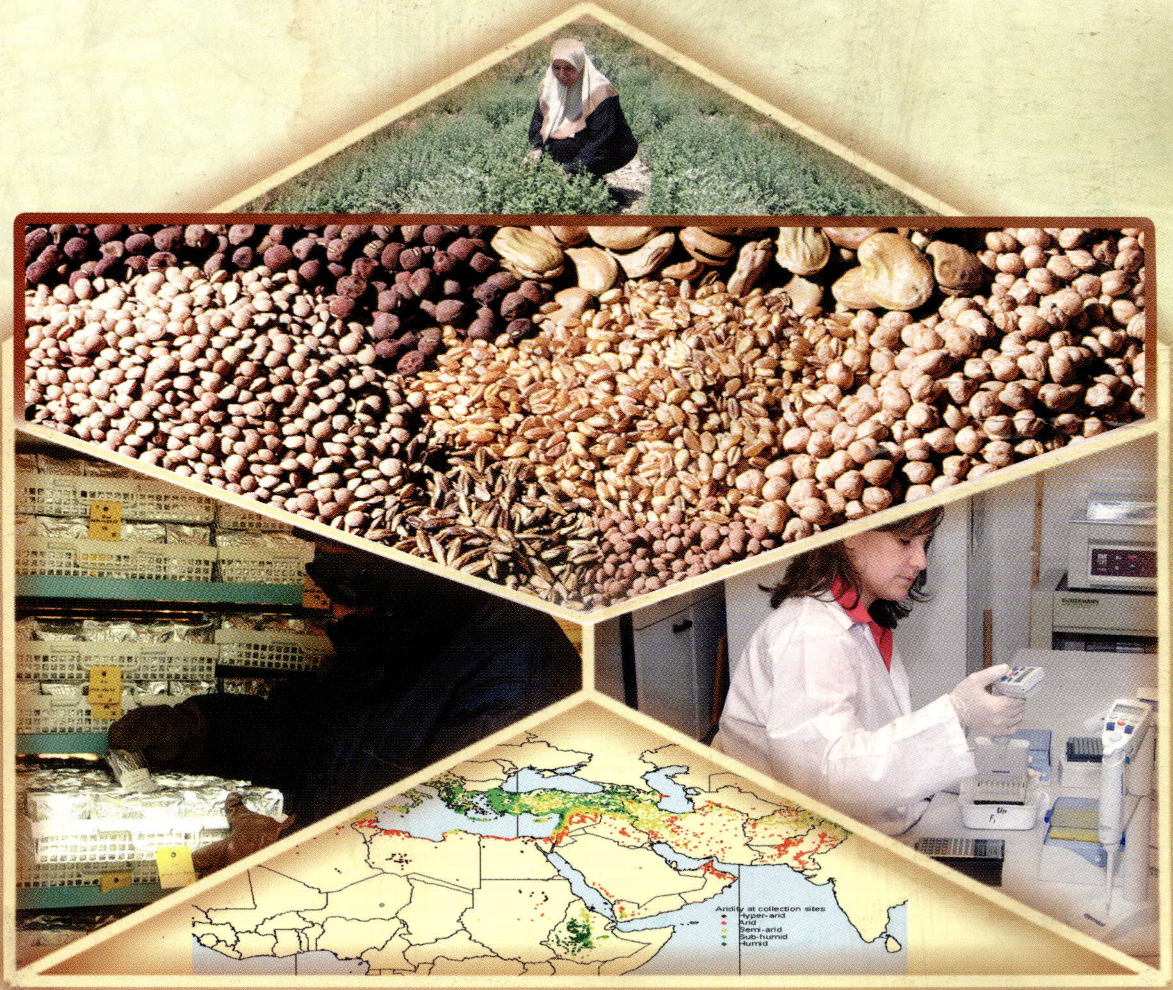
Genetic Resources Unit

Progress Report 1998-2003



ICARDA

International Center for Agricultural Research in the Dry Areas

About ICARDA and the CGIAR

ICARDA

Established in 1977, the International Center for Agricultural Research in the Dry Areas (ICARDA) is governed by an independent Board of Trustees. Based in Aleppo, Syria, it is one of 15 centers supported by the Consultative Group on International Agricultural Research (CGIAR).

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

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

CGIAR

The CGIAR is an international group of representatives of donor agencies, eminent agricultural scientists, and institutional administrators from developed and developing countries who guide and support its work. The CGIAR receives support from many country and institutional members worldwide. Since its 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 the strengthening of agricultural research in developing countries.

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

GENETIC RESOURCES UNIT

PROGRESS REPORT

1998-2003

ICARDA

International Center for Agricultural Research in the Dry Areas

The primary objective of this report is to rapidly communicate research results to fellow scientists, particularly those within the Central and West Asia and North Africa (CWANA) region, with whom ICARDA has close collaboration. Written and compiled by the Genetic Resources Unit scientists and staff, the report was not subjected to rigorous editing. A CD-ROM version of this report is also available and can be obtained, free of charge, from the Head, Genetic Resources Unit, ICARDA.

Printed at ICARDA 2004

International Center for Agricultural Research in the Dry Areas (ICARDA)

P.O. Box 5466, Aleppo, Syria
Tel: 963-21-221-3433
Fax: 963-21-221-3490
E-mail: icarda@cgiar.org
Website: http://www.icarda.cgiar.org, http://www.icarda.org/arabic

Table of Contents

Foreword

The Genetic Resources Unit (GRU) of ICARDA produced its last Annual Report, for the years 1996 and 1997, in 1999. Since then, due to several reasons, no reports were produced although members of staff prepared individual reports of their collecting missions, conservation and gene bank management, plant genetic resources (PGR) research, and training activities. This report, which includes the growing seasons 1997/1998, 1998/1999, 1999/2000, 2000/2001, 2001/2002 and 2002/2003, substitutes the Annual Reports for the years 1998 to 2003.

In recent years there have been many new developments at the GRU. For instance, four special projects became operational with their coordination being provided by GRU. These projects were supported by the Australian Center for International Agricultural Research (ACIAR), the Australian Grain Research and Development Corporation (GRDC) and the Global Environment Facility (GEF)-United Nations Development Program (UNDP). These projects are still on-going at the time of writing this report.

In 2003, the flooring of GRU's Nazareno Strampelli building, that was generously donated by Italy in 1989, was refurbished and work began on the construction of completely new cold store rooms to house the ever-expanding genetic resources collections as well as to fulfill the international requirements of storage. The latter have been mandated by the agreement between ICARDA and the Food and Agriculture Organization of the United Nations (FAO) under whose auspices GRU is holding the designated seed samples for the greater good of humankind. The World Bank upgrading program for IARC's gene banks provided funding for upgrading the old cold store, and construction of new medium-term and long-term storage facilities at ICARDA's gene bank.

The international centers of the CGIAR system are required to develop Medium Term Plans (MTPs) to cover three-year periods. These MTPs, however, are updated annually and are organized around various projects. This six-year report pertains to the MTP project – 3.3 Agrobiodiversity Collection and Conservation for Sustainable Utilization – that is based at the ICARDA's GRU.

The reporting requirements of the MTPs are brief, tabulated, and insufficient for distribution to the national programs and other stakeholders that ICARDA serves in its mandated regions. Hence, in 2004, GRU decided to produce a six-year report to compile all its gene bank activities, genetic resources collection, conservation and related research, seed health testing and training and other assistance to the national programs.

We hope that this six-year consolidated progress report will be of use to our collaborators in the NARS, cooperators, as well as to concerned scientists in the advanced institutions around the world with whom we work.

Jan Valkoun
Head, GRU
ICARDA

ICARDA's Research Portfolio

PROJECT 3.3. AGROBIODIVERSITY COLLECTION AND CONSERVATION FOR SUSTAINABLE UTILIZATION

ICARDA's research is organized within five themes: (1) Germplasm Enhancement, (2) Production Systems Management, (3) Natural Resource Management, (4) Socioeconomics and Policy, and (5) Institutional Strengthening Implementation. All research is conducted in close collaboration with the national agricultural research systems (NARS) of the countries that fall within framework of the seven regional programs of ICARDA, viz., West Asia, North Africa, Nile Valley and Red Sea, the Highland, Arabian Peninsula, Latin America, and Central Asia and the Caucasus. Within this framework the Center's regional agenda is built around 19 interdisciplinary projects. Of these, one project "3.3 Agrobiodiversity Collection and Conservation for Sustainable Utilization" is based in the Genetic Resources Unit of ICARDA and is covered in this six-year report.

1. INTRODUCTION AND HIGHLIGHTS (EXECUTIVE SUMMARY)

Scientists involved: Dr J. Valkoun, GRU, and ICARDA staff

Introduction

The continuing challenge for the world's plant genetic resources (PGR) conservation scientists is to facilitate feeding an ever-increasing global human population and to halt or restrict the rate of crop plant extinctions. The economic, political and social consequences of the steady loss of plant genetic diversity and associated farming systems combined with rapid population growth are likely to be catastrophic if left unchecked. The potential benefits to humankind, however, that could result from the conservation and sustained exploitation of genetic diversity are potentially limitless, especially with newfound scientific expertise, combining plant breeding, genetic engineering and other biotechnological tools. This exploitation assumes that such diversity will continue to exist and is available whenever needed for incorporation into new varieties of economic plants. The steady loss of plant genetic diversity in recent decades because of widespread land clearing and environmental degradation casts a shadow over the future availability of plant germplasm for crop improvement.

This report represents work carried out by the Genetic Resources Unit (GRU) scientists of ICARDA in the years 1998 to 2003, which includes the growing seasons 1997/1998, 1998/1999, 1999/2000, 2000/2001, 2001/2002, and 2002/2003. During this six-year period the GRU carried on with its normal core activities of collection, characterization, documentation and conservation of genetic resources, as well as training and seed health testing. In addition, the GRU also conducted related research on pre-breeding, genetic variation studies using molecular markers, *in situ* conservation simulation and methodology, and evolution of crop genetic resources. Furthermore, the GRU is playing host to two sets of major special funding projects, viz., those supported by the GEF/UNDP and the Government of Australia. These two special projects have been reported in separate Chapters 9 and 12, respectively.

The seasons at Tel Hadya, the main experiment station of ICARDA, 27 km from Aleppo on the Damascus-Aleppo national highway, vary considerably each year. Much of the performance of the germplasm sown at Tel Hadya depends upon the weather conditions. Hence, monthly precipitation, air temperatures, and frost events for all six seasons mentioned above have been listed in the Appendix A (Chapter 17). The highlights (essentially an executive summary) from last six years of work and research at the GRU is given below chapter-wise:

Highlights of Chapter 2. Exploration, Collection, and New Introductions
During the years 1998 to 2003, the exploration and collecting efforts in the WANA region were reduced, whereas those in Central Asia and the Caucasus (CAC) countries increased. The latter activity was greatly facilitated by the special project "Conservation, Evaluation and Utilization of Plant Genetic Resources from Central Asia and the Caucasus" supported by the Australian Center for International Agricultural Research (ACIAR). In all the GRU staff participated in 20 exploration and collection missions in 16 different countries and details are given in Chapter 2. In total, 3725 accessions were collected and added to the gene bank (Table 1).

Table 1. The missions and collections each year (1998-2003).

Year of Collection	Country	No. of Accessions
1998	United Arab Emirates	127
	Oman	92
	Uzbekistan	196
		Total 415
1999	Armenia	234
	Syria	26
	Turkmenistan	114
		Total 374
2000	Kazakstan	200
	Kyrgyzstan	123
	Tajikistan	148
		Total 471
2001	Azerbaijan	244
	Georgia	151
		Total 395
2002	Jordan	375
	Romania	61
	Syria	117
	Turkmenistan	147
		Total 700
2003	Armenia	307
	Jordan	81
	Lebanon	488
	Syria	177
	Tajikistan	317
		Total 1370
		Grand Total 3725

A unique set of 1241 accessions was added to the gene bank from further plant collection missions to Armenia, Jordan, Lebanon, Syria and Tajikistan. In addition, 500 accessions of cereals and legumes from Afghanistan collected by the NARS scientists themselves, after being trained by GRU, were added to ICARDA's holdings. Out of this by far the most valuable addition were 529 unique accessions of bread and obsolete wheats from collections made by N.I. Vavilov and his colleagues in Afghanistan before 1941 and donated to ICARDA by VIR. In December 2003, ICARDA's genetic resources collections reached a total of 131,017 (for a comprehensive list by country and crop see Chapter 13).

Re-introduction of lentil as a crop in its secondary center of diversity

When the CAC countries gained their independence after the collapse of the Soviet Union, various crops had to be grown in each country to meet the dietary requirements of the human population. Lentil was the crop of choice from the food legumes due to its historic importance as a source of protein in the absence of animal proteins in the diet. Due to the efforts of the Germplasm Program at ICARDA with support from the GRU at ICARDA gene bank, several landraces from the past and improved lentil lines of today have been selected for re-introduction by the national programs in Armenia, Azerbaijan, Georgia, Uzbekistan and Turkmenistan and lentil is well on its way in regaining its lost importance in the commerce and diet of the CAC countries (see section 2.6. under Chapter 2).

Highlights of Chapter 3. Characterization, Evaluation and Multiplication

Germplasm characterization, preliminary evaluation for biotic and abiotic stresses as well as for morphological and agronomic traits using international descriptors is one of the principal tasks of the GRU and has been reported in Chapter 3. Also, accessions stored in the gene bank are constantly monitored for viability and those that fall below the prescribed levels for each crop are multiplied in the next available season and the rejuvenated seed are once again entered into the gene bank for storage and for distribution. Those accessions that are more requested than others also need to be multiplied even though they may not require rejuvenation. In addition, genetic diversity analysis and assessment of the potential of conserved material for crop enhancement was also undertaken together with multiplication of germplasm to replenish stocks wherever required.

Multiplication and characterization of germplasm from the Vavilov Institute

Through the Grains Research and Development Corporation (GRDC, Australia) and in collaboration with the Vavilov Institute of Plant Industry (VIR), St Petersburg, Russia and the Center for Legumes in International Agriculture (CLIMA), faba bean (340), lentil (457), chickpea (341), pea (498) and barley (207) accessions were brought to ICARDA for multiplication, preliminary characterization/evaluation and introduction into the ICARDA genetic resources collections. This germplasm was largely from North Africa, West Asia and Central Asia (see section 3.1. under Chapter 3 for details).

Disease resistance in newly collected faba bean accessions

Chocolate spot resistance of germplasm collected in Ecuador and in the administrative regions of Yunnan province in China in 1996 was reconfirmed in the 1997/98 season at Tel Hadya. The germplasm from Ecuador showed many accessions with resistance to chocolate spot though there was little resistance to chocolate spot in the germplasm collected from China. The germplasm from Yunnan was less susceptible than the germplasm from Sichuan administrative regions (see section 3.3. under Chapter 3).

Characterization and evaluation of VIR material supported by Australian-funded projects

During the first year's operation of the two Australia-funded projects, two scientists from the N.I. Vavilov Institute (VIR) in St Petersburg, Russia, visited ICARDA to work on parts of these projects. They assisted the GRU staff in characterizing genetic resources received from VIR at Tel Hadya. The two scientists, Dr Sergey Bulyntsev and Dr Larissa Prilyuk took advantage of the advanced facilities and greater resources at ICARDA to not only develop computing skills but also improve on their English language knowledge as well. Both Russian scientists had long experience in their respective fields of expertise and the GRU as well as the two scientists benefited from their visit.

In 1999, GRU/ICARDA continued its collaboration with the Vavilov Institute of Plant Industry (VIR), St Petersburg, Russia, and the Center for Legumes in Mediterranean Areas (CLIMA) in a project supported by the Grains Research and Development Corporation (GRDC) Australia. During the 1998/1999 season 400 lentil, 500 *Pisum* spp., 399 faba bean, 299 chickpea and 207 barley accessions from the VIR collection were grown out at ICARDA for safety duplication and evaluation. Two scientists from VIR visited GRU for 2 months during 1999 to collaborate in the evaluation of the donated material.

In 2000/2001 germplasm characterization and preliminary evaluation for biotic and abiotic stresses as well as for morphological and agronomic traits using international descriptors continued as regular part of GRU activity. A total of 3800 accessions were characterized for 12 to 33 agro-morphological descriptors and the data generated were entered in the GRU databases. This data was used to perform genetic diversity analysis and the potential of the conserved material for crop enhancement was assessed. Of this total number, 308 accessions were collected during the 1999 Turkmenistan and Armenia missions (see sections 3.3. and 3.4. under Chapter 3).

CWANA core collections

CWANA core collections of wild and cultivated barley were sent to Institute of Plant Genetics and Crop Plant Research (IPK), Gatersleben, Germany for evaluation of biotic and abiotic stresses under the GENRES project. The development of faba bean lines resistant to *Botrytis* and *Ascochyta* continued through repeated selections at the high rainfall site at Lattakia on the Mediterranean coastline. However, in July 2000 this latter activity was transferred to GP/ICARDA but has been concluded in the project MTP 3.3. The lines were thus made available for the immediate use of breeders (see section 3.6. under Chapter 3).

Ecological characterization of cereal genetic resources

Within the framework of the German Overseas Development Ministry (BMZ) funded project, "Exploration of Genetic Resources Collections at ICARDA for Adaptation to Climate Change: Identification and Utilization of Sources of Stress Tolerance", a set of 36 wild barley and 124 barley landrace accessions, as well as another one consisting of 36 *Aegilops*, 18 wild *Triticum*, 5 obsolete wheat and 91 durum wheat landrace accessions were selected from GRU/ICARDA collections using the information generated by NRMP Agro-ecological Characterization Group. A total of 41 ecological variables were used for selecting representatives of different clusters of drought-affected germplasm collection sites. These two sets, complemented with improved germplasm from the Germplasm Program, were used in molecular and photothermal characterization studies in the next phase of the project (see section 3.7. under Chapter 3).

Germplasm multiplication

A total of 10,033 accessions were multiplied in 2001 as seed stocks for these samples were getting low. Fresh seed was harvested and added to the active collection for distribution and long-term storage samples were replenished with fresh material with 100% viability. In addition, a total of 233 barley, wheat, lentil, chickpea and faba bean landraces from Afghanistan were planted at Tel Hadya for multiplication and agro-morphological characterization. Molecular characterization was also performed on these samples. Material with distinct traits was selected and multiplied at Terbol station in Lebanon in the summer as the environment there is similar to the origin of this germplasm. A sub-sample of the material was then planted for in-depth evaluation in Afghanistan during the 2002/2003 season and the data added to the database at GRU (see section 3.9. under Chapter 3).

Highlights of Chapter 4. Utilization and Distribution of Germplasm

ICARDA's Genetic Resources Unit (GRU) distributes by far the highest number of samples from its gene bank to users around the world as compared to other CGIAR centers (see Chapter 4). The total number of accessions distributed in six years was 188,712 (Table 2).

The 61,733 accessions distributed to GRU scientists represent those that were used for characterization, evaluation, viability testing, and regeneration. They also include samples used in pre-breeding and for genetic resources related studies, like on taxonomy and evolution.

Table 2. Recipient-type and number of seed samples distributed by GRU/ICARDA during the years 1998 to 2003.

To developed countries	26205
To developing countries	44742
To GRU scientists at ICARDA	61733
To GP scientists at ICARDA	43996
To other IARCs	105
For safety duplication at another gene bank	11931
Total	**188712**

Highlights of Chapter 5. Conservation and Gene Bank Management

During the years 1998 to 2003, GRU/ICARDA continued to contribute to the global efforts on saving and utilizing crop plant biodiversity. The *ex situ* genetic resources collections held at the ICARDA's gene bank increased from a total of 115,808 in December 1997 to 131,017 in June 2004, a jump of over 15 % (see Table 5 at the end of this Chapter). However, almost 90% are held in trust under the auspices of the Food and Agriculture Organization of the United Nations (FAO).

Viability testing of germplasm, a continuous all-year long activity, was delayed in 2003 due to the major reconstruction of the flooring and renovation of the GRU's Nazareno Strampelli Building. This activity will receive priority in 2004 and 2005.

Safety duplication

On recommendations of the System-Wide Genetic Resources Program (SGRP) ICARDA will continue to duplicate its collections at other CGIAR centers as and when spare capacity is available. In 2003, 3521 accessions were safety duplicated at the International Maize and Wheat Improvement Center (CIMMYT), Mexico, under the terms of a 'black box' letter of agreement. By the end of the year, 15,500 accessions were ready for dispatch to the International Potato Center (CIP) under the same 'black box' terms as soon as the LOA between ICARDA and CIP is finalized (see section 5.1. under Chapter 5).

Construction of a new cold store

The construction of a new cold store was started in earnest towards the end of the year 2003. The progress of this work continues in to 2004. The projected date of completion is the end of 2004. It is expected that with the commissioning of this new cold store ICARDA's genetic resources conservation space in cold rooms would have effectively been doubled and international standards of medium- and long-term storage maintained (see section 5.3 under Chapter 5). This extra capacity will also allow the Center to hold safety duplication of other CGIAR centers in reciprocation, as well as collections from the NARS.

Highlights of Chapter 6. Documentation and data management

The computerized database of plant genetic resources is a vital tool assisting GRU staff in research, conservation and distribution of germplasm. The integrity of the data as well as the user friendliness combined with adequate performance of the system in a multi-user network environment is critical for many aspects of work with genetic resources. The GRU databases on various crops are available to users *on-line worldwide. In addition, where facilities are limited, off-line access to same* databases is provided through CD-ROMs and printed catalogs (see Chapter 6).

Within the framework of the System-wide Genetic Resources Program (SGRP), the GRU of ICARDA has compiled a database on 8670 accessions of nitrogen-fixing organisms maintained in gene banks of CGIAR Centers, such as, CIAT, IITA, ILRI, IRRI and ICARDA. In addition to data gathering, verification and compilation, the user-friendly software to work with the database was developed in-house in the GRU (see section 6.2. under Chapter 6).

The GRU was able to provide major assistance to several NARSs in ICARDA's mandated region in setting up their genetic resources databases. For instance, Mr J. Konopka, Documentation Specialist at the GRU, visited the Uzbek Research Institute of Plant Industry (UzRIPI) in Tashkent in response to that Institute's request for assistance. The visit was also a follow up to the SGRP project to support national plant genetic resources programs in Central Asia. He also conducted several training courses in the Central Asia and the Caucasus (CAC) countries, including a major one in Tashkent at the Uzbek Research Institute of Plant Industry (UzRIPI). The trainees who undertook this training themselves became trainers later on and were subsequently able to travel to other CAC countries to impart instructions in Russian, which is the lingua franca among the scientists in the CAC countries that formed part of the former Soviet Union. See section 6.7 in Chapter 6 for the details of assistance to NARS in documentation and data management.

Highlights of Chapter 7. Seed health testing
The Seed Health Laboratory (SHL) attached to the GRU met its objectives fully in ensuring the safe movement of germplasm in and out of ICARDA during the six seasons.

The SHL in collaboration with the Virology Lab at ICARDA tested approximately 183 faba bean accessions (100 seeds per accession) for the presence of Broad Bean Stain Virus (BBSV), Bean Yellow Mosaic Virus (BYMV) and Pea Seed-borne Mosaic Virus (PSbMV). Following rigorous testing on the basis of host range and serological reactions, 50 accessions were found to be infected with one of the above-mentioned seed-borne viruses (see section 7.6 under Chapter 7).

Over and above its normal duties of seed health testing, treatment and inspection, the SHL also carries out its own research to improve its performance and devising new tests to intercept pathogens. The SHL, in collaboration with the International Maize and Wheat Improvement Center (CIMMYT), worked on selection of durum wheat germplasm for resistance to *Anguina tritici* and black point diseases. A large number of resistant samples of germplasm were identified and the tests used confirmed (see section 7.8. under Chapter 7)

In addition, the SHL staff was heavily involved in setting up seed health testing facilities in Afghanistan, including the associated training lecturers and material (see section 8.3.7. under Chapter 8).

The SHL, in collaboration with the International Maize and Wheat Improvement Center (CIMMYT), worked actively in plastic house experiments on selection of durum wheat germplasm for resistance to *Anguina tritici* and black point diseases (see section 7.8 under Chapter 7).

Highlights of Chapter 8. Training, capacity building and assistance to NARS
In response to increasing demand from the NARS, especially in the new republics of the CAC countries, GRU conducted several types of training activities. The total number of trainees during the period 1998-2003 was 332 from 40 countries (Table 3). One of the highlights was an international training course/study tour offered jointly by GRU/ICARDA and the University of Birmingham, UK, on "Conservation and Utilization of Plant Genetic Resources" leading to a MSc degree (see 8.1.3. in Chapter 8). Major efforts were made by the Seed Health Laboratory staff (Dr S. Asaad) for setting up and training personnel in Afghanistan and Iran in seed health testing (see section 8.3.7 in Chapter 8) . The short training course on "Use of Molecular Markers in Biodiversity Studies" conducted by GRU Biotechnologist, Dr K. Chabane, proved to be popular and was

conducted every alternate year. Individual higher degree students also carry out research in AFLP and RAPD techniques (see section 8.1.4. under Chapter 8).

Assistance to NARS in PGR conservation and training

Assistance to the NARS has been a major activity in the last 5 years, thanks to the two Australia-funded special projects entitled "Development and Conservation of Plant Genetic Resources from the Central Asian Republics and Associated Regions" and "International Linkages for Crop Plant Genetic Resources" (see section 8.2.3. under Chapter 8). These projects have been able to make an important contribution to strengthening the national genetic resources conservation programs in ICARDA's mandate region and also to GRU staff strength. Dr Kenneth Street was appointed as the coordinator for these projects in 1999. Training assistance was provided to staff of the newly established genetic resources units in Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan in Central Asia, and Armenia, Azerbaijan and Georgia in the Caucasus. In addition, GRU expertise was utilized in making plans for construction of cold stores for medium to long-term conservation of genetic resources. International donors will be sought to provide funding for their construction and implementation.

Table 3. Three hundred and thirty-two trainees from 40 countries received training by GRU staff during the period 1998-2003.

1. Algeria	14. Kuwait	27. Qatar
2. Angola	15. Lebanon	28. Saudi Arabia
3. Bahrain	16. Libya	29. South Africa
4. Bhutan	17. Malawi	30. St. Vincent
5. Botswana	18. Mauritania	31. Sudan
6. Egypt	19. Morocco	32. Syria
7. Ethiopia	20. Mozambique	33. Tunisia
8. Eritrea	21. Namibia	34. Turkey
9. Germany	22. Netherlands	35. United Arab Emirates
10. Iraq	23. Palestine	36. Uzbekistan
11. Italy	24. Oman	37. United Kingdom
12. Jordan	25. Pakistan	38. Yemen
13. Kazakhstan	26. Portugal	39. Zambia
		40. Zimbabwe

Highlights of Chapter 9. *In Situ* Conservation and the GEF-UNDP project on agro-biodiversity

The Global Environment Facility (GEF), through the United Nations Development Program (UNDP), funds ICARDA's project for the conservation and sustainable use of dryland agrobiodiversity. It aims to promote community-driven *in situ* conservation and sustainable use of dryland agrobiodiversity in Jordan, Lebanon, the Palestinian Authority and Syria. ICARDA is responsible for regional coordination and networking among the national components and provides, in cooperation with the International Plant Genetic Resources Institute (IPGRI) and the Arab Center for Studies of the Arid Zones and Dry lands (ACSAD), the necessary technical backstopping and training.

The project was approved for funding in 1998 and its implementation started in June 1999 with the appointment by ICARDA of Dr Ahmed Amri as the Project Coordinator based in Jordan. The project, initiated by ICARDA and developed jointly with IPGRI, ACSAD and NARS of the participating countries, brought in more than US$ 8,000,000 in funds to the region that has been the origin of our major food crops and great potential for diversity for *in situ* and on-farm conservation at the regional, national and community level. ICARDA is playing a major role in the project implementation as the implementing agency of the whole project and executing agency for its regional component through regional integration, networking and providing technical back-stopping and training. The project has highlighted activities and actions that will contribute to the ultimate goal of improving the livelihood of local communities while conserving agrobiodiversity, but greater national and international support might be needed to conserve endangered agrobiodiversity. Lessons should be drawn from the failed expansion of alternative crops promoted at the expense of rich local agrobiodiversity.

The project regional component and country component reports, mass media awareness efforts and other media-based outputs are listed in Appendix 17E).

International Conference in April 2005
An international conference on "Promoting Community-driven Conservation and Sustainable Use of Dryland Agrobiodiversity" will be held at ICARDA 18-21 April 2005. The meeting will highlight the achievements of the GEF-UNDP funded project, and at the same time bring forth lessons learnt on some of the aspects of community-supported *in situ* conservation. The program includes a field trip to *in situ* conservation sites where actual conservation can be observed firsthand. There are nine proposed themes, and an invited speaker will deliver the plenary lecture for each of these (see page 123 of this report).

