ICARDA Caravan
Issue No. 10 Winter/Spring 1999

Review of agriculture in the dry areas

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- Time is running out for the plague on WANA wheat crops caused by the Hessian Fly
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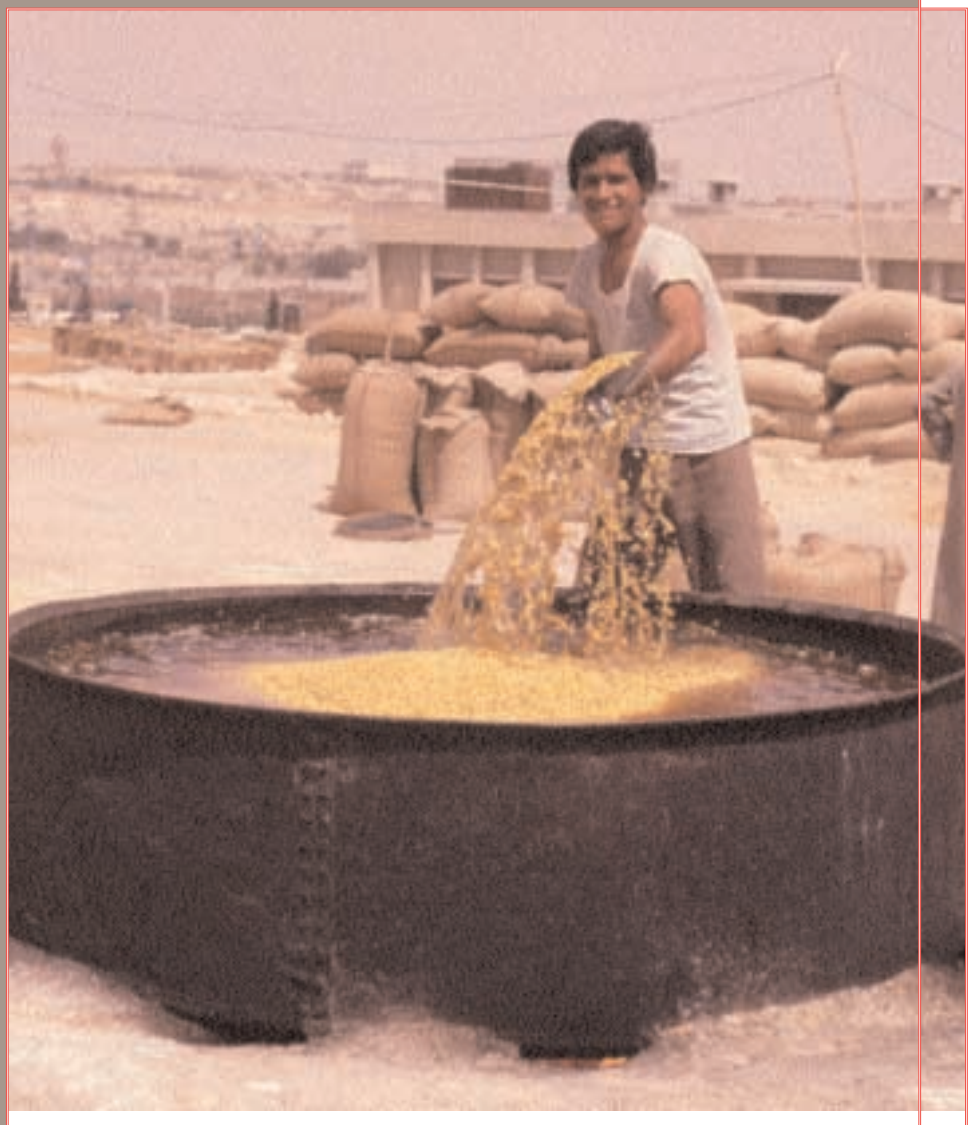

From the Director General

It is appalling that 840 million people worldwide go to bed hungry, and a further two billion suffer from malnutrition. Unchecked population growth will drive these numbers even higher at a time when shortage of natural resources for food production is becoming more and more serious.

A minimum of 0.7 hectares of good land is needed to meet the annual food needs of one person, but even this minimum requirement is whittling away. Over four billion people are projected to be facing land scarcity by 2050, and those in the dry areas are likely to be hit more severely than anywhere else.

Since much of the arable land has already been brought under cultivation, it falls on every one of us to make the best use of the land that is available; to increase the level of production per hectare; and to correct past mistakes in land management.

The harsh and climatically challenging environments in dry areas, coupled with demographic pressures, make agriculture a difficult enterprise. These factors are leading to increased natural resource degradation. Very often it is human intervention and neglect that is accelerating this degradation with serious consequences for both present and future generations. For example, in Yemen, this degradation is evident in the deterioration of many of the mountain terraces which account for about 25% of the country's arable land. Walls have been allowed to fall into disrepair and collapse, permitting soil erosion, and limiting the ability of the terraces to harness moisture for crops or fruit trees. As a result many people have lost their employment, and the remaining land has come under tremendous pressure, given the steadily increasing size of the average Yemeni family. Yemeni colleagues, in collaboration with ICARDA, are finding ways to put the terrace farming back on track, to increase food production as well as save good land from being lost for ever (see article on page 8).

In the dry areas, the pastoral communities are also dwindling because the depleted land is no longer able to support continual grazing by livestock which once would have been shifted seasonally to allow time for recovery. This is as evident in West Asia and North Africa as in the Republics of

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Cover: Burghul *is prepared for sale in a WANA village. The availability of durum wheat in the dry areas, where this traditional cracked wheat product is just one of the ways in which this important food is eaten, will be boosted by the extra yield from bread and durum wheat varieties containing the new resistance to attack from Hessian fly. See page 16.*

Central Asia and the Caucasus. Some of the reduction in output from the steppe, for example, is the result of the economic transformation taking place in these Republics. The Karakul sheep population in Kazakhstan, for example, has fallen from 30 million during the era of the Soviet Union to just 8 million animals now. To correct this requires not just the efforts of rangeland specialists to restore degraded rangelands or geneticists to improve livestock, but also guidance in finding new added-value markets for the new generation of sheep products. ICARDA has taken the initiative in working with the national agricultural research systems of these Republics in transferring the expertise it has built up over the years to rehabilitate rangelands. The articles on pages 11 and 13 provide a sample of the Center's work in this important component of the farming systems in the dry areas.

I hope this issue of *Caravan* will provide the reader a glimpse of the holistic approach that ICARDA is employing to achieve increased efficiency in food production from the dry, marginal areas.

Prof. Dr Adel El-Beltagy

A $20 million pest is beaten. See p16.

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 at 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 range 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.

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Annual Presentation Day marks a year of "Excellence in Science"

A chance to reflect on the past year but also look forward to the future. That was the ICARDA Annual Presentation Day which took place this year on April 24.

It brought together the ICARDA Board of Trustees and a large number of distinguished guests, including members of the diplomatic corps, senior government officials and representatives of collaborating institutes from the WANA area and further afield. Members of the External Program and Management Review (EPMR) Panel also attended during the course of their review visit.

A year of excellence in science enhanced by closer cooperation with farmers and others making use of ICARDA's research was reported at the Annual Presentation Day.

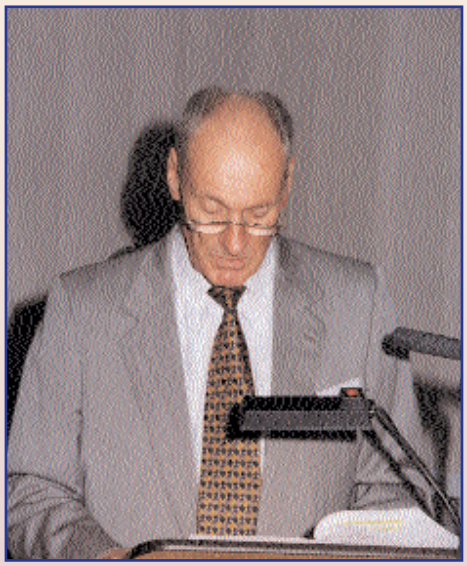
One of the highlights of 1998 for the scientific staff was the award of the CGIAR Chairman's Science Award for identifying genes tolerant to several biotic and abiotic stresses. But, in his review of the year, ICARDA Board Chairman Dr Alfred Bronnimann, who is Director of the Swiss Federal Research Station for Agroecology and Agriculture, also highlighted the renewed thrust on conservation and efficient use of water; the integration of work in natural resource management with crop improvement; enhanced use of geographical information systems (GIS) for soil and water management and for biodiversity conservation. He also praised the decentralized breeding, which has brought the introduction of new varieties suited to specific production conditions.

During the year technologies for information management were upgraded and a major effort made to enhance public awareness of ICARDA's work.

Dr Bronnimann, who retires as a Board member in August 1999 after six years including five as Chairman, praised ICARDA for its expertise and efficiency. He pointed out that the overwhelming evidence from the 28 different experts involved in nine internally-commissioned external reviews, carried out over the last four years, of ICARDA's work, including research programs, finance and administration, and management, was that the Center was making efficient use of grants obtained from donors.

Dr Bronnimann said ICARDA had introduced a number of new techniques, systems and plant varieties in the regions of West Asia and North Africa, and had extended its activities to new parts of Central Asia and the Caucasus.

It had been a privilege, he said, to contribute to ICARDA's development, and he would always cherish his association with ICARDA, with colleagues from the other 15 CGIAR centers, and with the people of Aleppo.



Dr Alfred Bronnimann, ICARDA Board Chairman, who welcomed the many distinguished guests to Tel Hadya.

