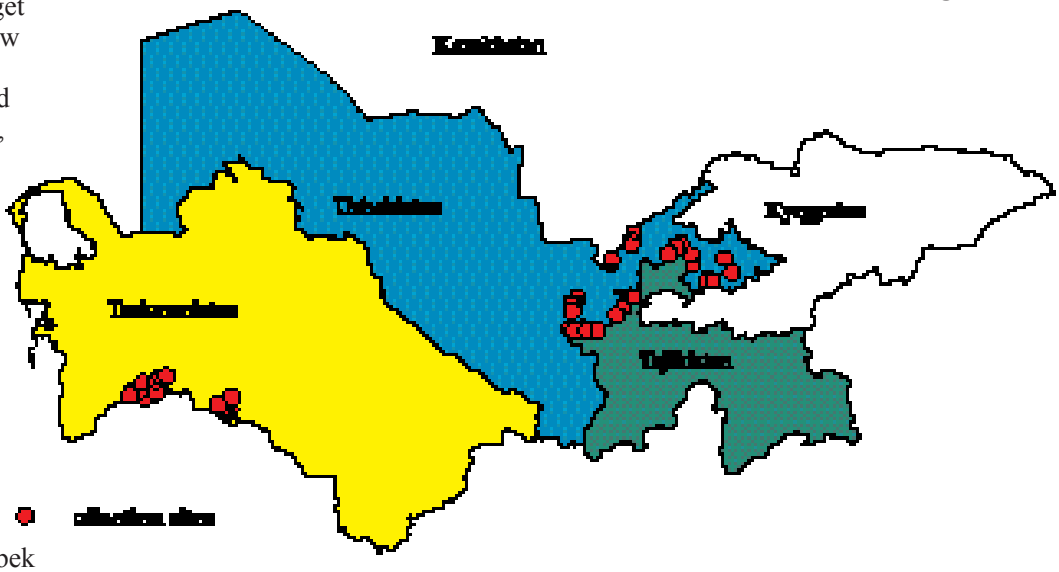
Jan Valkoun

Dr Anna Filatenko (right) of the Vavilov Institute in Syria in 1990. Dr Filatenko was taking part in a collection mission for wild relatives of wheat, conducted jointly by ICARDA and the Syrian national program.

Africa regions, so there are bound to be opportunities for plant breeders on both sides to get their hands on new raw material.

First, though, we need to harmonize systems and, where necessary, provide training and support to our colleagues. Unlike many areas, Central Asia does have expertise in biodiversity conservation. This is reflected in the existence of the Uzbek Institute of Botany, which holds more than one million herbarium items from Central Asia, and the Uzbek Institute of Plant Industry.

Map showing locations of wild relatives collected by ICARDA scientist Dr Michiel van Slageren in 1991.



Graphic by Jan Valkoun

The latter was established in the 1920s by the great crop researcher, Vavilov, as the Central Asian branch of the Vavilov Institute. With approximately 55,000 germplasm accessions, the Institute is the largest genetic resources center in the whole region. Unfortunately, the germplasm is stored in inadequate short-term facilities. But this will change if the plan materializes for building a new gene bank at the Uzbek Institute of Genetics with Japanese support.

There are real constraints, however. Those highlighted by the October meeting were:

- Lack of adequate storage facilities.
- The absence of computer support in the documentation and information system.
- Insufficient contacts and germplasm exchange within the region and with VIR.
- Lack of training opportunities.
- Budgetary constraints.
- Insufficient interaction with the international community.

The new network will split its activities into five working groups: field crops; industrial crops; range, pasture and forage crops; horticultural crops; and forest trees. It will also make an early start on the training aspect with a course on genetic resources conservation and documentation. Scientists will be brought there from VIR to help with the course. It will be conducted jointly by ICARDA, IPGRI and VIR.

ICARDA and VIR have also drawn up a provisional collaborative workplan for 1997/98. This includes harmonization of databases, so that the two institutions can identify what each one has and hasn't got, making exchange easier. At the moment it is sometimes unclear what VIR is holding in St Petersburg, and what is at their Southern genebank at Krasnodar. Also, ICARDA will support the participation of VIR scientists in two conferences being held jointly with IPGRI in Syria in the spring of 1997, one on *Triticae* and the other on the origins of agriculture.

In 1998 it is hoped that there will be joint evaluation trials of VIR and ICARDA germplasm at ICARDA to see what VIR has that would be useful in the West Asia and North Africa region. A visiting scientist from VIR will be appointed to work at ICARDA for six months on the joint evaluation trial.

In addition, ICARDA scientists will visit VIR during the season to work with documentation harmonization and develop future collaborative research activities in collection, conservation and evaluation of germplasm.

It is this work that would be supported by the project currently under consideration for funding by the Australian Centre for International Agricultural Research (ACIAR). This will, if approved, involve ICARDA, VIR, and another long-standing partner of ICARDA's—CLIMA, the Centre for Legumes in Mediterranean Agriculture, a Commonwealth-supported institute in Australia. CLIMA and ICARDA have worked together on the transfer of ICARDA germplasm to build up the Australian lentil industry, among other things (see *Cobber, Digger...and transgenic lupins*, in *Caravan* No. 2).

The project would reconstruct the link between the Central Asian Republics and VIR. ICARDA will multiply seed from Central Asia; it will then go to VIR, which cannot multiply all types at St Petersburg because of environmental constraints—it is too far north.

It will also thus again have access to Central Asian germplasm, as it did before the breakup of the Soviet Union. ICARDA will ensure that the germplasm is safety-duplicated. And germplasm will go to CLIMA in Australia for pest and disease screening; the information thus gained will come back to all the partners in the project. In the meantime, a similar exercise will take place with the priceless collection held at VIR, which was a pioneer in germplasm collection and conservation in the early part of this century.

ICARDA is well placed to work with partners in the former Soviet Union. Two of GRU's senior staff, including the first author, speak Russian!

Dr Jan Valkoun is Head, and Dr Larry Robertson Legume Germplasm Curator, of ICARDA's Genetic Resources Unit.

Into the driest areas

ICARDA's mandate covers the world's dry areas—and the Arabian Peninsula is one of the driest regions of them all. The Center has entered a new phase in its collaboration with seven countries in the region to meet the challenges of the future.

By John Peacock

There is nothing new about ICARDA's involvement in the Arabian Peninsula. The Arabian Peninsula Regional Program (APRP) began in 1989 and, in its initial phase, operated for about seven years from ICARDA's headquarters in Aleppo. It concentrated mainly on institutional strengthening.

Phase II, however, will be different. For a start, it will be run out of the region itself. This has been made possible through the enthusiastic support of the United Arab Emirates, whose Minister of Agriculture and Fisheries, H.E. Saied Al-Raqabani, has backed us from the start. As a result, in January 1997 ICARDA formally opened the APRP office in Dubai. APRP is financially supported by the International Fund for Agricultural Development (IFAD) and the Arab Fund for Economic and Social Development (AFESD).

APRP Phase II will have to be at the cutting edge of dry-area agriculture technology. To decide what the priorities should be, a group of distinguished senior scientists from the region, and representatives of AFESD and IFAD, arrived at ICARDA headquarters in early March 1997 to get Phase II off the ground. The scientists from the UAE, the Kingdom of Saudi Arabia, Bahrain, Qatar, Kuwait, the Sultanate of Oman and the Republic of Yemen attended the Regional Technical Coordination and Regional Steering Committee Meeting of the APRP, which took place from 1 to 4 March. They were joined by donor representatives Dr Abdelmajid Slama (IFAD) and Mr Samir Jarrad (AFESD).

Each delegation gave presentations on the technology available and required in four areas. These were rangeland, shrubs, irrigated forages/livestock, protected agriculture, and abiotic stresses, on-farm water use and irrigation management. Predictably, water loomed large in the final conclusions.