For a complete report of the progress of this project so far see Chapter 9.

Highlights of Chapter 10. Research on variation and evolution of genetic resources
Dr K. Chabane, GRU Biotechnologist and his group have been carrying out this research since 1997 in collaboration with advanced institutions viz., **Kyoto**

University (Japan) to detect through AFLP fragment from *Aegilops* spp. to define microsatellites. Several microsatellites were found recently and ongoing work for constructing specific primer is undertaken; **University of Bristol (UK)** for evaluation of genetic diversity in wild diploid and tetraploid wheats using AFLP markers; **University of Birmingham (UK)** in molecular taxonomy of *Vicia* spp. based on AFLP; **Lismore University (Australia)** for developing ESTs for barley is undertaken and we are expecting to get the sequences for using them for characterization of traits by the end of this year; **IPGRI (CWANA)** for characterization of wild collection of pistachio from Syria using AFLP marker and characterization of *Vicia* spp using RAPD markers; **Institut National de la Recherche Agronomique (INRA)-Ecole Nationale Supérieuren d'Agronomie Montpellier (ENSAM), Montpellier, France,** for survey of functional diversity for drought tolerance and seed quality traits in Triticeae using microsatellite markers; **University of California (Davis, USA)** for study of genomic patters of wheat using microsatellites and molecular organization in *Lens* using AFLP analysis.

See section 10.1. in Chapter 10 for details of taxonomic studies in the *Vicia sativa* aggregate that have been one of the highlights of 1998. DNA was extracted from 520 accessions of *Vicia sativa*, forming the tentative core collection of this species. The DNA was used for molecular fingerprinting of the accessions in a study to map the genetic variation of the species to identify gaps in the collection and possible *in situ* conservation sites. This core collection of *Vicia sativa* was also planted in the field so that morphological characterization and basic evaluation data can be added to the fingerprinting data. Besides the more traditional taxonomic data, also genetic fingerprinting data (AFLPs) was used in an attempt to clarify the confusion that exists in the taxonomy of the species aggregate.

In 1998, GRU also received two MSc degree students for training in molecular genetics from Lebanon and Eritrea. Currently two MSc degree students from, one from Guangzhou University in China and the second from University of Aleppo are conducting research on AFLP fragment from *Aegilops* spp. and molecular characterization of cereals, respectively.

In 1999, the taxonomic studies in the *Vicia sativa* aggregate continued from the pervious year. In 2000, 129 accessions representing the taxa in the series and originating from a very wide geographic area were evaluated using two primer combinations in an attempt to clarify its taxonomy. The accessions were analyzed for the first time using AFLPs to study *Vicia sativa* and related species. The study concluded that four species exist in the series. *Vicia incisa* should be considered as a separate taxon and does not belong to the *Vicia sativa* aggregate. This work has been published in the journal Plant Systematics and Evolution 229: 95-100 (2001).

In 2001, twenty-six accessions from the gene bank that represented natural populations of four wild *Triticum* spp. (*Triticum dicoccoides*, *T. araraticum*, *T. urartu*, and *T. baeoticum*) and five *Aegilops* spp. (*Ae. geniculata*, *Ae. triuncialis*, *Ae. speltoides*, *Ae. tauschii*, and *Ae. vavilovii*) were analyzed using amplified fragment length polymorphisms (AFLP) marker technique in order to shed light on the evolution and geographical distribution of genetic diversity of wild relatives of wheat in the Near East. Variations within populations were detected in all accessions. For most of the species, the level of nucleotide polymorphism within populations was relatively low ($ð < 0.005$). However, *Ae. speltoides* had relatively high levels of variation within two populations ($ð = 0.0151$ and 0.0233). This species also had the highest value of nucleotide variation between accessions ($ð = 0.0319$). In the *Triticum* species, the level of variation within populations was relatively low in *T. urartu* and *T. baeoticum*. Two tetraploid *Triticum* species had relatively high levels of variation within accessions ($ð = 0.005$) but divergence between *T. dicoccoides* and *T. araraticum* was not complete in the phylogenetic tree (see 10.3.5.). A part of this research, carried out in collaboration with scientists from the Laboratory of Plant Genetics, Kyoto University, Japan, was published in Euphytica 127: 81-93 (2002).

Collaboration with University of California, Davis

Under collaboration with advanced institutions and to bring the latest techniques and know-how to ICARDA, a project for the evaluation of *Triticum* spp. using AFLP markers was developed with the Department of Agronomy and Range Science, University of California at Davis (UCD), USA and GRU/ICARDA on molecular genetics. Under this project, K. Chabane visited the laboratory of Professor Jan Dvorák at UCD in July 2002 and July to December 2003 for this research (see section 10.3.9. under Chapter 10).

Highlights of Chapter 11. Pre-breeding and new genes for wheat breeders

Pre-breeding or germplasm enhancement is necessary because other genetic effects such as maturity response can mask even simply inherited traits. Several cycles of recombinations and selections may be required to develop gene pools that are sufficiently stable and at the same time well-adapted to the target environment. Clearly pre-breeding is a time-consuming and difficult process.

The initial crosses of the durum wheat with *Triticum urartu*, *Triticum baeoticum*, *Triticum dicoccoides* and *Aegilops speltoides* were produced by GRU in 1994/95 season and the subsequent backcross generations were produced in the plastic house. During the 1997/98 season, the wide hybridization products were first exposed to biotic and abiotic stresses in the field. Fully fertile plants with a gene(s) conferring high resistance to yellow rust were detected in crosses of

'Cham 5' with *T. dicoccoides* ICWT 601116 and ICWT 600117, originating from southern Syria. Yellow rust resistant and fully fertile plants were also found in crosses of durum wheat with wild diploid wheats: 'Cham 5' with *T. baeoticum* ICWT 500647 and 'Haurani' with *T. urartu* ICWT 500530. This is, to our knowledge, the first transfer of yellow rust resistance from diploid to tetraploid wheat (see Chapter 11 for more details). These research results have also been published in Euphytica 119: 17-23 (2001).

Highlights of Chapter 12. Genetic Resources Conservation Projects Supported by Australia

Australia has traditionally been a strong supporter of agricultural research both at home and abroad. For the financial year 2002-2003 Australia contributed US$139,000 to the core budget of ICARDA and $542,000 towards special projects. But perhaps even more important than this significant financial contribution to the Center's budget is the sharing of skills, experience and advanced techniques between ICARDA and the Australian scientists involved in collaborative projects (see Chapter 12 for complete details).

Several of the crops collected by GRU since 1983 are important to Australian agricultural and livestock production. Indeed, the GRU holds one of the most comprehensive collections of genetic material in the entire region. Australian scientists frequently requested and continue to request germplasm samples from ICARDA. The seven projects supported by Australia are listed below details of which can be found in Chapter 12:

Project 1. International Evaluation of *Vicia faba* germplasm at ICARDA (1994-1999), funded by Grains Research and Development Corporation (GRDC);
Project 2. Offshore Evaluation of International Field Pea Germplasm for Resistance to Black Spot (*Mycosphaella pinodes*) and agronomic merit (1994-1999), funded by GRDC;
Project 3. Conservation and Preservation of Grain Legume Genetic Resources from the Eastern Mediterranean region (1994-1998), funded by GRDC;
Project 4. International Linkages for Crop Genetic Resources (1999-2003), funded by GRDC;
Project 5. Technologies for the Targeted Exploitation of the N.I. Vavilov Institute of Plant Industry (VIR), ICARDA and Australian Bread Wheat Landrace germplasm for the Benefit of the Wheat Breeding Programs of the Partners (2001-2005), funded by GRDC;
Project 6. Development and Conservation of Plant Genetic Resources from the Central Asian Republics and Associated Regions (1998-2001), funded by Australian Center for International Agricultural Research (ACIAR).

Project 7. Conservation, Evaluation and Utilization of Plant genetic Resources from Central Asia and the Caucasus (2001-2003), funded by ACIAR.

Highlights of Chapter 13. ICARDA's Current Gene Bank Holdings

The number of accessions in ICARDA's gene bank increased each year as a result of collecting missions and fresh acquisitions received as donations from other gene banks. The current holdings of the GRU/ICARDA gene bank total 131,017 accessions, an increase of 13% over 1997, when the total collection was 115,808 (see GRU Annual Report for 1996 and 1997). The status and other details of these collections as of December 2003 are given in Chapter 13 and a summary is given here in Table 4.

Table 4. Summary of origins of accessions in ICARDA gene bank at GRU (December 2003)

Crop	CWANA Countries		Other countries		Unknown origin		Total
	(No)	(%)	(No)	(%)	(No)	(%)	(No)
Barley	11628	48.2	12319	51.0	186	0.8	24133
Wild *Hordeum*	1716	93.8	83	4.5	31	1.7	1830
Durum wheat	14686	74.6	4765	24.2	224	1.2	19675
Bread wheat	9311	84.4	1492	13.5	225	2.1	11028
Primitive wheat	496	66.0	209	27.8	47	6.2	752
Wild *Triticum*	1530	97.6	20	1.3	17	1.1	1567
Aegilops	3052	81.7	656	17.6	26	0.7	3734
Total cereals	**42419**	**67.6**	**19544**	**31.2**	**756**	**1.2**	**62719**
Chickpea	9565	79.5	2243	18.6	224	1.9	12032
Wild *Cicer*	267	99.6	-	-	1	0.4	268
Lentil	5646	57.3	4147	42.1	56	0.6	9849
Wild *Lens*	493	86.8	75	13.2	-	-	568
Faba bean	2776	49.3	2580	45.8	278	4.9	5634
Faba bean BPL	5106	100.0	-	-	-	-	5106
Total food legumes	**23853**	**71.3**	**9045**	**27.0**	**559**	**1.7**	**33457**
Medicago annual	6646	83.4	1173	14.7	146	1.9	7965
Vicia	4338	71.9	1678	27.8	17	0.3	6033
Pisum	1353	22.5	4060	67.5	600	10.0	6013
Lathyrus	1735	54.4	1450	45.4	7	0.2	3192
Trifolium	4004	82.8	757	15.7	74	1.5	4835
Other forage/. rangeland spp	5258	77.3	1450	21.3	95	1.4	6803
Total forages	**23334**	**67.0**	**10568**	**30.3**	**939**	**2.7**	**34841**
Grand Total	**89606**	**68.4**	**39157**	**29.9**	**2254**	**1.7**	**131017**

Highlights of Chapter 14. List of Publications

One of the keys to the success of the GRU has been its excellent scientific publications record. And those listed in this report is no exception. A summary of the list of 126 publications giving the numbers in each of the five categories is given in Table 5. The complete list is given in Chapter 14.

Table 5. Summary of publications for the years 1998 to 2003.

Journal papers	Conference/ book chapters	Newsletter articles	Books	Un-Publ. reports
43	66	8	4	5
Total = 126 Publications				

However, one of the major publication highlights remains the Harlan Symposium proceedings book that is still one of the 'best sellers' for ICARDA since the Center began levying charges for its publications for orders outside the CWANA region. The first run of 1000 copies printed in February 1999 was soon exhausted, and ICARDA had to go into a second printing of an additional 500 copies. And we are told that even this stock will be soon exhausted. The citation of the book is as follows:

Damania, A.B., J. Valkoun, G. Willcox, and C.O. Qualset (Eds). 1998. *The Origins of Agriculture and Crop Domestication - The Harlan Symposium.* ICARDA, Aleppo, Syria, 352 p.

The GRU Staff List

The major changes in staff during the period 1998-2003 were the departure of the Legume Germplasm Curator in 1998 and the arrival of an Associate Expert – Australia (now designated CAC Coordinator) in 1999. A new Legume Germplasm Curator joined in 2004. The complete GRU staff strength, as of June 2004, is provided in Chapter 15.

Acknowledgements

The GRU thanks its entire support staff and other units and programs at ICARDA for assisting in the production of this report.

Appendices

The Appendices giving the meteorological information for Tel Hadya (Appendix 17A), a copy of the MTA Agreement (17B), a copy of the Genetic Resources Collection Permit (17C), and the full list of GRU Training Courses and Participants in 1998-2003 (Appendix 17D), appear at the end of this Report. Appendix 17E lists Unpublished Reports produced by GRU staff and/or their associates in the GEF/UNDP Agrobiodiversity project.

2. EXPLORATION, COLLECTION, AND NEW INTRODUCTION

Scientists involved: Dr Jan Valkoun, Dr Ahmed Amri, Dr Kenneth Street, Mr Bilal Humeid, Mr Ali Shehadeh, Mr Ali Ismail and Mr Fawzi Sweid and Mr Mohammed Hamran

2.1. N.I. Vavilov – plant explorer, collector, geneticist and breeder
2.2. Collection mission to Uzbekistan in 1998
2.3. Collection missions to UAE and Oman for forages
2.4. Collection mission to Turkmenistan
2.5. Collection mission to Armenia
2.6. Re-introduction of lentil as a crop in its secondary center of diversity
2.7. Collecting in Syria
2.8. Collecting missions to Lebanon
2.9. Collecting missions to Kazakstan, Kyrgyzstan and Tajikistan
2.10. Unique set of genetic resources collected from Azerbaijan and Georgia
2.11. Collecting mission in Jordan
2.12. Collecting mission to Romania
2.13. Central Asia and the Caucasus (CAC) Regional Program – Plant Genetic Resources
2.14. ICARDA's CAC collections benefit farmers in Australia

Background
The purpose of exploring regions of genetic diversity and collecting germplasm samples of ICARDA's mandate crops and their wild relatives is to conserve genes that could be used for current and future plant breeding endeavors. It is an on-going activity at the GRU since plants continue to evolve all the time in response to changing environments and biotic and abiotic stresses. This work contributes towards the expansion of ICARDA's genetic resources holdings which are conserved at GRU and utilized by the crop improvement programs at ICARDA, the NARSs in ICARDA's mandate region, as well as by scientists and other users worldwide. During the period 1998-2003, GRU/ICARDA collected a total of 3725 accessions of cereals, food and forage legumes and their wild relatives from several countries (Table 6). Out of these, 1147 were collected in Syria and the neighboring countries of Lebanon and Jordan.

All germplasm that GRU/ICARDA and collaborators collect comes under the terms set out in the Permission to Collect Germplasm Agreement (see Appendix 17C) that is signed by the parties participating in the collection mission as required by the International Code of Conduct for Plant Germplasm Collecting and Transfer Agreements. All material and characterization data that is held by ICARDA is made freely available for scientific research under the conditions defined by the International Treaty on Plant Genetic Resources and detailed in a Material Transfer Agreement (MTA) (see Appendix 17B).

Table 6. Number of accessions collected in each year (1998-2003).

Year of collection	No. of accessions
1998	415
1999	374
2000	471
2001	395
2002	700
2003	1370
Total	**3725**

Also, from 1998 onwards GRU/ICARDA conducted several collecting missions with staff of the N.I. Vavilov Institute (VIR), St Petersburg, Russia and the number of samples collected each year has steadily increased. A large part of crop plant germplasm collecting undertaken by GRU/ICARDA and collaborators has to do with Russian botanist Nikolai I. Vavilov's travels in the region. Some of these missions actually re-traced Vavilov's own travels in the 1920s and 30s in Lebanon and Syria, and the CAC countries. Vavilov was the first plant explorer who targeted areas to be sampled based upon his scientific theories on the Centers of Origin and Diversity.

2.1. N.I. Vavilov – plant explorer, collector, geneticist and breeder

Nikolai I. Vavilov (Fig. 1) was born in Moscow in November 1887. In 1911, having graduated from the Agricultural Institute, Vavilov continued to work at the Department of Agriculture in Saratov. During 1913-1914, Vavilov traveled to Europe where he studied plant immunity with British biologist W. Bateson, who at the time was Professor of Genetics at Cambridge University.

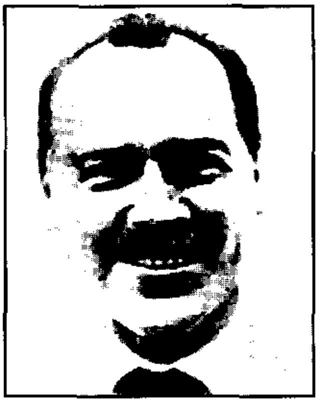


Fig 1. N. I. Vavilov (1887-1943)

In 1920 Vavilov was elected Head of the Department of Applied Botany, and soon moved to Petrograd (which was renamed Leningrad and is now St Petersburg, which was the city's original name) together with his students and associates. In 1924, the Department was transformed into the Institute of

Applied Botany and New Crops and was later to be named after Vavilov. The Vavilov All-Union Institute of Plant Industry (VIR) became the central nationwide institution responsible for collecting the world's plant diversity and studying it for the purposes of plant breeding and crop improvement in the Soviet Union.

Vavilov himself organized and took part in over 100 collecting missions. His co-workers and students, who had trained under him, conducted other missions. His major expeditions outside the Soviet Union included those to Iran (1916), Central and South America, and the United States (1921, 1930, 1932, respectively), Afghanistan (1924), and the Mediterranean, including Lebanon and Syria and Ethiopia (1926-1927). These meticulously planned missions and the determined search for crop plants, that could improve agriculture in Russia, were based on the Vavilov's own concepts in the sphere of evolutionary genetics, i.e., the Law of Homologous Series in Variation (in 1920) and the theory of the Centers of Origin of Cultivated Plants (in 1926). As a result of his firm and unwavering confrontation with the authorities regarding his views on genetics Vavilov was arrested in August 1940. He died in a cell in the Saratov prison in January 1943. For more detailed and comprehensive biographical, collecting missions, and other information on Vavilov go to: [http://www.vir.nw.ru/history/vavilov.htm] and [http://www.genetics.org/cgi/content/full/165/1/1].

The exploration and collection missions undertaken by GRU staff and their counterparts in other institutions and countries, and introduction of new germplasm to the ICARDA gene bank are given below by year:

2.2. Collection mission to Uzbekistan in 1998

In 1998, GRU/ICARDA in collaboration with the Centre for Legumes in International Agriculture (CLIMA), Uzbek Research Institute of Plant Industry (UzRIPI), Andijan Research Institute of Cereals (UzARIC) and Uzbek Scientific Production Institutes of Cereals in Gallaaral, conducted a two-week collecting mission in Uzbekistan during June and July 1998. The target of the mission was landraces and wild relatives of cereals and food legumes. The teams explored the Fergana Valley and the regions of Andizhan, Bostanlik, Dzhizak, Namangan, Samarkand, and Tashkent and collected 196 accessions (127 cereals and 67 food and forage legumes) from 85 sites. The team was led by GRU/ICARDA's Legume Curator, L. Robertson, accompanied by J. Konopka, Documentation Officer, and A. McClosky, CLIMA and K. Bairnetov of UzRIPI.

2.3. *Collection missions to UAE and Oman for forages*

Germplasm collection missions were also carried out during March 1998 in the United Arab Emirates (UAE) and during March-April 1998 in the Sultanate of Oman for major indigenously grown forages, legumes, and shrubs. The objective of these missions was to identify plant material with potential for the rehabilitation of degraded rangeland, and for irrigated fodder production with less water than currently used.

3.3.1. Collecting mission in the UAE

This mission targeted the higher rainfall zones that occur north of Abu Dhabi to the Al-Ain main road. The collecting team explored the Emirates of Abu Dhabi, Dubai, Fujairah, Ras al Khaimah and Sharjah. Before the mission, the taxa to be targeted for collection were finalized in consultation with local farmers, botanists, and an international consultant on rangeland development, Dr Morag Ferguson. In total 127 forage accessions, representing 19 taxa from 27 sites were collected and are given in Table 7.

2.3.2. Collecting mission in Oman

In Oman the mission targeted the northern regions including the northern and eastern coastal plains, Wahiba Sands, the northern and eastern interior plains, and the Hajar Mountains. The provinces explored were Batina, Muscat, Oman Interior, and Sharqiya. In all 98 accessions of forages representing 23 taxa (Table 7) were collected from 18 sites. In addition, informal discussions were held with farmers and their indigenous knowledge was documented. This also enabled the team to prioritise species for rangeland rehabilitation and use as fodder crops in animal husbandry.

The missions also trained personnel from the Ministry of Agriculture and Fisheries of the UAE (two trainees) and the Directorate of Agricultural Research of Oman (six trainees) in genetic resources exploration, survey, identification of forages and collecting techniques, including making herbarium samples. Soil samples were also taken and analyzed in both countries and at ICARDA to determine soil preferences of the taxa collected. The seed material was stored in the ICARDA gene bank till such time that germplasm storage facilities become available in both countries.

A database has been compiled of all the collection and passport data and together with a photographic record, forms a valuable tool for identifying the rangeland species. In addition, farmers, herders and botanists in both countries brought 152 rangeland plants and their biological characteristics to the mission's attention. This indigenous knowledge has been added to the database.

Table 7. Number of accessions of rangeland species collected in the UAE and Oman in March-April 1998 (in alphabetical order).

Genus and species	No. of Accs. UAE	No. of Accs. Oman
Achyrantus aspera	-	1
Asphodelus tennuifolius	-	2
Astragalus fatmensis	-	1
Atriplex leucoclada	-	1
Barleria hochstetteri	-	1
Blumea spp.	-	1
Calligonum comosum	-	1
Calligonum crinitum subsp. *arabicum*	1	1
Cassia italica	1	-
Cenchrus ciliaris	12	8
Cenchrus setigerus	-	1
Coelachyrum piercei	6	-
Commicarpus helenae	-	1
Convolvus viraatus	-	1
Crotalaria aegyptiaca	-	5
Cyperus conglomeratus	-	3
Dichanthium foveolatum	6	5
Dipterigium glaucum	8	6
Euphorbia riebeckii	-	1
Farsetia aegyptiaca	1	-
Farsetia linearis	-	2
Heliotropium calcareum	-	1
Heliotropium kotschyi	2	1
Indigofera articulata	2	2
Indigofera intricate	-	2
Indigofera spp.	2	-
Jaubertia aucherii	-	2
Kohautia retrorsa	-	1
Lasiurus scindicus	12	8
Launeae intybacea	-	2
Leptadenia pyrotechnica	1	-
Leucas inflata	-	1
Limonium stocksii	-	1
Lotus garcinii	-	1
Lycurus spp.	-	1
Ochradenus arabicus	-	1
Ochradenus aucheri	-	4
Ochtochloa compressa	-	1
Panicum turgidum	19	4
Pennisetum divisum	20	6

Table 7. (Continued)

Genus and species	No. of Accs. UAE	Oman
Polygala eriotera	-	1
Polygala mascatense	-	1
Rhanterium eppaposum	5	-
Savignya parviflora	1	-
Sphaerocoma aucheri	2	-
Sporobolus ioclades	2	2
Sporobolus spicatus	5	1
Stipagrostis plumosa	16	1
Stipagrostis spp.	2	-
Taverniera glabra	-	1
Tephrosia apollinea	-	1
Ziziphus spina-christi	-	2
Unidentified	2	3
Totals	**127**	**92**

These databases have been used to produce a list of future target species for improved forage production and rangeland rehabilitation. The list includes 27 species of high priority, 39 of medium and 60 of low priority. However, 26 species were found to have yet unknown potential.

Bulk seed samples were also collected from the field of the following species and these will be used in future experiments in improving forage production and rangeland rehabilitation in both countries: *Panicum turgidum, Pennisetum divisum, Lasiurus scindicus, Cenchus ciliaris, Dipterigium glaucum, Dichanthium foveolatum, Rhanterium eppaposum, Stipagrostis plumose, Coelachyrum piercei,* and *Calligonum comosum.*

Another collection mission was conducted in Dhofar province in the Sultanate of Oman in November 2001. This mission was launched in response to the recommendations of the Expert Consultation Meeting on "Conservation and Sustainable Utilization of Plant Genetic Resources in Oman" held in Muscat earlier in 2001.

The collecting mission, targeting indigenous forage and rangeland species with a potential for degraded rangeland restoration, was conducted with the participation of ICARDA and the staff of the Ministry of Agriculture and Fisheries (MOAF) of Oman. It covered three areas in Dhofar region, the Eastern Heights, the Central Heights and the Western Heights of the region (Table 8). At each site soil samples were also taken to describe the site more fully. The samples will be analyzed at the soil laboratory at Salalah for physical and chemical characteristics. Herbaria samples were taken at all sites visited. The herbaria were split between Research and Extension, Rumais and ICARDA's Arabian Peninsula Regional Program (APRP). However, due to inadequate facilities for long-term storage in Oman, their share of the seeds was brought to GRU, ICARDA, for 'black box' storage, until suitable storage facilities become available within the country.

In total, 22 large population samples of seed representing 18 plant species were collected in the course of the mission. On the job training was provided for all the local support staff that participated in the mission in all aspects of germplasm collection, use of GPS and in the handling and storage of herbaria samples. The mission also yielded valuable information on the species presence in different rangeland ecosystems in Oman, but the ubiquitous rangeland degradation resulting from animal overstocking is alarming.

Collection missions and acquisition from genetic resources donors increased GRU/ICARDA germplasm holdings in 1998 by 1354 cereal, 605 food legume and 315 forage and pasture legume accessions, making the total of 2279 new accessions introduced in 1998.

Table 8. Number of accessions and species collected in Dhofar, Oman in November 2001.

Genus and species	No. of Accs.
Acacia etbaica	1
Apluda mutica	2
Acacia gerardi	1
Cenchrus spp.	1
Acacia nilotica (subsp. *indica*)	1
Dactyloctenium scindicum	1
Acacia laeta	1
Dichanthium aristatum	1
Acacia senegal	2
Dyschoriste dalyi	1
Anogeissus dhofarica	2
Loudetia flavida	1
Belepharispermum hirtum	1
Setaria spp.	1
Euphorbia balsamiphora	1
Themeda quadrivalis	2
Ormocarpum dhofarense	1
Trigonella spp.	1
Total	**22**

2.4. *Collection mission to Turkmenistan*

The GRU/ICARDA, in collaboration with the Center for Legumes in Mediterranean Areas (CLIMA), Australia and the Turkmenistan Institute for Desert Flora and Fauna conducted a two-week plant collecting mission in Turkmenistan during June 1999. The target species of the mission were landraces and wild relatives of cereal and food legumes. The mission covered areas in central and south Turkmenistan, including the Ashkabad, Barkharden, Krasnovodsk and Kara-Gala provinces, covering a total distance of 1000km. One hundred and fourteen accessions (41 cereals and 73 food and forage legumes) representing 44 species were collected. The mission was led by M. Bounejmate (NRMP/ICARDA), accompanied by K. Street (GRU/ICARDA) and J. Kurbanov, Turkmenistan Institute for Desert Flora and Fauna (TIDFF).

2.5. *Collection mission to Armenia*

Within the framework of a project supported by the Australian Center for International Agricultural Research (ACIAR), a collaborative plant collection mission was conducted in Armenia during July 1999. The joint mission team included personnel from CLIMA, ICARDA, N.I. Vavilov, All-Russian Scientific Research Institute of Plant of Plant Genetic Resources (VIR), St. Petersburg, Russia and the Armenian Agricultural Institute (AAI), Yerevan. The provinces explored by the team were Ararat, Ehegnadzorski, Sjunik, Vanadzor and Yerevan. The target species were landraces and wild relatives of cereal and food legumes. In all, 234 accessions (158 cereals and 76 food and forage legumes) were collected from 57 sites. The high incidence and diversity of *Aegilops tauschii*, the D-genome donor of beard wheat (29 samples collected), was of particular interest to the collecting team. Several *Ae. tauschii* populations were sampled from single plants in order to undertake a study of the species' diversity and implications for bread wheat evolution. *Ae. cyclindrica*, another D-genome wild relative of wheat (26 accessions), and *Ae. triuncialis* (25 accessions) were also frequently encountered by the team and collected. A high diversity of forms was found in bread wheat (*Triticum aestivum*) landraces (34 accessions), as well as obsolete wheat *T. aestivum* subsp. *compactum* (11 accessions) occurring as admixture in a bread wheat field.

A pre-breeding program has been initiated in "on farm" conditions, using the facilities of the Open Air Village Museum Szombathely. During this program einkorn is under evaluation as a crop for special purposes: food and feed, a species suited for biological gardening, for scientific tourism, straw for handcrafts etc.

A variety of weedy forms of rye, *Secale cereale*, were present in bread wheat fields, but farmers in Armenia do not weed these out, preferring to harvest both together and use the mixture of wheat and rye grains for local bread-making. Cultivated emmer wheat (*T. turgidum* subsp. *dicoccum*), another obsolete form, is still grown as a crop in high elevations and is valued culturally for preparation of local dishes. Its relatively high fiber content makes it a desirable health food also. As most fields at higher elevations were still green, only two samples of this wheat were collected. In addition, 11 accessions of wild einkorn, *T. monococcum* subsp. *baeoticum* was also collected. The team was led by J. Valkoun (GRU/ICARDA) and comprised of Prof. P. Gandilyan of the Armenian Academy of Sciences, Armenian Agricultural Institute (AAI), A. Goukasyan (AAI) and T. Smekalova (VIR).