DG's mandate extended for five more years

This is the full text of the announcement made on 23 April 1999:

"It gives me great pleasure to inform you that the Board of Trustees at its Extra-ordinary meeting held in Aleppo during the period 22-23 April 1999, and taking into consideration the valuable contribution of Dr Adel El-Beltagy to the Center in terms of reorientation of the research programs and scientific leadership, unanimously agreed to offer Dr Adel El-Beltagy an extension of his appointment with ICARDA as its Director General for another five years starting 1 February 2000. I take this opportunity to thank Dr El-Beltagy for his dedication and well-noted efforts in the improvement of ICARDA as a Center of Excellence, and to congratulate ICARDA staff for their commitment to the Center's growth; hoping that mutual cooperation will further augment the research productivity of ICARDA.
With my best wishes for success and prosperity."

—Dr A. Bronnimann, Chairman of ICARDA Board of Trustees.

Meeting the Challenge of Poverty and Population

A future of challenge but one in which ICARDA expertise in many areas of technology will play a major combative role was outlined by the Center's Director General Prof. Dr Adel El-Beltagy in his address on Annual Presentation Day.

Acute shortage of water, scarcity of land, an expanding population, and the threat of global warming combine to pose this daunting challenge for the future, he said. While 840 million people worldwide are classed as hungry, a further two billion suffer from malnutrition. These numbers could rise even further because of unchecked population growth, warned Prof. El-Beltagy.

As a result, the pressure on already limited arable land will increase even more. Since it takes a minimum of 0.07 hectares of arable land to feed one person, the net effect is that four billion people are likely to be affected by land scarcity by 2050. The prospects for millions of people in the dry areas are particularly alarming. Out of a population of one billion in 41 countries in these areas, 696 million have a per capita income of less than $2 a day. About 300 million live below their nationally-determined poverty lines.

ICARDA, with its focus on research and training to increase the production, productivity and nutritional quality of food, while preventing degradation of natural resources and protecting the environment, was seeking to challenge this scenario with solutions and alternatives, in partnership with all stakeholders.

Among these is the development of technologies for making best use of limited water. This includes breeding varieties more efficient in water use, and by establishing agronomic practices which are not wasteful of this valuable but limited resource. The Center's joint work in Iraq, Syria and Turkey clearly demonstrated that the right amount of supplemental irrigation at the right time can raise wheat yields substantially and consistently.

Equally successful are water harvesting techniques, such as the microcatchment harvesting system of semicircular bunds to trap rainwater—an approach being tried out as part of an ecoregional project in which Egypt,

Prof. Dr Adel El-Beltagy, DG, said ICARDA expertise would rise to meet the challenges of the future.

Iraq, Jordan, Libya, Morocco, Oman, Pakistan, Syria, and Tunisia are participating.

But ICARDA does not ignore the past. It is taking stock of indigenous knowledge and is adopting a consciously multidisciplinary approach to natural resource conservation and management to permit use of both conventional and modern technologies. The Center is developing an inventory of indigenous water-harvesting systems used in the region for thousands of years while, at the same time, a three-year project has been completed on the use of geographic information systems (GIS) to identify areas of high water-harvesting potential.

Research by the Center into management of natural resources includes rehabilitation of degraded rangelands by planting shrubs suitable for grazing; development of pitting machines to make small pits for water capture to assist the germination of seeds of native range plant species; and on shallower rangeland soils, reseeding with these species using a 'Land-Imprinter' to trap moisture.

Prof. El-Beltagy highlighted the impact of ICARDA work in the world beyond the Center's mandated areas. Rangelands play a key role in controlling global warming by capturing carbon dioxide in their vegetation. ICARDA has set up monitoring equipment to assess carbon-dioxide sequestration in the rangelands of Uzbekistan. In Central Asia and the Caucasus—which account for 225 million hectares of rangelands and which are seeing an alarming drop in the population of

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EPMR Panel Chairman Dr Donald Plucknett (center) and other visiting members of the review panel found plenty to interest them among the field exhibits at Annual Presentation Day. Seed samples from some of the improved cereal, legume and forage cultivars being developed by ICARDA, including examples from the participatory breeding program with barley, were on display.

Saving the Best to Last

It's a familiar story — man's endeavors to survive are wiping out the very fundamentals that could turn mere survival into something yet more positive and satisfying. This time it's the wild progenitors of many cultivated crops and trees that are at risk from neglect which a pioneering $8.1 million five-year project seeks to overcome.

GEF Coordinator Ms Inger Andersen, with Dr John Dodds (center), ADG (Research), and Dr Mahmoud Solh, (DIC), told stakeholder delegates from Syria, Jordan, Lebanon and the Palestinian Authority in May that safeguarding a diverse genetic base will strengthen food security.

Most people don't keep their savings at home. They deposit them in a bank—in agriculture's case that's a gene bank for saved seed.

Generally, those savings stay there until it's time to make the occasional withdrawal. Few of us forget what we've put in, or what we had planned to do with our savings. It isn't always so with seeds, however.

Sure, the seed bank categorizes and records very carefully what was collected, by whom, and where it came from. What isn't necessarily known in 10 or so years' time when a plant breeder comes along to make a withdrawal is how the plants grown from those seeds formed an integral part of the local environment from which they were collected. Information or local knowledge of how they were exploited may have been lost, reducing the opportunities to again make them serve a new purpose in modern variety development.

Gene banks will continue to serve their vital role *ex situ* but an alternative approach is to be developed in the West Asia and North Africa (WANA) region, thanks to the United Nations Development Programme (UNDP) and its General Environment Facility (GEF). As a result of the 1992 Rio Earth Summit, the GEF was set up to fund projects in four basic areas, including biodiversity, identified as of particular importance by the Summit. Now, it has set up a "Conservation and Sustainable use of Dryland Agrobiodiversity Project" with the aim of conserving the building blocks of plant genetic resources on-site through cooperation at farm and village level.

In this way it is envisaged that local knowledge will be retained together with the long-established farmer-bred, local varieties (landraces) and their wild relatives which hold promise for use in future plant breeding crosses.

Currently, it is these very species and plants which are under threat from man; sometimes because farmers are improving their production by adopting new modern varieties which crowd out their predecessors. At other times, land reclamation destroys habitat or because livestock owners, either through ignorance or necessity, overgraze vulnerable land.

The rich diversity of plants in WANA makes it an ideal choice for a pioneering project aimed at retaining landraces and wild relatives of a number of staple crops, including cereals, legumes, and fruit trees. *In situ* conservation is a recent concept now to be elevated to a dynamic process of conservation with sustainable use of the genetic diversity in target environments, along with the related local knowledge.

GEF coordinator Ms Inger Andersen, of the UNDP, believes safeguarding a diverse and wide-ranging genetic base for food plants strengthens food security in the arid and semi-arid areas. The conservation of biodiversity in farmer-grown cereals and other crop varieties, as well as the progenitors and wild relatives of these food plants, is particularly important.

Jordan, Lebanon, the Palestinian Authority, and Syria are taking part in

Over two days stakeholders thrashed out how the national and regional elements of the biodiversity project will work together.

the Agrobiodiversity Project at national and local level, while the regional component is being implemented by ICARDA in cooperation with the Damascus-based Arab Center for Studies of the Arid Zones and Dry Lands (ACSAD) and the Rome-based International Plant Genetic Resources Institute (IPGRI), which has a regional office at ICARDA headquarters in Syria.

Agriculture has its origins in the ICARDA region which is well known for its diverse natural flora. Sites have been chosen at Ajlun and Muwaggar in Jordan, Baalbeck and Aarsal in Lebanon, Hebron and Jenin in Palestine, and Slenfeh and Suweida in Syria. Farmers and local communities will be asked for help in identifying indigenous species, and encouraged to maintain the populations within the project sites.

This will be done using either field margins or buffer strips—closed off using previously-cleared stones—to form retaining habitats for wild relatives. Farmers will be encouraged to keep grazing livestock away from these strips at crucial stages such as flowering. Since the loss of any land, even for worthy causes, has a knock-on effect on income, the project will try to offset this with either improved crop production from the remaining land, or new alternatives such as beekeeping.

Cooperation by farmers is a vital part of the project, not just in gaining their assistance in conserving the wild relatives but also in continuing to grow a diversified selection of traditional landraces. These can be just as important to the plant breeder for crossing as the more primitive wild material.

Extension officers will carry out monitoring of this *in situ* conservation at the local level. It is hoped the project will provide a working model for the technique so it can then be adopted elsewhere in the world. In tandem with this conservation, the project will also gather information on the genetic base of 10 target crops and how they are being influenced by social and farming practices.

While each country will be responsible for administering and monitoring its own sites, ICARDA will provide the technical assistance to coordinate each national component and permit them to network with each other. Project monitoring will also be the responsibility of ICARDA which will adapt the project when necessary as new lessons are learned. As the technical backstop, ICARDA will also be supporting on-site training in farm conservation and the sustainable use of agrobiodiversity.

With the help of IPGRI, national scientists will be introduced to the use of geographic information systems (GIS) for building the project database.

A two-day meeting for the project stakeholders at ICARDA's Tel Hadya headquarters in May thrashed out how the central and nationally-based elements of the agrobiodiversity project will work together. Representatives from the participating countries saw *in situ* conservation in practice both at ICARDA and at the Yahmoul experimental station of the Syrian Agricultural Research Directorate. ICARDA is conducting a joint experiment at Yahmoul to conserve the wild relatives of wheat, barley and wild annual legumes.

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small ruminants—the Center is developing technologies to arrest rangeland degradation and improve livestock production.