There is a strong link there with forages, according to the Saudi Arabian representative, Mr Abdulkarim Bin Mohamed El-Ghamdi. Mr El-Ghamdi, who is Director General of the Agricultural Research Department of the Kingdom's Ministry of Agriculture and Water, commented that he was concerned that by producing irrigated alfalfa that then leaves the country, Saudi Arabia was actually exporting water. He believes that supplemental irrigation of grasses instead would be more water-use efficient in the Kingdom.

These concerns were reflected in the conclusions of the meeting, which included a strong prioritization of water management, including salinity, soil health, and efficiency enhancement of several types of water application. There will also be a strong training element. It will be important to make better use of existing crop-water use models developed for the region; we do not wish to reinvent the wheel. Also included in the priorities was specific work on rangeland shrubs, irrigated forages and livestock. A database will be developed for major characteristics of natural fodder species and irrigated forage crops with emphasis on water-use efficiency. Dr Jan Valkoun, Head of ICARDA's Genetic Resources Unit, is collecting indigenous rangeland forages and shrubs, and will assist in training scientists from the Arabian Peninsula on how to collect and conserve plants from the wild, many of which are tolerant to heat, drought and salinity. Livestock work will be done in collaboration with our sister Center, the International Livestock Research Institute, based in Kenya. It is an example of how programs like the APRP can broaden host countries' access to the work of other international Centers as well as ICARDA.

Protected agriculture is also of crucial importance in such a harsh region. This consists of the production of appropriate crops—fruit, vegetables and flowers—in greenhouses or similar structures. The level of experience

varies: Qatar, for example, has been working in the area since the mid-1970s, and Kuwait also has an active sector. However, some other countries have done less. The national programs all made brief presentations on where they stood with regard to this industry. Diverse problems emerged, but there was also commonality; for example, the need to conserve energy and the possibilities of solar power were suggested as fields for research. There is a general problem with excess humidity in the greenhouses and plastic tunnels, as water cannot escape; this renders the plants vulnerable to disease. For the research priorities decided in the March meeting, we again included water-use efficiency—but also integrated pest and disease management and structures design. During 1997-98, APRP will be looking at the economics of structures and verifying the resistance/tolerance of commercial varieties to prevailing viruses and other diseases. And there will, again, be a training element.

Other priority research areas picked out by the delegates included the need to develop databases on the state of research in each of the four main themes. Scientists in the national programs and at ICARDA will develop a questionnaire to help collect the data. Collaboration on production of these databases will be sought with the International Service for National Agricultural Research (ISNAR), another CG Center, based in The Hague.

While these themes are pursued, the APRP partners intend to develop other projects for the future. These will include one on citrus, which will be centered on the Kingdom of Saudi Arabia but will benefit the region as a whole. And, although there is already a strong water-use efficiency element in the plan, research will be developed for water harvesting and supplemental irrigation in the rainfed areas of the Arabian Peninsula.

The author was able to see the relevance of all these research themes for himself during a long trip around the region in the autumn. For example, the economics of structures used in protected agriculture are illustrated by installations such as the Arab Qatar Agricultural Project at Al Shaheniyah, Qatar. Built originally with cooperation from The Netherlands and The Arab Organization for Agricultural Development (AOAD), it is a success, producing cucumbers, tomatoes and flowers. Water source is through desalinization using reverse osmosis;

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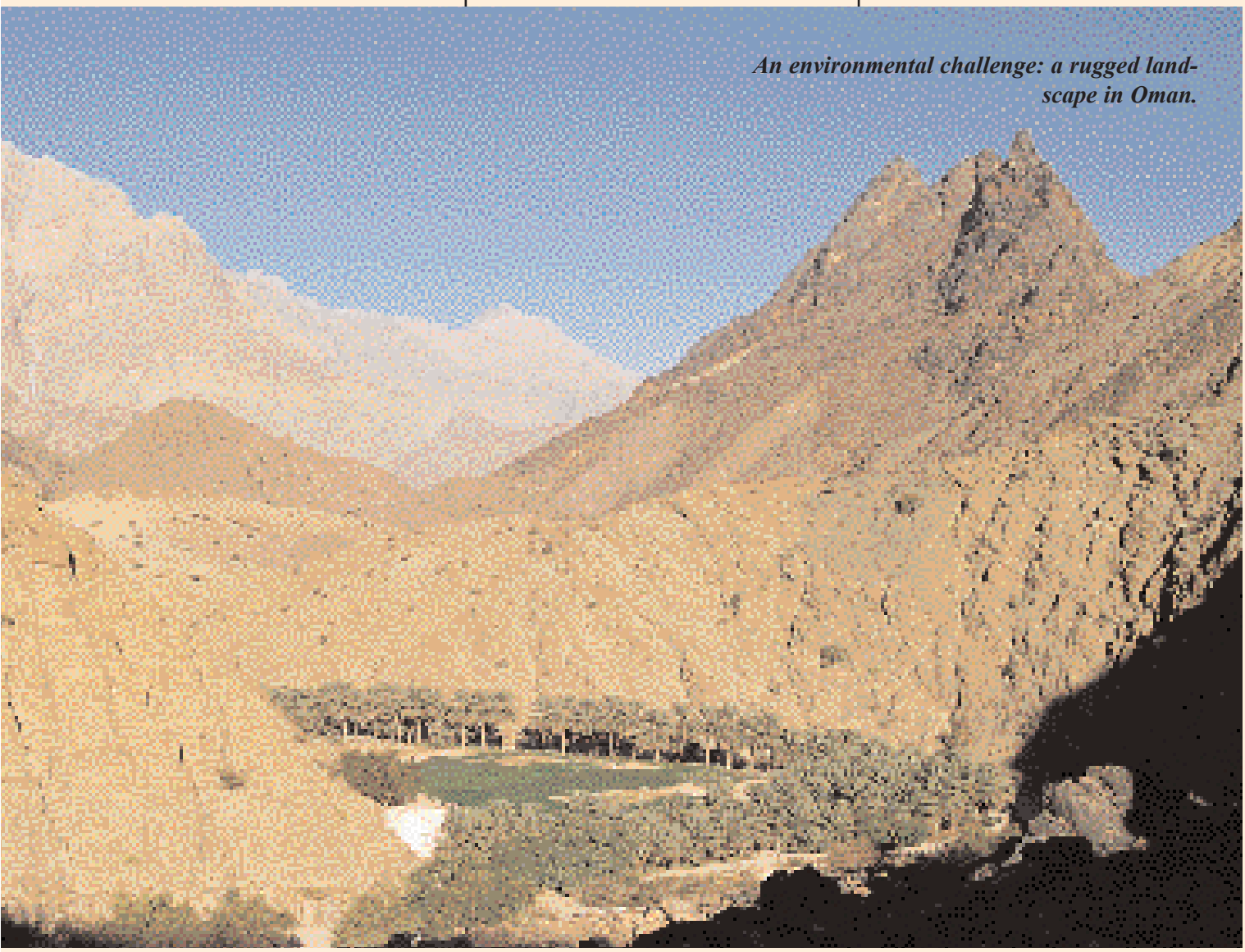


An environmental challenge: a rugged landscape in Oman.

John Peacock

From scientist to shepherd—and back again

Shrubs play an important role in rangeland biological stability. They are also a key element in the rehabilitation of degraded rangeland. But there must be experience and feedback before it will become really effective. ICARDA, Tunisia and their partners have just taken a major step to that end.

By Gustave Gintzburger, Tom Nordblom, Mustapha Bounejmate and Georges Arab

Desertification is a menace in semi-arid and arid Mediterranean zones. Its causes are complex, but overgrazing is one of them. To help slow down this trend, there is an urgent need to develop appropriate measures to restore feed resources on rangelands. Technical options are available; one of them is the re-establishment and use of native and exotic fodder shrubs and trees such as saltbushes (*Atriplex* spp.).