The team also visited the Erebuni site that was identified by N.I. Vavilov as a nature reserve with a very rich diversity of species of cereals and their wild relatives. Unfortunately, the team observed, that overgrazing had degraded the site, and urgent action was needed to save the remaining populations, specifically in forage legumes, where there is still some diversity of species growing in the wild or as weeds in cultivated fields. Thirteen *Vicia* spp. and seven *Lathyrus* spp. with a total of 41 and 16 accessions, respectively, were collected from this site. Over all, Armenia proved to be a rich source of unique germplasm of both forage legumes and wild relatives of cereal crops.

2.6. *Re-introduction of lentil as a crop in its secondary center of diversity*
Pre-revolution texts and records noted that people in the present CAC countries consumed a fair amount of lentils (mostly as a thick gruel or soup). That indicated that lentil once was a crop widely cultivated in the region. This is not surprising since central Asia is the region thought to be the secondary center of origin and diversity for lentils as the crop moved out and spread after initial domestication in the nuclear area of the fertile crescent. Wild progenitors of lentils, such as *Lens orientalis*, was collected by the GRU/ICARDA team headed by K. Street in Armenia, Turkmenistan and possibly also in Tajikistan.

However, as a result of monoculture of cotton, wheat and barley and the growing of grape vines dictated by the government-controlled collective commune-style farming of the Soviet era, lentil was neglected and ultimately disappeared from the diets as well as the growing fields of the region. When Armenia, Azerbaijan, Georgia, Kazakstan, Kyrgyztan, Tajikistan, Turkmenistan, and Uzbekistan gained their independence after the collapse of the Soviet Union, various other crops had to be grown in each country to meet the dietary requirements of the human population. Lentil was the crop of choice from the food legumes due to its historic importance as a source of protein in the absence of animal proteins in the diet. Due to the efforts of the Germplasm Program at ICARDA with support from the ICARDA gene bank, several landraces from the past and improved lentil lines of today have been selected for re-introduction by the national programs in Armenia, Azerbaijan, Georgia, Uzbekistan and Turkmenistan and lentil is well on its way in regaining its lost importance in the commerce and diet of these CAC countries.

2.7. *Collecting in Syria*

During 1999, GRU conducted two missions inside Syria. The first mission for collecting cereals was conducted in the Hama, Idlib, and Homs provinces and resulted in sampling of 21 accessions of wild relatives of wheat, especially *Aegilops* spp. The following species were collected: *Aegilops biuncialis* (10), *Ae. cylindrica* (2), *Ae. geniculata* (1), *Ae. juvenalis* (1), *Ae. searsii* (2), *Ae. speltoides* var. *speltoides* (1), *Ae. triuncialis* (3), and *Ae. vavilovii* (1). In the second mission, targeted at forage legumes in the same provinces, an addition 5 food legume accessions were also collected by the team. The team comprised of B. Humeid, M. Hamran (DRU/ICARDA) and K. Oubari (ARC/Douma). The collected material was shared equally between ICARDA and ARC, and will be characterized and multiplied in the 2000-2001 season at Tel Hadya.

In 2000, GRU/ICARDA and the Agriculture Research Center (ARC), Douma, Syria, participated jointly in two missions. The first mission for cereal wild relatives was conducted in northeastern Syria in June, while another mission collected food and forage legumes in northeastern provinces of Al-Hasakah, the Damascus region (Al Qunaytirah), and southern Syria, south of Damascus in Suweida Province. In all, the missions collected 107 accessions comprising of 43 wild cereals, as well as 7 food and 57 forage legumes. The collections made by the team are given in Table 9.

Chickpea (*Cicer arietinum*) is one of the important pulse crops domesticated in these areas ca 7000 years ago. Most probably, it originated in an area of south-eastern Turkey and Syria. The team was fortunate in being able to collect the rare wild *Cicer* spp. *C. bijugum*. Three wild annual *Cicer* species, *C. bijugum*, *C. echinospermum*, and *C. reticulatum*, are closely related to chickpea, cohabit with the cultivar in this area. The wild species (e.g., *C. reticulatum*, *C. bijugum*) occur in weedy habitats (fallow or disturbed habitats, roadsides, cultivated fields of wheat, and other places not touched by man or cattle), mountain slopes among rubble (e.g., *C. pungens*, *C. yamashitae*), and on forest soils, in broad-leaf or pine forests (e.g., *C. montbretii*, *C. floribundum*).

The teams comprised of the following collectors: B. Humeid, A. Ismail, F. Sweid and M. Hamran (GRU/ICARDA) and K. Oubari, E. Ahmer, S. Ibrahim, and F. Mousa (ARC/Douma).

Collecting in Damascus, Al Qunaytirah, and Suweida provinces in Syria

In 2003, further collections for wild relatives of wheat and barley continued to the diversity-rich province of Suweida in southern Syria, as well as Damascus and Al

Table 9. List of cereal, forage and food legume species collected in Syria in 2000.

Species	No. of Accs
Cereals	
Aegilops biuncialis	3
Ae. columnaris	1
Ae. crassa	3
Ae. geniculata	2
Ae. peregrina	1
Ae. speltoides var. *ligustica*	3
Ae. speltoides var. *speltoides*	7
Ae. triuncialis	9
Ae. vavilovii	6
Hordeum vulgare subsp. *spontaneum*, wild barley	5
Triticum monococcum subsp. *baeoticum*, wild einkorn	2
Triticum urartu	1
Forage Legumes	
Lathyrus blepharicarpus	3
Lathyrus spp.	5
Lathyrus aphaca	2
Lathyrus chrysanthus	1
Lathyrus ciliolatus	1
Lathyrus inconspicuous	1
Pisum spp.	4
Pisum sativum	1
Vicia aintabensis	1
Vicia monantha	1
Vicia narbonensis	4
Vicia sativa	2
Vicia sativa subsp. *amphicarpa*	8
Vicia sativa subsp. *sativa*	6
Vicia spp.	3
Vicia cuspidata	1
Vicia hybrida	1
Vicia johannis	1
Vicia palaestina	2
Vicia sativa subsp. *nigra*	1
Vicia ervilia	2
Vicia lathyroides	3
Vicia peregrina	1
Vicia mollis	1
Vicia sericocarpa	1
Food Legumes	
Lens orientalis	5
Cicer bijugum	2
Total	**107**

Qunaytirah provinces, the latter being close to the Syria-Lebanon border area. The mission was carried out jointly in collaboration with ARC/Douma and the following accessions were collected: 28 accessions of wheat including wild relatives, 60 forage legumes, and only 4 food legumes (Table 10).

Table 10. Accessions collected in Damascus, Al Qunaytirah, and Suweida provinces in Syria in 2003.

Species	No. of Accs.
Cereals	
Aegilops peregrina	3
Ae. searsii	1
Ae. triuncialis	1
Ae. vavilovii	1
Hordeum vulgare subsp. *vulgare* convar. *distichon*, 2-row barley	1
Hordeum vulgare subsp. *spontaneum*, wild barley	2
Triticum turgidum subsp. *durum*	1
Triticum turgidum subsp. *dicoccoides*, wild emmer	15
T. urartu	3
Forage legumes	
Lathyrus amphicarpos	2
Lathyrus cicera	2
Lathyrus inconspicuus	6
Lathyrus aphaca	3
Lathyrus chrysanthus	3
Lathyrus pseudocicera	4
Lathyrus spp.	2
Pisum spp.	5
Pisum fulvum	1
Vicia hybrida	4
Vicia narbonensis	10
Vicia ervilia	2
Vicia mollis	1
Vicia sativa subsp. *amphicarpa*	5
Vicia sativa subsp. *sativa*	2
Vicia cuspidate	1
Vicia lathyroides	2
Vicia monantha	11
Vicia palaestina	3
Food legumes	
Cicer bijugum	2
Cicer echinospermum	1
Cicer pinnatifidum	1
Total	**92**

The collecting teams comprised A. Amri, A. Ismail, and A. Shehadeh (GRU/ICARDA), N. Dalati, G. Mir-Ali, F. Mousa, M. Temmo and G. Ahmad (ARC/Douma). The material was shared equally between ICARDA and ARC/Douma and will be planted at Tel Hadya in 2004 in the isolation field for characterization and multiplication. The data will be made available to ARC/Douma scientists as soon as it is entered in the ICARDA database. Analysis of the data will be carried out jointly.

2.8. Collecting missions to Lebanon

The GRU/ICARDA staff participated in two joint missions in the neighboring country of Lebanon in 2003. The first plant collection mission in Lebanon focused on forage legumes was planned and undertaken by GRU staff in collaboration with Lebanese NARS in June 2003. CLIMA, the University of Western Australia and Ag West supported the mission. The mission collected *Trifolium, Medicago, Vicia, Lathyrus* and various other minor legume species. In all, 432 accessions were collected from 39 sites.

A second collecting mission to Lebanon for wild wheat relatives and forage legumes, supported by the Global Environment Facility - United Nations Development Program (GEF-UNDP) Agrobiodiversity project (see Chapter 9), was carried out in the Akkar, Baalbek, Biqaa Al Gharbi, Bcharre, Chouf, Jezzine, Rachaiya and Zahle provinces. The UNDP-GEF project staff based in Lebanon and a scientist from the Lebanese Agricultural Research Institute (LARI) also took part in the mission. The team collected 34 accessions of wild cereals and 60 accessions of wild forage legumes (Table 11).

The collecting team comprised A. Shehadeh (GRU/ICARDA), S. Bsat, N. Chamoun and M. Munzer (GEF-Lebanon), and S. Eskef (LARI). The collected material was shared equally with LARI and ICARDA and will be characterized and multiplied at Tel Hadya during the next available season. The data will be shared with LARI and the Lebanon component of the GEF-UNDP project staff.

Germplasm collection

During 2000, collecting missions were mounted to Kazakhstan and Tajikistan. As a result of collections and donations from VIR and other institutions the Center's germplasm collection grew by 4654 new accessions to make a total of 124,363. Among the most valuable donations were once again those received from the Vavilov Institute (VIR), St Petersburg, Russia. These included a large set of 2454 accessions of unique cereal and food legume landraces collected by Vavilov himself or his colleagues before 1941 in the countries of the former USSR and in CWANA. Supported by special project funds from Australia, GRU/ICARDA-led

Table 11. Wheat wild relatives and forage legume accessions collected by second mission in Lebanon in 2003.

Species	No. of Accs.
Cereals	
Aegilops ovata	6
Ae. triuncialis	9
Triticum turgidum spp. *dicoccoides*, wild emmer	19
Forage legumes	
Lathyrus ochrus	1
Lathyrus aphaca	7
Lathyrus cicera	2
Lathyrus hierosolymitanus	4
Lathyrus inconspicuous	1
Lathyrus pseudocicera	1
Lathyrus spp.	5
Lathyrus gorgoni	1
Lathyrus sativus	1
Pisum fulvum	1
Vicia spp.	1
Vicia cuspidate	1
Vicia hybrida	5
Vicia lutea	3
Vicia mollis	1
Vicia monantha	4
Vicia narbonensis	6
Vicia palaestina	3
Vicia sativa	1
Vicia sativa subsp. *amphicarpa*	2
Vicia peregrina	1
Vicia sativa subsp. *nigra*	3
Vicia sativa subsp. *sativa*	3
Total	**94**

missions to collect endemic landraces and wild relatives of food crops as well as potential forage species. Scientists from the host countries NARS, VIR and Australia also joined the missions at various stages. The collected material was shared between the participating institutions and ICARDA.

2.9. Collecting missions to Kazakstan, Kyrgystan and Tajikistan

During 2000, GRU/ICARDA mounted three missions together with counterparts from the nationals. In all, 384 accessions representing 55 species were collected. These missions were supported by the Australian Center for International Agricultural Research (ACIAR) and the Australian Grain Research and Development Corporation

(GRDC). The missions, in areas that were not frequently collected in the past, yielded a treasure trove of unique genetic resources as ICARDA brought together the NARSs in the CAC countries with donors in an alliance that would prove to be beneficial to all concerned.

The first mission was to Kazakhstan in July 2000. The mission was led by K. Street (GRU/ICARDA) with S. Shuvalov (VIR) filling the role of interpreter and logistics specialist. N. Dzubenko (VIR), and I. Maslev (Institute of Botany) also participated in the mission. The mission explored Alam-Ata, Chimkent, and Dzambull provinces and collected 200 accessions comprising of 73 cereals and 127 forage legumes. The team was joined for a few days by S. Khusainov, Director of the Aral Sea Area Experiment Station (URSERE) at Chelkar. The team noted with amazement the ecotypic diversity collected within each species, especially the *Triticum aestivum* (bread wheat) landraces and wild relatives of wheat, especially *Aegilops* spp. At many sites ancient landraces were found growing among fields of improved varieties. Like in some WANA countries, farmers deliberately sow mixtures of the old and modern varieties in order to stabilize yields, as landraces are more tolerant to temperature extremes and fluctuations in rainfall patterns. It would be interesting to know for socioeconomical reasons, if there are other cultural reasons, like quality of bread produced from such mixtures.

Collections continued in Kyrgyzstan with a different team. The team, led by K. Street was joined by S. Toktogojaev, Head of Forage Crops Department, Kyrgyz Scientific Research Institute of Livestock, Veterinary and Pastures, and V. Pshenichny, wheat breeder, Kyrgyzstan. The team explored the Issyk-Kul and Talas provinces only, collecting in all 123 accessions (6 accessions of cereals and 117 of food and forage legumes).

Guided only by old maps used by Vavilov himself in 1916 in Tajikistan, the mission explored parts of Tajikistan in the vicinity of Dushanbe for two weeks. The team was joined by V.F. Chapurin (VIR), A. Morgounov (CIMMYT-CAC), A. Ergoshev and S. Immanov (Academy of Agricultural Sciences- TACSC), and B. Djumakhanov (UzRIPI) who also assisted the team in differentiating the ecotypes of the ears of wild relatives of wheat that were collected. Despite the difficult terrain and occasional brush with the local law enforcement agencies, the targeted species of cereals, food legumes and forage species and their wild and weedy relatives were collected from semi-arid and arid regions in varying environments ranging from deserts to rugged mountainous terrains covering large distances of over 4000 km in each of the three countries. Collections were made wherever genetic resources were found: landraces in the fields of standing crop, harvested bundles or stack, along roadsides, orchards, threshing floors, and even cottage gardens in the remote mountain villages. In all, 148 accessions were collected (81 cereals, 50 food legumes and 17 forages).

The collected material, as always, was divided equally among the participating institutions. The forage species belonging to the following genera are of most interest: *Artemesia*, *Astragalus*, *Callygonum*, *Eurotia*, *Haloxylon*, *Kochia* and *Salsola*. The material brought back to GRU/ICARDA was sown in the field at Tel Hadya for seed characterization and multiplication for *ex situ* long-term conservation. Scientists from the countries in which the germplasm was collected will visit GRU/ICARDA in the future to assist in in-depth evaluation of the material, so that the distribution and range of each species collected, the biological characteristics, and the reproductive characters, are added to the ICARDA database. This valuable information will provide a basis for the selection of the genotypes most likely to succeed under the climatic, soil and management systems prevailing in the CAC countries.

Germplasm Collection

In 2001, the GRU/ICARDA's germplasm collections grew by 2902 new accessions to reach a total 127,247. Out of the 2902 accessions, 1452 new accessions were obtained as a result of collecting missions in 8 CAC countries. Among the most valuable new acquisitions was a large set of bread wheat, chickpea, lentil and pea landraces (899 in all) donated by the VIR, St. Petersburg, Russia. This germplasm was collected before World War II by Vavilov himself and his colleagues mostly in the former USSR and also in the WANA region countries. These genetic resources are particularly important as they represent landraces as developed by the farmers themselves before the arrival of improved material from Europe, particularly from Italy and France.

2.10. Unique set of genetic resources collected from Azerbaijan and Georgia

Another set of unique germplasm was obtained from a plant collection mission undertaken in Azerbaijan and Georgia in July 2001 with special project funding from Australia. These missions would not have been possible without the active support of the international organizations that participated. The mission participants in Azerbaijan included scientists from the Azerbaijan Research Institute for Agriculture (ARIA) in Baku (Y. Akberova, L. Amerov, A. Ibagimov and M. Mamedov). The mission participants in Georgia were T. Jinjikhadze and R. Dzidishvili (Genetic Resources Unit, T'bilisi, Georgia). D. Enneking (Institute of Plant Genetics and Crop Plants Research - IPK, Gatersleben, Germany), M. Mackey (Australian Wheat Collection, Tamworth, NSW, Australia), S. Shuvalov and N. Dzubenko (VIR) and K. Street (GRU/ICARDA) took part in both missions.

Over 3000 km were covered through diverse agro-ecological zones and seeds from 130 taxa were collected from a total of 80 sites (a total of 244 and 151 accessions were collected in Azerbaijan and Georgia, respectively). The material collected included wild relatives and landrace material of cereals (76 accessions), food legumes and fodder and range species (170 accessions). In Azerbaijan, the provinces of Ag-su, Agdam, Gadabek, Garadagh, Goytapa, Guba, Ismayilli, Lankaran, Qobustan, Salyan, Samaxi, Shaki, Tovuz, Yardymly, Yevlax, and the Abseron Paninsula were explored. In Georgia the provinces of Ajaria (on the Black Sea), Akhakhali, Ardoti, and T'bilisi were explored. The collected material was divided among the NARS Programs and ICARDA. At ICARDA this material was multiplied at Tel Hadya to produce sufficient seed for gene bank storage and distribution. This mission concludes a series of such collections in the Central Asia and Caucasus republics that were part of activities associated with an ACIAR-funded project focusing on plant genetic resource collection and conservation.

Germplasm Collection

In 2002, ICARDA's germplasm collections grew by 1,331 new accessions, to reach a total of 128,462. A unique set of 692 accessions resulted from plant collection missions to Jordan, Romania, Syria and Turkmenistan (Table 12). Most valuable were 585 unique accessions of barley and bread wheat, originating from the germplasm collections of Vavilov and his colleagues in 1920s and 1930s and donated by the Vavilov Institute (VIR), St Petersburg, Russia.

Studies of ICARDA's wild barley core collection, the genus *Aegilops* and the six closely related taxa that comprise *Vicia sativa*, yielded new insights into the genetic diversity of these groups. Germplasm was characterized and multiplied, and more than 16,000 samples dispatched to researchers and other users in 28 countries. In West Asia, the promotion of *in situ* conservation and sustainable use of dryland agrobiodiversity continued in Jordan, Lebanon, the Palestinian Authority and Syria. In Central Asia and the Caucasus (CAC) countries, a new regional genetic resource network was instituted to promote the conservation of genetic resources. At the same time, the updating of related facilities, and the provision of capacity-building training was also instituted. Progress was also made in providing an internet-based inventory of barley genetic resources throughout the world. Seed health testing continued in 2002, and ICARDA's gene bank accessions were cleaned of seed-borne viruses.

2.11. Collecting mission in Jordan

The Dryland Agrobiodiversity GEF/UNDP Project supported two one-week collection missions conducted in Jordan by GRU/ICARDA and the National Center for Agricultural Research and Technology Transfer (NCARTT), Amman, Jordan.

The first collecting mission to Jordan
This mission was conducted to collect wild relatives and landraces of cereals, forage legumes and pasture species, was targeted at the central and northern provinces of Jordan. A total of 375 accessions were collected during the mission (103 cereals, 40 forage legumes and 232 forage and pasture species). The cereal, food legume, and forage species were collected from Amman, Balqa, Irbid, Karak, Mafraq, and Zarqa.

Wild wheat relatives, *Aegilops biuncialis, Ae. columnari, Ae. crassa, Ae. geniculata, Ae. longissima, Ae. peregrina, Ae. searsii, and Ae. vavilovii.* Cultivated barley, *Hordeum vulgare* subsp. *vulgare* convar. *distichon*, 2-row barley, *Hordeum vulgare* subsp. *vulgare* convar. *vulgare*, 6-row barley, and wild progenitor of barley *Hordeum vulgare* subsp. *spontaneum*. *Triticum aestivum*, bread wheat, and *T. turgidum* subsp. *durum*, durum wheat. Wild food legume, *Cicer judaicum*. Forage and pasture legumes, *Vicia ervili, V. hybrida,V. johannis, V. monantha, V. narbonensis, V. palaestina, V. sativa* subsp. *nigra, V. sativa* subsp. *sativa, Lathyrus aphaca, L. blepharicarpus, L. hierosolymitanus, L. pseudocicera, Pisum fulvum, P. sativum, P. sativa* subsp. *nigra*, and *P. sativa* subsp. *sativa.*

The second collecting mission to Jordan
The Dryland Agrobiodiversity GEF/UNDP Project supported a second collection mission conducted in Jordan by ICARDA and NCARTT in 2003. The mission, to collect wild relatives and landraces of cereals, yielded a total of 80 accessions. Importantly, 28 populations of *Triticum dicoccoides*, the wild progenitor of wheat endangered by genetic erosion, were identified and sampled in the mission.

The collectors participating in the two missions were A. Amri, A. Shehadeh, B. Humeid, and M. Hamran (GRU/ICARDA), K. Laila, M. Fayad, I. Rawashdeh, M. Syouff, S. Saifan and Z. Tehabsem (NCARTT, Amman, Jordan).

2.12. Collecting mission to Romania
In Romania, as in other eastern European countries belonging formerly to the Soviet bloc, agriculture was run under large cooperatives and state farms. In the lowlands, the old and traditional landraces were replaced by modern varieties. However, 10% of the arable areas in Romania never fell under the collective farming practice. This included several mountainous and isolated areas, often located on steep slopes with poor soils, where villagers with small fields plant traditional local and landrace varieties valued for their quality and special uses and part of the cultural life.

ICARDA organized another collection mission to Romania, in collaboration with the Suceava Gene Bank, Romania, and VIR. The mission was conducted with support from Australian donor projects, viz., Australian Center for International Agricultural Research (ACIAR) and the GRDC. Its main objectives were to survey, collect and conserve the genetic diversity of crops in isolated areas of the west Transylvanian plateau of Romania in the provinces of Alba, Bihor, Cluj and Salaj. In the areas where collection was undertaken, farming is done on a relatively small scale due to the topography of the plateau, which is characterized by high mountains covered by dense pine forests. Therefore, landraces of wheat, barley, and other crops have persisted in the region largely due to isolation. Although priority was given to cereals and legumes, other crops, such as vegetables and economically important crops, were also collected by the team whenever they were found, as they were of interest to the national genetic resources conservation program and also to VIR. Due to the high altitude most of the farmers' fields were still green and hence much of the collection was done from farmers' stores except in the case of *Phaseolus vulgaris*, which were mature and could be sampled directly. It was observed by the team that farmers in the high mountains planted a mixture of two or three varieties of *Phaseolus* beans in their fields as an assurance of yield and for cultural reasons.

Einkorn (*Triticum monococcum* ssp. *monococcum*) is an ancient diploid hulled wheat, a relic of the Neolithic period in the Alps - Balkan - Carpathia - Danube (ABCD) areas. The collecting team was especially interested in collecting samples of *T. monococcum* since this species has been adapted in these mountain areas to marginal land cultivation. This adaptation is highly polygenic, including genes involved in nutrition, interspecific competition, drought and frost tolerance, resistance to pests and diseases, as well as genes making the crop suitable for multipurpose utilization. These are the main reasons of the (quite sparse) on-farm preservation of the species in the Carpathians (Transylvania plateau, Romania). In the Eastern range of the Carpathian mountains (including the Depression of Transylvania) genetic erosion advanced heavily in the Soviet Era. Chronological and paleoethnobotanical data seem to support the continuity of the einkorn germplasm in Transylvania for millennia. This germplasm is of high theoretical and historic value, as one of the last "living fossils" of the Neolithic agriculture. Unfortunately, the team did not come across any farm cultivating einkorn.

In all the team collected 147 accessions comprising 75 cereals, 70 forages and 2 food legumes. The mission was conducted during two weeks in September 2002. Fifty-two sites were visited and more than 2500 km covered by the collecting team comprising of B. Humeid (GRU/ICARDA), D. Dascalu and D. Rusu from Suceava Gene Bank, Romania, and Bouravtseva from VIR. Each sample collected was divided according to the mandate and needs of the three participating institutions.

2.13. Central Asia and the Caucasus (CAC) Regional Program – Plant Genetic Resources

Many of the world's economically important domesticated crop species originate in Central Asia and the Caucasus area. Thus, besides the landrace material that is native to the area there is also a wealth of wild progenitors and wild relatives of these domesticated species that contain unique combinations of potentially useful genes. The CAC region possesses rich plant diversity. With regard to germplasm collection, ICARDA's long-standing relationships with national programs ensure that the countries concerned benefit from the results of collection missions. This is most readily achieved through the ICARDA gene bank, which now houses one of the world's leading germplasm collections of the mandate crops. Between 1998 and 2001, ICARDA, in collaboration with NARS and the Vavilov Institute of Plant Industry (VIR), organized collection missions to all eight countries of the CAC and a total of 1442 accessions of ICARDA's mandate crops were collected.

2.13.1. Collecting in Turkmenistan

From 25 May to 15 June 2002, a collaborative plant collection mission was undertaken in Turkmenistan, involving the Turkmenistan Gary- Gala Research Institute for Plant Genetic Resources, VIR, ICARDA, United States Department of Agriculture (USDA) and Agriculture Western Australia. The mission was supported by the two Australian donor projects (ACIAR and GRDC), and covered territory from the Caspian Sea to the west of Ashgabat, as well as to the east along the Afghan border. A total of 413 accessions, belonging to 106 species, were collected from 48 sites (see Table 12 and Fig. 2).

Fig. 2. The team collecting *Aegilops* spp. in Turkmenistan in 2002.

Germplasm collection

In 2003, ICARDA's genetic resources collections grew by 2607 new accessions to reach a total of 131,023. A unique set of 1241 accessions were added to the gene bank from plant collection missions to Armenia, Jordan, Lebanon, Syria and Tajikistan (Table 12). In addition, 500 accessions of cereals and legumes from Afghanistan collected by the NARS scientists themselves, after being trained by GRU, were added to ICARDA's holdings. Out of this by far the most valuable addition were 529 unique accessions of bread and obsolete wheats from collections made by N.I. Vavilov and his colleagues before 1941 and donated to ICARDA by the Vavilov Institute (VIR), St Petersburg, Russia.

2.13.2. Collecting mission to Tajikistan

A collection mission to Tajikistan was carried out in August 2003 (Table 13 and Fig. 3). The mission was carried out in collaboration with the Tajik Agricultural Academy, VIR, and ICARDA with invited participants from CIMMYT and the Uzbek Botanic Institute also joining in. It was jointly funded by the Australian Center for International Agricultural Research (ACIAR) and the United States Department of Agriculture (USDA) with contributions from the Grains Research and Development Corporation of Australia (GRDC). The route of the mission was planned in order to retrace parts of the route taken by N.I. Vavilov for his missions in the Pamirs. In the area explored, the environment was arid and mountainous with sparse vegetative cover that showed signs of being under intense grazing pressure. In the valleys, at lower altitudes, conditions support a grassland-type ecology. These areas are also under intense grazing pressure and/or are being cut annually for winter animal fodder. Very little material of interest was collected in non-cultivated and non-irrigated land. Most collections were made from within cultivated fields, field margins or from harvested material that was to be threshed. The cultivated fields in most villages visited were profuse in species and intra-species diversity. One could find diverse bread wheat cultivars, rye, *Pisum* spp., *Lathyrus* spp., alfalfa, faba bean and a number of vetches all sown together in the same field. Most villages visited were growing local material and complained that seed of improved cultivars often does not yield well under their set of environmental conditions. In fact, this is not surprising given that almost all the cultivated soils the team encountered were of a low fertility rocky calcareous alluvium type. This fact, as well as the minimal husbandry and fertilizer input, would not be conducive to the growth of modern high input cultivars. This situation, therefore, makes these locations a treasure trove of unique landrace forms specifically adapted to specific local growing conditions and a valuable genetic resource.

Table 12. Number of accessions collected in missions to Jordan, Romania, Syria and Turkmenistan in 2002.