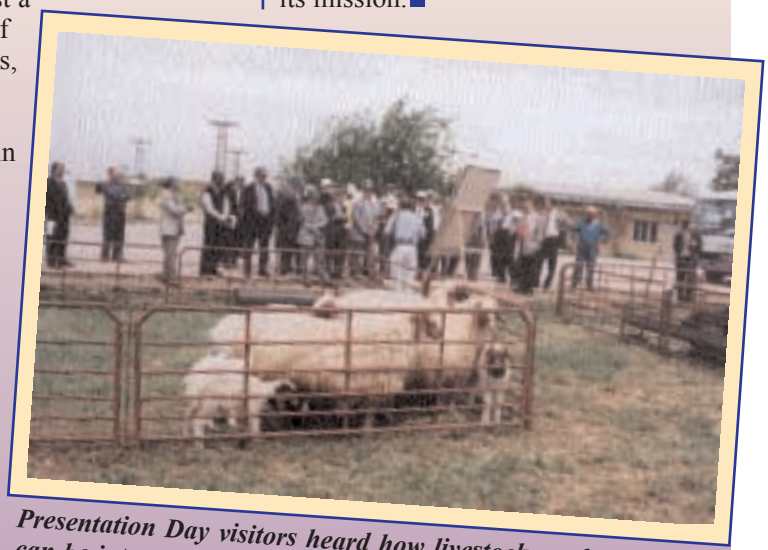
Improved feed sources to provide better nutrition and increase livestock fertility rates have been developed. "This is significant as rangelands support livestock, and livestock play an important role in breaking the vicious circle of poverty and environmental degradation," he added.

Take-up of such new techniques was often rapid. Introducing vetch in rotation with cereals in El-Bab, Syria, proved so effective that the number of farmers adopting the practice rose dramatically from three in 1991 to 200 in 1998.

This was also an example of how ICARDA interacted with farmers and created partnerships with national programs in pursuing its research strategy. One of the key functions of ICARDA is to link different research efforts so that, together, they reach critical mass.

Looking at the immediate future, Prof. El-Beltagy presented a potential production-consumption scenario for food grains in 29 Central and West Asia and North Africa (CWANA) countries. By 2020, total grain consumption was expected to be 323 million tonnes against a total production of 247 million tonnes, assuming a 2% growth rate, he said, giving a grain deficit in these countries of 76 million tonnes. Exclude Turkey and Kazakhstan and the deficit in 2020 would be a staggering 114 million tonnes. If this 114 million tonnes was to be imported by CWANA countries in one go, "it would take a train 17,000 kilometres long, and cost us US$14.8 billion!" he observed.

Prof. El-Beltagy thanked the various donors, and also the Government of Syria and its President, H.E. Mr Hafez Al-Assad, for their generous and continuing support for ICARDA and its mission.



Presentation Day visitors heard how livestock and arable crops can be integrated to break the vicious circle of poverty and environmental degradation in the dry areas.

Step forward, Yemen terraces

Just imagine that sometime back in the 19th century your great grandfather went to the law to argue ownership with a neighbor over a field whose origins were lost in the mists of time. Imagine the case is still being fought 100 years later. Do you seriously think either you or the neighbor's descendants are going to spend much time looking after the disputed plot? This is just one of the scenarios to be resolved as the 25% of Yemeni arable land to be found in the mountain terraces is brought back to food production.

With the benefit of good maintenance, the terraces (above) will continue to supply Yemeni households with crops ranging from wheat and barley to potatoes on the most productive soils. Neglect in the more marginal areas for food production means that uncontrolled runoff of rainfall and soil erosion can cause terrace collapse (right).

By Aden Aw-Hassan, Mohammed Alsanabani and Abdul Rahman Bamatraf

Just about everything in Yemen is dramatic. From the medieval appearance of Sana'a, through the system of tribal law and customs, to the dramatic landscapes of the cultivated mountain terraces.

At first sight, it may seem a country of limited natural resources—although startlingly attractive to the visiting tourist—but the Republic of Yemen has the potential to counteract the increasing drift to the cities that has contributed to the degradation of its more marginal arable land.

This degradation is evident in the deterioration and abandonment of many of the man-made mountain terraces that actually account for about 25% of the country's arable land. Walls have been allowed to fall into disrepair and collapse, permitting soil erosion, and limiting the ability of the terraces to harness moisture for crops or fruit trees. Fewer people are employed on the land when these uneconomic terraces are abandoned. The remaining cultivable land comes under even greater pressure because of the steadily increasing size of the average Yemeni family. No wonder then that the upcoming generation looks instead to the urban areas for higher earnings, even if that doesn't always mean a steady income.

This urban population is increasing at the rate of 6.7% annually, and the country's current total population estimated at 17 million is expected to double to around 35 million by 2025. The rapid growth in the urban population spurred on by rural poverty is putting enormous pressure on urban resources and increasing urban poverty.

Only about one-third of Yemen is agricultural land, and only 9% of that land is suitable for growing crops. The rest can be loosely described as permanent pasture but that covers everything from a limited amount of good grazing land through to the commoner rock-strewn mountainside and degraded rangeland. Rainfed agriculture in the mountainous areas was developed centuries ago based on intricate systems of man-made terraces. This is difficult terrain, with steep slopes, terraced croplands, rangelands and patches of trees.

It shouldn't be surprising then that food production is being stepped up in those less hilly and more accessible areas of land on plains between the mountain ranges and along the banks of *wadis* where irrigation is possible. But there are threats away from the mountain slopes too. Spate floods can destroy crops and carry away soil, while desert sands are responsible for significant encroachment at the geographical margins. This is coinciding with population explosion. Yemeni government figures show the proportion of arable land per head of population fell from 0.16 ha in 1979/81 to 0.09 ha per person in 1994/96. During the same period, the proportion of land under irrigation rose from about 10% to more than 30%.

Yemen's arable land is limited—about 1.66 million ha, of which just 64% was cultivated in 1996. Man-made terraces are a feature found in several countries in West Asia and North Africa. They have been established in mountainous parts of Lebanon, Syria, Oman, Saudi Arabia, and Tunisia. Farmers in both Ethiopia and Eritrea have also cultivated terraced areas for centuries but it is in Yemen that the technique has traditionally played a substantial role in producing crops ranging from wheat, barley,

sorghum and millet to coffee and *qat* – the age-old stimulant chewed by many Yemenis.

It should not be overlooked that many of Yemen's terraces are still highly productive but they are in the main those on the lower slopes with deeper soil and higher rainfall which permit farmers to grow moisture-hungry crops such as potatoes. Some of these rich terraces are in foothills where they can accommodate a tractor and plow for cultivation, while other productive terraces can be found in those mountains that benefit from high rainfall. These terraces are not at risk but rather it is those on slopes with lower annual rainfall and in less accessible valleys that are more vulnerable to the pressures of land ownership disputes, crumbling stone walls, soil erosion, and the ever-present uncertainty of market price fluctuations.

Terrace erosion appears to be accelerating because of the failure to rebuild walls and maintain traditional systems of run-off diversion, collection and storage. Soil is being lost and the failure to contain water is adding to the destructive potential of the spate floods which seasonally affect the valley bottoms.

All this combines to contribute to an ever-present background of rural poverty, the rise in urban migration and the destruction of local communities. The trends were so great that it became clear action was needed to improve the livelihoods of rural people and reverse the land degradation that lay behind many of the social changes.

However, there are some aspects of Yemeni society which underline the potential that exists to remove the threat to these vulnerable terraces and prompt their restoration to productive agriculture. The relationship between man and the land is just as strong here as in other countries of the region. Even if their terraced land is completely run down and unproductive, few villagers want to give up the ownership of land that may have been in the hands of their families for many generations.

Even if their income now comes predominantly from outside agriculture, most people are adamant that they retain their village roots and their attachment to land even if it is no longer cultivated. They do nurture the possibility that one day they, like their forefathers, will be able to make something of that land holding.

Using funding from IDRC (International Development Research Centre) of Canada, ICARDA conducted an exploratory study in 1997/98 in the western escarpments of Yemen, in collaboration with the University of Sana'a and Yemen's Agricultural Research and Extension Authority (AREA). It collected the background information needed to start assessing how best to promote the rehabilitation of terrace farming.

Most importantly, the study also casts light on the several reasons why the terraces no longer fulfil their traditional productive role. In those areas where the community feeling is still strong, ownership disputes can often be readily settled through the knowledge of the village elders. The exact arrangements will vary from community to community but there are very often locally-defined rules for apportioning terrace maintenance and cost sharing as well as income sharing between tenants and landowners.

Yemen at a Glance

Think Yemen, think terraces and spectacular mountain and desert scenery. But behind the touristic façade, Yemen is changing, not least on the terraces. Many have fallen into disrepair and the will of owners to reverse the decline has been sapped.

ICARDA and Yemen's Agricultural Research and Extension Authority plan to breathe new life back into the neglected terraces with new soil conservation and management techniques. This will go hand-in-hand with encouragement for stronger landlord-tenant relationships.

An initial study carried out with funding from the IDRC discovered positive signs that the crumbling terraces have a worthwhile role still to play in growing crops such as wheat, barley, sorghum, millet and food legumes.

Apart from the mountain slope rangelands used communally, land holding in Yemen is split between private, state and religious endowments (*waqf*). However, agricultural land registration is weak—official registration covers only urban areas—although a trusted local (*amin*) keeps records of farmland transactions in many districts. About 70% of private land is cultivated by the owners, with the rest rented out under sharecropping arrangements, as is the state and *waqf* lands. In some districts, the proportion of state land is reported as being very low, perhaps because farmers are reluctant to acknowledge they may have appropriated some of that land for their own use.

With family members away in the cities, the limited labor remaining is often heavily committed to fetching wood and water rather than working the land.