Between 27 October and 2 November 1996, ICARDA and Tunisia held a meeting of experts from 24 countries to discuss their production and use. The participants included farmers from nine countries, and NGOs from four. Called the *Regional Training Workshop on Native and Exotic Fodder Shrubs in Arid and Semi-Arid Zones*, it was held in Hammamet, Tunisia.

Mustapha Bounejmate

While many countries have embarked on large-scale plantation programs of fodder shrubs for direct grazing, other countries argue that not enough is known on the grazing management of such plantations and their use by the local nomads and settled farmers. Expensive fodder shrub projects have proved to be failures, destroyed sometimes by climatic accidents, but more often by mismanagement. This is a pity, as native or exotic shrubs could play an important role in rehabilitation programs of marginal lands and rangelands in these zones, not only as feed reserves but also in soil and water conservation in environmentally-degraded areas (see *Shrubs could help save the steppe*, in *Caravan* No. 3). But, as with any technology, it is important to exchange experiences so that research is not duplicated. It is also important to include farmers' experience and perceptions in the process. This was one of the objectives of the Hammamet meeting.

The farmers came from as far afield as Syria, South Africa, Senegal and Australia. One of the farmers attending was Mr Faysal Al-Ahmad Ibn Nuri, who is also head of the Jub Ahmad Almshael Cooperative for Sheep Breeding and Range Amelioration, in Aleppo Province, Northwest Syria. "I own 1,100 sheep," he said before the meeting. "My extended family had traditional control of 40,000 hectares below 200 mm mean rainfall, for grazing and for some barley cultivation prior to 1994/95, when the latter was prohibited."

He described how the Government had arranged shrub plantations on a total of 14,300 hectares near Maragha, 150 km south east of Aleppo. Shrub plantations to provide feed at lean times, when sheep are hungry and the vegetation is at a vulnerable stage in its growth, are an important part of Syria's rangeland strategy. ICARDA is collaborating in this.

"In April 1995, I leased 900 hectares for one month of grazing in the government plantation at Maragha. It was a dry year and grazing inside the plantation was good at first; milk production increased. Towards the end of the month, however, milk production fell back as the green grasses turned yellow. Because of the salty soils and salt-rich vegetation inside the plantation, I had to offer one meal of fodder to the sheep every day and double the normal amount of fresh water—each sheep drank up to 11 liters per day." However, Mr Ibn Nuri is in favor of shrubs as a possible solution to feed deficit and restoring degraded rangeland.

Another Syrian farmer had a less satisfactory experience. Mr Ahmed Jasin El Mohamed was not at Tunis, but farms in the same area as Mr Ibn Nuri. He tried his luck with fodder shrubs in 1983 by growing *Atriplex nummularia*, provided by the Syrian Ministry of Agriculture. It didn't work, a fact that Mr El Mohamed attributes to the drought of that season. A second attempt, this time with *Atriplex canescens*, in 1987, was more successful but the stand, some years later, is poor, probably because of overgrazing. The contrast between the two farmers reveals the importance of good management.

Mr Rob Van Holdt, from the Karoo region of South Africa, was one of three South African representatives who attended the workshop. He is also an active member of Somerset East Farmer's Association and Organised

Agriculture. The role of this organization is to promote economic fodder-shrub establishment and management. Mr Van Holdt focused his presentation to the workshop on on-going efforts to reduce cost of *Atriplex* plantations and maximize the establishment rate. Mechanization over the last 25 years, he reported, has brought cheaper seed-handling. And he has developed a simpler, cheaper method to establish fodder-shrub plantations by direct drilling of dehusked and pelleted seeds.

Illustration of the use of shrubs for rangeland rehabilitation was given by a farmer from western Australia, Mr M.J. Lloyd: "Salinity is becoming an increasing problem because of the rising water table as a result of clearing of the natural trees and shrubs for agriculture. My farm has an area of 2,160 ha, of which 700 ha is saline. I was searching for ways, first, to deal with the saline areas, and second, to try and slow down, or stop, the spread of salinity. In 1989, I planted some saltbush seedlings (*Atriplex* spp.), and after viewing some work done by another farmer, I tried 17 ha. This was a great success and since then I have seeded over 350 ha on my property and a further 200 ha for a neighbor. This farmer has not experienced any difficulty in getting the sheep to eat the saltbush. In fact, the sheep will cluster around each bush as they enter the paddock to feed."

Indeed, said Mr Lloyd, the stocking rate has improved when saltbush is grazed, with more clean wool per head, giving a higher wool price per kilogram and higher gross income per sheep, and the gross margin per hectare for the saltland shrub area was US$33/ha. Other benefits are erosion control, increased wildlife, lower groundwater levels, improved cover of annuals, improved aesthetics and improved farm value.

Majed Khateb

Not only farmers, but national research leaders also gave presentations on their experiences with shrubs; they included Jordan, Morocco, Pakistan, Syria, and Tunisia. In these countries, intensive efforts are being deployed to introduce fodder shrubs on a commercial scale. Revegetation of denuded areas, filling seasonal feed-gaps, and strategic reserves for drought management are examples of the various roles fodder shrubs play. But more research is required on the value and uses of fodder shrub species.

A two-day field trip was organized to visit a sample of Tunisian fodder shrub plantations. The diversity of sites and management conditions was remarkable. It included both *Acacia cyanophylla* plantations, and introduction of native shrub species— *Periploca leavigata*, *Callicotum villosa*, *Rhus tripartitum*— both on collective lands managed by the Forestry Department. The participants also saw a spineless cactus plantation on private lands for fruit and forage production. Initially introduced as a fodder crop, cactus is more and more used for fruit production with high gross margin per hectare. Cactus fruits are consumed as such or used for jam making. Our colleagues from Central Asia—two scientists from Uzbekistan—were impressed.

The scientific program included a retrospective on the history of fodder shrubs in the region by Dr H. N. Le Houerou, one of the leading researchers on the subject. There were also special sessions on the biology and ecology of the shrubs themselves, the plant-animal relationship, the socioeconomics of the technology and its transfer to users.

However, the presence of fodder-shrub users during the workshop brought another dimension to the traditional scientific approach. Everyone, including the ICARDA scientists, felt that they had learned a lot from the farmers. This way of bringing scientists, farmers and others together will continue, as it is very much in line with ICARDA strategy. This is to involve those who will use a technology in its development. There is no better way to ensure that it works—and that they will use it.■

Dr Gustave Gintzburger is Leader of ICARDA's Pasture, Forage and Livestock Program. Dr Tom Nordblom is an Agricultural Economist with PFLP. Dr Mustapha Bounejmate is Consultant to PFLP. Mr Georges Arab is Economics Research Assistant, PFLP.

A total of 113 participants from 24 countries attended the Regional Training Workshop on Native and Exotic Fodder Shrubs in Arid and Semi-Arid Zones. Countries represented included: Algeria (4), Australia (2), Chile (1), Egypt (8), France (7), Greece (3), Iran (2), Iraq (1), Japan (1), Jordan (4), Kazakhstan (1), Lebanon (1), Libya (2), Morocco (15), Pakistan (2), Senegal (2), South Africa (3), Spain (3), Syria (9), Tunisia (21), Turkey (1), United Kingdom (2), United States (1), and Uzbekistan (2). Farmers came from Morocco (2 farmers), Syria (3), Jordan (1), Australia (1), South Africa (1), Tunisia (1), France (1), Egypt (3), and Senegal (1) NGOs came from Morocco (2), Jordan (1), Pakistan (1), and Tunisia (1). The event was sponsored jointly by ICARDA, the Tunisian Ministry of Agriculture, CIHEAM (Centre International de Hautes Etudes Agronomiques Mediterraneenes, France), SDC (the Swiss Agency for Development and Cooperation), IDRC (Canada's International Development and Research Center), ICARDA's sister Center IPGRI (International Plant Genetic Resources Institute), and the Food and Agriculture Organization of the United Nations (FAO).