Crop/Genus	Country	Number of accessions
Wild *Hordeum*	Jordan	24
	Syria	5
	Turkmenistan	24
Sub-total		**53**
Barley	Jordan	20
	Romania	9
	Turkmenistan	6
Sub-total		**35**
Aegilops	Jordan	43
	Syria	32
	Turkmenistan	49
Sub-total		**124**
Wild *Triticum*	Syria	**3**
Primitive wheat	Turkmenistan	**1**
Bread wheat	Jordan	1
	Romania	17
Sub-total		**18**
Durum wheat	Jordan	**4**
Wild *Lens*	Syria	12
	Turkmenistan	2
Sub-total		**14**
Wild *Cicer*	Jordan	1
	Syria	2
Sub-total		**3**
***Medicago* annual**	Jordan	**65**
Lathyrus	Jordan	13
	Syria	17
	Turkmenistan	12
Sub-total		**37**
Trifolium	Jordan	98
	Romania	2
Sub-total		**100**
Vicia	Jordan	29
	Romania	4
	Syria	41
	Turkmenistan	44
Sub-total		**118**
Pisum	Jordan	2
	Syria	5
	Turkmenistan	1
Sub-total		**8**
Other forage and range species	Jordan	69
	Romania	17
	Turkmenistan	13
Sub-total		**99**
Total		**692**

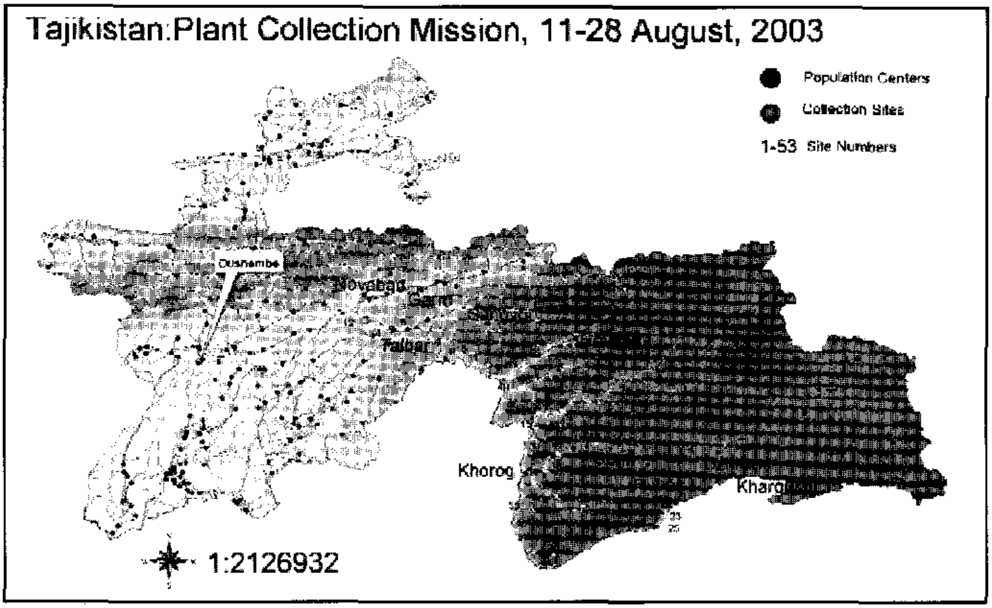
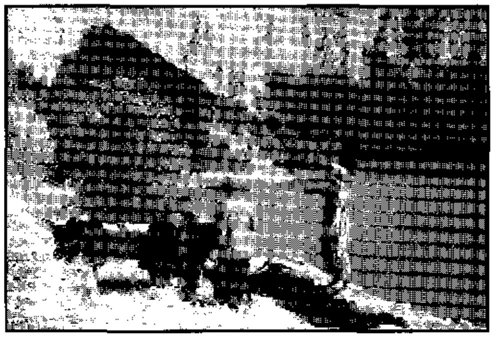
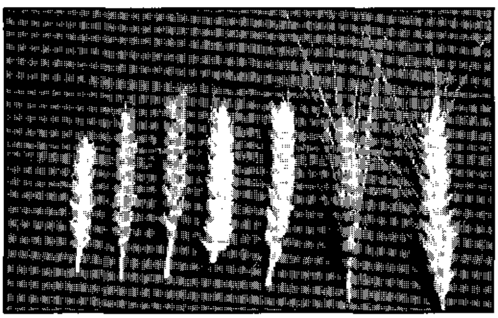


Fig. 3. Map of Tajikistan showing collections sites (white dots and numbers)
Note: the colors on the map represent elevation. The darker the color the higher the altitude

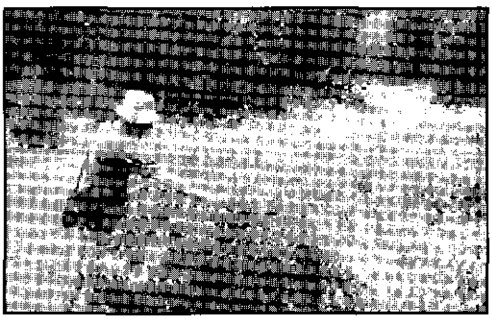
Main road Dushanbe – Khorog



Oxen threshing



Wheat spikes taken from the same field



Mixed cereal/legume field

Table 13. Collections from Armenia, Jordan, Lebanon, Syria and Tajikistan in 2003.

Crop/Genus	Country	No. of accessions
Wild *Hordeum*	Armenia	1
	Jordan	3
	Tajikistan	9
Sub-total		**13**
Barley	Armenia	5
	Jordan	4
	Tajikistan	22
Sub-total		**31**
Aegilops	Armenia	67
	Jordan	23
	Lebanon	5
	Tajikistan	7
Sub-total		**102**
Wild *Triticum*	Armenia	9
	Jordan	28
Sub-total		**37**
Bread wheat	Armenia	7
	Tajikistan	94
Sub-total		**101**
Durum wheat	Armenia	2
	Jordan	21
Sub-total		**23**
Wild *Lens*	Armenia	6
	Syria	7
Sub-total		**13**
Wild *Cicer*	Armenia	1
	Syria	5
	Tajikistan	1
Sub-total		**7**
***Medicago* annual**	Armenia	11
	Lebanon	96
	Tajikistan	9
Sub-total		**116**
Lathyrus	Armenia	28
	Lebanon	23
	Syria	11
	Tajikistan	17
Sub-total		**79**
Trifolium	Armenia	35
	Lebanon	263
	Tajikistan	27
Sub-total		**325**
Vicia	Armenia	85
	Lebanon	36
	Syria	20

Table 13. (Continnued).

Crop/Genus	Country	No. of accessions
Tajikistan	39	
Sub-total		**180**
Pisum	Armenia	2
	Lebanon	1
	Syria	6
	Tajikistan	25
Sub-total		**34**
Other forage and range species	Armenia	34
	Lebanon	60
	Tajikistan	53
Sub-total		**147**
Lentil	Armenia	2
	Jordan	1
	Tajikistan	2
Sub-total		**5**
Chickpea	Armenia	5
	Tajikistan	6
Sub-total		**11**
Faba bean	Armenia	1
	Tajikistan	16
Sub-total		**17**
Total		**1241**

2.14. ICARDA's CAC collections benefit farmers in Australia

Germplasm from GRU/ICARDA's gene bank and those gathered from collecting missions to the CAC countries and CWANA region have paid off handsomely to farmers in Australia through the ACIAR and GRDC projects. A study commissioned by Australia determined that that country would benefit by an estimated Australian $13.7 million annually from ICARDA's research and germplasm over the next 20 years. In the newly established republics of Central Asia and the Caucasus (CAC), GRU/ICARDA missions collected approximately 1400 accessions representing about 140 species and 46 genera. Samples of crop plants and their wild relatives collected from saline and drought-prone areas have significant interest to Australia since there are vast tracts of lands that lie within areas with abiotic stresses. The ACIAR study reported that it anticipates spillover benefits in terms of cost reduction for Australian producers of barley, durum wheat, Kabuli chickpea, faba beans, and lentils, as well as positive results of successful ICARDA research in several cropping industries. The most significant gains, however, were being achieved in faba bean and lentil production.

3. CHARACTERIZATION, EVALUATION, AND MULTIPLICATION

Scientists involved: Dr Jan Valkoun, Dr Kenneth Street, Mr Bilal Humeid, Mr Ali Shehadeh, Mr Ali Ismail, and Mr Fawzi Sweid

3.1. Multiplication and characterization of germplasm from the Vavilov Institute
3.2. Disease resistance in newly collected faba bean accessions
3.3. New genes for wheat breeders
3.4. Collaboration and joint activities with VIR
3.5. Characterization and Evaluation supported by Australian-funded projects
3.6. CWANA core collections
3.7. Ecological characterization of wild wheat relatives in Syria using GIS tools
3.8. Chickpea and faba bean material from VIR characterized
3.9. Germplasm multiplication
3.10. Germplasm multiplication, characterization and use
3.11. Ecological characterization of cereal genetic resources

Background
Germplasm characterization, preliminary evaluation for biotic and abiotic stresses as well as for morphological and agronomic traits using international descriptors is one of the principal tasks of the GRU. Also, accessions stored in the gene bank are constantly monitored for viability and those that fall below the prescribed levels for each crop are multiplied in the next available season and the rejuvenated seed are once again entered in to the gene bank for storage and for distribution. Those accessions that are more requested than others also need to be multiplied even though they may not require rejuvenation. In addition, genetic diversity analysis and assessment of the potential of conserved material for crop enhancement was also undertaken together with multiplication of germplasm to replenish stocks wherever required.

During the six seasons from 1997/1998 to 2002/2003 GRU staff multiplied and characterized/evaluated 16,027 and 1,956 accessions of forage legumes, respectively. During the same period, GRU staff multiplied and characterized/evaluated 13,564 and 12,441 accessions of food legumes, respectively. For the cereals, the numbers were 873 and 15,800, respectively.

Favorable weather prevailed across the region during the 1997/98 season resulting in higher cereal yields than in previous years. At Tel Hadya, the main research station of ICARDA, the total rainfall was 410.5 mm making it a season with higher than normal rainfall.

3.1. ***Multiplication and characterization of germplasm from the Vavilov Institute***
Through the Grains Research and Development Corporation (GRDC, Australia) and in collaboration with the Vavilov Institute of Plant Industry (VIR), St Petersburg, Russia and the Center for Legumes in International Agriculture (CLIMA), seed samples of faba bean (340), lentil (457), chickpea (341), pea (498) and barley (207) were brought to ICARDA for multiplication, preliminary characterization/evaluation and introduction into the ICARDA genetic resources collections. This germplasm was largely from North Africa, West Asia and Central Asia. The pea curator from VIR, Larisa Prilyuk was at ICARDA for three months working on the evaluation trial for the VIR pea germplasm at Tel Hadya. The barley curator from VIR, Olga Kovaleva, visited ICARDA for one month to prepare joint experiments for VIR barley germplasm evaluation.

3.2. ***Disease resistance in newly collected faba bean accessions***
Chocolate spot resistance of germplasm collected in Ecuador and in the administrative regions of Yunan in China in 1996 was reconfirmed in the 1997/98 season at Tel Hadya. The germplasm from Ecuador showed many accessions with resistance to chocolate spot though there was little resistance to chocolate spot in the germplasm collected from China. The germplasm from Yunan was less susceptible than the germplasm from Sichuan administrative regions. The germplasm from Ecuador collected in 1996 in comparison to previous sources of resistance to chocolate spot shows a much larger range in flowering dates with resistance to botrytis and some lines were earlier than 90 days as compared to the check variety with flowering of 110 days. Disease resistance in newly collected accessions of faba bean chocolate spot resistance of germplasm collected in Ecuador and in the administrative regions of Yunan in China in 1996 was reconfirmed in the 1998/1999 season.

3.3. ***New genes for wheat breeders***
In the 1997/98 season more than 2000 BC_2 and F_1BC_1 plants, derived from crosses of durum wheat cultivars 'Haurani' and 'Cham 5' with wheat wild progenitors and closed relatives, were evaluated in the field for disease resistance using the conditions of the heavy natural epidemics of yellow and leaf rust. The initial crosses of the durum wheat with *Triticum urartu, Triticum baeoticum, Triticum dicoccoides* and *Aegilops speltoides* were produced by GRU in 1994/95 season and the subsequent backcross generations were produced in the plastic house. This season, the wide hybridization products were first exposed to biotic and abiotic stresses in the field. The hybrid plants displayed a wide range of phenotypic variation in comparison with the respective durum wheat parent in a number of agronomically important traits, e.g., plant height, tillering capacity and spikelet number per spike. Fully fertile plants with a gene(s) conferring high resistance to yellow rust were

detected in crosses of 'Cham 5' with *T. dicoccoides* ICWT 601116 and ICWT 600117, originating from southern Syria. Yellow rust resistant and fully fertile plants were also found in crosses of durum wheat with wild diploid wheats: 'Cham 5' with *T. baeoticum* ICWT 500647 and 'Haurani' with *T. urartu* ICWT 500530. This is, to our knowledge, the first transfer of yellow rust resistance from diploid to tetraploid wheat. Leaf rust resistance was also identified in two durum wheat crosses with wild diploid wheat: 'Haurani' with *T. baeoticum* ICWT 500652 and 'Cham 5' with *T. baeoticum* ICWT 500647. In the latter cross, plants with resistance to both yellow and leaf rust were identified, which may be of particular interest to breeders. Some BC_2 plants coming from crosses of 'Cham 5' and *Ae. speltoides* were immune to yellow and leaf rust, as well as to powdery mildew and stem rust. However, all the *Ae. speltoides* derivatives were sterile and had to be further backcrossed to the durum wheat parent.

The multiplication, characterization, evaluation of germplasm during the 1997/1998 season has been summarized in Table 14.

Table 14. The multiplication, characterization/evaluation of germplasm during the 1997/1998 season.

Crop	Multiplied/ Regenerated	Characterization and/or Evaluation	No. of Traits
Forage Legume			
Vicia spp.	-	-	-
Lathyrus spp.	-	-	-
Pisum spp.	-	-	-
Totals			
Food Legumes			
Lentil	-	523	25
Chickpea	-	2967	25
Faba bean	842	400	23
Wild *Lens* spp.	120	-	-
Wild *Cicer* spp.	85	-	-
Totals	**1047**	**3890**	
Cereals			
Barley	-	244	18
Durum wheat	-	1274	17
Bread wheat	140	2325	17
Wild *Triticum* spp.	476	437	16
Aegilops spp.	-	181	17
Totals	**616**	**4461**	

3.4. *Collaboration and joint activities with VIR*

In 1999 GRU/ICARDA continued its collaboration with the Vavilov Institute of Plant Industry (VIR), St Petersburg, Russia and the Center for Legumes in Mediterranean Areas (CLIMA) in a project supported by the Grains Research and Development Corporation (GRDC) Australia. During the 1998/1999 season 400 lentil, 500 *Pisum* spp., 399 faba bean, 299 chickpea and 207 barley accessions from the VIR collection were grown out at ICARDA for safety duplication and evaluation. Two scientists from VIR visited GRU for 2 months during 1999 to collaborate in the evaluation of the donated material. In December of 1999 more VIR material was planted at Tel Hadya including 755 durum and bread wheats, 304 *Pisum* spp., 633 chickpea and 45 barley accessions. As in 1998/99, the material will be evaluated in 2000 with scientists from VIR joining in the effort. For details of multiplication, characterization, evaluation and the number of traits for which data was recorded see Table 15.

In 2000/2001 germplasm characterization and preliminary evaluation for biotic and abiotic stresses as well as for morphological and agronomic traits using international descriptors continued as regular part of GRU activity. A total of 3800 accessions were characterized for 12 to 33 agro-morphological descriptors and the data generated were entered in the GRU databases. This data was used to perform genetic diversity analysis and the potential of the conserved material for crop

Table 15. The multiplication, characterization/evaluation of germplasm during the 1998/1999 season.

Crop	Multiplied/ Regenerated	Characterization and/or Evaluation	No. of Traits
Forage Legume			
Vicia spp.	1764	-	-
Lathyrus spp.	750	-	-
Pisum spp.	435	459	32
Totals	**2949**	**459**	
Food Legumes			
Lentil	991	-	-
Chickpea	1387	-	-
Faba bean	245	1692	23
Wild *Lens* spp.	458	-	-
Wild *Cicer* spp.	76	-	-
Totals	**3157**	**1662**	
Cereals			
Barley	-	546	18
Bread wheat	-	2812	17
Totals		**3358**	

enhancement was assessed. Of this total number, 308 accessions were collected during the 1999 Turkmenistan and Armenia missions. In addition, these analyses also included 555 wheat, 45 barley, 304 *Pisum* spp., and 603 chickpea accessions received from VIR. Also, nearly 10,000 accessions of various species of cereals and legumes were multiplied to augment the seed available for distribution on request. Scientists from Armenia and Turkmenistan, P. Gandilyan and R. Nazarian, respectively, also visited ICARDA and took part in the characterization and evaluation of the material collected in their own countries. They were also able to take advantage of the advanced computing facilities at the GRU as well as sharpen their language skills.

3.5. *Characterization and Evaluation supported by Australian-funded projects*

During the initial years of operation of the two Australia-funded projects, two scientists from the N.I. Vavilov Institute (VIR) in St Petersburg, Russia, visited ICARDA to work on these projects. They assisted the GRU staff in characterizing genetic resources received from VIR at Tel Hadya. Both Russian scientists had long experience in their respective fields of expertise and the GRU as well as the scientists benefited from their visit. The two scientists, S. Bulyntsev and L. Prilyuk took advantage of the advanced facilities and greater resources at ICARDA to not only develop computing skills but also improve on their language knowledge as well.

3.6. *CWANA core collections*

CWANA core collections of wild and cultivated barley were sent to IPK, Gatersleben, Germany for evaluation of biotic and abiotic stresses under the GENRES project. The development of faba bean lines resistant to *Botrytis* and *Ascochyta* continued through repeated selections at the high rainfall site at Lattakia on the Mediterranean coastline. However, in July 2000 this activity was transferred to GP/ICARDA and has been concluded in the project MTP 3.3 and the lines were thus made available for the immediate use of breeders.

The multiplication, characterization, evaluation of germplasm during the 1999/2000 season is summarized in Table 16.

In the 2000/2001 growing season, a total of 2700 accessions were characterized by the GRU in the field at ICARDA for 12 to 30 descriptors. The largest trials planted were of faba beans and durum wheat, comprising of 1200 and 500 accessions, respectively. Germplasm supplied by the Vavilov Institute (VIR), St Petersburg, Russia, was characterized by J. Valkoun and B. Humeid with the assistance of the curators E. Zuev and O. Laponova from VIR who visited GRU/ICARDA for a period of 3 months in the spring. They also assisted in the identification and study of several accessions of four durum wheat landraces of

Russian origin. A visiting scientist from Armenia, R. Nazaryan, participated in the characterization of material collected during missions to Kazakstan, Kyrgyzstan, and Tajikistan in 2000.

A high priority was given to seed multiplication in 2001 to replenish seed stocks in the gene bank. More than 9,000 accessions were multiplied in the field and in the greenhouses to replenish stocks in the GRU/ICARDA gene bank and to ensure compliance with international standards of seed viability under cold storage.

3.7. *Ecological characterization of wild wheat relatives in Syria using GIS tools*
Sixty-seven climatic and four edaphic variables were generated for 381 collection sites in Syria, from which ICARDA gene bank accessions were collected and geographic coordinates were known, using the Almanac Characterization Tool developed by Texas Agricultural Experiment Station, USA and ICARDA. The data were subjected to a series of multivariate statistical analyses. Dendrograms from these analyses indicated a high similarity in the ecological adaptation between *Ae. umbellulata*, U-genome diploid, and U-genome tetraploid *Ae. biuncialis, Ae. triuncialis,*

Table 16. The multiplication, characterization/evaluation of germplasm during the 1999/2000 season.

Crop	Multiplied/ Regenerated	Characterization and/or Evaluation	No. of Traits
Forage Legume			
Vicia spp.	1459	-	-
Lathyrus spp.	1128	-	-
Pisum spp.	1130	296	32
Totals	**3717**	**296**	
Food Legumes			
Lentil	1046	-	-
Chickpea	417	622	25
Faba bean	-	1290	23
Wild *Lens* spp.	465	-	-
Wild *Cicer* spp.	132	-	-
Totals	**2060**	**1912**	
Cereals			
Barley	134	192	18
Wild *Hordeum* spp.	16	754	22
Durum wheat	26	471	17
Bread wheat	117	272	17
Wild *Triticum* spp.	51	44	16
Aegilops spp.	538	-	17
Totals	**882**	**1733**	

Ae. geniculata and *Ae. columnaris*. Similar to this, D-genome diploid *Ae. tauschii* clustered with D-genome polyploids, *Ae. crassa* and *Ae. vavilovii*. *Ae. searsii* was closely linked to *T. dicoccoides*, whereas *Ae. speltoides* was associated with *T. araraticum*. When all the species were analyzed together, monthly precipitation and evapotranspiration variables were all included in the canonical discriminant functions, while only few out of 24 monthly temperature extreme variables and none of the eight annual climatic variables were involved in the species discrimination. Standardized canonical discriminant coefficients indicated which climatic variables had the highest discriminating power for a given pair or group of species.

Wild barley core collection was characterized by molecular markers
[See 10.2.6. in Chapter 10]

3.8. Chickpea and faba bean material from VIR characterized

About 800 chickpea and faba beans and 400 durum wheat accessions from the VIR collection were characterized at ICARDA. In addition, 40 wild relatives of wheat from diverse locations in the CAC countries were compared for the agro-morphological traits. Data was also collected on durum wheat from Russia, and as a result duplicates were eliminated from the collection. The development of a lentil core collection in collaboration with GP scientists was postponed to 2002. However, characterization data on 7633 accessions or 80% of the collection are available.

Comparison of 40 wild wheat relatives originating from different locations in the CAC countries and comparison of data from VIR and GRU/ICARDA to eliminate duplicates in the durum wheat landrace collection with Russian origin was carried out in 2002.

3.9. Germplasm multiplication

A total of 10,033 accessions were multiplied in 2001 due to germination falling below 80% as well as seed stocks for some of these were running low. Fresh seed was harvested and added to the active collection for distribution and long-term storage samples were replenished with 100% viability material. In addition, a total of 233 barley, wheat, lentil, chickpea and faba bean landraces from Afghanistan were planted at Tel Hadya for multiplication and agro-morphological characterization. Molecular characterization was also performed on these samples. Material with distinct traits was selected and multiplied at Terbol station in Lebanon in the summer as the environment there is similar to the origin of this germplasm. A subsample of the material was then planted for in-depth evaluation in Afghanistan during the 2002/03 season and the data added to the database at GRU.

The multiplication, characterization, evaluation of germplasm during the 2000/2001 season is summarized in Table 17.

Table 17. The multiplication, characterization/evaluation of germplasm during the 2000/2001 season.

Crop	Multiplied/ Regenerated	Characterization and/or Evaluation	No. of Traits
Forage Legume			
Vicia spp.	892	-	-
Lathyrus spp.	797	-	-
Pisum spp.	1795	-	-
Totals	**3484**		
Food Legumes			
Lentil	1814	-	-
Chickpea	556	460	25
Faba bean	-	1168	23
Wild *Lens* spp.	49	-	-
Wild *Cicer* spp.	128	-	-
Totals	**2547**	**1528**	
Cereals			
Barley	154	450	18
Wild *Hordeum* spp.	-	212	22
Durum wheat	276	40	17
Bread wheat	67	604	17
Wild *Triticum* spp.	-	386	16
Aegilops spp.	-	167	17
Totals	**497**	**1859**	

3.10. Germplasm multiplication, characterization and use

In the 2001/2002 growing season, a total of 2500 accessions were characterized using 15 to 30 descriptors. A representative set of barley, wheat, lentil, chickpea, pea and faba bean landrace accessions from Afghanistan (271 in total) were selected from ICARDA's gene bank. These were multiplied in large plots in the field, and characterized for a number of agro-morphological characters. Priority was given to seed multiplication to replenish seed stocks, as a result on increasing demand for seeds from ICARDA's gene bank.

The multiplication, characterization, evaluation of germplasm during the 2001/2002 season is summarized in Table 18. Germplasm characterization and preliminary evaluation for biotic and abiotic stresses and morphological and agronomic traits using international descriptors continued during the 2003/2004 season.

3.11. *Ecological characterization of cereal genetic resources*

Within the framework of the German Overseas Development Ministry (BMZ) funded project "Exploration of genetic resources collections at ICARDA for adap-

Table 18. The multiplication, characterization/evaluation of germplasm during the 2001/2002 season.

Crop	Multiplied/ Regenerated	Characterization and/or Evaluation	No. of Traits
Forage Legume			
Vicia spp.	496	-	-
Lathyrus spp.	840	-	-
Pisum spp.	2149	382	32
Totals	**3485**	**382**	
Food Legumes			
Lentil	1002	210	25
Chickpea	610	140	25
Faba bean	-	1208	23
Wild *Lens* spp.	145	-	-
Wild *Cicer* spp.	48	-	-
Totals	**1805**	**1558**	
Cereals			
Barley	-	321	18
Wild *Hordeum* spp.	-	96	22
Durum wheat	-	625	17
Bread wheat	-	802	17
Wild *Triticum* spp.	-	235	17
Aegilops spp.	-	157	17
Totals		**2236**	

tation to climate change: Identification and utilization of sources of stress tolerance", a set of 36 wild barley and 124 barley landrace accessions, as well as another one consisting of 36 *Aegilops*, 18 wild *Triticum*, 5 obsolete wheat and 91 durum wheat landrace accessions were selected from GRU/ICARDA collections using the information generated by NRMP Agro-ecological characterization group. A total of 41 ecological variables were used for selecting representatives of different clusters of drought-affected germplasm collection sites (see dendrogram Fig. 4.). These two sets, complemented with improved germplasm from the Germplasm Program, were used in molecular and photothermal characterization studies in the next phase of the project.

The new GIS-generated information was also used for univariate and multivariate statistical analysis of ecological relationships between 25 wheat wild relative species. The study was based on more than 12,000 accessions with known geographical coordinates held globally in gene banks and included in the Wild Wheat Global Database developed by IPGRI/ICARDA and upgraded and maintained at GRU/ICARDA. Accessions included in the study come from more than 3500 different collection sites.

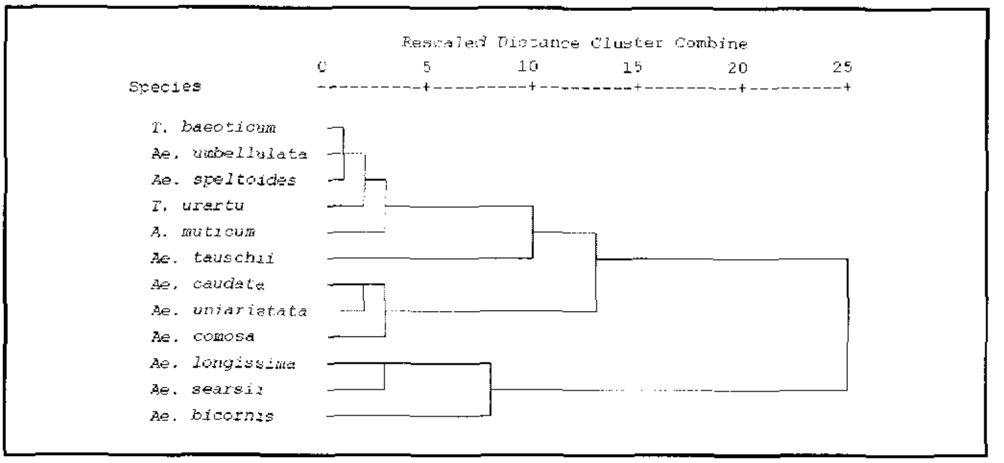


Fig. 4. Dendrogram indicating ecological relationships among diploid wheat wild relatives

585 accessions from CAC countries were characterized and evaluated in partnership with VIR, St Petersburg, Russia. And, 840 chickpea accessions from CAC countries and the Mediterranean centers of diversity were compared using statistical methods.

340 lentil and 273 *Pisum* spp. accessions were characterized and evaluated for 33 and 36 agro-morphological descriptors, respectively. The lentil subset was characterized by AFLP molecular markers using ABI 3100 automated system by K. Chabane, GRU Biotechnologist, in collaboration with Department of Agronomy and Range Science, University of California at Davis (UCD), USA. The 273 *Pisum* spp. accessions will be characterized using the same methods at UCD during 2004.

Subsets of 150 wild and cultivated barley and 160 wheat and wild wheat relative accessions collected from stressed drought-affected sites were identified using 67 GIS-generated ecological variables and tools.

In the season of 2002/2003, GRU continue to characterize and multiply its cereal germplasm. A set of 662 barley accessions, and 770 accessions of bread wheat were planted at Tel Hadya for preliminary characterization that includes qualitative and quantitative traits. This work was done in joint collaboration between GRU scientists and visiting scientists from VIR. Another set of durum wheat (560 accessions) were planted at Tel Hadya for characterization to meet the GRU's MTP. This information could also be used for producing a second part of the Durum Wheat Germplasm Catalog. In addition, a total of 161 accessions, *Aegilops* spp. (112), and *H. spontanum* (49) were characterized during that season. A total of 376 cereal germplasm accessions were multiplied and put back in the seed bank.