More often than not, poor maintenance of terraces is blamed on some breakdown of relationship between owner and farmer/sharecropper. Owner-occupied terraces are invariably better kept. In those areas where there is still a strong community influence playing a decisive role in disputes, it appears the relationships between tenants and landlords may be stronger but also flexible to meet changing circumstances such as the investment needed for cultivation of coffee and other high-value crops.

Where the customary rules on the division of terrace maintenance between landowner and tenant break down, it is often because there is no written provision in the land tenure contract. These rules vary: in one district tenants may meet minor repairs themselves but split major flood or storm damage 50-50 with the landlord; in another area, the tenant may carry out all repairs but then be permitted to keep all of his harvests for the succeeding two to five years.

A Yemeni judge told the research team that settling inheritance disputes was the most difficult problem for the legal system. Where there is no written or official record of ancient transactions, land disputes can stay in the courts for generations. And, even when judgement is finally handed down, it can be difficult to enforce back in the mountains. A simpler, quicker property registration system would go a long way in dealing with this.

Another limiting factor in terrace restoration is the non-availability of Government loans for rehabilitating the terraces. Labor sharing and collective community action has declined in these more modern times, and labor now has to be costed in terms of what is offered by alternatives available off the farm. Competing for this labor without access to credit is difficult for farmers. It is even worse for the poor who are most likely to have to devote much of their own limited family labor resources to collecting wood for fuel or fetching water.

However, a program of terrace improvement would require quite substantial labor input, offering a steady incentive to remain in the villages. In general, agronomic practices should improve at the same time, creating demand for additional inputs such as fertilizer, and stimulating a seasonal demand for more labor to work in the restored terraces.

Farmers also cite the presence of imported, subsidized grain as another disincentive for restoration of the terraces. They see little point in growing local alternatives such as wheat, sorghum, barley, millet or food legumes other than for their own consumption, when they cannot easily compete in the marketplace with imported foodstuffs. This has now been partially addressed since the study took place by an increase in the official price of such wheat.

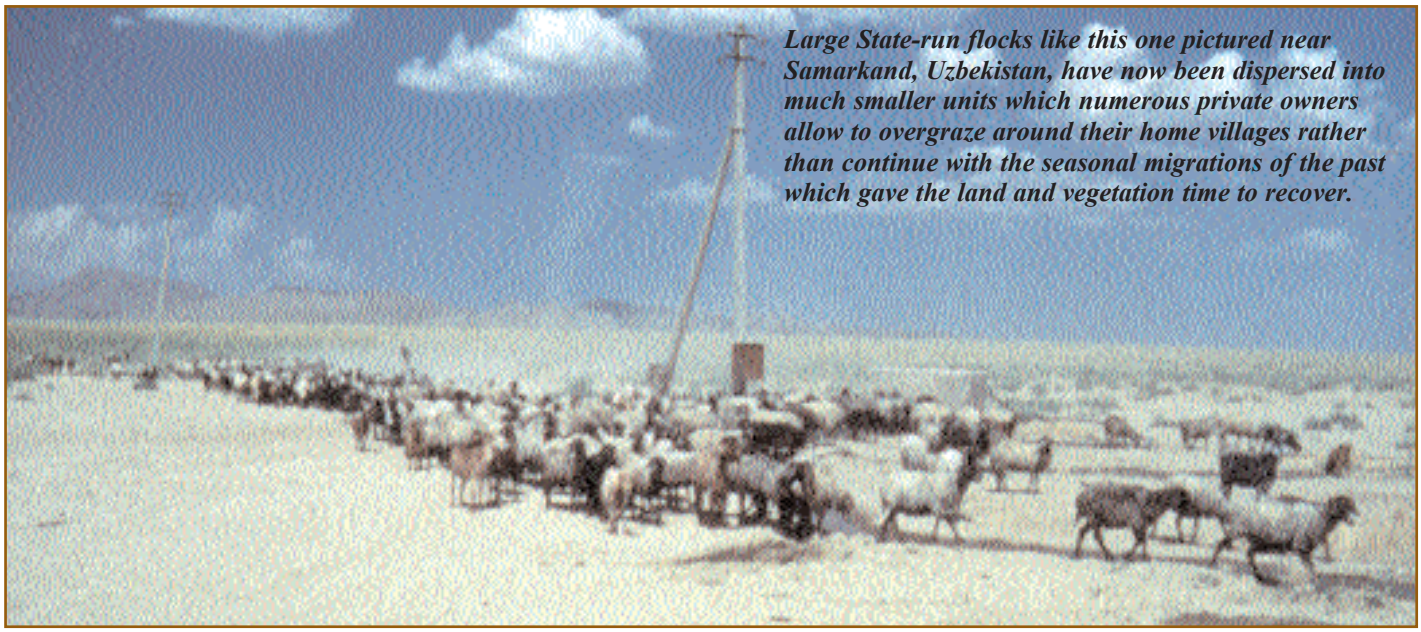
The study recommends government action to strengthen existing local institutions, in documenting sharecropping contracts, in improved and targeted agricultural credit services, better pricing polices and improved technologies for farmers. These will increase expected returns on investment, particularly for food crops, and increase the willingness of landowners to invest in projects such as terrace maintenance.

A project phase aimed at putting the study information and recommendations into practice is now being planned by AREA and ICARDA. This will involve farmers in developing and testing new methods of preventing soil erosion and retaining water where it is most needed on productive terraces.

Yemen's terraces are justly famed throughout the world and undoubtedly one of the attractions which visiting tourists regard as a must-see. With help, there will be much less danger of them being shown a dusty, stricken patch of bare mountainside and asked merely to visualize the laden fruit trees, flourishing cereal crops, or vegetables. Instead, they could well be dining that night on top-class produce grown to a centuries-old blueprint which can still serve Yemen well into the 21st century.

Above: A positive program of terrace restoration will provide labor opportunities both in rebuilding and maintaining the terraces, then in growing and harvesting the range of food and cash crops that can be produced even in lower rainfall areas of the mountains.
Left: A job well done! With good moisture conservation and protective measures against erosion, Yemen's terraces will not remain just a feature of the past.

Dr Aden Aw-Hassan is an Agricultural Economist in the Natural Resource Management Program at ICARDA. Mohammed Al-Sanabani is an Associate Professor in the Faculty of Agriculture, University of Sana'a, and Abdul Rahman Bamatraf is Vice Minister of Agriculture at the Ministry of Agriculture and Irrigation, Yemen.



Large State-run flocks like this one pictured near Samarkand, Uzbekistan, have now been dispersed into much smaller units which numerous private owners allow to overgraze around their home villages rather than continue with the seasonal migrations of the past which gave the land and vegetation time to recover.

Helping Hands to Put Sheep Back on Their Feet

The transition from centralized Soviet economic planning to competing in a free world market hit agriculture hard in the emerging Central Asian republics. Not only did markets evaporate but also the support infrastructure which had been geared hitherto for dealing with large State farms not small private farmers. Livestock is one of the hardest hit sectors but now help is on the way to restore sheep production to its rightful place as a major income earner.

By Luis Iniguez

A new mood of optimism is building on the steppes of Central Asia where the harsh lessons of moving almost overnight to a market-led economy hit traditional sheep production particularly hard.

In Kazakhstan alone, up to 36 million sheep formerly kept the home market and other parts of the former Soviet Union supplied with wool, pelts, and mutton. Now there are just eight million remaining in the national flock—the difference being equivalent to the complete elimination of sheep in Syria, Lebanon, and Jordan put together.

Other neighboring new republics, which also reared and exported the wool, pelts, and meat from large numbers of small ruminants, have likewise seen their agricultural sectors suffer from a common economic downturn in traditional markets. As their outlets evaporated, farmers were forced to respond with equally dramatic cuts in herds and flocks – a critical erosion of valuable genetic resources.

Before the demise of the Soviet Union, there was a continuing market demand from member countries for many different qualities of pelt and wool. One of the typical fat-tailed sheep in the region is the Karakul. It is extremely well adapted to the harsh and changing conditions of the steppe, partly because of its ability to draw on stored energy in times of scarcity. The Karakul sheep industry, devoted to pelt production, dominated the steppe regions of Uzbekistan and parts of Kazakhstan and Turkmenistan. Pelts were produced from newly born lambs – the most expensive *astrakhan* coming from deliberately stillborn lambs for which older ewes destined for culling were used for the final time.

Pelts were marketed throughout the Soviet Union and other countries under its influence as well as in the luxury Western market which was, and still is very easily saturated. Only a few thousand pelts are required each year by buyers for the fashion industry. Now this tiny specialist trade in *astrakhan* to adorn only the very wealthiest of couture buyers is just about all that remains of the once substantial export market which disappeared along with the Soviet Union.

Large areas of the republics were also devoted to wool production from a number of indigenous sheep breeds improved by crossbreeding with imported fine-wool types such as the Merino. Once again the principal outlet for this wool was formerly the large Soviet Union market and the associated countries.

Many different breeds of sheep—including local types crossed with imported Merino strains—make up the flocks in the new republics of Central Asia. These breeds will be improved and matched to the most suitable market niches for their production under the new collaborative project.

However, under the free market system this wool produced in Central Asia is not currently able to match that from Australia and New Zealand for quality and price on a crowded world market. With their long experience of this wider market, the Southern Hemisphere countries are also able to employ their more sophisticated marketing expertise to maximum effect.

Under the Soviet system, State-run flocks in Kazakhstan, Turkmenistan, and Uzbekistan very often ran to several thousand head. These large flocks were maintained under rotational grazing patterns that exploited both the range-based and cultivated feed resources. Due to privatization, the large collective and State farms were dispersed into numerous small flocks with a severe impact on the pastoral sheep management and feeding system in Central Asia.