ICARDA is also coordinating the project Production and utilization of multi-purpose fodder shrubs as part of the Consultative Group on International Research's System-wide Livestock Initiative. This involves several Centers belonging to the CGIAR, which is ICARDA's parent body. Other participants in the project are the national programs of Burkina Faso, Mali, Niger and Senegal, as well as those with which ICARDA has more frequent links, such as Morocco, Jordan and Tunisia. Spain is also participating.

The good earth...

...Or is it? All over the West Asia and North Africa (WANA) region, the soil is being swept away, blown away, drained of nutrients and drenched in saline water. But farmers, weighed down by short-term economic pressures, have little time to think about it. So what do we do? There is a way. And, in places like these olive groves, ICARDA is putting it into practice.

By Michael Zöbisch, Mike Robbins and Jouhayna Issa Ramadan

The olive groves sweep across the hills of Northern Syria in long, straight lines of trees, like soldiers on parade. In the mild, bright early-December morning, the earth between the trees is a light gray-brown; here and there in the valley bottoms, patches of deep brown earth or light green mark the arable land. In the distance, to the north, the snowcapped mountains of Anatolia fade away into

Mike Robbins

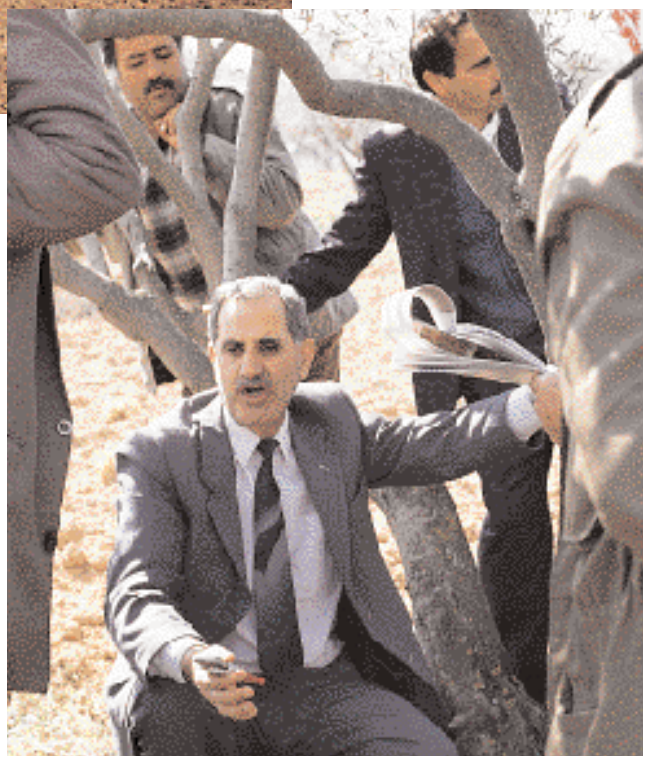
The olive harvest in December (main picture); the crop is knocked to the ground (center), gathered and bagged . But yields are threatened by soil exhaustion and by water runoff that can remove precious earth from the sloping hillsides. Tractors can plow only vertical furrows on some of these slopes, worsening the problem. Using animals instead might help—but in that case, why are tractors used? Researchers from ICARDA (above) are looking for the answers.

the haze; closer at hand, villages perch precariously on the summits of hills, houses jammed together, looking for all the world as if they were about to tumble down the hillside. The delicate light from the low early sun picks out every detail in the landscape. The scene reminds the onlooker of Tuscany—an impression reinforced by the Italian makers' names stamped on the heavy, old-fashioned olive presses that stand in the villages.

An attractive view. But to the farming systems researcher, this landscape can be read like a book. The villages are where they are because the hilltops are the poorest land; the deeper swatches of green in the valleys are there because the valley bottoms have been nourished for centuries by the soil that is washed off the higher ground in the heavy winter rains. It is still happening. And for the farmers whose income depends on the olive groves that lie between the two, that is not good news.

Applied research into soil conservation and land management is needed urgently here; in fact, right across the WANA region. The problem is that soil is a subject that tends to make the farmers' eyes glaze over. It is not because they don't care. It is because they are short of time and short of money and must look to the next harvest, not to the state of the soil in five, 10, or 15 years.

But it is also true that they watch the soil washing down the hillside all of their lives, as did their parents before them, and they're still there and farming. Is it, they may ask, really that urgent?



(Left): The difference that correct pruning can make; the tree on the left has suffered frost damage. It was one of the points that Mr Zakaria Kawas of the Idleb Olive bureau discussed with the Idleb and Yakhour farmers (below).

Jouhayna Issa Ramadan

Yes. What happens to the soil has an immediate effect on income. Exhaustion of nutrients will show up in falling yields, and excessive erosion will make the ground uncultivable. And silting of rivers and irrigation canals will limit the water supply.

The old answer to what is perceived as farmer apathy has been to devise soil conservation measures and enforce them. That does not work. A prime example, albeit in a very different country, was in Ethiopia, where slopes were terraced through a food-for-work program after the great famine of the 1980s. Farmers worked hard on this because they were obliged to, but also because the food that was supplied made it economically worthwhile. Yet the terraces reduced effective land area, and thus yield; moreover they were too narrow to turn a plow. So after the changes of 1991, when the area became Eritrea, farmers, still under economic pressure, actually dismantled the conservation measures themselves. Had the measures been devised in consultation with farmers, they might have survived.

But how do you get busy cash-strapped farmers to cooperate? This is the challenge facing ICARDA's Farm Resources Management Program (FRMP). We decided to tackle it by starting with what the *farmers* perceived as the immediate problems—and demonstrate the relevance to these of soil conservation. This calls for a cautious, courteous approach. Building such an alliance with land users cannot be done in a week. It is *our* job to convince *them*. And it was this need which brought us here—to the hilltop village of Yakhour, a few kilometers from the northern frontier of Syria.

We found that the problems perceived by the farmers included falling yields due to loss of soil off slopes, biennal drops in yield, pests and frost damage. If we could help farmers solve these, within the context of soil conservation, we could get them to work with us in the longer term. But one has to be careful, still; if we imply that they don't know how to grow olives, the response will be at best amused. They have, after all, been doing it for generations.

An indirect approach was needed. So we decided to invite a group of the farmers from Yakhour to meet and swap notes with olive growers further south, in Idleb province, where we hoped that what they saw would start them thinking about their problems. We would play a proactive role only in organizing the visit. When we got there, we would shut up and let the farmers talk to each other in peace. But we would be there to underpin the technical aspect of any discussions, as would a team from the Idleb Olive Bureau of Syria's own Ministry of Agriculture and Agrarian Reform.

The meeting took place in the middle of March 1997. At Idleb, a team from the Idleb Olive Bureau, headed by Mr Zakaria Kawas, joined in. A group of specialists from Aleppo's Directorate of Agriculture joined us later. The first stop was at one of the large olive fields in Idleb where the Idlebi farmers received the group. We introduced the two groups to each other and invited farmers to talk about their operations and exchange ideas.

The Yakhouri farmers started the discussions talking about their bad experience this year in pruning the olive trees which, unlike other years (according to them), may lead to 30-40% losses in olive production following the frost period. Looking at the healthy olive trees around the Idleb farms, the Yakhouri farmers seemed puzzled by the fact that the frost did not seem to have had the same effect in Idleb.

Here, Mr Zakaria of the Olive Bureau came in with some technical backstopping. Overpruning, and pruning at too early a stage, exposed the trees more to the frost which caused the damage. This is especially harmful when done before February, because

there is still a chance of frost. "The Yakhouri farmers tend to overprune their olive trees. In future they should follow the example of their counterparts in Idleb, who practice proper pruning and at the right time (late February/early March). That is how they protected their trees from the frost," he explained.