The multiplication, characterization, evaluation of germplasm during the 2002/2003 season is summarized in Table 19.

Table 19. The multiplication, characterization/evaluation of germplasm during the 2002/2003 season.

Crop	Multiplied/ Regenerated	Characterization and/or Evaluation	No. of Traits
Forage Legume			
Vicia spp.	911	-	-
Lathyrus spp.	352	-	-
Pisum spp.	1139	819	32
Totals	**2392**	**819**	
Food Legumes			
Lentil	783	136	38
Chickpea	1851	840	25
Faba bean	-	714	23
Wild *Lens* spp.	287	201	40
Wild *Cicer* spp.	27	-	-
Totals	**2948**	**1891**	
Cereals			
Barley	199	662	18
Wild *Hordeum* spp.	-	49	22
Durum wheat	177	560	17
Bread wheat	-	770	17
Aegilops spp.	-	112	17
Totals	**376**	**2153**	

The GRU at ICARDA continues to multiply its seed bank samples to meet the requirements of breeders and scientists all over the world through distribution.

4. UTILIZATION AND DISTRIBUTION OF GERMPLASM

Scientists involved: Dr Jan Valkoun, Mr Jan Konopka, Mr Bilal Humeid and Mr Mohammed Hamran

4.1.Distribution of germplasm
4.2. Special purpose collections with multiplied seed for distribution
4.3. Repatriation of accessions to Morocco

4.1.Distribution of germplasm

ICARDA's Genetic Resources Unit (GRU) distributes by far the highest number of samples from its gene bank to users around the world as compared to other CGIAR centers. Fig. 5 below shows the pie-chart distribution of genetic resources samples by ICARDA as compared to other CGIAR centers during 2003.

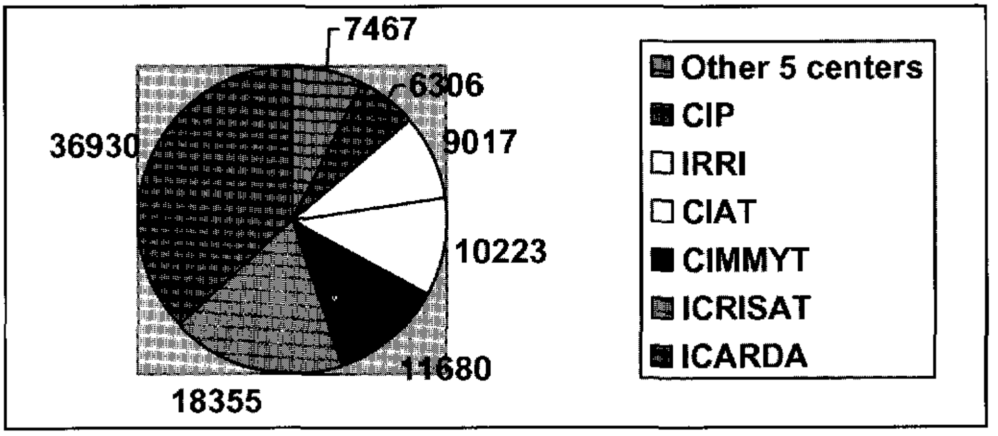


Fig. 5. Distribution of samples from CGIAR gene banks in 2003.

During the six years (1998-2003) the Genetic Resources Unit of ICARDA distributed 188,712 samples of seed to various users as well as for safety duplication (Fig. 6). These figures comprise as follows:

A. To users in developed countries	26,205
B. To users in developing countries	44,742
C. To scientists at GRU	61,733
D. To other ICARDA scientists	43,996
E. To other IARCs	105
F. To other gene banks for safety duplication	11,931
Total	**188,712**

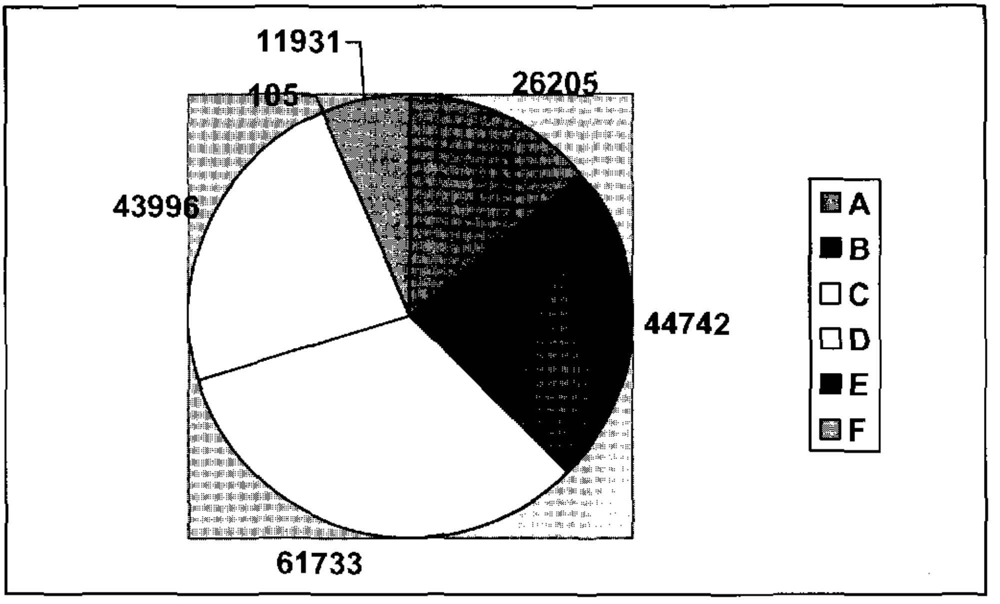


Fig. 6. Distribution of samples by GRU during 1998-2003.

Samples distributed to GRU scientists include those for research as well as for characterization, evaluation ad multiplication.

1998

In 1998 a total 38,018 seed samples were distributed from the GRU active collection as given in Table 20. Out of this number, 8410 accessions were duplicated at three other gene banks for security and safety of the germplasm. These were as follows:

Table 20. List of seed samples distributed by GRU/ICARDA in 1998.

To developed countries	5176
To developing countries	12535
To GRU scientists at ICARDA	6831
To GP scientists at ICARDA	4962
To other IARCs	104
For safety duplication at another gene bank	8410
Total	**38018**

796 accs. of lentils at the National Bureau of Plant Genetic Resources (NBPGR), Delhi, India; 536 accs. of *Lathyrus* spp. at the Research Station for Plant Production-Changins (RAC), Nyon, Switzerland; and 1301 accs. of chickpea at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, India.

1999

In 1999 a total 30,327 seed samples were distributed from the GRU active collection as given in Table 21.

Table 21. List of seed samples distributed by GRU/ICARDA in 1999.

To developed countries	5261
To developing countries	7218
To GRU scientists at ICARDA	10498
To GP scientists at ICARDA	7349
To other IARCs	1
For safety duplication at another gene bank	-
Total	**30327**

2000

In all 139 lines of BC_2F_1 and BC_1F_2 generations derived from crosses between cultivated and wild wheat were also evaluated for yield and other positive traits in the field. Out of these 130 lines were distributed to GP scientists for in depth evaluation. In addition, 12 and 20 lines derived from crosses of wild *Triticum* spp. With durum wheat cultivars 'Haurani' and 'Cham 5', respectively, out yielded their durum parents. Two new synthetic hexaploid wheats developed in a pre-breeding program from a cross of 'Haurani', the local well-adapted Syrian durum wheat cultivar, and drought tolerant *Aegilops tauschii* accessions were included in to the GRU collection as genetic stocks and available to breeders and researchers. This work continued in to 2001.

In 2000 a total of 20,646 seed samples were distributed from the GRU active collection as given in Table 22.

2001

In 2001 a total of 25,865 seed samples were distributed from the GRU active collection as given in Table 23.

Table 22. List of seed samples distributed by GRU/ICARDA in 2000.

To developed countries	2319
To developing countries	5862
To GRU scientists at ICARDA	6687
To GP scientists at ICARDA	5778
To other IARCs	-
For safety duplication at another gene bank	-
Total	**20646**

Table 23. List of seed samples distributed by GRU/ICARDA in 2001.

To developed countries	3081
To developing countries	3992
To GRU scientists at ICARDA	8234
To GP scientists at ICARDA	10558
To other IARCs	-
For safety duplication at another gene bank	-
Total	**25865**

2002

A total of 16,292 seed samples were dispatched, in response to various requests, to external users in 28 countries out of a total of 36,926. This included the repatriation of indigenous germplasm to Afghanistan (271 samples), Jordan (1350) and the Palestinian Authority (1000). An additional 4652 seed samples were requested by breeders and other scientists within ICARDA. The break-up of seed samples that were distributed from the GRU active collection is given in Table 24.

Table 24. List of seed samples distributed by GRU/ICARDA in 2002.

To developed countries	7966
To developing countries	8326
To GRU scientists at ICARDA	15982
To GP scientists at ICARDA	4652
To other IARCs	-
For safety duplication at another gene bank	-
Total	**36926**

2003

Demand for seed samples held at ICARDA gene bank continued unabated in 2003 and the GRU distributed on request nearly 20,000 seed samples to scientists and other users all over the world. Of this, 6809 seed samples were sent to users in developing countries, 2402 to those in the developed world and 10697 to scientists at ICARDA in the Germplasm Program. Thus the GRU addresses the need for genetic resources equally to the outside world's as well as to its internal needs of the breeding and crop improvement research.

4.2. *Special purpose collections with multiplied seed for distribution*

A special subset of over 8800 durum wheats with detailed ecological and evaluation data was assembled at GRU with the purpose of developing specific subsets for distribution to users. A special-purpose subset of 750 accessions collected from drought-affected sites identified within the GRU/ICARDA, VIR and Australian bread wheat collections has been assembled. In addition, 2900 chick pea, 2500 lentil and 1400 wild wheats with detailed ecological and evaluation information have also been assembled for distribution. Scientists and bonafide users are requested to contact the Head at GRU, ICARDA to obtain more information and seeds of these germplasms.

4.3. *Repatriation of accessions to Morocco*

Within the framework of INRA/ICARDA collaboration in genetic resources and biodiversity conservation, 3300 accessions of cereal and legumes genetic resources were repatriated to Morocco. Other accessions where seed was insufficient for repatriation in 2003 will be multiplied at Tel Hadya and repatriated in 2004 and 2005 thus completing the duplication process of the entire collection with country of origin Morocco at the fully operational gene bank at Settat.

In 2003 a total of 36,930 seed samples were distributed from the GRU active collection as given in Table 25. This included 3521 accessions of cereals duplicated for security and safety at the International Center for Maize and Wheat Improvement (CIMMYT), Mexico as follows:

Hordeum vulgare subsp. *vulgare* (barley) landraces	351 accs.
Triticum aestivum (bread wheat) landraces	1347 accs.
Triticum turgidum subsp. *durum* (durum wheat) landraces	1027 accs.
Aegilops spp.	412 accs.
Wild and obsolete *Triticum* spp.	292 accs.
Wild barley, *Hordeum vulgare* subsp. *spontaneum*	92 accs.

Table 25. List of seed samples distributed by GRU/ICARDA in 2003.

To developed countries	2402
To developing countries	6809
To GRU scientists at ICARDA	13501
To GP scientists at ICARDA	10697
To other IARCs	-
For safety duplication at another gene bank	3521
Total	**36930**

5. CONSERVATION AND GENE BANK MANAGEMENT

Scientists involved: Mr. Bilal Humeid and Mr Mohammed Hamran

5.1 Conservation and gene bank management
5.2. Safety duplication of germplasm
5.3. Plans for 2005
5.4. Cold storage capacity expansion at GRU/ICARDA

ICARDA's goal is to enhance food security and sustainability of agricultural production based on the conservation and utilization of biodiversity of the Center's mandate crops; wheat, barley, lentil, chickpea, faba bean and pasture and forage legumes. Conserving and studying the biodiversity of some of world's most important food crops is not only extremely important to meet the current challenges of food production but also for the future needs of agriculture. Due attention is given to the wild progenitors and other wild and weedy relatives of ICARDA's mandate crops as they have many valuable genes for biotic and abiotic stress tolerance. They are also useful for breeding crop varieties for adaptation to low-input and low-moisture environments, and at the same time, they are the most threatened part of the mandate gene pool.

5.1 *Conservation and gene bank management*

During the years 1998 to 2003, GRU/ICARDA continued to contribute to the global efforts on conserving and distributing crop plant diversity for the greater good of humankind.

In 1998 *ex situ* genetic resources collections held at the ICARDA gene bank increased to a total of 117,926 that comprise of 57,468 cereals, 29,510 food legumes, 30,661 forage legumes and 287 forage grasses. However, 105,970 out of the total (or almost 90%) are held in trust under the auspices of the FAO.

In 1999 *ex situ* collections held at ICARDA gene bank increased to a total of 120,270 by January 31, 2000.

In 2000 GRU/ICARDA germplasm collections increased by 4654 new accessions derived from collecting missions and donations. These include a large set of 2454 accessions of unique cereal and food legumes genetic resource collected by Vavilov himself and/or his colleagues before 1941 in the former USSR and the CWANA region. These valuable additions brought the total number of accessions conserved at ICARDA, at the end of 2000, to 124,363 accessions.

In 2001 genetic resources collections at GRU/ICARDA further increased by 2902 new accessions that were added to the gene bank, bringing the total to 127,247 accessions. The former number includes a large set (899 accessions) of unique and valuable cereal and food legume germplasm collected by Vavilov and/or his colleagues before 1941 in the former USSR and the CWANA region. The total number of genera and accessions received at GRU/ICARDA were 35 and 5751, respectively (see Table 26).

The planned objective of the GRU of placing 90% of accessions in the long-term base collection by 2002 could not be achieved that year due to budgetary constraints. However, the goal was partially met as 90% of the wheat and barley collection was put under long-term storage. It is the aim of the GRU to place over 90% of the lentil and chickpea accessions under long-term conservation by the end of 2004. The extent of the annual viability testing of samples from the gene bank's long-term conservation planned for the coming years will also be carried in the light of the available budget for 2002 and 2003. A total of 376 germplasm accessions were multiplied and put pack in the seed bank.

Viability testing is among the major activity at GRU that aim to provide cooperators with viable seeds. In the season of 2002-2003 a total of 3340 accessions from different ICARDA mandated crops were tested for viability. And a total of 8178 accession resulted from characterization and multiplication were stored in the seed bank.

By the end of 2003 ICARDA's holdings increased to 131,017 accessions. Viability testing of germplasm, a continuous all-year long activity, was delayed in 2003 due to the major reconstruction and renovation of the GRU's Strampelli Building. This activity will receive priority in 2004.

5.2. *Safety duplication of germplasm*

On recommendations of the System-Wide Genetic Resources Program (SGRP) ICARDA will continue to duplicate its collections at the International Potato Center (CIP), Lima, Peru, since they have spare capacity, as well as at the International Maize and Wheat Improvement Center (CIMMYT) in Mexico. In 2003, 3521 accessions were safety duplicated at CIMMYT under the terms of a 'black box' letter of agreement. By the end of the year 15,500 accessions were ready for dispatch to CIP under the same terms as soon as the LOA between ICARDA and CIP is finalized.

Table 26. Donation of germplasm to ICARDA from the N.I. Vavilov Institute, St Petersburg, Russia from 1998 to 2003.

Taxon	No. of Accs.
Vicia faba	412
Triticum vavilovii	1
Triticum urartu	1
Triticum turgidum subsp. *turgidum*	50
Triticum turgidum subsp. *turanicum*	1
Triticum turgidum subsp. *polonicum*	9
Triticum turgidum subsp. *durum*	805
Triticum turgidum subsp. *dicoccon*	25
Triticum turgidum subsp. *dicoccoides*	7
Triticum turgidum	5
Triticum timopheevii subsp. *timopheevii*	1
Triticum timopheevi subsp. *araraticum*	1
Triticum persicum	1
Triticum monococcum subsp. *monococcum*	1
Triticum monococcum subsp. *baeoticum*	1
Triticum militinae	1
Triticum karamyschevii	1
Triticum jakubzineri	1
Triticum compactum	3
Triticum aestivum subsp. *sphaerococcum*	1
Triticum aestivum subsp. *spelta*	2
Triticum aestivum subsp. *macha*	1
Triticum aestivum subsp. *aestivum*	929
Triticum aestivum	507
Pisum spp.	2
Pisum sativum subsp. *transcaucasicum*	3
Pisum sativum subsp. *sativum*	575
Pisum sativum subsp. *asiaticum*	5
Pisum sativum	374
Lens culinaris subsp. *culinaris*	545
Hordeum vulgare subsp. *vulgare* convar. *vulgare*	262
Hordeum vulgare subsp. *vulgare* convar. *distichon*	302
Hordeum vulgare subsp. *vulgare*	23
Cicer arietinum	893
Total	**5751**

5.3. *Plans for 2005*

- The new screen houses for faba bean multiplication/regeneration will prevent cross-pollination and thereby maintaining the genetic integrity of the gene bank accessions of this partially cross-pollinated species;

- Backlogs of characterization, multiplication, regeneration and viability testing of gene bank accessions that have accumulated across the years due to budget constraints and repairs to the GRU main building will be removed;
- The Database Management System (DMS) will be upgraded and data quality improved to increase access and facilitate utilization of gene bank accessions for Global Public Good;
- Additional means for seed health testing and cleaning gene bank accessions from pathogens will guarantee safe introduction of new gene bank accessions and distribution of seed samples from the ICARDA gene bank to users worldwide;
- Backlog in safety duplication will also be eliminated and the long-term safety of the formally designated accessions will be guaranteed.

5.4. *Cold storage capacity expansion at GRU/ICARDA*

To meet international standards, a new cold store is needed to accommodate accessions currently held in sub-standard conditions and also provide added capacity for new introductions. This urgent need has already been brought to the attention of the Gene Bank Stripe Review in External Program and Management Review of ICARDA in 1999. Action has been recommended by all these reviews and ICARDA has responded to it.

When the new cold store is ready, the material will be shifted to the new cold store and repairs and upgradation of the compressors, dehumidifiers and supply of other spare parts will be taken up on a war footing so as to take care of those samples that cannot be accommodated in the new cold rooms. The total cost of the new cold store as well as the upgradation and refurbishment of the old cold store is estimated to cost US$ 870,000. The following constraints that GRU/ICARDA is working under will be addressed by the funding of this project:

The new cold store will provide adequate and greater storage space for accessions that are currently in sub-standard conditions, and at the same time, provide sufficient extra capacity for new introductions. The new facilities will provide medium-term storage space of 83.95m^2 at 4°C with controlled relative humidity and 81.22m^2 of space at –20°C and no humidity control. Repairs and upgrades of the present cold store facilities and replacement of the old machinery will guarantee a safe long-term storage of formally designated accessions that are held in trust for the international community under the auspices of the Food and Agriculture Organization of the United Nations (FAO) for public good.

The construction of a new cold store was started in earnest towards the end of the year 2003. The progress of this work continues rapidly in 2004 (Fig. 7). The outer structure of the building is scheduled for completion by end of September 2004. The projected date for the completion of installation of machinery and full commissioning will be some time in 2005. It is expected that with the completion of this new cold store ICARDA's genetic resources conservation space in cold rooms would have effectively been doubled and international standards of medium- and long-term storage maintained. This extra capacity will also allow the Center to hold safety duplication of other CGIAR centers in reciprocation, as well as the collections from the NARS whose long-term storage units are under construction.

The details of the plan to upgrade all CGIAR gene banks can be seen in the document "A Funding Plan to Upgrade CGIAR Center Genebanks" produced by the CGIAR System-wide Genetic Resources Program (SGRP), Rome, March 2000.

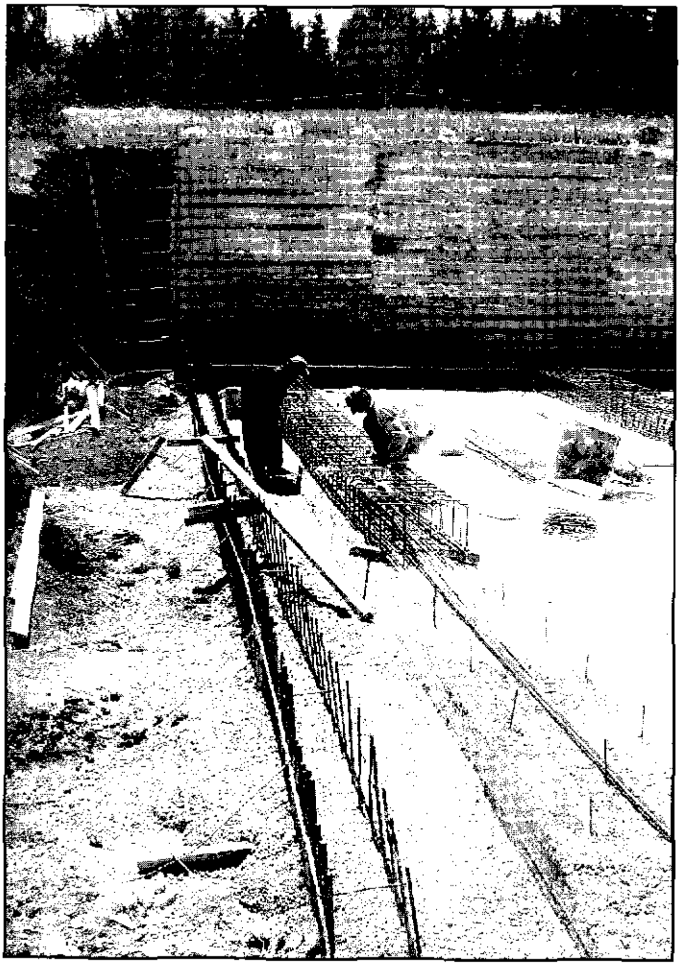


Fig. 7. Foundation for the extension to the gene bank being laid in March 2004.

6. DOCUMENTATION AND DATA MANAGEMENT

Scientists involved: Mr Jan Konopka and Ms Sumaya Jankieh

6.1. Genetic resources database system
6.2. The SINGER project
6.3. Database on microbial genetic resources of the CGIAR
6.4. Database of bread wheat landraces
6.5. Eco-geographic database of GEF-UNDP Project
6.6. Global inventory of barley genetic resources
6.7. Assistance to NARS in genetic resources documentation

Background

The computerized genetic resources documentation system is a vital tool assisting GRU staff in research, conservation and distribution of germplasm. The system developed in GRU since 1997 combines user friendliness with adequate performance on the center-wide network so that all ICARDA scientists can readily consult the information they need. As seen in Fig. 8, the database user working with selected crop will get access to the data files common for all crops (such as passport data, taxonomy, stock, distribution of seeds, etc.), to the crop specific information (such as characterization and evaluation data) and, additionally, he/she has a possibility to add "personal" data files to the system.

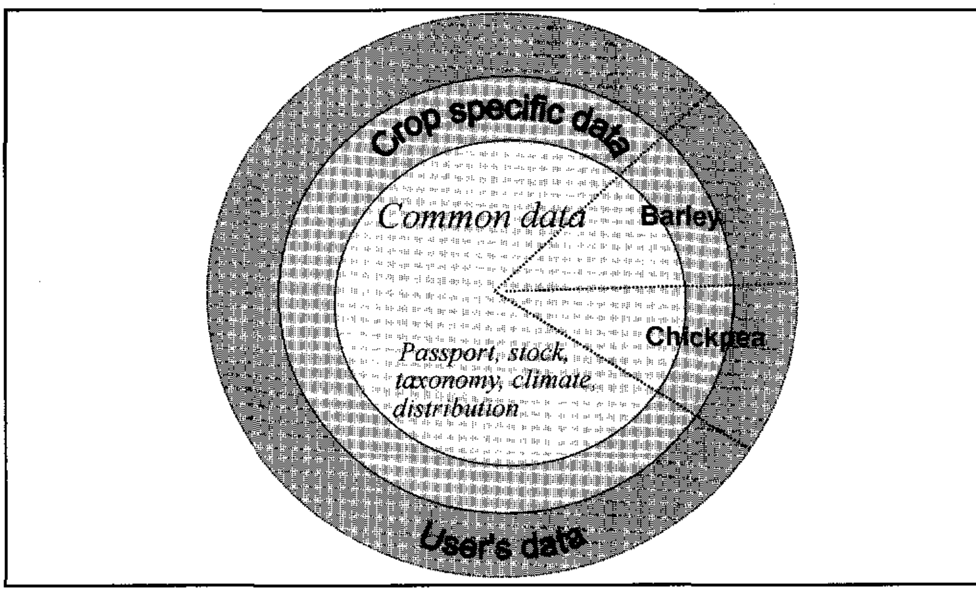


Fig. 8. GRU database system layers

The latter feature effectively extends the coverage of data being dealt with. The "user's data files" usually store the information from not finished experiments and thus are not in public domain. Once the data are complete and checked, the files are moved to either common or crop specific data layers and made available to all users.

6.1. *Genetic resources database system*

The functionality and content of GRU database is evolving in response to changing requirements for new data, new queries, and the need to automate the gene bank procedures. During the period 1998-2003 the following sub-systems/procedures were implemented:

(a) Seed Stock Control System. The location, seed amount and viability of each sample are monitored to assist gene bank manager in seed distribution, planning for multiplication and/or regeneration, safety duplication, etc.
(b) Seed Distribution module assists the staff in selection of samples needed by the user, printing labels, generating the documentation that is sent along with seeds. The Material Transfer Agreement (MTA) is also generated. The Seed Distribution system provides the curators of collections with the statistics on the volume and pattern of use of germplasm within ICARDA and by external users.
(c) Sub-system to register and prepare field experiments in GRU. Curators are assisted in selecting the samples for planting, randomization of plots, printing field books, and entry of results to the database.
(d) Sub-system for herbarium specimens helps to manage internal GRU herbarium.
(e) Querying of a database by scientific and vernacular/common names of plants is not straightforward process due to synonyms. In 2003, the synonymous names were cross-referenced and query module that consults the synonyms was developed.

The integrity and completeness of the data are critical elements of documentation system and receive adequate attention of GRU staff. A number of database tools are available to assist in these tasks. During the period 1998-2003, particular attention was paid to the normalization, filling the gaps and accuracy of information in records regarding the collection sites. Now the database holds geo-referenced site data for over 69,000 accessions, i.e., 56% of total holdings. The geo-referenced site records can be lined to spatial databases in order to extract environmental information usually missing in the original collection site data. Using this approach in 2002-2003, in cooperation with GIS-group of NRMP we have derived and added to the GR database the following data (see Fig. 9):

(a) Minimum and maximum temperatures
(b) Precipitation
(c) Potential evapotranspiration
(d) Aridity index
(e) Agroclimatic zone (using UNESCO classification)
(f) Soil type (from FAO map of soils)

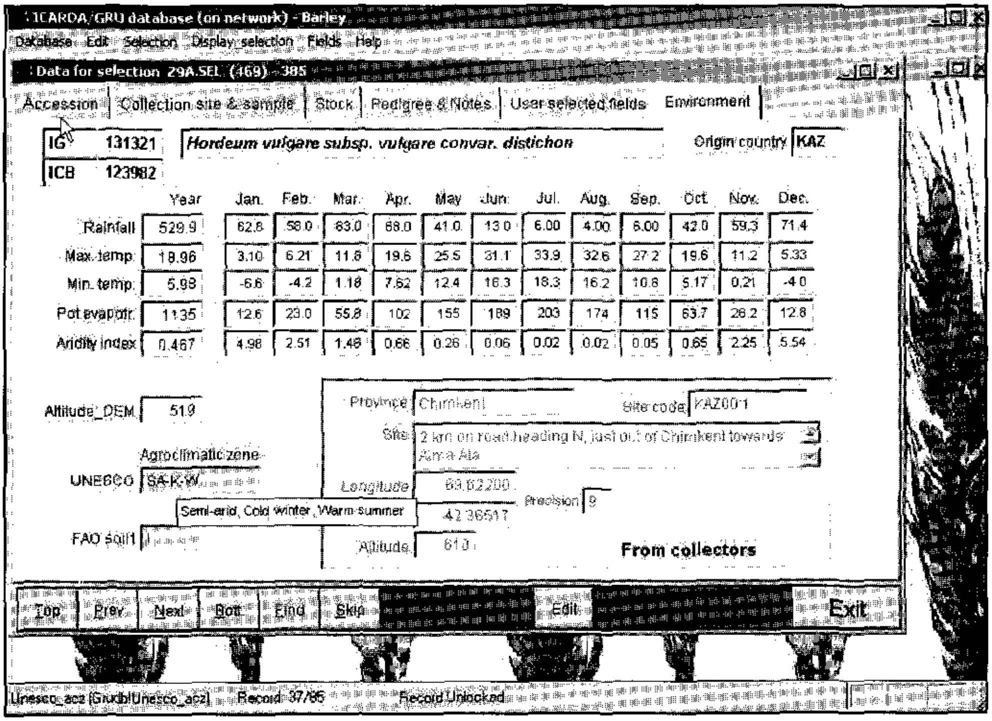


Fig. 9. Sample database screen with environmental data

Summary of accessions with known geographical latitude-longitude coordinates by regions is shown in Table 27.