There had been organized support under the Soviet Union for an infrastructure that saw to it there was an ample supply of mechanically-harvested fodder to keep sheep in top condition during the bleaker winter months. The centrally-based system also made certain there were sufficient shepherds as well as transport to ensure the sheep could follow their traditional seasonal pattern of migration.

From the semi-arid plains of southern Kazakhstan, for instance, the flocks would follow a four-season migration system taking them from winter quarters in the sandy dunes of the northern desert to spend spring from March onwards on the semi-desert steppe where lambing and shearing takes place. In June the trek up to mountain meadows started for the shepherds who live in the traditional *yurts*. In the autumn, the flocks return to a different area of the semi-desert steppe for the annual cull. They move on before the first heavy snowfalls back to the dunes at the end of an annual journey which is often over 300 km.

Many of the privatized farmers now have as few as 5-20 sheep in their flocks, particularly in Kyrgyzstan and Kazakhstan where privatization has been more intense. Few farmers have larger flocks and most have abandoned their seasonal migration in favor of keeping these small flocks around their home villages where overgrazing and land degradation is commonplace. The loss of support services such as ready access to veterinary advice has increased the possibility of disease affecting the flocks.

Other knock-on effects have been severe. It has proved impossible to retain the same level of organized breeding services as before, threatening the genetic quality of the remaining animals. The production support infrastructure is now in virtual decay since output from the new smallholders is insufficient to maintain it on anything like the same levels as before. This is coupled with similar disruption to the production of seed for forage and arable crops, and difficulties in obtaining new farm machinery. The result? A fall in productivity of the remaining crops and more people drifting away from rural areas to the cities in search of work.

Now the national agricultural research systems (NARS) in the emerging republics, assisted by ICARDA and its other partners, are working to redirect privatized production to fit the new market scenarios. This will provide flock owners not only with much-needed opportunities to raise their incomes but give them confidence to rebuild and upgrade the remaining flocks.

ICARDA specialists, in cooperation with the national research centers in each country, will be looking at the potential for targeting the remaining regional and national market demand with new production strategies. This will include investigation of benefits from increasing lamb meat production rather than mutton from older animals as in the past. With some breeds there is scope to produce milk for yogurt and cheesemaking, particularly in areas where there is a consistent supply of extra feed available—known as crop/livestock interaction zones.

Central Asia harbors one of the largest blocks of irrigated areas of land in the world and some of this borders with sheep production areas. By exploiting the ability of this cropping land to grow high energy forage and feeds to supplement natural grazing,

(Continued on page 15)

Meat has previously been viewed by flock owners almost as a by-product of wool or pelt production. Instead of mutton from older breeding animals sent for slaughter, the potential for lamb production for meat is to be investigated, along with other added value products such as yogurt and cheese which may have export as well as local market promise.

Range Roller Spirals to Steppe Seed Success

If you stumble across unfamiliar track markings spiraling across the Syrian Steppe, don t worry.It isn t a landing zone for some strange, tracked space vehicle, and the tracks will soon disappear under a thriving layer of range vegetation. It s a sign that the latest machine to emerge from the ICARDA Range Project for keeping regeneration costs to a mini-

Converted in the ICARDA workshop from a 3t roller, the Land Imprinter is solidly built, low-tech and can be pulled easily across the steppe with a small tractor.

By Dr Gustave Gintzburger

Why has ICARDA built the world's biggest garden roller? And why isn't it perfectly round, anyway?

The answer lies in a link between the effect of sheep or cattle hoof imprints and an improvement in plant growth on the degraded rangelands of arid zones. Simple field observations have highlighted that in arid zones, grasses and other plants grew much better in the imprints left after rain by passing sheep and cattle than they did in the surrounding, unmarked flat soil.

Since the same stronger growth can also be seen in the wheelmarks of cars or the deeper imprints of bulldozers that have passed across the steppe, here was an effect that might be used to restore degraded rangeland in the 150-250 mm winter-rainfall zones. In many of these areas the vegetation cover has been destroyed by overgrazing or by uprooting when shrubs are collected for use as fuel wood. Continuous cropping with barley also exhausts the soil seed stock and destroys the native vegetation cover.

The classic approach to rangeland regeneration in many countries is expensive. Sites are fenced off or enclosed with a ditch to keep out trespassing flocks. Forestry techniques are then used if there is an abundant and cheap rural labor force. Nursery-reared seedlings are transplanted during the winter into soil that has been opened with a deep 80cm ripper. The young shrub seedlings, which may be native or imported species, have to be watered two or three times with 10 liters each for their first two summers. They have to be protected from grazing for at least two seasons.

Where hoof prints or car tracks have been imprinted, the thin 2 mm soil crust which is typically found on these baked arid rangelands is effectively punched through and a depression created. Within this area, rain or runoff water is collected and focused on the imprint which is nurturing and providing a stable rooting environment for its fragile seedling plants. This water running off the surrounding fairly impervious crust also washes in tiny particles of soil and organic matter that provide a friendly environment for a newly emerged seedling. It adds up to water harvesting in micro-format.

Keeping large flocks of sheep continually moving across the steppe to increase hoof printing is neither very practical nor desirable. Alternatives which are both considerably cheaper and more efficient than forestry-type transplantation are being sought.

Building low-cost, low-input range regener-

For slightly deeper, loamy soils the ICARDA team, led by range specialist Dr Gus Gintzburger built a pitting machine (above and right) which scoops a shallow pit in the soil into which the seed of local desirable species is dropped, then lightly covered by the following tines.

ation machinery is one of the targets set for the Range Project of the ICARDA Natural Resource Management Project (NRMP) in collaboration with the Syrian Steppe Directorate. The first machine tested with reasonable success by the team is a simple and light 'pitting' machine—modeled on the Camel Pitter from Kimseed Ltd in Australia (See *Caravan* No. 3). Capable of being towed by a two-wheel-drive car, it has been tried out on 200 ha of difficult range reseeding with native *Artemisia* and *Salsola* species on the Obeisan, Adame and Delboah Range Stations, and on the Tallila FAO project near Palmyra, Syria.

The second, simple machine—a rather bizarre roller—was tested recently on an utterly degraded range site on the Obeisan station. With the knowledge that imprints encourage plant growth, the research team modified a heavy 2.3t roller-compactor, filled with a further tonne of water, so it punches 100 cm long grooves in the soil. Towed by a small 45hp tractor, it leaves imprints—7-8cm wide and 1-6 cm deep depending on soil moisture—to harvest rain and runoff water.

It is believed this machine will have an advantage over the pitting machine in that it will not destroy the remaining native vegetation and the very valuable carpet of *Poa bulbosa* grass, a precious feed highly palatable to the flocks of the agro-pastoral community.

Safe in its imprint, the young seedling is also protected from the seasonal blast of cold or hot winds that can lay bare the root structure of vulnerable plants. Wind erosion and exposure are frequent causes for the loss of rangeland species in degraded areas.

The imprinting concept itself is not entirely new since a prototype was first built in the 1970s in the USA and named Land-Imprinter by its inventor (Dixon, 1977). However, the range group's version, built in ICARDA's Fabrication Workshop with technical support from Dr J rgen Diekmann and Abdulwahab Kabbani, is designed for use in the region.

The two machines tested by ICARDA are very different in that the pitting machine scoops a pit in the soil which removes the top layer of soil, with any vegetation. This means it is best suited for use on medium (10-30cm) depth loamy soils with a homogenous soil profile. Because soils on the Syrian steppe are frequently gypsiferous, the bottom of the pits being created can be quite sterile and inhospitable to emerging seedlings.

There may be sufficient water collected in the pits but the fertility of pure gypsum is not ideal. Nevertheless, these large gypsiferous areas of the Syrian steppe have an important role in supporting livestock. They are usually covered with a shallow—no more than 2 cm—top organic horizon which is biologically quite active and carpeted in spring with *Carex stenophylla* and the nutritive, but short-lived plant, *Poa bulbosa*. This ephemeroid short grass is a valuable spring feed for sheep.

The range project team wants both to improve the productivity of this grass and also to encourage the establishment of palatable shrubs such as *Artemisia* and *Salsola* to create a denser and more diversified, vegetation mat cover and most importantly, more feed resources for the agro-pastoral communities.

In the scoops left by the pitting machine on gypsiferous soil, the young plants emerge with some initial shelter from the piercing winds that can blast across the range in winter. Their ability to self-reseed means as little as 10% of the steppe surface needs to be seeded for reestablishment.

It is hoped the shallow grooves of the Land-Imprinter will avoid destroying the existing vegetation while at the same time making easier the introduction to the range of mother plants of white *Artemisia* and *Salsola vermiculata* which don't need to be seeded on all of the range area.

Treating just 10-20%, or even less, of the range using the imprints could be enough to re-establish a starter-vegetation with these valuable, self-reseeding native plants.

Particular care is being taken in the species chosen for range reseeding since they must be acceptable to the pastoral community. *Salsola vermiculata*, locally known as "Queen of the Steppe" is favored by the Bedouin communities, along with *Artemisia herba-alba*.

In a good year, the seed is easily collected en-masse and then cleaned. During reseeding the seeds are mechanically dispersed in the pit from seed boxes mounted on the pitting machine or broadcast in the imprinted grooves mixed with finely ground sheep manure. Just 100 g of the very fine clean seeds of *Artemisia* are sufficient to re-stimulate one hectare of degraded steppe. Both it and *Salsola* have established successfully in the pits on several Syrian range sites.