The party then visited the farm of Abou Ali, an Idlebi olive farmer, where the soil is very similar to that of Yakhour. The Yakhouri farmers raised many questions, most of which revolved around proper cultural practices, including pruning, land preparation, and the use of fertilizers. Problems such as wilting and stem borer were also raised. Lively discussions were held between farmers and with the staff of the Olive Bureau. All the questions raised by the farmers were answered either by their fellow-farmers from Idleb or by the Olive Bureau officials. The day, it seemed, had gone well. We all sat down to lunch. Over the meal, the Yakhouri farmers told us that the visit had been useful. Yes, they did want to work with ICARDA.

The next step is to set the research agenda. This won't be done in the office. We will hold a planning meeting with the Idlebi and Yakhouri farmers and the Olive Bureau, this time in Yakhour itself, perhaps in the schoolhouse. At this meeting we will analyse the problems they face there—pests, the odd biennial fall in yields, loss of soil cover, pruning problems—and then break them down into biophysical components—the plants themselves and their husbandry, the nature of the terrain and soil, and the rainfall. There are a number of areas that may emerge as worth considering. We suspect, for example, that pests can be dealt with partly by improved pruning practices, and that application of sheep manure, compound or foliar spray will combat the yield fluctuations.

And the soil will be in our minds. We suspect that tillage will need looking at—should they be plowing along the contours instead of down them? But can they do this with a tractor, on a steep slope? If they have to use mules instead, will it be economic? Should tillage be done only after the rains?

We won't suggest these, though, at least not at the beginning. Such ideas might turn out to be completely wrong. Even if they are not, we hope that they will emerge from the discussions so that the farmers feel their views are being properly reflected. And, at the end of the meeting, we can put together a research agenda.

There will be two net results of this. First of all, the farmers will be more committed to the work than they would if it was done with a top-down approach. And second, we will have got on-farm soil conservation research underway with the wholehearted cooperation of the community—even though the farmers aren't immediately interested in soil conservation in itself.

It is one thing for an international center like ICARDA to apply this approach on a local scale with the full cooperation of the national Ministry. It is quite another to get the technique of participatory research into natural-resources conservation to spread worldwide, so that it has some impact.

Arguably, what prevents it is the fundamental divorce between national research and extension systems. The result is something like what happened in the Ethiopian project we mentioned at the beginning. Researchers devise solutions; extensionists take them to the field. The extensionists then find either that they can't transfer the technology, because it doesn't work in the real world; or, worse still, they do succeed, the measures prove inappropriate, and the researchers work on in blissful igno-

Mike Robbins

rance of the shambles being wrought on the ground by solutions that were worse than the problem.

Why don't research and extension divisions work together more? The reasons vary from bureaucratic inertia to physical separation to a feeling by the scientific researchers that extension is a common profession, while the extensionist regards the scientist as a strange creature with his head in the clouds. The only answer may be to abolish the distinction.

This has, in fact, been done in places. For example, Bhutan's authorities decided to tackle the problem and held consultations with ICARDA's sister Center, the International Service for National Agricultural Research (ISNAR), based in The Hague. The Ministry in the end decided to group all its activities, including research and extension, in one body called Renewable Natural Resources (RNR). Further measures under consideration include ending the physical separation of the two branches by grouping provincial representatives together under one roof.

This may be a model for other national research systems in the future. But the key will always lie with people. We repeat: when dealing with farmers, it is *our* job to convince *them*. After all, if natural-resource conservation fails, it is the farmer, not the scientist, who will be the first to suffer. ■

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Farmers believe farmers...

Majed Khateb

Farmers from Mersah Matrouh, and ICARDA staff with Syrian farmers who have been working with ICARDA on cereal/legume rotations.

No one on earth can persuade farmers of the benefits of the new technology better than other farmers. So the methodology being used at Yakhour (see *The Good Earth*, page 12) is not confined to that project. Recently, a similar activity was organized by the ICARDA Pasture, Forage and Rangeland Program as an input into the Mersa Matrouh Project in Egypt. This project is an Egyptian initiative to raise agricultural production sustainably in the coastal strip between the Mediterranean and the hot, arid lands to the south. ICARDA is assisting the project through technical back-up in collaboration with the Egyptian national program. As part of it, it was decided to invite a group of farmers from Mersa Matrouh to Syria to show them the work being done jointly by the Center's scientists and local farmers on cereal/legume rotations and on rangeland rehabilitation with shrubs.

Between 4 and 6 March 1997, at El Bab (60 km northeast of Aleppo) and Maragha (120 km northwest of Aleppo) research sites, five farmers and six technicians from Egypt had a chance to exchange views with their Syrian counterparts.

The tour started at Bershaya site in

By Jouhayna Issa Ramadan

El-Bab, where scientists and local farmers briefed the Egyptian farmers about the history of the crop-rotation experiments which have been running since 1986/87 and the benefits obtained by farmers in that village. This technology has been designed to combat falling cereal yields and, at the same time, provide an alternative feed source for small ruminants (see *Feed for the future* in *Caravan* No. 1). Commenting on this, Mr Abou Hassan, the first farmer in the village with whom ICARDA started working, said that back then farmers were not convinced of the benefits of the rotation trials: "In 1986/87, only two hectares were planted to vetch, with all the seed and fertilizer provided by ICARDA. Now more than 170 ha are planted to the same crop with the seed and fertilizer being provided by the farmers themselves," said Abou Hassan. "The number of farmers associated with ICARDA has jumped from three in 1990/91 to about 40 in 1996/97."

The next stop was at Batajek, where ICARDA is leading a land rehabilitation project. The local farmers demonstrated to the participants how land which was totally degraded due to overgrazing has now improved considerably after phosphate fertilization and sowing with native pasture legumes, protecting it during critical times of the year, but still having it open for grazing most of the time.

"We have benefitted a lot from introducing forage legumes to our degraded land. Our sheep gained a lot of weight and started mating," said Abou Ziad, one of ICARDA's cooperating farmers there. According to ICARDA pasture ecologist Dr Ahmed Osman, productivity has increased 6-10 times that of the neighboring land.

The tour continued to several other sites. At one, farmers were shown another Marginal Land Rehabilitation site, where the work is led by ICARDA and coordinated by Dr Osman. The difference between the improved land and that left to nature was quite evident to the participants. A detailed review of crop rotation trials was made for them by ICARDA's Faik Bahhady, focusing on the effect of the forage legumes (especially vetch) on grain and straw production of the cereal as well as on the soil. A visit to one of the wheat fields was made where participants saw a very good wheat crop following vetch.

Michael Zobisch

At home in Mersah Matrouh: figs and olives are attracting farmer interest.

"Crop rotation using vetch has become a regular practice for us due to its benefits," confirmed one of the farmers.

At Tel Tahin, participants also listened to farmers' experiences with vetch cultivation and the positive results they obtained. Farmers there also stressed the importance of land preparation, and confirmed the real benefit obtained from the technology. "ICARDA used to persuade us to follow this and other practices, providing all the necessary equipment. At first we were not convinced, but later as we made gains we started chasing ICARDA seeking its help," remarked Abou Hassan to the participants.

The next day of the tour was devoted to visiting the steppe, where ICARDA is leading a very important project on intercropping shrubs with barley for grazing. The first stop was at Korbatia, where Dr Osman demonstrated to the participants how shrubs (*Atriplex* spp.) are intercropped with the barley crop to be grazed by the sheep later with the stubble. In the steppe, where the annual precipitation does not exceed 150 mm and soil may be affected by salinity, shrubs can provide a very good source of feed for the sheep (see *Shrubs could help save the steppe* in *Caravan* No. 3).