Efforts were also made to identify collecting missions conducted in the CWANA regions. This was successful for approx. 75% of collected material; for remaining 25% the available data are not sufficiently detailed. The genetic resources conserved in ICARDA gene bank come from 425 collecting missions conducted during the period 1924 – 2003. ICARDA collectors have participated in 172 missions since 1977 and collected 26,400 samples.

Table 27. Summary of germplasm from sites with know latitude-longitude

	Cereals	Food legumes	Range	Forage legumes	Total
West Asia (WA)	13222	6084	2521	10656	32483
North Africa (NA)	12764	704	1880	4154	19502
Central Asia (CA)	1055	150	306	446	1957
Caucasus (CAUC)	893	186	114	459	1652
Western Europe	2579	575	82	1502	4738
Eastern Europe	688	147	27	142	1004
Russia	531	14	18	45	608
Asia (other than CA)	3897	954	15	534	5400
North America	303	26	0	11	340
South America	238	866	0	49	1153
Africa (other than NA)	25	71	1	0	97
Oceania	109	2	0	25	136
TOTAL	**36304**	**9779**	**4964**	**18023**	**69070**

6.2. The SINGER project

System-wide Information Network on Genetic Resources (SINGER) project was started in 1996 with the overall objective of putting together information on genetic resources conserved in all CGIAR Centers and making the information on such 'system collection' available on internet.

GRU participation in SINGER project has added the dimensions of direct compatibility of ICARDA genetic resources information system with the documentation efforts of 13 sister Centers and publishing of the data on internet. To meet SINGER requirements, the internal database has undergone significant structural changes facilitating replication of ICARDA data to central SINGER database. During 1998-2000, the project facilitated implementation of data quality control procedures as well as improvements of infrastructure. A new SINGER server was put in to operation. The "SGRP Tool Kit", a software tool that has been developed by the SINGER coordination office, to help web-enabling databases was installed and used to make GRU database available in ICARDA-wide intranet.

Periodic updates from the ICARDA database are propagated to SINGER database housed by IPGRI, Rome, Italy, provides the common interface to CGIAR germplasm data for Internet users.

6.3. *Database on microbial genetic resources of the CGIAR*

Within the framework of the System-wide Genetic Resources Program (SGRP), ICARDA/GRU has compiled a database on 8,670 accessions of nitrogen-fixing organisms maintained in collections of CIAT, IITA, ILRI, IRRI and ICARDA. In addition to data gathering, verification and compilation, the user-friendly software to work with the database was developed in-house in the GRU. The system was demonstrated during the meeting of Genetic Resources Program Committee, held at ICARDA in April 1998 and received favorable comments. The CD-ROM version was distributed among cooperators in 1998/99.

6.4. *Database of bread wheat landraces*

The database was developed in the framework of GRDC-supported project entitled "Technologies for the targeted exploitation of the N.I. Vavilov Institute of Plant Industry (VIR), ICARDA and Australian bread wheat landrace germplasm for the benefit of wheat breeding programs of partners" initiated in 2000. The system the data for 17,049 bread wheat accessions selected on the basis of known collection sites: 6,735 accessions come from ICARDA collection, 6,644 accessions from VIR and 3,670 accessions are from AWCC. For over 90% of accessions the project was able to obtain the latitude-longitude coordinates of collections sites and than, using GIS tools, the climatic and environmental data were generated. These and selected characterization data from respective collections were subsequently used to identify two subsets (see Fig. 10):

(a) 'representative' or 'core' subset of 749 accessions representing all agroecologies
(b) subset of 746 accessions selected for further studies on drought tolerance. The accessions are coming from areas with low precipitation and where low moisture and high temperature are predominant growth limiting factors

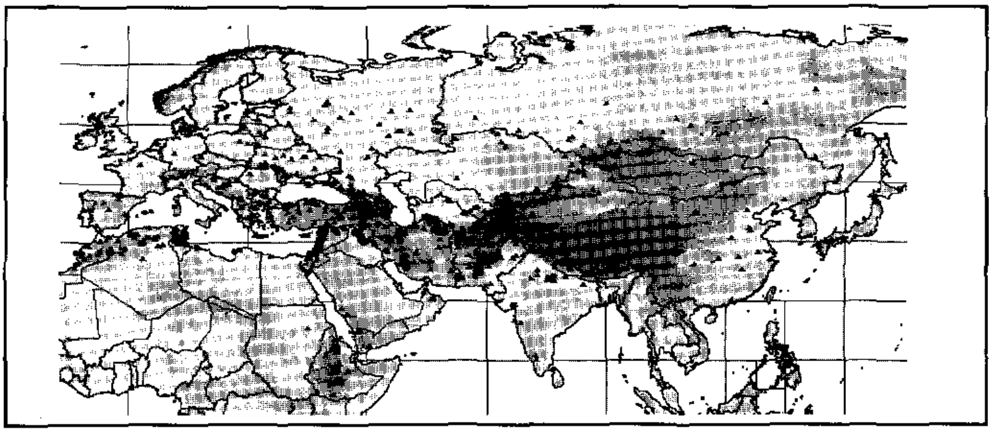


Fig. 10. Spatial distribution of 'core' and 'drought' subsets of bread wheat landraces.

During 2004 both subsets will be grown for multiplication and uniform characterization in Tel Hadya.

The database is currently using ICARDA-developed software allowing running the system on network, individual PC or CD-ROM. In order to assure the widest availability of the database, during 2003 the work was initiated to web-enable it. The Internet version should be finalized in 2004 and will have the capability of producing maps.

6.5. *Eco-geographic database of GEF-UNDP Agrobiodiversity Project*

The important component of GEF-funded Agrobiodiversity project (see Chapter 9) are botanical surveys (of biodiversity) in selected project sites in 4 countries: Jordan, Lebanon, Palestinian Authority and Syria. In order to assist the project staff in conducting periodic surveys and to facilitate the management and analysis of these data on country and regional levels, GRU has developed in 2001 a specialized database and deployed it in all countries. The database follows the methodology illustrated in Fig.11 for target area; the project works in 2-3 target areas in each country. After completion of each survey and documenting it in national database, countries send the data to ICARDA where regional database is populated. The regional database is in turn copied in all countries so the system is available to all project components. The database deals with over 250 fields to document the changes occurring at study sites. Particular attention is given to monitoring factors responsible for degradation of biodiversity; several diversity indices are produced to assist scientists in monitoring task. In view of changing project staff in countries, a refreshing workshop was held in ICARDA in 2003 to assure continuity.

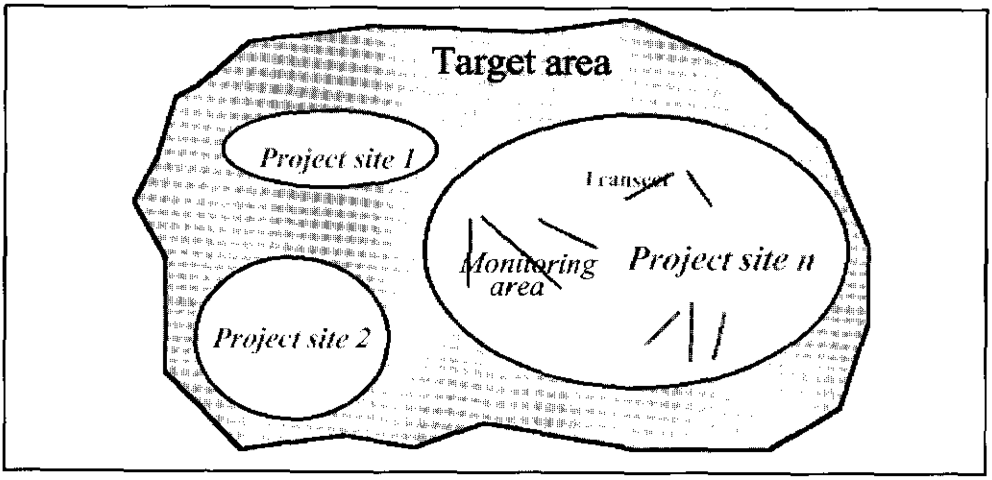


Fig. 11. Methodology of botanical surveys of GEF project

6.6. *Global inventory of barley genetic resources*

The FAO estimates that more than 300,000 accessions of barley are conserved in numerous *ex situ* collections. There is no doubt that there is significant overlap between these collections, but the extent of this overlap is unknown. What is more, although some collections can be accessed via the internet, differences in separate systems, both in the format of the data and in the interfaces offered, prevent users from efficiently accessing and using conserved material. During 2002, ICARDA's GRU began a collaborative project (involving organizations with large collections of barley) that aims to compile a Global Inventory of Barley Genetic Resources. This project is supported by the CGIAR Systemwide Genetic Resources Program (SGRP) and the Inventory will be published on the internet using the System-wide Information Network for Genetic Resources (SINGER) platform. The Inventory would also available on CD-ROM upon request from the GRU. Currently the database holds passport data on over 165,000 accessions conserved in 40 institutes (Table 28), and the challenge is to cross-reference the accessions across collections. Probably the most important part of any 'global collection' is the material collected in the field: approximately 40% of conserved material can be attributed to efforts of collectors. Based on available data, the project identified over 280 collecting missions conducted during the period 1921-2001 in 57 countries. Unfortunately, there still exist many accessions for which the information concerning collectors and/or collection dates is untraceable. The project places great emphasis on the geo-referencing of collection sites and the database can map out over 9,000 sites. However, the majority of conserved material is the result of breeding efforts, and the project aims to standardize the names of accessions by correcting misspellings, ensuring consistent transliteration into Latin, consolidating synonyms, etc. The standardization of names will allow the collections to be cross-referenced and will facilitate querying of the database.

Currently the system registers approximately 49,900 names, associated with over 83,200 accessions. For cultivars and breeding lines, the database compiles information on pedigree, developer and date of release. The inventory will be published on CD-ROMs and on internet.

Table 28. Collections and number of accessions in the database.

Collection/Institute	Number of accessions
USDA, USA	27,010
ICARDA, Syria	25,202
VIR, Russia	19,437
IPK, Germany	13,124
John Innes Centre (JIC), UK	10,828
AWCC, Australia	9,947
34 other smaller collections	59,660

6.7. Assistance to NARS in genetic resources documentation

An important component of GRU's work is assistance provided to NARS in different aspects of genetic resources work in countries. In particular, NARS frequently request ICARDA to help in setting up the germplasm documentation systems for their genetic resources collections/gene banks. Portability of GRU documentation system permits this with relative ease and in limited time; as a matter of fact the GRU system was designed and implemented with this feature in mind. In addition to cost-effectiveness, this approach assures direct compatibility of national systems with that of ICARDA and thus facilitates data exchange.
Below is a summary of assistance provided during 1998-2003.

6.7.1. *Documentation system for Uzbekistan*

Uzbek Research Institute of Plant Industry (UzRIPI) in Tashkent holds the biggest collection (over 50,000 accessions) of PGR in Central Asia. The institute used to be the strong node in the former network of VIR with headquarters in St. Petersburg. ICARDA has assisted UzRIPI in documenting its valuable collections since 1998 in a variety of ways:

(i) Support to establish the documentation section in UzRIPI, later assigned the status of department. In particular, ICARDA provided the funds to purchase computers and networking equipment
(ii) Consultation and advice on design and implementation of relational database.
(iii) The documentation specialist of UzRIPI visited GRU in 1999 for 3 months studying the documentation system of ICARDA. During this time a new database for UzRIPI was designed, the relevant data from VIR files were transferred and procedures were developed for subsequent data input and verification. A new database was successfully installed on UzRIPI computers.
(iv) The training/consultations on the occasion of training courses or PGR workshops for CAC held in Tashkent in 2001, 2002 and 2003.

6.7.2. *PGR database for Jordanian gene bank*

The gene bank of Jordan, established at the National Center for Agricultural Research and Technology Transfer (NCARTT), has opted for adoption of ICARDA documentation system to manage the data for its collection. In September 2000, the first version of PGR documentation system for Jordanian gene bank was installed on NCARTT computer network. At the same time, the subset of ICARDA database documenting material of Jordanian origin conserved in ICARDA was also installed in NCARTT. The latter facilitated greatly the process of step-wise repatriation of this material in subsequent years because NCARTT staff could precisely define priorities of seed transfer. Documentation of repatriated material was easily transferred to national database too. In December 2002, a short visit of ICARDA documentation officer to NCARTT allowed to upgrade the database software and to implement new features like seed stock control sub-system, storing digital images of plant taxa and collection sites, and handling herbarium specimen collection.

6.7.3. *Database of germplasm from the arid zones of Tunisia*

The Institut de Régions Arides (IRA), Medenine, Tunisia has assembled an impressive collection of plants from arid zones of the country. A living collection of shrubs, pasture species, medicinal and aromatic plants in the Institute's fields and seed conservation facilities are also available. In 1999, as part of a cooperative program between IRA and ICARDA, a database for this valuable collection was set up using ICARDA-developed software. In addition to descriptive information about the species and their distribution, the database also contains photographs of entire plants and/or their distinctive parts. A few months after the installation of database system in IRA, the documentation scientist from IRA paid a follow-up visit to GRU and adjustments of the systems were devised and implemented.

6.7.4. *PGR databases in NARS of Central Asia and the Caucasus (CAC)*

In 1996 a Central Asian Network for Plant Genetic Resources (CAN/PGR) was established by ICARDA and IPGRI to facilitate the planning and coordination of national and international efforts to safeguard the plant genetic resources of Central Asia. In 1998 the network steering committee voted to expand this network to include the Caucus republics. A few projects were funded to undertake a series of plant collection missions in the area and to train individuals in PGR conservation and documentation. A proposal for a larger project on establishment of a Regional Plant Genetic Resources Information Network for CAC was developed and presented to donors but never funded.

In December 2000, the Regional Technical Meeting on Field Crops in CAC Region, organized in the framework of ACIAR special project, paved the way to establishment of small PGR units in each country and recommended preparation of national inventories of PGR. As a follow-up, a template database for such inventories was prepared and distributed to NARS during two database training workshops:

(i) May 2001 in Tbilisi for countries of Caucasus region (Georgia, Azerbaijan and Armenia), and

(ii) December 2001 in Tashkent for countries of Central Asia

The progress of database work in CAC countries was monitored on annual meetings in 2002 and 2003. All countries agreed to finalize inventories mid-2004 and ICARDA/GRU will prepare regional database in 2004.

7. SEED HEALTH TESTING

Scientists involved: Dr Ahmed El-Ahmed, Dr Siham Asaad, Mr Mohamed Hayani (Seed Health Laboratory, GRU)

7.1 Incoming and outgoing germplasm screening
7.2. Screening against black point and wheat gall nematode
7.3. Disease resistance in newly collected faba bean accessions
7.4. Seed health testing in the field and plant treatment and inspection
7.5. Cleaning seed-borne viruses from ICARDA gene bank accessions
7.6. Seed-borne virus testing for legume germplasm
7.7. Assistance to Afghanistan

In 1982, ICARDA established phytosanitary safeguards and facilities were set up to prevent entry and spread of seed borne pests and diseases into areas where they were not found before. ICARDA receives and despatches several thousand seeds samples each year. Three measures to safeguard seed health are applied by ICARDA's Seed Health Lab (SHL) which is attached to the GRU: 1) seed health testing, 2) the production of clean seeds (including field inspections where needed), and 3) seed treatments with appropriate chemicals and fungicides. The SHL aims to guarantee the safe movement of outgoing and incoming genetic material at ICARDA.

After fumigation and thorough visual inspection, the SHL applies different methods recommended by the International Seed Testing Association (ISTA) to detect pathogens in the in-coming seeds. The SHL, through its research activities, has also developed a few testing techniques on its own, such as the "cold blotter test" for detecting the fungus *Pyrenophora graminea* in seeds of barley. Particular attention is given to pathogens that are specifically mentioned in the quarantine regulations for Syria. Over the past 5 years the number of accessions tested each year has ranged from 11,000 to more than 41,000.

7.1 *Incoming and outgoing germplasm screening*

In 1998, the incoming germplasm, 9276 (cereals) and 905 (legumes) entries were tested and out of this number 3.5% and 1% are respectively found infected with seed-borne pathogens. In bread wheat, *Tilletia indica* (4), *T. contraversa* (1) and in lentil *Ascochyta lentis* (8) seed samples are detected in imported germplasm. Seeds infected with exotic pathogens are destroyed, whereas healthy seeds are treated and grown for one generation in the post-quarantine isolation area (PQA). Field inspection was carried out in the PQA as well as increases and multiplication plots destined for international dispatch. Field inspection in seed multiplication fields for international nurseries, as well as in the post quarantine area for incoming materials, have been conducted this season in 126 ha, for cereals and food and forage legumes crops. During 1998 the SHL increased its activities considerably. The SHL tested the health status of 17,726 and 923 entries of outgoing cereal and legume crops, respectively. This number represents more than 3 times that of 1997.

7.2. *Screening against black point and wheat gall nematode*

As part of SHL's research, 278 lines of durum recombinant inbred lines (RIL) were screened in cooperation with durum improvement project at ICARDA against the black point (BP) and wheat gall nematode (WGN) seed-borne diseases. The material consisted of 112 and 166 entries derived from the crosses of Jennah Khetifa(JK)/Cham 1 and Korifla(KRF)/*Triticum dicoccoides*//KRF, respectively. For BP, results showed that very few lines were highly resistant (HR) in the two crosses, whereas 16 and 28 entries were found with (R) reaction in these two crosses, respectively. Results indicated that quantitative inheritance was exerted in both crosses for these diseases. Regarding the WGN, 32 and 7 with (HR) reaction and 36 and 144 with (R) reaction were respectively found in the above-mentioned crosses. Furthermore, the results showed that one pair of genes most probably, controlled resistance to WGN. For the two diseases, 6 and 3 entries were found with HR/R reaction in JK/Cham 1 and KRF/*T. dicoccoides*//KRF crosses, respectively.

7.3. *Disease resistance in newly collected faba bean accessions*

Chocolate spot resistance found in germplasm collected in Ecuador and in the Sichuan and Yunan regions of China in 1996 was confirmed during the 1997/1998 season. Among Ecuadorian samples, there were several accessions with resistance to chocolate spot, as opposed to little resistance in samples collected from China. The germplasm from Yunan was less susceptible than that of Sichuan. The germplasm from Ecuador collected in 1996, compared with previous sources of resistance to chocolate spot, showed a much larger range in flowering dates. Some lines flowered earlier than 90 days as compared with check variety that flowered in 110 days. This finding will facilitate development of cultivars for intensive cropping.

7.4. *Seed health testing in the field and plant treatment and inspection*

Field inspection and rouging of infected plants with seed-borne diseases in plots destined for international dispatch was conducted (March-June, 1999). This activity covered about 60 ha and 70 ha of food/feed legume and cereal crops, respectively. The major diseases encountered during the season were: common bunt, scald, barley leaf stripe, loose smut, covered smut, flag smut, barley stripe mosaic virus (in cereal crops), *Aschochyta* blight, *Botrytis* molds, *Fusarium* wilt, downey mildew, *Orobanche*, and viruses (in legume crops). Flag smut was found to infect 6 wheat plants, and necessary sanitation measures are taken to eliminate the disease. During the 1998/1999 season, SHL tested 41,000 samples for seed born pathogens (about 28,000 were sent to ICARDA's cooperators, and about 13,000 were received as incoming germplasm).

During the year 2000 the SHL tested 25,000 of in-coming as well as out-going seed samples for ICARDA. The tests showed that 11% of in-coming seed and 7% of out-going seed were infected with various pathogens. These seed samples were destroyed and harmful pathogens were prevented from entering ICARDA and Syria. Newly received plant material was planted in the isolation fields at Tel Hadya. A total of 150 ha of seed multiplication plots were inspected and plants affected with pathogens were rouged and destroyed. Three hundred and twelve lines of durum wheat were screened for *Anguina tritici* and black point during 2000.

In 2000 the most common contaminants found in in-coming seed were the fungi *Tilletia caries*, *T. foetida* and *Helminthosporium* spp. in cereals wheat and barley, and *Fusarium* spp. in the legumes. The most frequently found exotic pathogens were *T. indica*, *T. controversa*, and *Urocystis agropyri*. However, the number of cereal samples contaminated with really harmful pathogens was high only in the years 1991 and 1992 (3000 and 3600 samples, respectively). Therefore, their frequency has fallen sharply in recent years to only between 10 and 100 seriously contaminated samples per year. The fungi *Ascochyta lentis*, *A. rabiei*, and *A. fabae* were found sporadically each year in exotic legume seeds. Imported seeds that had the unacceptable level and kind of infection were promptly destroyed. The ones that were clean and unaffected were planted in the post-quarantine area of the GRU fields at Tel Hadya for observation for a single generation before being handed over to the breeders of the gene bank personnel for further processing. All seeds that were sent outside ICARDA were treated with appropriate fungicides and a phytosanitary certificate was issued. A separate certificate of origin and a certificate of donation were also provided in case of export to certain countries.

In 2001, more than 10,000 seed samples were received and tested for their health status. The majority of the samples were found to be free from quarantine seed-borne pathogens/pests. In all 2371 samples were found to be infected. Also, few teliospores of *Tilletia controversa* (dwarf bunt) and *Tilletia. indica* (Karnal bunt) were detected in 32 bread wheat samples, which were all destroyed following standard procedures. Only healthy seeds were later planted in the isolation fields for observation. A set of durum wheat germplasm was screened for 'black point', seed gall nematode, and *Septoria tritici*. A survey of black chaff on wheat was conducted in the El-Ghab area of Syria.

During 2002, approximately 12,000 incoming, and 18,000 outgoing seed samples were tested at the SHL. This volume of seed constituted 15 shipments imported from 13 countries and 270 shipments exported to 94 different countries world-wide. *Tilletia controversa* was the quarantine pathogen most frequent found, contaminating incoming bread wheat seeds. The percentage of contamination in shipments varied, reaching up to 38% (in seed from Turkey) and 100% (in seed from Russia).

In April-June 2002, SHL personnel carried out field inspections and rouging of infected plants with seed-borne diseases at Tel Hadya Station. The planted area was rather large (more than 200 ha) during this season, due to additional plots being used to produce seed for Afghanistan. In spite of a prolonged period of humidity during the season, the occurrence of seed-borne diseases was limited in most crops. However, black chaff (an unusual bacterial disease of wheat) was found in some bread wheat plots. In station fields, scientists look for the following: spot blotch, barley stripe, scald, loose and covered smuts, net blotch, barley stripe virus (on barley), black chaff, common bunt, loose smut (on bread wheat), *Ascochyta* blight, chocolate spot, wilt/root rot, Downey mildews, and *Orobanche* spp. and *Cuscuta* spp. (on legume crops).

7.5. *Cleaning seed-borne viruses from ICARDA gene bank accessions*

Fifty-eight lentil accessions, planted in the field for multiplication (1000 plants per accession), were tested in ICARDA's Virology Laboratory for the presence of seed-borne virus infection. This effort was intended to eliminate all infected plants during the late flowering stage (April-May), and only seeds from healthy plants were harvested and stored. A total of 2180 accessions of dry barley seeds were tested for the presence of Barley Stripe Mosaic Virus (BSMV): 233 accessions were found to be infected. The virus-free accessions will be stored in the gene bank, and accessions with virus-infected seeds will be cleaned.

7.6. *Seed-borne virus testing for legume germplasm*

The SHL in collaboration with the Virology Lab at ICARDA tested approximately 183 faba bean accessions (100 seeds per accession) for the presence of Broad Bean Stain Virus (BBSV), Bean Yellow Mosaic Virus (BYMV) and Pea Seed-borne Mosaic Virus (PSbMV). Following rigorous testing on the basis of host range and serological reactions, 50 accessions were found to be infected with one of the above-mentioned seed-borne viruses. A total of 383 lentil accessions were evaluated in isolation plots in the field at Tel Hadya by testing fresh leaf samples (400 plants per accession) for the presence of seed-borne virus infection. The test results showed that 217 accessions were virus-free. In addition, seed samples from 286 lentil accessions (400 seeds per accession) were tested during August 2002 for the presence of seed-borne viruses. Of these, 132 accessions contained one or more seed-borne infections and were rejected for dispatch to other countries.

The use of healthy seed in the field has at least two advantages: a) it is a key factor for increasing crop productivity; b) it prevents distribution of quarantine pathogens that are harmful to agriculture. Based on that, the SHL continues to ensure the safe movement of ICARDA seed. During the period January–November 2003 about 19,000 seed samples were tested at SHL for incoming (8,000) and outgoing (11,000) seed shipments. A total of 142 shipments were exported to 64 countries and 16 shipments were imported from ten countries. Most imported food and forage legumes were tested and found to be free from significant quarantine pathogens except one lentil seed sample. This sample was found to carry the *Ascochyta* blight (*Ascochyta lentis*). In addition, 6.6% bread wheat seeds where found to be contaminated with *Tilletia caries/T. foetida*, and one barley sample was infested with *Helminthosporium* spp.

During the 2002-2003 season about 170 ha at Tel Hadya Station were inspected by the staff of the SHL and rouged of plants infected with seed-borne diseases. For the first time in Syria, one durum wheat plant was found infected with the ergot disease (*Claviceps purpurea*). The plant was immediately eliminated. The following common diseases were detected in different ICARDA mandate crops: spot blotch, barley stripe, scald, loose smut, barley stripe virus (on barley), common bunt, loose smut, spot blotch, flag smut (on wheat), *Ascochyta* blights, chocolate spot, wilt/root rot, *Orobanche* spp., and various viruses (in both forage and legume crops).

Fig. 12. Afghan farmers being trained in detecting wheat diseases.

7.7. *Assistance to Afghanistan*

The SHL staff completed important activities in Kabul, Afghanistan on seed health testing in 2003 including training on detecting wheat diseases in the field by S. Asaad (Fig. 12). The action plan of Future Harvest Consortium to Rebuild Agriculture in Afghanistan (FHCRAA) involved installation of three comprehensive and six quarantine seed testing stations. Start-up, test and calibration of seed health testing facilities in the Badam Bagh Seed Testing Station in Kabul was carried by the staff of the SHL. They also carried out the start-up, testing and calibration work at the facility for the basic equipment, basic supplies, and safety equipment. More details of this activity are given in Chapter 8.

7.8. Seed Health Research

In addition to its normal duties of seed health testing, treatment and inspection, the SHL also carries out its own research to improve its performance and devising new tests to intercept pathogens. The SHL, in collaboration with the International Maize and Wheat Improvement Center (CIMMYT), worked actively for the second year in plastic house experiments on selection of durum wheat germplasm for resistance to *Anguina tritici* and black point diseases. A large number of resistant samples of germplasm were identified and the tests used confirmed.

8. TRAINING, CAPACITY BUILDING AND ASSISTANCE TO NARS

Scientists involved: Dr Jan Valkoun, Dr Ahmed El-Ahmed, Dr Ahmed Amri, Dr Kamel Chabane, Dr Kenneth Street, Mr Jan Konopka, Dr Siham Asaad, Mr Bilal Humeid, Mr Ali Shehadeh, Mr Ali Ismail, Mr Fawzi Sweid and Ms Sumaya Jankieh

8.1 Training
8.2. Capacity building and assistance to the NARS
8.3. Crop PGR developments in Central Asia and the Caucasus (CAC) – ICARDA's training initiatives
8.4. Capacity building for the national genetic resources centers in CAC countries
8.5. Plans for assistance to NARS in the CAC countries in 2004-2005

Background
ICARDA has a mandate to collect, conserve, and document crop and pasture plant genetic resources and to support the national programs in this activity through training and capacity building initiatives. Towards this end training of NARS personnel who are engaged in PGR conservation activities and research has received top priority at the GRU. A full list of training courses conducted and the number of participants who attended them is given in Appendix D at the end of this report. The detailed description of all training, capacity building and assistance to the NARSs is given below.

8.1. TRAINING

8.1.1. *Training in genetic resources conservation*
In 1998 GRU provided training in genetic resources activities to a total 65 NARS staff in three short-term group and 14 individual training courses. Two group-training courses were conducted jointly with IPGRI and one, on Conservation and Utilization of Genetic Resources, was newly established in Syria in collaboration with the University of Birmingham, U.K. In 1999 the GRU provided training in genetic resources activities to a total 75 NARS staff in six short-term group and eight individual training courses.