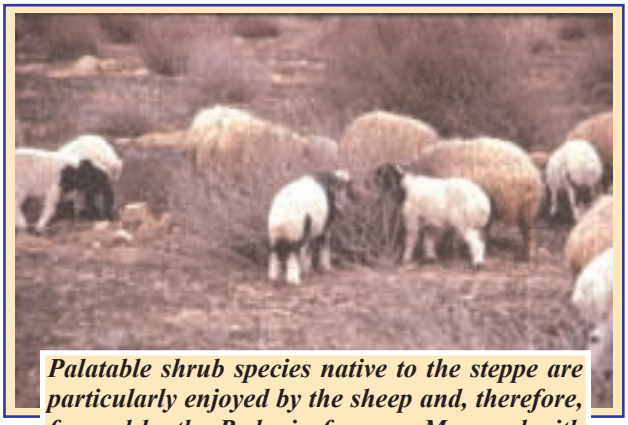
The shallow grooves left by the Land Imprinter on the thin, gypsiferous soils of the Syrian steppe serve several purposes. Existing vegetation is retained, the imprints catch water and soil particles in the run-off and a seedbed is provided for establishing new growth.

The Land-Imprinter is now being evaluated to confirm whether the initial success can be repeated, and that the cost of this type of re-seeding remains minimal and therefore acceptable to the Syrian Steppe Directorate and other development agencies in the region. The robust simplicity of the design keeps maintenance to a minimum.

It is planned to mount seed dispersal boxes on the Imprinter in front of the roller for dry soils. Using the same arrangement in wet soils would result in the freshly dispersed seed being picked up by the damp following roller so the seed boxes will be shifted to the rear. A small harrow comb can be fitted to run behind the Imprinter to scratch some light soil cover for the seeds.

The current version of the ICARDA Imprinter leaves only lateral, parallel imprints and doesn't yet have an offset or right-angled imprinting edge. Incorporating this will close off the lateral imprints and reduce the risk of erosion from having the imprints running in the same direction. In their existing versions, both the Imprinter and the pitting machine are drawn across the steppe in spirals to minimize the risk of water erosion.

However, there is more to be done. Direct seeding may prove useless if not supported by appropriate range management measures carried out by the agro-pastoral communities and supported by government authorities. The plants being used are resilient to overgrazing but it may still take at least 10 years to reestablish a proper and valuable range cover. Controlled spring grazing would allow collection of the biomass from the annuals and not touch the perennials. Let's be careful when we deal with this arid environment !■



Palatable shrub species native to the steppe are particularly enjoyed by the sheep and, therefore, favored by the Bedouin farmers. Managed with care, they are capable of reestablishing to cover the whole range from just a 10% seeding start.

Dr Gustave Gintzburger was formerly Range Specialist at ICARDA from 1992-1999, and has now joined the Institut National de la Recherche Agronomique (INRA), Montpellier, France. The regeneration equipment was developed and tested with the technical support of Nabil Bathika, Fahim Ghassali, Elias Khoudari and Ali Rajab (Range Group – ICARDA).

Helping Hands to Put Sheep Back on Their Feet

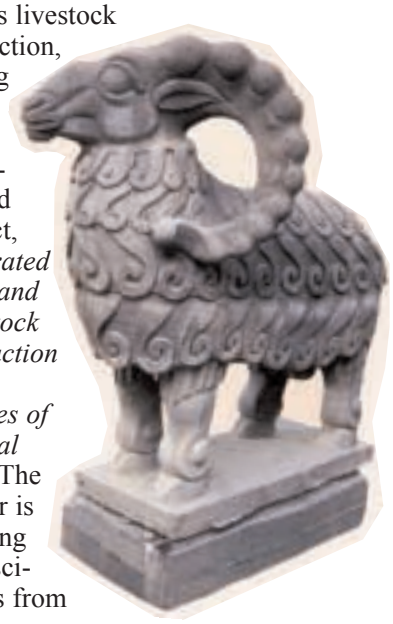
(Continued from page 12)

there is intensification potential for the production of meat and meat products. In these areas, in particular, there is scope to extend lactation periods to maximize the production of both high quality lamb and milk derivatives.

Full assessment still has to be made, however, of the market potential. Personal purchasing power is low in the troubled former Soviet Union so one alternative international market may be found by looking eastwards to China's expanding economy. There are further interesting niche markets for sheep meat that could be developed in the Gulf States and in West Asia, particularly at times of religious celebration when there are peaks of demand frequently leading to imports from outside the regions.

The potential of the sheep production base is promising and genetic diversity in Central Asia is still ample. In addition, an extensive knowledge base has been accumulated in sound national research centers. This will make it easier to reorient new production systems tailored to supply specific market requirements.

ICARDA is participating in a number of projects relating to Central Asia and its livestock production, among them the IFAD-funded project, *Integrated Feed and Livestock Production in the Steppes of Central Asia*. The Center is working with scientists from research institutes in Kazakhstan, Kyrgyzstan, Turkmenistan, and Uzbekistan. These projects will develop a natural resource management approach integrating different disciplines with the aim of improving the income of farmers through sustainable production systems and appropriate management of the valuable production base.



This 2.5 m high statue at the Karakul Sheep Research Institute in Samarkand depicts the Karakul sheep, long the mainstay of pastoralists in Central Asia. It represents a proud past—and in time a return to a prosperous future.

By using this approach, the collaborating project teams will not only look at the prospects for breed improvement, better management practices, and at developing new markets and support structures. They will also consider matters such as property rights that have also become a major issue in the republics since privatization took place.■

Dr Luis Iniguez is Small-Ruminant Scientist in the Natural Resource Management Program at ICARDA. He is coordinator of the IFAD-funded project on Integrated Feed and Livestock Production in the Steppes of Central Asia.

Mild Moroccan winters can permit up to three generations of Hessian fly to hatch out each year. This is second generation damage caused by feeding larvae cutting off the flow of nutrients to the undeveloped ears of wheat. Losses average about a third of potential.

Small, but Hessian fly is no beauty

A costly import bill for wheat for baking into bread can now be reduced, thanks to a joint program between Moroccan and international institutions.

A tiny pest – but a big $20 million problem for farmers in the semi-arid areas of Morocco – that's the Hessian fly which is being brought under control with new resistant wheat varieties.

At just 3mm long this midge-like pest doesn't look like much to the untrained eye but cereal growers throughout the Mediterranean rim have long been suffering its devastating effect on their crop yields. Average losses of 36% yield of affected bread wheat and 32% in durum wheat in Morocco can be expected but individual farmers might lose their entire crop yield if the infestation by larvae takes place during early plant growth stages.

The potential scale of these losses is deeply troubling for Morocco which has about four million hectares of spring bread wheat (*Triticum aestivum*) and durum wheat (*Triticum turgidum*) under production each year. However, yields are being kept down to an average of about one tonne per hectare because of this and other constraints.

This is costing the country dearly because it then has to import replacement stocks of both wheat for bread-making, and durum wheat which is a staple part of the Moroccan diet. Durum is the ingredient of the country's best known dish, *couscous*, and it features in other foods favored in North Africa, including pasta, *burghul* (cracked wheat), and *frike* (green grains)

Hessian fly (*Mayetiola destructor*) is the major pest on the country's wheat and, although the biology of this pest had been studied in Morocco, no effective control method was previously available. Damage is actually caused by the larvae which feed on the lower stem reducing the flow of nutrients to the ear, so the plant lodges or breaks off below the head as it begins to fill. Mild winters in Morocco permit up to three generations of Hessian fly per season.

Reducing pest carry-over from season to season by plowing under infested wheat stubble after harvest doesn't fit in with local farming practices. Wheat stubble provides valuable grazing for the livestock of more than 90% of farmers who have very small farms. For them, chemical control is also expensive and, more seriously, the available insecticides have a negative impact on the environment.

With this shortfall in home-produced grain, the Moroccan government has no option but to import about three million tonnes of bread wheat each year to meet demand from an expanding population.

The solution for this long-term pest problem is not coming from the use of expensive and environmentally-questionable insecticides but from a successful collaborative plant breeding program between Morocco's own National Institute of Agronomic Research (INRA), Mexico-based CIMMYT (International Maize and Wheat Improvement Center), ICARDA, and Kansas State University.

Scientists decided about 15 years ago to combine efforts into developing wheat varieties resistant to the Hessian

Resistance to Hessian fly can make a major difference to growers' harvests. The resistant variety (right) in this trial at Jemaa Shai, Morocco, will far outyield its susceptible neighbors.

fly. Initial screening of plants for resistance is carried out in selected known 'hot spots' in the wheat-growing areas of Morocco and in INRA greenhouses.

Germplasm was exchanged between Morocco and the USA, which has a long-standing serious problem with Hessian fly. Kansas State University, in particular, helped identify resistance genes from the exchanged germplasm.

Crossing to obtain new varieties is carried out at ICARDA's Tel Hadya headquarters in Syria, and in Morocco, using adapted Moroccan cultivars and the newly identified sources of resistance.

The resulting crosses are sent back to Morocco as segregating populations or fixed lines for field testing of their ability to withstand Hessian fly attack and, just as importantly, that they have good agronomic performance in other ways.

So far, the greatest success has been the identification of 15 sources of resistance in bread wheat and the release of three new varieties—Massira in 1996, Arrihane and Aguilal in 1998—to Moroccan growers. Several other new lines are in the breeding pipeline. They include three varieties developed using the doubled haploid technique.

Durum wheat presented the scientific teams with a greater challenge. Only one source of resistance has been identified in durum wheat itself.