A visit was also made to Abeesan Protected Land, which belongs to the Ministry of Agriculture. This project was established in 1995 with an area of 7000 ha. It includes all kinds of shrubs and aims at improving the rangeland and the plant cover. One-year-old plants were sown there. Dr Osman commented that this was a very good step taken by the government, because this land was communal land and was overgrazed. Protecting it is a very important social component not only for improving the land, but also for confining its grazing to the neighboring farmers and sheep owners, compensating them for what they had lost earlier from communal grazing.

Several questions were asked by Egyptian farmers on the practices used in planting, in an attempt to benefit from the experience of the local workers. The government plans to use about 50,000 ha in fodder-shrub planting. So far, 25,000 ha in Aleppo Province have been used in this way. The average annual rainfall at Abeesan is 150-180 mm.

Will the Mersah Matrouh farmers adopt the technology they saw on this trip? Only if it suits their plans. But they are certainly more likely to adopt after discussing it with other farmers who have already done so. Nobody wants to make a leap in the dark. So farmer-to-farmer consultation, sponsored by ICARDA, looks certain to continue.

Stubble—a burning issue

After the cereal harvest, the skies are filled with smoke from the burning stubble as farmers clear the fields for the next crop. This has environmental implications, especially for the soil. And it might not even be economic. ICARDA has been looking into it.

By Safouh Rihawi

In much of the West Asia and North Africa (WANA) region, the landscape in the wheat-growing areas is disfigured for several weeks after the harvest by thick black pillars of smoke, rising from the fields where the cereal stubble is burned. It's a pollutant; and it's bad for the soil, exposing it to wind erosion. As with so many issues in agricultural development, the farmers are reacting to economic pressure. They do it mainly so that they can put the field back into production quickly, usually under when they are irrigation. There is a spiralling demand for cereals in WANA, and farmers can hardly be blamed for wishing to maximize their returns from the land.

But stubble burning may actually be economically disadvantageous. Crop residues are valuable as animal feed in WANA—that might be money going up in smoke!

Many farmers do, in fact, take that view. Countries in the WANA region and many other regions around the world have a dry season when sheep graze cereal stubble after harvesting. Cereal stubble is an alternative to dry annual pastures in summer and autumn. This relieves grazing pressure on other parts of the farm; and increases returns, taking advantage of the considerable quantity of the dry matter for animal production. So stubble may be an important part of the gross economic return from crops. In fact, burning of stubble is very rarely practiced in in Syria in areas with areas with rainfall below about 325 mm, where every stalk of stubble is required for grazing.

However, in the past, in many regions particularly with rainfall of over 400 mm, farmers have regarded stubble as an unwanted by-product, and stubble management by fire has been an easy solution. There are, in fact, potential disadvantages in retaining stubble, as it may make seeding and weed control difficult, temporarily tie up nitrogen, and may assist to carry-over of crop disease.

Even so, in the long term, retaining stubble is better for the land. It can maintain or slightly increase soil organic matter and structural stability, and reduce erosion. These benefits can be important if stubble retention is combined with grazing. And there is an increasing awareness now exist of the need to retain surface cover to protect the soil from wind and water erosion. Stubble reduces erosion by reducing wind drag on the soil surface, physically protecting the surface from the impact of blown-in sand and intercepting moving soil particles.

But leaving stubble in place doesn't eliminate wind erosion entirely. Most stubble fields in WANA are grazed in summer by sheep, causing plants to be trampled, eaten and removed. The prostrate stubble resulting from grazing will protect the soil surface, but it tends to blow away, leaving the surface bare and vulnerable to erosion. Heavy grazing not only removes all the stubble but pulverizes the soil surface, increasing the risk of wind erosion. In Syria, wind erosion of topsoil can be severe after harvest and stubble grazing. Erosive wind occurs mainly during June and August when soil is dry and the surface cover very sparse. Grazing should be controlled to leave sufficient surface stubble to protect the soil from erosion. We need to understand all this—and yet grazing of stubble has received little research attention and there is very little published on the grazing of cereal stubble.

The environmental implications go beyond wind erosion and pollution. Demand for animal products in West Asia and North Africa (WANA) is increasing as a result of population growth and increased urban consumption. Sheep and goats are the most important livestock species in WANA region, with a population of several hundred million animals. This large

Majed Khateb

population has led, in a chain reaction, to overgrazing, degradation and decline in productivity of the natural grassland (see *The battle for the steppe* in *Caravan No.3*); this has increased the importance of cereal crops for feeding ruminants. It is, in fact, an important part of the farming system—and of the regional environment, as well as its economy.

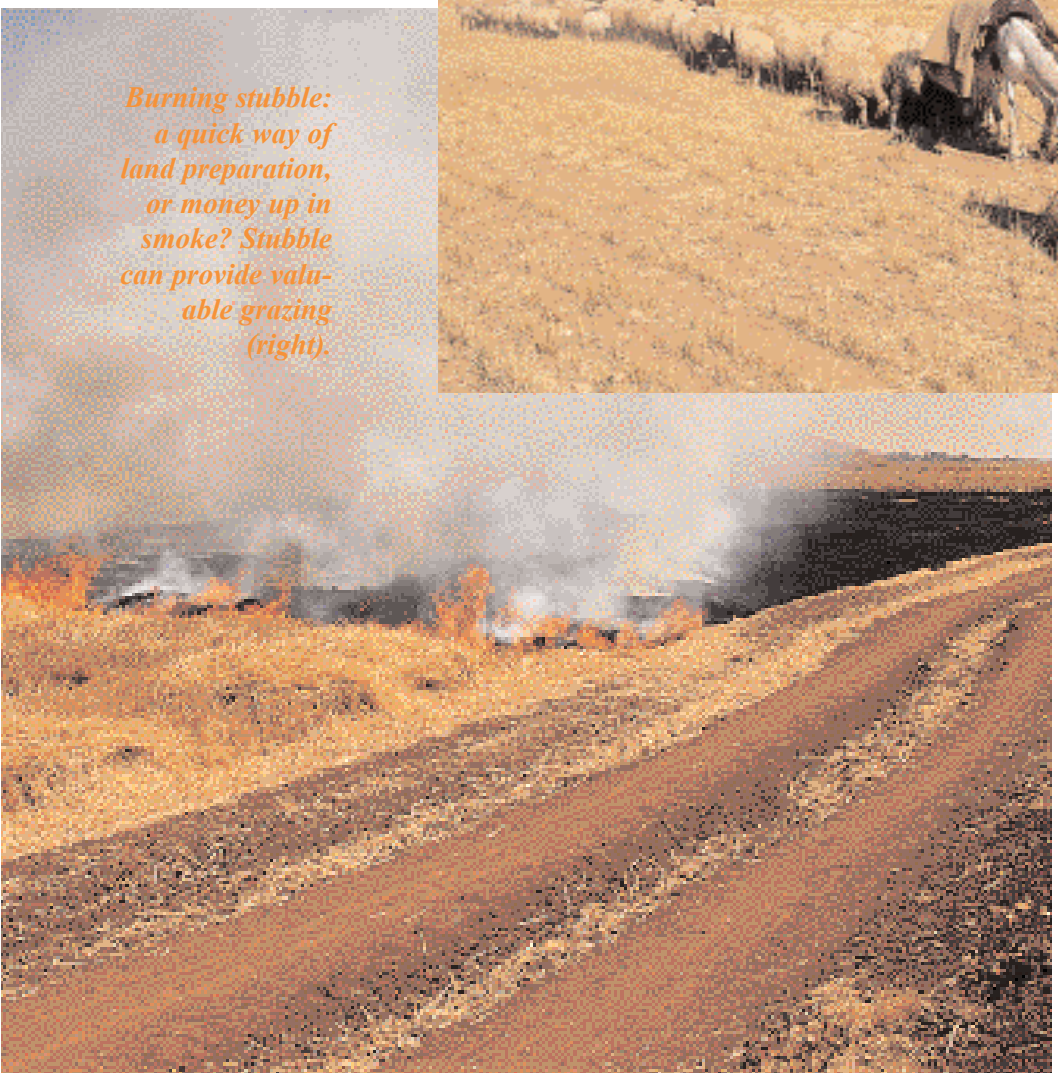
The close integration of livestock and crops in farming systems in the WANA region plays a key role in determining the current crop production strategy of the majority of farmers in the region. In the period between harvesting cereals in June and sowing the new criop in October, stubble grazing (i.e. on-field post-harvest residue) is the most important source of nutrient for small ruminants. Moreover, the stubble-grazing period coincides with mating and pregnancy in the flocks. As nutrition before mating and in the first month of pregnancy can have a major effect on the fertility and prolificacy of the flocks, stubble grazing has important implications for their performance during the whole year.