8.1.2. *Genetic resources documentation training course*
The regional training course on "Genetic Resources Documentation and Information Management" was held in November-December 1998 at

GRU/ICARDA. The course was organized jointly by ICARDA and IPGRI regional CWANA office. Participants came from Algeria, Egypt, Iraq, Libya, the Palestinian Authority, Oman and Syria, as well as from Kazakhstan and Uzbekistan. The course covered data management, data exchange, data analysis, data presentation and dissemination both in print and electronic forms. The participants were introduced to the latest concepts and techniques available in terms of data management, application development, information dissemination and exchange, and data analysis. The emphasis was laid on practical, hands-on training using comprehensive data sources including SINGER database. In addition, the NARS were assisted by the GRU's Documentation Specialist, J. Konopka, in setting up their own germplasm data-bases. For instance, computers at the documentation unit of the Uzbek Research Institute of Plant Industry (UzRIP) were networked and assistance in the development of UzRIPI genetic resources documentation system was provided.

8.1.3. ***The GRU/ICARDA/University of Birmingham training course***

The leading training and research reputation of the School of Biosciences and the Royal Botanic Gardens in the conservation and utilization of botanical diversity is well established. Since 1969, the University of Birmingham has provided short course and MSc training for over 1,200 students from 93 countries in fields such as *in situ*, *ex situ* and *in vitro* conservation, applied taxonomy, crop diversity and seed technology, as well as aspects of plant breeding and biotechnology, leading to the effective utilization of plant genes.

Specific Course Objectives

Specifically the course aims to provide:

- An understanding of genetic variation within the botanical diversity of crops and wild species;
- The ability and confidence to formulate effective conservation management policies;
- The skills to implement and integrate *ex situ*, *in situ* and *in vitro* conservation strategies;
- The competence required to manage *ex situ* (genebank) and *in situ* (reserve) collections;
- An understanding of breeding and biotechnology, and how genetic resources may be utilized for the benefit of humankind;
- The ability to identify, research and resolve a detailed scientific problem;
- An introduction to the international conservation and utilization community;
- An understanding of the ethical, moral and economic issues involved in the conservation and utilization of botanical diversity.

During each year at Easter time, all students of the MSc course on "Conservation and Utilization of Plant Genetic Resources" in the Department of Biosciences, University of Birmingham, UK, participate in a 14 day field course to the Mediterranean region. Recently the course has been given in Turkey and Syria. The object being to develop practical aspects of the theoretical subjects covered in detail in Birmingham. The areas covered include: *ex situ* conservation of wild and crop species, field seed conservation, population sampling strategies, inventory making, plant identification, voucher specimen collection, vegetation assessment, *in situ* reserve management, community ecology and field data collection. In 1998, the annual ICARDA/University of Birmingham training and study tour to came to Lebanon and Syria. The course included 10 students from six countries. In 1999, two group-training courses were conducted jointly with IPGRI and one, on "Conservation and Utilization of Genetic Resources", that was started in Syria with the University of Birmingham, U.K. in the previous year. This collaboration in training continues with the University of Birmingham and details of the trainees are given in the Appendix D.

8.1.4. *Short-term training course on use of molecular markers*

The use of molecular markers is a recently developed technique and scientists and students in the ICARDA region are eager to learn more about it. As a compliment to morphological, biochemical, ecological and genetic information, molecular markers can contribute greatly to the use of genetic diversity through the descriptive information they provide on the structure of gene pools and genotypes. Several hundred markers scattered all over the genome still constitute only a small fraction of the total genome. The analysis of such markers, reveal patterns of broad evolutionary trends or lines of evolution. These patterns reflect mutations accumulated over millennia of descent from distant ancestors, and may not necessarily be related to the occurrence of genes that control traits of economic or agronomic importance. The occurrence of useful genes may respond more to external selection pressures then the markers utilized to study genetic structure. Safety and availability of reagents in diverse institutions is also an issue that motivates the development of methodology and the choice of analytical tools. The training course included the following parts:

1. Techniques for analysis, characterization and conservation of plant genetic resources;
2. Total DNA extraction from plants;
3. Randomly amplified polymorphic DNAs (RAPDs);
4. Amplified fragment length polymorphism (AFLP);
5. Micro-satellites (SSRs);
6. Measuring genetic distance;
7. Current developments in the field.

During 1999, a much-in-demand short-term training course on "Use of Molecular Markers in Biodiversity Studies" was conducted once again by the GRU with practical training in the special lab. The course, conducted under the direction of K. Chabane, Biotechnologist, was repeated every alternate year and was organized in 2001 and 2003 as well. In 1998 GRU also received two MSc degree students for training in molecular genetics from Lebanon (R. Kassis) and Eritrea (A.M. Zerezghi). Currently two MSc degree students from, one from Guangzhou University in China (Ronghua Li) and the second from University of Aleppo (F. Alo) are conducting research on AFLP fragment from *Aegilops* spp. and molecular characterization of cereals, respectively.

8.1.5. ***Training course in seed science and technology in Afghanistan***
As part of the action plan of the Future Harvest Consortium to Rebuild Agriculture in Afghanistan led by ICARDA, a training course in Seed Science and Technology was organized in the Kabul College of Agriculture in Afghanistan from 8 to 15 July 2002. S. Asaad from the GRU/ICARDA Seed Health Lab conducted lectures on seed health testing aspects and practical training sessions. The course was attended by 75 participants from NGOs operating in Afghanistan, several government departments and other organizations and institutions. All participants were involved, at managerial or at grass root levels, in quality seed production and distribution. They came from all over Afghanistan specially to attend this course.

8.1.6. Seed health testing training
The SHL has expanded, during the last ten years, a considerable effort in transferring the seed health testing knowledge to national programs. This was done through training courses and assistance in the establishment of seed health laboratories. Egypt, Iran, Iraq, Jordan, Pakistan, Syria and Turkey are among the other CWANA countries received this kind of assistance in 2001. S. Asaad, Research Associate, from GRU/ICARDA's SHL went to Iran to assist in the setting up of the Seed Health Unit at the Seed and Plant Improvement Institute (SPII) in Karaj, Iran. S. Asaad also attended and represented ICARDA at the International Workshop on Seed Health Testing, 3-8 December 2001, in Taipei, Taiwan.

In collaboration with Seed Production Unit (SPU) of ICARDA, the Seed Health Lab (SHL) of ICARDA conducted a seed health train-the-trainer course in May 1998 for 11 participants that came from Iran, Pakistan, Morocco, Egypt, Syria, Iraq and Turkey. In addition, SHL staff provided individual training on seed health testing to NARS participants from Iran (one month), Syria (one week) and Ethiopia (10 days).

During 2002 the SHL also gave individual training courses on seed health testing and field inspection to six trainees from Iraq, Syria and Jordan (two per country). The SHL also gave training on aspects of seed health through (1) a two-week seed quality course held at Seed and Plant Improvement Institute SPII, Karaj, Iran; (2) a one-week seed science and technology course held in Kabul, Afghanistan, and (3) a four-day course on the production and processing of indigenous forages, held at Sharjah, UAE.

Individual training course on Seed Health Testing
Individual training was provided to 6 trainees from 4 countries (2 Iran, 2 Syria, 1 Jordan and 1 Algeria) "Seed Health Testing" in the SHL at ICARDA. S. Asaad of the SHL also conducted an in-country follow-up training course on "Seed Health Testing" in Egypt 1-13 September, 2000. A second course at ICARDA was organized 15-26 September 2002. This course was attended by 2 individual trainees from Syria and 2 from Jordan. In addition, individual training was provided in all aspects of genetic resources conservation work to 14 trainees from 8 countries other. In 2003, the SHL once again organized individual training courses at ICARDA on "Seed Health Testing", September 21-October 2, for two participants from Syria, and December 7-18 for a single trainee from Mauritania and a two-week training individual course on "Identification of Seed-Borne Pathogens in the Field" was conducted for 8 Syrian and 1 Libyan trainee.

Regional training course on Seed Health in Sharjah (UAE)
As a part of introducing seed health aspects to Arabian Peninsula Region, S. Asaad presented two lectures in the regional training course on "Production and Processing of Indigenous Forage Species" in Sharjah (United Arab Emirates), July 14-17, 2002. The course was attended by 15 participants from seven different countries of the Arabian Peninsula region. The two lectures were on: "Seed health and testing methods" and the on "Seed health and quarantine regulations".

8.1.7. *Short-term training courses*
Seven short-term training courses were conducted in 2000 at GRU/ICARDA covering different aspects of genetic resources conservation activity, including a course on Seed Health Testing conducted by the SHL. Fifty-six trainees from five CWANA NARS took advantage of these short-term training courses. During 2002, two short-term training courses were conducted, attended by a total of 14 participants. The first course was on "Molecular Tools for Biodiversity Studies" and the second was on "Seed Bank Management". In addition, GRU staff conducted two in-country short-term training courses in Jordan and Afghanistan on Rangeland and Livestock Management and Germplasm Methodologies, respectively. A total of 22 participants attended these courses.

8.1.8. *Group and individual training*

In addition, group and individual training was provided in all aspects of gene bank activities to 41 trainees from 9 CWANA countries in 2003. Also, English language skills and gene bank terminologies instructional training was provided to PGR units staff in all CAC countries.

8.1.9. *A women's traveling workshop in Jordan, Syria and Lebanon*

The GEF-UNDP Dryland Agrobiodiversity Project organized the "Women Traveling Workshop" for participants from the four countries, Jordan, Lebanon, Syria and Palestine, from 27 July to 5 August 2002. The countries that sent candidates for training were: Jordan, Lebanon, Palestinian Authority and Syria. The workshop focused on visiting NGOs and agro-food factories to show alternative sources of income and possibilities of added-valuing the agrobiodiversity products based upon local knowledge of landraces and wild relatives of fruit crops.

S. Asaad from SHL, GRU/ICARDA supervised the workshop in collaboration with GEF-UNDP project representatives in the involved countries. The twenty-two participants from the four national components of the project participated in the workshop and also together visited the project activities in Jordan, Syria and Lebanon.

8.1.10. *In-country training*

In 2002, an in-country training course and assistance to establish and operate genetic resources databases in CAC countries was provided on the basis of training-the-trainers approach. Two senior trainees from Armenia and Georgia were trained by documentation staff of the GRU in operating Dbase software for PGR data storage and management with technical back-stopping provided by GRU Documentation Specialist, J. Konopka. Subsequently the two fully trained personnel from Armenia and Georgia traveled to all the CAC countries, spending as much time as needed in each country, and conducted the same training exercise in Russian, the *lingua franca* of the region, as well as including English terminology as appropriate to impart the instructions.

8.1.11. *Regional training and coordination workshop for Plant Genetic Resource Units in Uzbekistan*

A regional training and coordination workshop for Plant Genetic Resource Units was held in Tashkent, Uzbekistan (10-12 April, 2002). Organized by the CGIAR Program Facilitation Unit and GRU-ICARDA, the workshop was attended by 24 scientists from the eight CAC countries. The instructors were K. Street and J. Konopka (ICARDA), and N. Garvey (USDA). The workshop assessed the progress made by the units over the last 12 months, discussed and tried to find solutions to operational problems, gave training on updating the database system, in order to document *ex-situ* collections, and in using e-mail to develop links between scientists from different units.

8.1.12. ***CAC PGR units' scientists train at advanced institutions***
A few key personnel from the CAC countries' PGR units were selected for further training at advanced institutions in Australia and Russia. In February and April 2002, documentation specialists from Georgia (T. Jinjikhadze) and Armenia (N. Rukhykyan) visited Australia for two months, for training in GIS and gene bank management at the Australian Winter Cereals Collection (AWCC), Tamworth. L. Zubkova (Turkmenistan) trained for 3 months in molecular fingerprinting at the Center for Legumes in Mediterranean Agriculture (CLIMA), Perth Australia. In addition, in September 2002, a documentation specialist (Y. Akbarova) from Azerbaijan visited the VIR, St Petersburg, Russia, for two weeks, in order to receive gene bank management and documentation training. All this training activity was supported by the Australian Center for International Agricultural Research (ACIAR) and the Crawford Fund, Melbourne, Australia.

8.1.13. ***English language training***
Two scientists from the Uzbek PGR Unit attended a three-and-a-half-month English course in Tashkent (2001/2002). Another twelve scientists from PGR Units in Georgia (1), Kazakhstan (1), Kyrgyzstan (2), Tajikistan (3), Turkmenistan (2) and Uzbekistan (3) attended the same course in 2002/03. Finally, in October and November, the three documentation officers from the Caucasus attended an on the job training program at ICARDA in which they learnt to design and construct a web-page on the internet. They also sharpened their English language skills during this visit. The product of this initiative will soon be published and act as a valuable networking and information service tool.

8.1.14. ***On-job training in Morocco***
Morocco possesses a rich diversity of species on importance to dryland ecosystems. The collaboration between Morocco and ICARDA in areas related to genetic resources collection and conservation started in the early 1980s and continues to this day. Within the framework of INRA/ICARDA collaboration in genetic resources and biodiversity conservation, on-job training in crop germplasm conservation and documentation was provided to trainees from the gene bank at Settat, Morocco. B. Humeid and J. Konopka from GRU traveled to Morocco for two weeks in September 2003 for this training exercise, respectively.

8.1.15. ***Seed bank management training***
On-job training to the Settat Gene Bank, Morocco, was provided in the following areas related to genetic resources conservation and seed bank management in 2003:

- Germplasm storage,
- Viability testing,
- Moisture determination,
- Seed drying for storage
- Germplasm regeneration, rejuvenation and multiplication,
- Seed stock control system.

In all 1300 accessions of wheat, barley, lentil, beans, and rice were prepared for storage and deposited in the cold store. Each accession was labeled with two numbers: a MGB number, which refers to the Morocco gene bank code number, and a second number which refers to the position of each accession in the cold store for easy location of the sample.

8.1.16. *Data management training*

On the job training in genetic resources data management also was provided to relevant trainees at the Settat gene bank. All available passport information on the 1300 accessions in the gene bank was entered in to a data base with well defined files. A separate stock control file was created in the stock control database and all storage data (such as, weight of sample or number of seeds stores, date of storage, and location of the sample, etc.) was entered by the trainees themselves under supervision of J. Konopka, Documentation Specialist.

Following the completion of the training, The GRU/ICARDA experts discussed the 2004 work-plan for germplasm regeneration with the Head of the Settat Gene Bank, Dr H. Ouabbou. The work-plan includes: 1) Regeneration and characterization of 1370 accessions of cereals of Moroccan origin acquired from GRU/ICARDA gene bank by way of repatriation, 2) Regeneration and characterization of 200 accessions of barley landraces received for storage from Guish research station, Rabat and 3) Regeneration of 12 accessions of wheat from Morocco. It is expected that the K. Chabane, Biotechnologist, from GRU/ICARDA will continue this training component by conducting a course in Morocco on the use of molecular markers for studying agrobiodiversity in 2004.

8.2. CAPACITY BUILDING AND ASSISSTANCE TO THE NARS

8.2.1. Conserving plant genetic resources: a new regional network

Due to financial constraints, the region's national genetic resource institutes' links with other research institutes have become weak. The national institutes' abilities to collect, conserve, and document local and exotic genetic resources needed to be enhanced, to allow them to secure germplasm for national breeding programs. Therefore, in 1999, the Central Asia and Transcaucasia Network on Plant Genetic

Resources (CATCN-PGR) was established, involving all eight CAC countries. Within this network, eight plant genetic resources (PGR) units were established to focus on field crops in the region. ICARDA supported the training of PGR documentation specialists, and provided the eight units with computers, so that they could produce inventories and documentation concerned with the PGR in their countries. This work has been initiated, and is ongoing, in all eight CAC countries. In addition, to highlight the aims and achievements of the ACIAR-funded PGR-CAC project, and to raise awareness of the importance of PGR work in the region and to act as a networking and information sharing device an Internet website was developed in 2002.

A regional meeting of the CATCN-PGR network was organized jointly by ICARDA and IPGRI in Tashkent (20-21 June 2002). Scientists involved in two working groups attended the meeting: 1) on Cereals, and 2) on Medicinal Plants. A total of 23 specialists from each of the eight CAC countries participated, along with scientists from ICARDA and IPGRI. During the working sessions, they reviewed PGR activities for the period 1999-2002 and developed a work-plan for 2002-2004. This meeting was followed by the CATCN-PGR Steering Committee Meeting of National Coordinators (NCs), which was attended by all eight NCs as well as by representatives from IPGRI and ICARDA. Participants discussed issues related to the strengthening of PGR activities in the region and approved the proposed work plan for 2002-2004.

8.2.2. New facilities, new opportunities

Considerable improvements in PGR facilities have recently been made in CAC in 2002. An upgraded gene bank, and three genetic resource centers were inaugurated. At the request of Uzbek PGR scientists and in collaboration with Ministry of Agriculture and Water Management of Uzbekistan, ICARDA, IPGRI and USDA jointly upgraded the Uzbek gene bank facility at the Uzbek Research Institute of Plant Industry (UzRIPI) in Uzbekistan. This medium-term storage facility could serve as a gene bank for the whole region, with good quality seeds being conserved for 10-15 years. Thus, replanting of stored accessions can now be undertaken every 10-15 years, rather than every 2-3 years, resulting in considerable cost saving. Strengthening the NARS of the CAC countries through visits of the NARS scientists to ICARDA, and providing computer hardware, material, and a vehicle for genetic resources collection missions was also carried out in 2002.

8.2.3. *Assistance to NARS provided by Australia-funded projects*

One of the recommendations (No. 9) emanating from the Harlan Symposium on "Origins of Agriculture and the Domestication of Crop plants in the Near-East", held at ICARDA on 10-14 May 1997, was the following:

"After the report (presented) by the participant from the Vavilov Institute (VIR) in St Petersburg, Russia, an opinion was expressed by the Symposium that greater efforts should be made by IPGRI to rescue VIR's genetic resources and other collections, including historical records of collecting trips, herbarium specimens, etc., and to conserve them in a better shape (than at the present). It was noted that Spain had volunteered to multiply and rejuvenate some of VIR's germplasm collection free of cost in order to contribute toward this effort.

Similar apprehensions were expressed about the fate of genetic resources and archaeobotanical material assembled in Armenia and other Central Asian Republics due to total curtailment of funding. It was generally agreed that such "orphaned" collections and archaeobotanical material need to be rescued and their conservation ensured".

Two Australia-funded special projects entitled "Development and Conservation of Plant Genetic Resources from the Central Asian Republics and Associated Regions" and "International Linkages for Crop Plant Genetic Resources" have been able to make an important contribution to strengthening the national agricultural research programs in ICARDA's mandate region, especially in the CAC countries, and also to GRU staff strength. Dr K. Street was appointed as the coordinator for these projects and also acted as Legume Curator. Thus, recommendation No. 9 from the Harlan Symposium was addressed to a substantial extent as will be seen in this chapter.

The funding from the two special projects also enable GRU/ICARDA to provide the national programs in the CAC countries with the following much-needed goods and services:

- Two computers for the national program in Turkmenistan,
- Networking of existing computers in the documentation department at the Uzbek Research Institute for Plant Industries (UzRIPI), Tashkent,
- 16,000 seed envelopes were provided to UzRIPI for conservation of seed samples in cold rooms,
- A 4-WD rough terrain vehicle was provided to the Aral Sea Research Station in Chalkar, Kazakstan to facilitate exploration and genetic resources collection activities.

A well-attended technical workshop on crop plant genetic resources in the Caucasus was held during 4-6 December 2000 in Tashkent, Uzbekistan with the following objectives: to discuss the current status of crop genetic resources in the region, to find ways to overcome constraints to the development of genetic resources conservation activities in each country, and to draw up a plant of action to support the development of an independent genetic resources conservation program in each country.

8.2.4. *Technical workshop in Tashkent, Uzbekistan*

A technical workshop on crop plant genetic resources in the CAC countries was organized and held in Tashkent, Uzbekistan. Such in-country workshops generated sufficient interest in the agricultural research communities so that by the end of 2000, 7 out of the 8 CAC countries had agreed to set up their own genetic resources conservation units and began documenting their national genetic resources of field crops, forages and fruit trees.

8.2.5. *Exchange of visits with VIR*

Existing links with the Vavilov Institute (VIR), St Petersburg, Russia, through exchange visits and collaborative projects and research were further strengthened in 2000 and will continue in the following years.

8.3. Crop PGR developments in Central Asia and the Caucasus (CAC) – ICARDA's training initiatives

ICARDA has an institutional mission to collect, conserve and document crop and pasture PGR in the CAC countries and to facilitate the development of national program to do the same. ICARDA is undertaking a number of practical initiatives to fulfill this mission in Central Asia and the Caucasus.

To further the establishment of steering committees and working groups for the major crops in the region, there is a need for additional support for practical activities. To meet this need, national PGR coordinators, key scientists from each of the Republics, and representatives from VIR, ICARDA and the CGIAR Program Facilitation Unit, came together in December 2000 in Tashkent, Uzbekistan, to identify measures to begin practical PGR work at a national level. This resulted in an agreement being ratified by all the Republics to establish national three-person genetic resources units, with the aim of collecting, conserving and documenting national crop and pasture PGR. The initial task will include an inventory and documenting existing *ex situ* collections. ICARDA is supporting the formation of these national units by providing computer equipment, operational funds and training, following the identification of suitable personnel by the individual Republics.

Training began in May 2001 with a workshop for the Caucasus, involving the modification of the ICARDA PGR Database to meet the needs of the participants and to train them in its use. Participants also developed a comprehensive task list for each national unit, focusing on practical implementation of the unit's broader and long-term aims. A similar training workshop was undertaken in November

2001 for the Central Asian Republics. The project also supported higher degree studies (Msc and PhD) of 13 students from Jordan, 4 from Lebanon, 3 from Palestine and 5 from Syria.

Funding was also obtained to send members of the Armenian and Georgian PGR units to an Australian gene bank after having completed an ICARDA supported diploma in GIS analysis. These scientists will use their newly acquired GIS skills to contribute to joint ICARDA, NARS and Australian collaborative projects. Plans have also been developed to send a member of the Azeri PGR group to the Vavilov Institute in St Petersburg, for further training in PGR work.

Financial constraints in 2001 continued to be the most significant obstacle to the development of sustainable national PGR program in this region. To obtain the project funding required to sustain and build upon the work outlined above, a three-year extension to the Australian funded project was developed and granted to ICARDA by the ACIAR. This will enable the continuation of capacity development, collecting missions and germplasm evaluation. Additional funding is also being sought to modernize the seed storage facilities at the Uzbek Research Institute of Plant Industry in Tashkent.

8.4. Capacity building for the national genetic resources centers in CAC countries

The GRU/ICARDA has launched a number of initiatives to fulfill its mandate on the support to national programs in recent years. Following the establishment of project groups for the CAC region's major crops, a need was felt for additional support for activities on the ground. To meet this need, national coordinators and key scientists from each country came together with representatives from the Vavilov Institute, St Petersburg, Russia, GRU/ICARDA, and the CGIAR CAC Program Facilitation Unit at a meeting held in Tashkent, Uzbekistan, in December 2000. An agreement to establish national genetic resources project units in each country with a minimum staff of three scientists resulted from this meeting. The aim of these genetic resources units would be to collect, conserve, and document their respective national plant genetic resources for crop and pasture germplasms.

The first task was to conduct a survey and prepare an inventory of the existing *ex situ* collections and their current status. The GRU/ICARDA supported this activity by providing organizational know-how, hardware and training by way of providing equipment and operational funds for start-up and the necessary training. To that end, two data-base management training workshops were conducted in Georgia and Uzbekistan in May 2001 where trainees from other 5 CAC countries also attended. In addition, hardware such as computers (9), printers, and scanners were provided to the NARS in the CAC countries so that their personnel could put their training to use immediately in plant genetic resources conservation work. Workshop participants also developed a comprehensive task list for each national unit, that focused on implementing the unit's broader and long-term aims. Similar training workshop was undertaken by GRU/ICRDA in November 2001 for the Central Asian Countries.

With funding from the ACIAR, two scholarships were provided that enabled personnel from the newly established plant genetic resources units of Georgia and Armenia to travel to the Australian gene bank in Tamworth, NSW to get a hands-on practical training in gene bank management. These two trainees undertook the trip after they had completed a GRU/ICARDA-supported diploma course in the use of Geographical Information System (GIS) as an aid to planning germplasm collection and classification. These scientists will use their newly acquired skills to contribute to joint ICARDA, national, and Australian collaborative research projects (see 8.1.12).

Despite the above initiatives and activities, financial constraints continued to be the most significant obstacle to the development of sustainable national plant genetic resources programs in the CAC region. In order to harness further funding needed to sustain and build on the achievements so far, a three-year (2001-2004) extension of the Australia-funded project was proposed and accepted by the ACIAR. The extension has allowed capacity development to progress in the CAC countries and new collecting missions and germplasm evaluation activities were carried out in collaboration with VIR scientists that enriched both the GRU/ICARDA gene bank and the Australian gene bank with more unique germplasm. With the injection of additional funds it has become possible to modernize the existing seed storage facilities at the Uzbek Research Institute of Plant Industry (UzRIPI) in Tashkent.

Following requests made by the Director General of the Agrarian Science Center in Azerbaijan, the Ministry of Agriculture in Armenia and the Agrarian Academy in Georgia, ICARDA organized a visit by an expert in gene bank management, B. Humeid, from ICARDA's GRU to Azerbaijan and Armenia and Georgia. Ways of strengthening the Caucasian plant genetic resources conservation program were assessed, and the potential for upgrading seed storage facilities in the three countries were appraised. National and international funding proposals are now being developed to support their development.

8.3.1. ***Training workshop for CAC countries in Tashkent***

A training workshop for participants from central Asia was held in Tashkent, Uzbekistan, November 23 – December 5, 2001. In addition to this, talks were held with local NARS concerning issues related to the implementation of PGR initiatives and activities in the area. A concept note for the upgrade of the UzRIPI gene bank was presented to Japan International Cooperation Agency (JICA).

Arising from a technical meeting held in Tashkent, December 2000, each of the CAC countries committed to forming small Genetic Resource Units composed of a cereal, legume and documentation specialist. The first task of this group was to undertake a national inventory of their countries *ex-situ* seed collections of ICARDA mandate species and their wild relatives. Part of the support to be rendered by ICARDA was to train the documentation specialists. In May 2001 a training workshop on documentation was held for the CAC.

The participants were given a general introduction to relational database concepts after which they were introduced to the database developed and used by ICARDA's GRU. They learnt how to both extract and add new information to the database. The type and structure of the data that the PGR groups will be compiling in future was discussed. Based on this discussion the ICARDA database was modified to suit the individual needs of the PGR units of each country. They then practiced using the modified database by entering real data that they had bought with them. More advanced features of the database were demonstrated and practiced. After the workshop, it was gratifying to see that the participants had developed the skills necessary to undertake the inventory of their *ex situ* collections. A copy of the modified database including the user-friendly interface was left with each of the participants and will be installed on their computers for immediate use.

The workshop was organized and facilitated by GRU Documentation Officer J. Konopka, Z. Khalikulov (Program Facilitation Unit-PFU, Tashkent), and K. Street (GRU/ICARDA) with presentations by B. Laliberte (IPGRI), Z. Khalikulov (PFU), and M. Turdieva (IPGRI). T. Jinjikhadze from Georgia and F. Abdullaev from Uzbekistan, who have had previous training, attended to reinforce their own training and to provide assistance to the organizers, especially in language issues.

The following scientists from the NARSs participated in the workshop:
Z. Khalikulov (PFU), B. Laliberte (IPGRI-Europe), M. Turdieva (IPGRI-CWANA), T. Jinjikhadze (Institute of Farming, Georgia), F. Abdullaev (Uzbek research Institute of Plant Industry, Tashkent), I. Venera (Kyrgyz Research Institute of Farming, Bishkek), Y. Sakych (Kazakh Research Institute of Agriculture), K. Farkhad (Research Institute of Agriculture, Dushanbe, Tajikistan), and S. Ashirmukhamet (Garrygalinski Experimental Center of Plant Production, Turkmenistan).

8.3.2. *Strengthening the plant genetic resources conservation in Azerbaijan*
Azerbaijan is located in the southern Caucasus between 44°52 East Long. and 38°42 North Lat. where it borders the western coast of the Caspian Sea. The coun-

try is mountainous with major and minor Caucasus mountains as well as the tallish mountain chain to the north, west and east. Azerbaijan also has a large steppe area in the eastern part towards the Caspian Sea. The environment is very diverse and 9 out of 11 agroclimatic zones are represented in Azerbaijan. This topography exerts a strong influence on the environment with annual precipitation ranging from 500-800 mm in the median mountain ranges and the foothills, 1500 mm in the south-east plain region of Lenkoran, and only 200-300 mm in Kur-Araz or the lowlands of the Nakhichevan region.