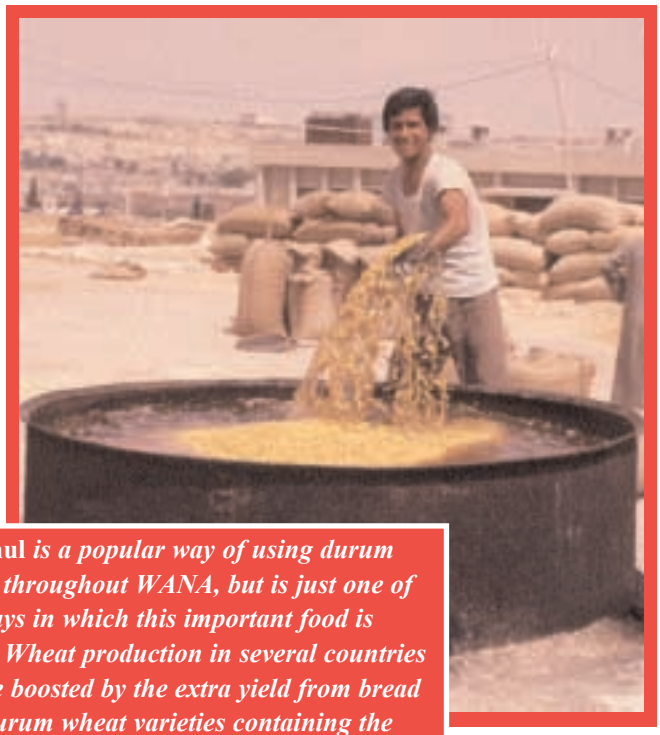
However, the collaboration between INRA (Morocco) and the CIMMYT/ICARDA durum wheat program for WANA, paid off in the development of resistant lines by the introgression of the H5 resistance gene, previously identified in the bread wheat work, into durum wheat.

As a result, three new lines are almost ready to be released as varieties. Named Telset 1, 2 and 3 to reflect the cooperation between **Tel** Hadya in Syria and **Set**tat in Morocco, these new varieties combine the essential good quality of durum wheat with the ability to grow well under drought and heat conditions in Mediterranean dryland. The breeding program continues for both types of wheat and further improved varieties will be released in future years.

So what does this mean for the Moroccan wheat grower? Wheat yields in the country's dry marginal areas are being increased by 30-50% to give a substantial income boost to poorer farmers. One unofficial estimate suggests that extending the Hessian fly resistant varieties throughout wheat-growing areas in Morocco would allow farmers to recover grain losses worth $336 million.

A study has shown there is a 39% internal rate of return on the investment in the development of resistant varieties — a particularly high pay off.

Other benefits of the international cooperation include the multiple sources of environmentally-friendly genetic resistance now put in place against Hessian fly, and the much improved scientific knowledge of how to control this pest. This means that growers facing a similar problem in other Mediterranean countries such as Algeria, Tunisia, Spain and Portugal now stand to benefit from access to the resistant material. The cooperating universities in the USA have also been able to make use of the Moroccan material in their own research. ■



Burghul *is a popular way of using durum wheat throughout WANA, but is just one of the ways in which this important food is eaten. Wheat production in several countries will be boosted by the extra yield from bread and durum wheat varieties containing the new resistance to attack from Hessian fly.*

A multi-disciplinary team of entomologists, breeders and economists has been carrying out this collaborative research work:

Dr A. Amri, Cereal Breeder, INRA, Morocco; Dr M. Jiblene, Bread Wheat Breeder, INRA; Dr N. Nsarellah, Durum Wheat Breeder, INRA; Dr S, Lhaloui, Cereal Entomologist, INRA; Dr M. Moussaoui, Agricultural Economist, INRA; Dr M. El-Bouhssini, Entomologist, ICARDA; Dr M.M. Nachit, Durum Wheat Breeder, CIMMYT/ICARDA; Dr O. Abdalla, Bread Wheat Breeder, CIMMYT/ICARDA; Dr G. Ortiz-Ferrara, Bread Wheat Breeder, CIMMYT/ICARDA; Dr M. Mergoum, Cereal Breeder, CIMMYT; Dr J. Hatchett, Wheat Entomologist, KSU, USA; Dr S. Azzam, Economist, UNL, Lincoln, USA; Dr O. Benlhabib, Cytogeneticist, INAV Hassan II, Morocco; Dr A. Be Belaid, ICARDA WANNADIN Economist.

The Hessian fly (above) is a major pest of all types of wheat in North Africa, from Morocco to Tunisia, in Spain and even in the USA where it was imported during the War of Independence. It lays its eggs on the leaves of wheat plants and the larvae hatch to feed on the flow of vital nutrients to the ear.

Farmer choice makes better use o

The professional plant breeder is always aiming to finish up with a variety that shows consistent improvements over its predecessors and over as wide a geographical area as possible. The farmer is concerned primarily with how a variety performs on his soil and his growing conditions, but not what happens 100 kilometers away. Now a way has been found to ensure the knowledge of both plant breeder and farmer are available to each other.

By Salvatore Ceccarelli

Who is better to judge which variety of wheat or barley best suits a particular area or climatic zone than the farmer with years of hard earned experience and knowledge of his fields and his crop?

The dangers of remotely-based plant breeders and scientists imposing the new crosses they think are ideal have long been realized at ICARDA which tries to work closely with local partners when helping improve yields of cereals and other crops. Whereas research-station-based plant breeding is often quick to reject the results of some crossings as being unsuitable, the farmer approach can be more considered and pragmatic.

A project funded in northern Syria by Germany's Federal Ministry for Economic Cooperation (BMZ) has underlined the importance of allowing farmers access at an early stage to the considerable genetic variability created by plant breeders in the search for new varieties. It is important for adapting varieties to differing environments and for the maintenance of genetic diversity. Barley growers themselves favored many crossings using germplasm that was being discarded by a plant breeder.

At the start of any breeding program, the scientists begin with a wide pool of genetic variability in the form of germplasm. In the past this has been narrowed down through field selections of crosses to produce improved but closely related cultivars which can be grown over a wide geographical area without too much variation in yield or performance. In the process of narrowing the selection down, many potential varieties are discarded, perhaps because they have advantages which are too specific to a particular area or growing conditions to be of wider use.

One of the expected results of farmers selecting for specific adaptation is that, even in a relatively small geographical area, this decentralized participatory selection should produce many different cultivars instead of the few bred conventionally and selected centrally.

The BMZ-funded project, which is continuing into 1999, demonstrates that bringing farmers early into the equation does indeed affect genetic diversity. Two cycles of selection—in 1996/97 and 1997/98—were run at ICARDA's Tel Hadya and Breda research stations and on farm sites. Starting with the same initial population of 208 barley types, a professional breeder and nine farmers were given access to the same mixture of germplasm types differentiated by being two-row or six-row, modern or landraces, fixed or segregating, or varying in seed color. On one location trials were conducted both on barley-barley and barley-vetch crop sequences.

Including varieties known to be unsuitable for the trial locations helped stimulate farmer interest in the project by providing a talking point for the 'judges.'

Where farmers were involved there were twice as many entries left after two cycles than for breeder selection alone at Breda, and three times as many as remained when the breeder was left to

The initial stocks of barley seed used in the farmer-participatory trials varied not only in color but between two- and six-row ear types, modern or landraces, fixed or segregating populations.

f the barley gene

A researcher (center) from the Syrian agricultural extension service helps farmers record their opinions of the 208 barley types supplied to the nine farmers given unprecedented early access to breeding germplasm.

work alone at Tel Hadya *(See table)*. The breeder eliminated all the landraces and black-seeded types at Tel Hadya and all six-row types at Breda.

Some germplasm types also disappeared when the farmers took part but they were of different types in differing locations. Six-row barley was rejected at all nine village sites except at Ibbin and Ebla, both categorized as 'wet' sites where the frequency of six-row types rose from 24% in the original population to 50% (Ibbin) and 56% (Ebla). Six-row types are generally more lodging-resistant—a useful trait in wet environments.

Different types of barley germplasm left after two cycles of farmer-aided selection and centralized breeder selection.

	Initial population	Farmer-aided (9 villages)	Breeder only (Tel Hadya)	Breeder only (Breda)
Two-row	158	42	12	26
Six-row	50	10	5	0
Modern	100	23	17	10
Landraces	108	29	0	16
Fixed	100	27	10	17
Heterogeneous	108	25	7	9
White	161	38	17	16
Segregating	19	5	0	0
Black	28	9	0	10
Total entries	208	52	17	26

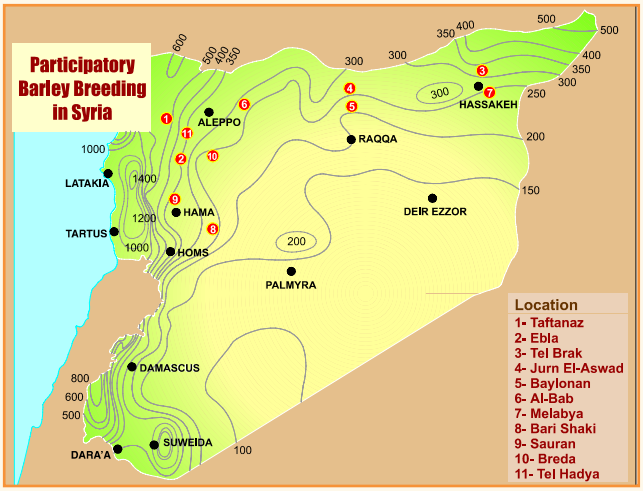
Dry and wet locations also influenced whether or not the landraces stayed in the farmer selections and the breeder shared this divergence of opinion over their value at Tel Hadya (wet) and Breda (dry). Farmers at Ebla agreed with those at Tel Hadya that the landraces and the black-seeded types were unsuited to their wetter conditions and should go.