Is stubble alone enough at this period? ICARDA decided to look at this in more detail. Its Pasture, Forage and Livestock Program (PFLP) surveyed farm practice in northern Syria and started experiments on the effects of stocking rate and feed supplementation on stubble intake. The sheep were the hardy fat-tailed Awassi breed common in the region (see *When sheep's tails had wheels* in *Caravan* No. 1).

The experiments illustrated the change in level of nutrition that occurs as stubble becomes depleted with time or heavy stocking. Sheep usually graze stubble at mating time; better nutrition at this time makes lambing earlier and increases the number of lambs born in the flock. Offering small amounts of supplement—cottonseed meal or barley and cotton seed meal—to ewes grazing barley stubble increased body weight at mating, and reduced the time required to conceive. Responses were greater in ewes receiving supplements with higher protein concentration.

Future work will address problems at the farm level—in particular, the practicality of using non-protein nitrogen (urea blocks) to reduce the cost of nitrogen supplementation, and whether the findings are applicable to sheep grazing wheat stubble. There is also a possible link here with the broad range of other work that PFLP is doing on the use of feed and forage legumes to replace continuous cereal cultivation (see *Feed for the future* in *Caravan* No.1). These legumes, too, are an important source of feed, and good for the soil (legumes fix nitrogen). Other relevant activities at ICARDA include the breeding of high-yielding cereals for good feeding-quality straw (see *A broad spectrum of barley* in *Caravan* No. 2). Careful, integrated research in a farming-system context could all but eliminate the economic pressures that lead to stubble burning.

That is how it should be. We are balancing environmental and economic factors within the context of the farming system.



Burning stubble: a quick way of land preparation, or money up in smoke? Stubble can provide valuable grazing (right).

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Agriculture: a weapon against global warming

Agriculture in fragile environments is known to contribute to the menace of global warming. But it needn t be like that. Good agriculture, based on sound research, could increase carbon sequestration and slow down global warming even in marginal areas. And ICARDA has some ideas on how.

By John Ryan and Mike Robbins

Global warming has become one of the chief preoccupations of popular journalism. Emission of greenhouse gases, we are told, has led to the greenhouse effect—a heating-up of the Earth's climate that will change the ecology of every part of the world and reduce the polar ice-caps, and may put the Statue of Liberty under water. Every coastal city will be at risk; the sea will lap around the streets of New York, Bombay and London, to name just three.

The destruction of the Amazonian rainforests for unsustainable agriculture has, we are told, hastened this process by robbing the world of its lungs, so that "bad" gases hold sway over "good". So agriculture is one of the villains of the piece?

Well, yes, in that instance it could be. But it is more complicated than that. The great majority of greenhouse-gas emissions come from industry and motor vehicles. Emission of such gases has global impact irrespective of their geographical origin. North America is the biggest offender, followed by first Eastern and then Western Europe. And, arguably, appropriate and well-planned agriculture in fragile environments can *slow* the process.

First, let us define the problem. The world is, without question, getting warmer. The temperature has always fluctuated, but what is happening is something more. Between 1900 and 1950, there was a 0.4^{o}C increase; then, from 1990 to 1996, there was an increase of 0.2^{o}C—a dramatic acceleration. The 10 warmest years in the last 130 have all occurred in the last 15 years. The Intergovernmental Panel on Climate Change (IPCC) stated recently that "the balance of evidence suggests there is a discernible human influence on global climate."

The gases causing this (the "greenhouse gases") are: methane (CH_4), emitted by ruminants (including sheep and cattle) and termites; nitrous oxide (N_20), from wetlands and fertilizer use; and carbon dioxide ($C0_2$), from the burning of fossil fuels (motor cars included!), from burning of straw, from slash-and-burn practices and from deforestation. All these are potentially relevant to agriculture. Methane we can forget for our purposes. Although it is emitted by livestock, the amount produced on the vast feedlots of North America dwarfs any produced in the Middle East, despite our spiralling flock sizes. Nitrous oxide is produced by agriculture; it originates as nitrate fertilizer put into the soil, and if the soil is poorly aereated, the soil bacteria will cause it to be emitted as N_20 instead of as oxygen. But this happens more in flooded land such as rice paddies, which are not a major feature in the West Asia and North Africa

(WANA) region where ICARDA mainly works. We will return briefly to nitrogen later, but the main one of the trio we are interested in is carbon dioxide.

It is definitely linked to global warming. Geological surveys, and investigation of ancient air-pockets in the polar ice-cap, indicate that it was present in the air at the rate of around 300 parts per million (ppm). In 1900 it was about 290 ppm. But in 1996 it was 360 ppm and is expected to rise at the rate of 2-3 ppm over the next 50-100 years.

As we have said, most of the carbon dioxide warming up our planet is emitted by the industrial world. The role of agriculture here is not that it is producing $C0_2$; rather, it is that its introduction into areas that were permanent forest prevents CO_2 being harmlessly absorbed and retained in the vegetation. Most of the carbon is not in

Wind erosion (above) will help turn the land into desert—but it may be an effect, not a cause, resulting from overgrazing and loss of vegetative cover. Firewood collection (below) may not help.

Majed Khateb

the air; it's in the sea and in the ground, and that is where it should stay. It is pulled into the land by plants, to be converted into plant matter—that is, biomass.

But deforestation of the rainforests destroys the existing biomass, replacing it with agricultural biomass that doesn't last, because the laterite below cannot support it for long. Writing in *Nature* in 1994, Canadian and Venezuelan scientists reported that continuous agriculture without supplementary fertilization was viable for 65 years on temperate prairie, but just three years on Amazonian soil—after which it had no potential for agriculture at all.

Carbon sequestration will then cease altogether on that piece of land. Just what effect this could have is illustrated by the amount of carbon held in the soil on ICARDA's experiment station in Syria. Held in the top 20 cm, it is 16 tons per hectare. And that is a low figure, for millenia of agriculture have left the carbon level quite low in the Fertile Crescent.

The danger here in WANA is that unwise agriculture could release it back into the air. This is especially so of the steppe, the great plains used for livestock grazing that cover vast tracts of land from Mongolia, through Central Asia, to the Middle East. This is fragile land. In hot, dry environments, carbon sequestration is much lower than in the cold, wet lands of the North (the best example of carbon sequestration is a peat bog or a coal seam—both composed of ancient biomass that was originally created from carbon in the atmosphere). At Maragha, the research station in the steppe where ICARDA works with Syria's Steppe Directorate, the soil layer containing carbon is just 2 cm deep. Unwise cereal cultivation on this land had caused loss of natural shrubs leading to soil erosion, and overgrazing has not helped (see *The battle for the steppe* in *Caravan* No.3). Such carbon as had been sequestered into that soil and vegetation will now be released back into the atmosphere as CO_2 because of rapid oxidation.

This happens quickly. Since cultivation of the North American prairie started around 1900, no less than 60% of the soil carbon content has been lost. A graphic illustration of how this process

Use of nitrogen fertilizer is not always bad; if it increases yield, it increases below-ground biomass and therefore carbon sequestration. Here, technicians at ICARDA check nitrogen content in the soil after fertilizer application.

happens was the horrific Dust Bowl of the 1930s. The biomass that contains the carbon was also holding the soil together. Anyone who thinks that soil erosion is a subject solely for scientists should read John Steinbeck's *The Grapes of Wrath* to understand the scale of the tragedy. The land blew away.

Are we to conclude, from all this, that agriculture in fragile environments—for example, WANA—reduces carbon sequestration, and automatically contributes to global warming?

No.

On the steppe, it may be better to avoid cultivation. But responsible grazing will do no harm. And, in areas where settled agriculture *is* sustainable, the right sort of cropping can *increase* carbon sequestration. On the ICARDA experiment station, scientists have been running long-term rotation trials since 1984. Recent tests showed that, where medics, which are feed legumes, had been introduced into the rotation, carbon content had increased from 1% to 1.3%. The reason is that legumes have a large below-ground biomass. Thus more plant residues are retained in the soil. All legumes are good for this (though some less so than others—with lentil, for example, the root system is pulled out at harvest). The effect is multiplied, because the cereals grown in rotation with legumes give better yield; this means more below-ground biological activity, and an accumulation of nutrients, especially N. Carbon sequestration goes up.

As for wind erosion, this won't happen with proper agronomic practices, provided the soil is suitable for agriculture in the first place. Minimum tillage is essential. Anything which raises yield sustainably is also helpful. This includes nitrogen. Fertilizer is not necessarily bad. The issue is how it is managed. The example of nitrous oxide being released into the atmosphere applied only to flooded fields. If the soil can breathe, it won't happen.

There is a further aspect—aggregation. This is the degree to which the soil holds together in larger rather than smaller particles. Larger are better; Dr Zuhair Masri of Syria's Soil Directorate, who has just completed a PhD thesis under the supervision of the first author, showed that increased carbon content following incorporation of legumes in the rotation increased soil aggregation and thus water ingress, as there is space between the particles, making the soil more porous. This will obviously make the land more productive and will lead to greater water-use efficiency; and to higher yield, producing more biomass and increaing carbon sequestration.

This has encouraging implications. If the process of carbon enrichment in the soil could be accelerated and high levels maintained, the soil will be much improved; the danger of soil erosion will be reduced, and so will the levels of one "greenhouse gas" in the atmosphere.

These observations give cause for great optimism. ICARDA has been working for years on the replacement of fallow and/or continuous cereal with feed legume/cereal rotation. The purpose was to break the pest/disease cycle, raise yields and provide an alternative source of feed for sheep, bringing net benefits to the farmer (see *Feed for the future* in *Caravan* No.1). Now it seems that these rotations are actually improving the physical and biological properties of the soil.

From this work, we have drawn three conclusions:

- Improved soil organic matter—e.g. carbon—is critical for semi-arid areas.
- A build-up of this matter is compatible with intensive farming in the dry areas.
- Intensive agricultural production and the need to prevent global warming are also quite compatible.

Or, in other words, protect the environment—grow more food! ICARDA will be pursuing a number of related themes in its research from now on. It will look, for example, at tillage, seasonal variations, stubble residue decay (an important part of the WANA farming system—see *Stubble—a burning issue*, page 18), the impact of sewage sludge on soil organic matter, and the biomass carbon/nitrogen relationship. But one thing now seems certain. With very careful management, fragile environments can—up to a point—be farmed intensively. And doing so should actually slow down global warming.

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the standard of management needs to be high, and the gap between profit and loss is narrow. There are three basic designs of structure—fully-ventilated plastic houses, fully ventilated with a glass roof and non-ventilated with a roof of aluminium strips. The first two designs work well, but the third gets too hot.

This Qatari experience needs to be spread around the region if the economics of protected agriculture are to be understood. Otherwise, high investment in protected agriculture could be lost. In the Kingdom of Saudi Arabia, the protected-agriculture industry has shrunk drastically over the last two years due to economic and marketing issues and a build-up of nematodes. One of APRP's tasks will be to coordinate the practical research needed to ensure that this does not happen throughout the region.

While in Saudi Arabia, the author was interested to find how the Kingdom is actively looking at the whole issue of water-use efficiency. It is not only through forages that Saudi Arabia has been exporting its precious water; it was also doing so with wheat. This is now being stopped. The Kingdom's Government is also having a re-think on central pivot systems for irrigation, as it regards them as inefficient. Also, working with the Food and Agriculture Organization (FAO), the Ministry of Agriculture has produced guidelines to the irrigation requirements of the Kingdom's major crops, and a crop-growth model which could be a reference for the design and operation of efficient irrigation systems in the Arabian Peninsula.

John Peacock

John Peacock

Livestock are crucial to the farming economy in much of the Arabian Peninsula. But so is protected agriculture, and much is being done in research stations like this one in Qatar (below left).

Any technology which leads to more efficient water use in the region is welcome; it is not just an issue of scarcity, but of soil salinity. Salt content varies widely, but is often high; for example, 3-12,000 parts per million (ppm) is Bahrain and 6-10,000 ppm in Kuwait. There is potential here for using salt-tolerant crops—barley, for example, can cope with up to 10,000 ppm, and there could be further development of shrubs for grazing (an area in which ICARDA is very active—see *Shrubs could save the steppe* in *Caravan* No.3).

Other work in hand in Saudi Arabia which is likely to be useful in the rest of the region is on rangeland conservation. Over 70% of the country's land area is so classified. Grazing is a traditional way of life. In recent years the Government has become increasingly concerned over damage being done through overstocking, and is treating conservation and rehabilitation as major issues. Its Department of Range and Animal Development now has a number of substations which are in effect protected, and on which effective land management and rehabilitation are being demonstrated.

Date palm is important in the region. A Date Palm network has already been set up at the King Faisal University in Al-Hofuf, where there is a research center specifically for this crop. Date palm is vulnerable to pests and diseases, but it is encouraging to find countries in the region working on Integrated Pest Management (IPM) instead of chemical control; indeed Oman has now banned importation of chemicals that are no longer legal in countries like the USA. Both Oman and Yemen are researching indigenous techniques for pest control; in the latter country, for instance, there is a farmer's method of getting ants to eat the larvae of the Lesser Date Moth.

It will be APRP's task to coordinate research on the four main themes in order to reduce duplication, and to ensure complementarity (e.g. the country best equipped to tackle a particular subject can do so, and share its experience). It will also ensure that ICARDA's research and germplasm is accessible and relevant to the countries of the region. (It is good to report that crop lines from ICARDA and other CG Centers, for example ICRISAT and CIMMYT, are already playing a role.)

It will be a fascinating task. In Oman the author, in the company of hospitable colleagues, drove some 2,000 metres up Jebel Akhdar and was delighted by the steep slopes, date gardens, and small farms with a thriving honey industry (and a superb product).The journey finished at a spectacular fort with a natural spring and near-boiling water. This is a diverse region. To be sure, much of it is extremely harsh. But that in itself is part of the challenge.

ICARDA is looking forward to meeting that challenge.

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The land itself—a crucial resource which is threatened...

...by wind erosion, which can destroy the agricultural potential of land in marginal areas with frightening speed. Especially when the soil is shallow, and the native vegetation destroyed by overgrazing or failed cereals cropping. Sloping land is at risk from water runoff, removing soil from orchards and olive groves. Even when the soil remains, it can be exhausted from constant cropping; and the soil structure can be wrecked by inappropriate irrigation with saline water. ICARDA, with its partners, is working to conserve soil in collaboration with farmers, helping them to take a long-term view by using methods which acknowledge the economic pressures on the farming community. It is carrying out research on soil structure and nutrients. It is developing ways of using the land intensively while preserving below-ground plant biomass and soil structure, for example through long-term rotation trials using "soil-friendly" plants such as legumes. And it is finding ways to devise conservation measures that are economic, by bringing the farming community into the research process.