In dry sites the frequency of black-seeded types increased almost two-fold during the two cycles of selection. However, local preferences for or against particular colors did also create a couple of extreme selections of one or other.

The breeder and the farmers were able to agree on some traits. In their own fields and at Breda, farmers went for taller plants and higher grain yield—as did the breeder—while at Tel Hadya the farmers and breeder agreed on selection for lodging resistance, higher grain yield, larger kernels and shorter plants. Later heading ability was also used by the breeder alone to select types at Tel Hadya.

Nor are the farmers slow to pick out lines that yield significantly better in their own fields. They were just as good as the breeder at selecting the high yielders at Breda, but at Tel Hadya the breeder selections always outyielded significantly the population mean. Farmers got it right five times out of nine, and it must be realized that the real issue in participatory plant breeding is whether the farmers' selections in their own fields are reliable and not whether they can select efficiently in the unfamiliar environment of a research station in a high-rainfall area.

The project has also demonstrated another advantage of including growers in the selection of barley varieties which may have to fit in with changing agronomic practices or rotations. The top 5% of the lines in a barley-barley rotation were all different from the 5% most preferred types in the barley-vetch trial. One line which scored a 54% preference in the barley-barley trial came just seventh in order of preference in the barley-vetch selections. Similarly, the most preferred lines from the barley-vetch trial scored no higher than 26% with farmers growing barley followed by barley.



Nine farmer-sites and two breeder-sites in either 'wet' or 'dry' locations in Syria were used to compare the selection choices of barley growers and breeders.

This shows that by including farmers as partners in breeding, it opens up the possibility of rapidly adapting breeding material to the changes in agronomic practices and farming systems of the target environments. It is very difficult and very expensive to incorporate differing rotations and agronomic practices in a centralized breeding program. By decentralizing plant breeding, there is no additional cost—only additional benefits—provided farmers are included among the participants.

Dr Salvatore Ceccarelli is Barley Breeder in the Germplasm Program at ICARDA.

A trial farmer (left) at Bylounan, Syria, shows a sample of one of the varieties grown on his dry land site to researchers from Morocco, Italy and Mauritania. The growers were often harsh judges of the material supplied but also frequently recognized the value to them of germplasm rejected by a professional breeder.

AND BRIEFLY . . .

Training Circle

The concept of training-the-trainer took a step forward in Yemen when four graduates of the ICARDA course for trainers organised in-country sessions on seed processing and economics.

With training materials and technical backstopping from ICARDA, Khalid Hizam, Ibrahim Chejni, Abdul Baset Samad, and Najeed Mohammed used their new experience to set up the courses for Yemeni seed center managers and technicians. The courses coincided with the early stages of a World Bank Seed and Agricultural Services Project and gained widespread recognition in the Yemeni media.

Water for Wealth

Improved water-use efficiency is the driving force behind two initiatives in Kazakhstan where ICARDA is to work with the Kazakh Research Institute of Water Resources of the National Academy Center for Agricultural Research (NACAR).

About 10,000 hectares of land producing barley, alfalfa and sorghum could be irrigated using the 40 million m^3 of treated wastewater available each year in the area around Sorbulak, north of Almaty. The joint project, based on a 300ha mixed farm, will develop integrated on-farm soil and water technologies to ensure safe use of water.

The experience gained from the second research site near the Arys-Turkestan Canal in southern Kazakhstan is relevant not just to 150,000ha of irrigated land in the immediate area but also to many thousands more hectares in Central Asia that suffer from sub-optimal drainage. Irrigation regimes, crop rotations and improvements to drainage will be evaluated in this project which aims to reduce both leaching and the build-up of soil salinity.

Emphasis will be put on building the awareness among local farmers of the benefits to be gained from managing improved drainage.

Doubly Honored

Soil fertility specialist Dr John Ryan has been honored on both sides of the Atlantic Ocean for his substantial and valuable contribution to soil science. In his home country, the National University of Ireland has awarded the Doctor of Science (DSc) degree to Dr Ryan. The Soil Science Society of America has also recognized his achievements in his chosen field of research by selecting him as one of a small number of 1999 SSSA Fellows.

Swiss Cooperation

Vegetation and land use mapping for one million hectares of agricultural and rangeland in the Aleppo, Hama, and Homs provinces of Syria has been presented to the Ministry of Agriculture at the end of the first stage of the Arid Margins of Syria (AMS) project.

The map, produced in conjunction with the University of Nantes, France, covers land along the 200 mm isohyet and steppe lines. The first phase of the AMS project, carried out in cooperation with the Syrian Ministry of Culture, focused on the history of the area. Now the Swiss Agency for Development and Cooperation, ICARDA, and the Syrian Ministry of Agriculture and Agrarian Reform propose using the information collected to safeguard rangelands from desertification in the second phase.

Striving for Quality

The Mediterranean table groans with food made from quality durum wheat from the WANA region.

With this in mind, a plant breeding seminar on durum, jointly organized by ICARDA, is being staged on 12-14 April 2000, at the Mediterranean Agronomic Institute in Zaragoza, Spain. More details by e-mail from: iamz@iamz.ciheam.org

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 estimate 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

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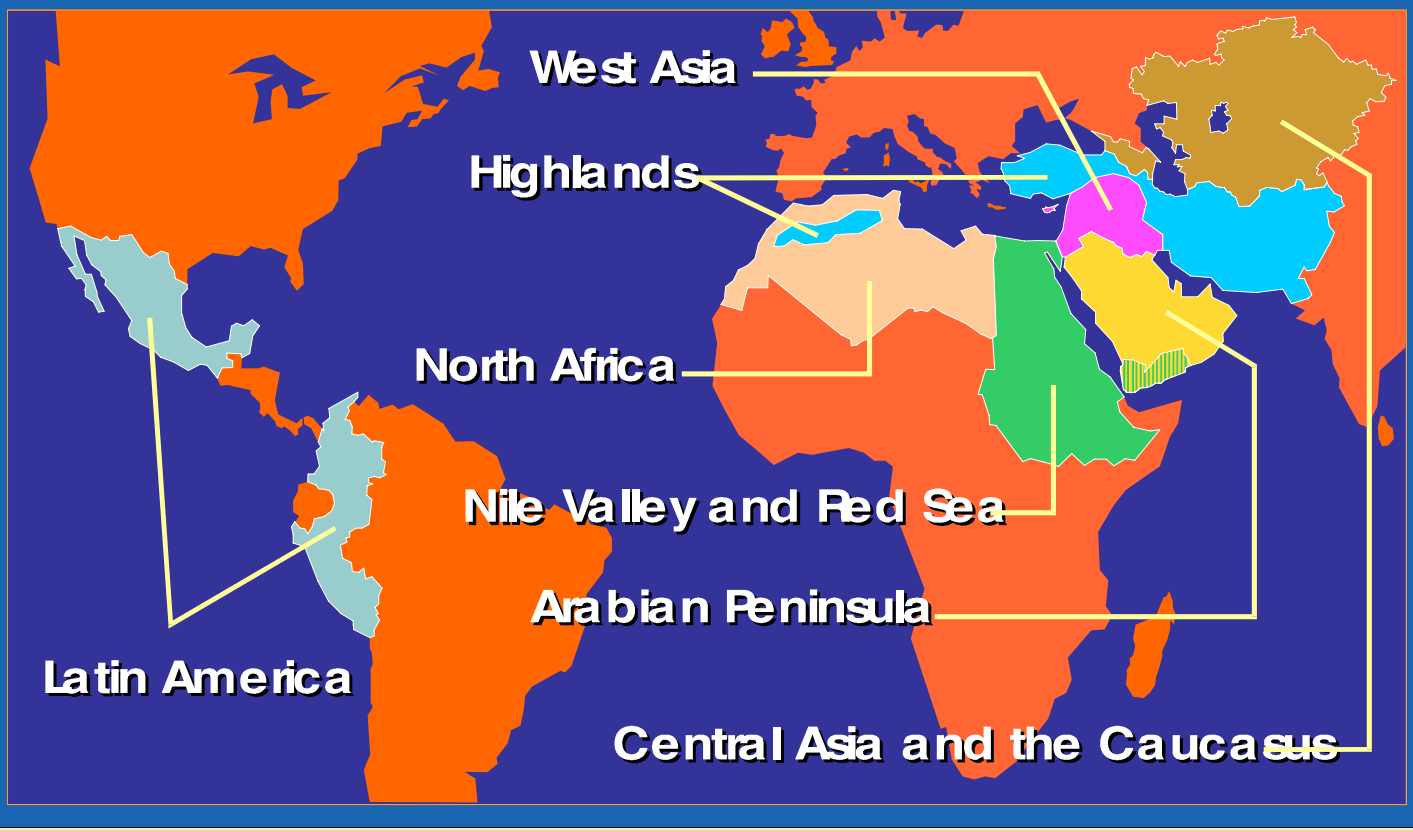
19. Canada
20. Spain
21. UNDP
22. France
23. IDRC
24. Switzerland
25. Republic of Korea
26. OPEC
27. South Africa
28. Austria
29. Ethiopia
30. China
31. Others

ICARDA's Regional Programs



Bringing scientists together for a sustained partnership is a key part of ICARDA's role in alleviating poverty and securing food supplies in its mandate area. Seven regional programs, six in Central and West Asia and North Africa (CWANA) and one in Latin America, act as a mechanism
for resource use effectiveness, eliminating duplicated effort, balancing activities according to the identified needs of each country, exploiting spillover of research from one region to another and, more importantly, for providing a research continuum and a long-term vision of the impact of ICARDA's work.