Azerbaijan has a unique biodiversity of flora and fauna, crop landraces, as well as a fair share of wild relatives of crop plant. According to recent estimates the plant flora of Azerbaijan includes nearly 70% of the total flora of the whole Caucasus region. There are approx. 4700 plant species, out of which 237 are true endemics. The area includes the center of origin and primary diversity for several important crops of global importance. In fact, the Russian geneticist Dr P.M. Zhukovsky showed that wheat evolved in this region. This is borne out by the fact that 16 species of *Triticum*, 13 species of *Aegilops*, 9 species of *Secale*, 7 of *Hordeum*, and other cereals species as well are to be found in Azerbaijan. In addition to cereals, 400 legume species, 114 species of fruits and their wild berry ancestors, and 130 species of vegetable crops have been documented in this country.

Unfortunately, this rich diversity of plant forms is being severely threatened due to risk of genetic erosion. This is being caused by a series of factors that are a result of the collapse of the Soviet Union. During the Soviet era all the collection and conservation of plant genetic resources was carried out by the All-Union Research Institute of Plant Industry (VIR) in Leningrad, USSR (now St Petersburg in Russa). VIR scientists actively collected, evaluated and documented and stored the germplasm from Azerbaijan at St Petersburg and the Kuban Experimental Station in Kransnodar in Russia. However, after the disintegration of the USSR, Azerbaijan became a republic and was left with very little infrastructure and personnel to manage its own genetic resources.

At the request of Dr A. Musayev, Director General of Agrarian Science Center in Baku, Azerbaijan, GRU/ICARDA's gene bank manager, B. Humeid paid a visit to the country 6-12 April 2002. Mr Humeid observed that all of the collections of 34604 accessions were being maintained in paper bags, cotton sacks, or in glass bottles as breeder's collection without internationally recognized environmental controlled rooms for long-term conservation. This material needs frequent regeneration further straining the meager financial resources of the country. Therefore, it was recommended that a fully functional medium-storage facility be set up as soon as possible with the assistance of international donors. Cost estimates and floor plans for it have been drawn up by B. Humeid and K. Street. ICARDA will help in training 4 scientists who will be able to handle the functioning of a small plant genetic resources unit at the Research Institute of Agriculture 25 km from Baku. These scientists, who have received training and assistance from GRU/ICARDA, are: Z. Akparov (Head of the GRU and National Coordinator), R. Mirzaev (Legume Specialist), Y. Akbarova (Documentation Specialist), I. Karimova (Cereal Specialist), and A. Mammadova (Central Database Expert).

The Genetic Resources Institute of the National Academy of Sciences will make available an entire floor of a building that can be renovated and adapted to house the genetic resources unit and upgraded cold storage facilities (Table 29). Until then GRU/ICARDA had been conducting training on all aspects of PGR conservation for the national program in Azerbaijan.

Table 29. ***Ex situ*** **collection being maintained in Azerbaijan.**

Crop	Species	No. of Accs.
Cereals	18	15900
Legumes	20	3500
Vegetable melons	60	5812
Fruit berries	82	5884
Grape	2	643
Tea	1	263
Forage and pasture	50	1500
Industrial crops	8	1102
Totals	**241**	**34604**

8.3.3. ***Strengthening the plant genetic resources conservation in Armenia***

The Armenian plateau is located within the centers of diversity of West and Central Asia. Encompassing an area of 29,800 sq km, Armenia possesses unique biodiversity of flora and fauna. Almost all the vegetation types of West Asia are represented in Armenia. However, after the collapse of the Soviet Union and transition to new social, political and economic orders, Armenia, not unlike the other post Soviet republics in the CAC, faced severe financial difficulties and the subsequent agricultural and political upheavals with its neighbors.

During the Soviet era, plant genetic resources conservation activities were conducted in Armenia were supervised and conducted from the All-Union Research Institute of Plant Industry (VIR) in Leningrad (now St Petersburg). However, in the beginning of the post-Soviet era, Armenia like the other SSRs, was left with practically no infrastructure to carry on PGR conservation activities. Over 4,000 accessions of various crops, mostly landraces and wild forms, originating from Armenia are stored outside the country at other institutions, with VIR holding about a half of that number. Bereft of any technical expertise and physical facilities to maintain crop plant genetic resources in a sustainable state, Armenia turned to international help. Following the visit of B. Humeid and K. Street from GRU/ICARDA to Armenia during June 2002, recommendations for upgrading the existing cold storage facilities and training of gene bank personnel was made. Discussions were held with Armenian scientists at the Agriculture Academy and the Institute of Botany in Yerevan. A factory manufacturing cold store equipment was also visited to assess local expertise and capacity for fabricating the machinery required for at least a medium-storage facility. Final discussions for fine-tuning proposals and finalizing GRU/ICARDA assistance was held during 27-28 June with Dr L. Rukhkyan, Deputy Minister for Agriculture, Dr S. Avetissyan, First Deputy Minister for Agriculture, as well as N. Rukhkyan and R. Nazaryan of the Plant Genetic Resources Unit. The two major constraints identified were: lack of operating funds, and training. GRU/ICARDA stands ready to assist with the latter, but funds will have to be secured for international donor agencies to construct new cold storage facilities and buildings for PGR-connected activities.

8.3.4. *Strengthening the plant genetic resources conservation program in Georgia*

The republic of Georgia is located between 41°07– 43°35 North Lat. and 40°01–46°44 East Long. The country can be divided into two different climatic regions: The western part that is humid and warm, and the eastern part, moderately warm, with a continental climate. The topography of the country exerts a strong influence on the annual precipitation, which is more in western Georgia due to the proximity of the Caspian Sea.

As a result of this diverse mix of climatic zones, Georgia is very rich in genetic diversity of crop plant germplasm with a relatively large area supporting populations of wild wheat relatives. However, this valuable treasure trove of genetic resources is being threatened by recent events that include the collapse of the Soviet Union followed by immense socioeconomic upheaval. The crop plant germplasm conservation activities were being supported by VIR from St Petersburg (formerly Leningrad, USSR), Russia. But this support dried up after independence and Georgia was left without any technical backing to carry out PGR conservation activity and sought assistance from ICARDA. B. Humeid, GRU/ICARDA gene bank manager, visited Georgia in July 2002 to assess the situation and report on ways and means to assist the NARS and seek support from international donor agencies to upgrade their facilities.

At present, Georgia holds about 7000 accessions of its own germplasm at different institutions in the country (see Table 30). These samples are kept without proper refrigeration in paper or cloth bags, or in glass jars as breeders' working collections at the following institutions:

- Y.N. Lomouri Institute of farming, Tserovani
- Agrarian State University: Genetics and Selection Dept., Tbilisi
- N. Ketskhoveli Institute of Botany, Tbilisi
- Institute of Horticulture and Viticulture and Winemaking, Tbilisi
- Tbilisi Central Botanical Garden, Tbilisi

The collections at present are in danger of serious deterioration due to improper storage conditions even for the short-term. Therefore, it was felt that what was urgently needed is a medium-term storage facility to conserve this genetic resources. But a major constraint to the development of plant genetic resources conservation efforts in Georgia is lack of funding and expertise. ICARDA, therefore, took the initiative to train Georgian personnel and to develop plans for a modest genetic resources conservation unit staffed by three scientists who will be trained at GRU/ICARDA and consequently should be able to acquire skills to document and conserve the germplasm. However, funds need to be secured from international donors to assist in the physical facilities and infrastructure that would include a cold room with suitable environmental conditions for at least medium-term storage. B. Humeid, in consultation with K. Street, drew up an estimate of cost and plans for a genetic resources storage facility.

It is proposed that a fully functional genetic resources unit be established as soon as possible to undertake the following PGR activity:

- Exploration and further collections
- Documentation of existing collections
- Characterization of the collection
- Seed health testing of the collection
- Conservation
- Environmental monitoring using remote sensing and GIS.

The Y.N. Lomouri Institute of farming, Tserovani, will make available an entire floor of one of its buildings that could be renovated and adapted to house a genetic resource unit that also includes a cold room. A floor-plan for such a construction has been prepared by GRU/ICARDA scientists. While ICARDA is supporting at present the documentation of the national *ex situ* collections, what is urgently needed is functioning cold room with medium-term storage temperatures and humidity control with proper packaging of the germplasm. In the meantime, the Ministry of Agriculture has identified the three scientists to be trained at ICARDA as follows: T. Jinjikhadze (Documentation Office), R. Dzidzishvili (Cereal Curator) and A.

Zubiashvili (Legume and Forages Curator). The two curators are currently working on the inventory of the collection and creating a database. Concurrently, efforts are underway at ICARDA to secure funding. There are two options for this: 1) an in-country proposal could be developed and put up to the competitive grants scheme by GRU/ICARDA, and 2) K. Street, GRU/ICARDA will develop a funding concept note to be presented to the international donor community.

Table 30. Status of the current holdings of gene bank in Georgia.

Crop	No. of Accs	Crop	No. of Accs.
Winter wheat	3367	*Trifolium* spp.	3
Spring wheat	60	Cabbage	52
Barley	978	Salad beetroot	1
Oats	2	Cucumber	1
Corn (maize)	898	Carrot	10
Buckwheat	5	Potato	4
Setaria italica	2	Onion	20
Pennisetum spp.	2	Garlic	12
Sunflower	2	Eggplant	10
Peanut	46	*Capsicum* spp.	50
Bean	1001	Veg. Marrow	2
Soybean	91	Tomato	20
Chickpea	477	Coriander	3
Lentil	141	Dill	4
Vetch	46	Mint	2
Horse bean	42	Basil	2
Lathyrus sativus	46	Savory	2
Pisum spp.	60	*Lepidum sativum*	5
Lucerne	200	Parsley	2
Pumpkin	7	Celery	2
Muskmelon	28	Spinach	3
Watermelon	7	Lettuce	2
Onobrychis spp.	22	Saffron	2
Total			**6852**

The work of strengthening the capacity of national and regional genetic resources conservation institutions continued into 2003. The GRU met its training commitments to the fullest extent possible despite the current budgetary and staff constraints. With the addition of two new staff members in 2004, it is expected that the GRU will be fully staffed and that at least the latter constraint will have been addressed.

8.3.5. *Strengthening the plant genetic resources conservation in Kyrgyzstan, Tajikistan and Uzbekistan*

Following a request received from the Kyrgyz Agricultural Research Institute (KARI), Bishkek, Kyrgyzstan, GRU/ICARDA sent an expert in gene bank management, B. Humeid. Ways of strengthening the national plant genetic resources conservation program were assessed, and the potential for upgrading seed storage facility were appraised. The Farming Institute, a part of KARI, was visited 19-22 February 2003. Discussions were held with Acad. Dr J. Akimaliev, Director General of KARI, Dr M. Akimaliev, Director of the Farming Institute, and V. Iseava of the Kyrgyz Plant Genetic Resources Unit. The current status of the PGR activities was studied and avenues of GRU/ICARDA assistance noted to safeguard the crop plant genetic resources currently stored to the maximum extent possible. Due to the urgency, a self-contained, walk-in cold room was recommended. The option to upgrade the existing room into two parts and refrigerating one of them was also discussed. An estimate of costs for both options was prepared and a report submitted. Both options have almost the same cost, but the first option seemed to be more secure and effective to save the germplasm already collected in the past and the samples to be collected in the future, whereas the second option would afford greater storage capacity due to bigger size of the room. National and international funding proposals are now being developed to support the setting up of a cold room as soon as possible.

The next stop on B. Humeid's visits was Dushanbe, Tajikistan from 23-27 February 2003. Discussions were held on the same lines as above with Acad. Dr K. Jumonkulov, Secretary of the Tajik Academy of Agricultural Sciences (TAAS) and Dr B. Tolibbek, Director of the Crop Husbandry Institute. The current status of the PGR activities was studied and avenues of GRU/ICARDA assistance noted to safeguard the crop plant genetic resources currently stored to the maximum extent possible. In this case too, due to the urgency, a self-contained, walk-in cold room was the first option recommended. The second option was to upgrade the existing room opposite the documentation unit at the Plant Genetic Resources Unit of the Crop Husbandry Institute was also examined. A third option was to construct a special cold-room next to the existing genetic resources facility that can be easily connected later to the main building. An estimate of costs for both options was prepared and a report submitted. The first option would be the least costly but the storage capacity would be limited to about 6000 seed samples, the second option would allow about 8000 samples to be stored and the third option, with the highest storage capacity with be able to conserve the current as well as future genetic resources holdings of the country for up to 12,000 samples. In this case the last option would be the ideal one if funds could be found to execute the project. National and international funding proposals are now being developed to support one of the options.

The last stop was in Tashkent, Uzbekistan, where technical assistance was provided to UzRIPI on previously agreed issues, such as a shelving system in the cold store to allow maximum use of space. At the end of his stay 27 February-1 March 2003, Mr Humeid visited ICARDA's Central Asia and the Caucasus Regional Program office in Tashkent and briefed the regional coordinator of the outcomes of his visits.

8.3.6. ***Assistance to NARS of Yemen***

GRU/ICARDA played a major role in the implementation of Genetic Resources Sub-program 2.3 of the UNDP project on "Sustainable Environmental Management Program in Yemen Arab Republic". In 1998, and in the period Oct-Dec 98, in particular, the following activities were completed in collaboration with GRU/Agricultural Research and Extension Authority (AREA), Yemen:

- The existing cold storage facilities were upgraded, furnished and put into operation.
- The existing germplasm material was deposited in medium-term storage.
- Most of the equipment needed for running the genetic resources activities was purchased and delivered to GRU/AREA.
- Consultancy on plant genetic resources conservation strategy, including *in situ* conservation, was provided to NARS Yemen in October 1998. A discussion paper on plant agro-biodiversity conservation was developed to facilitate the deliberations of a national workshop to be held in 1999.
- Most of the germplasm originating from Yemen and held in ICARDA collections was returned to GRU/AREA.
- The support staff of GRU/AREA was trained on-the job in seed processing.
- Re-allocation of space (offices and labs) at GRU/AREA to different genetic resources activities was made.

In 1999 GRU/ICARDA completed the task on the implementation of Genetic Resources Sub-program 2.3 of the UNDP project "Sustainable Environmental Management Program in Yemen Arab Republic" except for an MSc study where several universities were contacted for acceptance. In addition, assistance was provided to Yemen to assess the genetic resources of its rangelands.

8.3.7. Assistance to NARS of Afghanistan

One the most important functions of GRU/ICARDA has been to repatriate genetic resources wherever they are lost due to human acts or infrastructure failures. This is one of those times when all the efforts and funds expended to maintain a truly reliable and active gene bank bear fruit. In the past germplasm has been repatriated to Ethiopia, when the farmers had lost their landraces due to war and had to abandon their standing crops for their own safety. The Ethiopian farmers, for cultural and other reasons including non-adaptability of foreign germplasm, insisted on continuing to grow their own landraces. Fortunately, ICARDA's gene bank had a comprehensive collection of cereals that could help the farmers. Similarly, when Morocco lost its collection due to malfunction of their storage facilities, ICARDA repatriated a collection of cereals and food legumes collected in that country.

Repatriation of germplasm

After the recent conflict in Afghanistan most of the agricultural research facilities were destroyed or vandalized. It was reported that in September 2002 vandals had destroyed Afghanistan's largest crop seed collection. The looters discarded the seed in order to take away the special plastic containers in which they were kept. ICARDA managed to recover seed material originating in Afghanistan from other CGIAR gene banks all over the world: Seventy-three accessions of beans from the International Center for Tropical Agriculture (CIAT), Cali, Colombia; 21 accessions of maize and wheat from the International Maize and Wheat Improvement Center (CIMMYT), Mexico; 723 accessions of chickpea, small millets and sorghum from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, India; 77 accessions of mixed genetic resources from the International Institute for Tropical Agriculture (IITA), Ibadan, Nigeria; 23 forage accessions from the International Livestock Research Institute (ILRI), Nairobi, Kenya; and 69 rice accessions from the International Rice Research Institute (IRRI), Los Banos, Philippines. In addition, over 2200 accessions of wheat, barley, lentil, chickpea, and forage legumes from Afghanistan assembled at the GRU/ICARDA gene bank were also readied to be repatriated to their country of origin and efforts are underway to restore the gene bank and the cold store facilities as soon as possible. Training is being provided to scientists from NARS of Afghanistan to man the new facilities when they are functional. Efforts will be made to re-collect as many varieties, landraces and their wild relatives from Afghanistan itself wherever it is safe to do so. In fact, 60 varieties of almonds have already been collected. Other vegetables (like carrots and radish) and fruits (such as cherry, plum, apricot, peach, pear, apple, walnut, pistachio, fig, and pomegranate), whose center of diversity includes Afghanistan, will also be targeted for re-collection as soon as possible. Fig. 13 shows S. Asaad of GRU's Seed Health Lab giving a training course on Seed Health Testing in Afghanistan to the staff.

Fig. 13. A training course on Seed Health Testing in Afghanistan.

The GRU staff provided training on developing germplasm collecting strategy through the use of GPS. Thirteen participants from five Afghan provinces of Kabul, Kunduz, Baghlan, Takhar, and Badakshan, who were supported by different agencies (The Aga Khan Development Network (AKDN), Kunduz Rehabilitation Agency (KRA)) took part in the training course. They were joined by some ICARDA staff stationed at Kabul and Baghlan provinces. The course included:

- Collection mission preparation
- Collection strategy planning
- Collection methodology
- Use of GPS
- Sample registration (collection forms)
- Sample handling

In addition to the above-mentioned class-room lectures and demonstrations, a practical (illustrative) mission took place to areas around Kabul (20 km west). Four collecting teams were formed, each consisting of two course participants and a counterpart from the provincial ministry of agriculture and livestock, and a driver. The four groups were deployed in the following provinces:

1 Kunduz province
2 Badakshan province
3 Baghlan province
4 Takhar province

The starting date of the collecting also was discussed keeping in mind the proper time for sampling in terms of maturity. The collection lasted for 2-3 weeks and was a success.

Strengthening the national plant genetic resources conservation program in Afghanistan

For identifying a suitable site for a Genetic Resources Unit, two agricultural research stations were visited near Kabul. Dar Al-Aman research station was found not to be appropriate. It was recommended to establish a functional genetic resources unit at Badam Bagh research station located in Kabul city to be responsible for the following activities:

- Exploration and collection
- Documentation
- Characterization
- Seed health testing
- Conservation
- Environmental monitoring using modern technologies such as remote sensing

A new building for the genetic resource unit would also include storage facilities.

The Seed health Lab completed important activities in Kabul, Afghanistan on Seed health testing

Start up and Calibration

The action plan of Future Harvest Consortium to Rebuild Agriculture in Afghanistan (FHCRAA) involved installation of three comprehensive and six quarantine seed testing stations. Start-up, testing and calibrating the seed health testing facilities at the Badam Bagh Seed Testing Station in Kabul was carried out by S. Asaad. The work was completed for the basic equipment, basic supplies, and safety measures and equipments.

Training on seed health testing

Further seed health testing courses were organized as part of the action plan of FHCRAA and involved for 11 participants from Afghanistan. The course was organized to provide the new staff of the seed health testing aspects, the managerial and technical skills that are necessary for efficient and effective running of the facility. ICARDA seed health specialist, S. Asaad, covered the course program with lectures and comprehensive practical training sessions in all aspects of seed health testing and quarantine. All the seed health testing equipment and facilities were operated in order to provide a live demonstration to the new staff. The staff then operated the same successfully on their own leaving them fully trained and experienced in day-to-day operations of the new facilities of seed health testing in Kabul.

8.3.8. *Feasibility studies for an Arab genetic resources center*

GRU staff and scientists traveled to the gene banks of Egypt, Morocco, and Tunisia to provide specific technical assistance. Feasibility studies supported by UNEP were undertaken by GRU/ICARDA for an Arab genetic resources center including a gene bank. However, the host country for the gene bank has not been identified, and no decision has yet been taken on the location of the gene bank.

8.3.9. *Expert technical consultation*

On invitation from the Government of the United Arab Emirates (UAE), S. Asaad submitted her recommendations to the Central Laboratories in Al-Ain, UAE to upgrade their Seed Health Lab facilities and techniques in order to carry out seed health tests and quarantine for the imported seeds and plants in to the UAE.

8.5. PLANS FOR ASSISTANCE TO NARS IN THE CAC COUNTRIES IN 2004/2005

The NARSs in the CAC countries require varying degree of assistance to set-up or upgrade their gene banks and related activities. The GRU/ICARDA staff, with financial backing from the Australia-supported projects, are providing this vital assistance since 1999 and this activity will continue to 2004 and beyond, if funding is still available. In the meantime GRU/ICARDA staff are assisting the CAC NARSs in identifying other donors to develop their PGR programs which have been 'orphaned' after the collapse of the Soviet Union and withdrawal of material and personnel support from VIR, St. Petersburg, Russia. The following is a list of activities planned in 2004 by country.

Armenia

1 Complete the inventory of all collections in the country, especially the ICARDA mandate crops
2 Monitor and gather data on characterization and evaluation
3 Check collection site data using GIS tools and disseminate this information widely
4 Promote web-site construction and updates
5 Assist in analyzing cytological and DNA data
6 Create a CD-ROM catalog of wild relatives and landraces from Armenia with all the data including pictures
7 Strengthen collaboration with breeders, both national and international, and facilitate in utilization of Armenian genetic resources, especially the wild relatives and obsolete forms
8 Assist in identifying donor agencies for upgrading gene bank.

Azerbaijan

1 Continue assistance in database organization and data collection and management
2 Organize further training on database management
3 Organize local training courses on PGR activities
4 Assist in establishing linkages with international organization
5 Assist in analysis of evaluation data
6 Facilitate information and genetic resources exchange with other gene banks
7 Participate in more collection missions
8 Organize expert collecting teams for targeting wild relatives and indigenous populations of crops.

Georgia

Despite the disturbed situation in Georgia the following activities are planned:

1 Completion of inventory on the passport data of all collections
2 Increase accessions through multiplication and improve quality of data
3 Initiate characterization of accessions in the gene bank
4 Assist in the in-depth evaluation of accessions (e.g., biotic stresses)
5 Seek donors for upgrading facilities and purchase of new equipment
6 Completing the gene bank construction and preparations for medium-term storage facilities.

Kazakhstan

1 Assist in completing inventory of gene bank collections by April 2004
2 Provide funding for a staff member to visit an international gene bank in order to get first-hand operational experience
3 The above person can then provide guidance in development of the gene bank in Kazakhstan.

Kyrgyzstan

1 Assist in completing inventory of gene bank collections by April 2004
2 Provide complete training for one documentation official
3 Complete construction of the gene bank.

Tajikistan

1 Continue inventory of ICARDA mandate crops and forest trees identified by IPGRI's CWANA office
2 Conduct 2-4 day visits to institutions in central and southern Tajikistan to obtain information on ICARDA mandate crops and their wild relatives
3 Conduct mini collections in the neighboring areas during the above visits
4 Continue the work of database expansion through data entry
5 Assist in characterization and evaluation of genetic resources
6 Set up a nursery for material collected in 2003 missions
7 Assist in web-site construction
8 Provide more individual training on database management.

Turkmenistan

1 Procure computer(s) and accessories to facilitate the inventory of national genetic resources
2 Provide training course in Tashkent to speed up inventory process
3 Complete inventory of all samples in the gene bank
4 Update and improve construction of web-site
5 Assist in the construction of a genetic resources unit, including procurement of equipment for separate rooms
6 Support English language training for PGR staff.

Uzbekistan

1 Assist in completing the inventory of passport data of genetic resources in the national gene bank. Complete inventory on ICARDA mandate crops
2 Organize a Workshop on database management and web-site construction
3 Conduct training courses on PGR documentation at UzRIPI
4 Complete the organization of databases and assist in publishing catalogs
5 Assist in promoting PGR activities through mass media.

9. IN-SITU CONSERVATION AND THE GEF-UNDP PROJECT

Dr Ahmed Amri, Dr Jan Valkoun, Mr Jan Konopka, Mr Bilal Humeid, Mr Ali Shehadeh and Mr Mohammed Hamran (GRU) and Dr W. Khoury (until 2002) and Dr R. Assi (Lebanon), Dr M. Ajlouni (Jordan), Dr A. Sawas (1999), Mr A. Khnifis (2000-2001), and Mr A. Saad (Syria), and Mr Y. Sbeih (Palestinian Authority)

9.1. Experiments simulating *in situ* conservation of crop wild relatives

9.2. Importance of conserving agrobiodiversity of West Asia – the GEF-UNDP Project on *"Conservation and Sustainable Use of Dryland Agrobiodiversity"*

Background

Conservation of plant biodiversity in natural habitats, *in situ*, is becoming a concern of the world community. United Nations Conference on Environment and Development (UNCED)'s Agenda 21, which was adopted at the Earth Summit in Rio de Janeiro in 1992, urged nations to take responsibility for conservation of indigenous biodiversity, including the wider gene pool of crops.

Syria, which is located in the heart of one of three world nuclear centers of agricultural origin is very rich in wild ancestors and relatives of globally or regionally important crops: wheat, barley, lentil, chickpea, vetch, chickling (*Lathyrus* spp.) and annual medics. These wild species have been growing in Syria for millennia and during their long history of existence they have accumulated a number of genes for adaptation to harsh climatic and soil factors in the region and for tolerance to biotic and abiotic stresses. These genes may be needed in current or future crop improvement programs.

Unfortunately, a part of the original biodiversity in this region has been lost due to several adverse factors. Among the most determinate are overgrazing by small ruminants and a loss of the natural habitat caused by changes in traditional farming practice (cultivation of grazing land, fallow replacement), by urbanization and other human activities. The loss of genetic diversity in a crop gene pool is called "genetic erosion". This negative trend is especially severe in most wild crop progenitors, not only in Syria, but also in other countries of the Near East.

The Syrian national program, in collaboration with international centers (IPGRI and ICARDA), has conducted a number of collection trips during the last two decades to locate and sample the remaining populations for conservation in gene banks (*ex situ*). Although this joint effect yielded a number of new gene bank accessions, the trips conducted and subsequent studies revealed two factors for concern:

I) The extent and speed of natural habitat destruction in wild crop progenitors is alarming in most parts of the country;
II) Genetic diversity of some natural populations of wild wheats is so high that these could not be adequately sampled and maintained in an *ex situ* collection.

To avoid these constraints, the gene bank germplasm *ex situ* collections should be integrated with *in situ* conservation of native populations in their original habitats. However, little is known about this method of germplasm conservation and, consequently, there is no standard methodology available for *in situ* conservation of wild progenitors of cereals and legumes. Additional research is, therefore, needed to develop practical guidelines for *in situ* conservation of wild species and crop progenitors and relatives in different agro-ecosystem of Syria. The current collaborative research between Agricultural Research Center (ARC) Douma, Syria and ICARDA has been started as a pilot project with the main goal of bringing new knowledge applicable to natural population and ecosystem management in larger *in situ* conservation activities anticipated in the Near East region. The focus was on *in situ* conservation of wild *Triticum* species, since these are globally important as a genetic resource and, at the same time, probably the most endangered crop genetic resources in the Near East center of crop origin and diversity.

9.1. Experiments simulating *in situ* conservation of crop wild relatives
As very little is known about the management and sustainable utilization of ecosystems with natural populations of crop annual wild relatives in the Near East, GRU/ICARDA initiated in 1992 two pilot experiments on its main experimental farm. In 1994 and 1995, in collaboration with NARS of Syria, larger experiments were set up on three national program research stations (Ain Al-Arab, Sarghaya and Yahmoul) of the Agricultural Research Center (ARC) to simulate *in situ* conservation of the target species. Experiments with self-regenerating populations of wheat wild progenitors were established at Yahmoul research station of the ARC near Aleppo in 1994 and in 1995 at two more research stations in southern Syria.

The main objectives of these experiments were to: 1) study the feasibility of restoring lost natural populations of wheat and other wild relatives using seeds from accessions collected from previous natural populations in those very same areas and conserved *ex situ* in the ICARDA gene bank, 2) establish self-regenerating local populations of wild *Triticum* spp. and their mixtures with other cereal and legume species. The aim was to study the population dynamics under simulated conditions similar to actual *in situ* conservation sites; 3) have a reference populations for *in situ* site management studies in order to develop appropriate methodologies for conservation of cereal and other wild relatives; 4) restore semi-annual plant eco-systems similar to those that had existed in the region before the land was cultivated and grazed, and 5) train the ARC staff in species identification and in monitoring natural populations of wild relatives of cereals and legumes for future *in situ* conservation projects.

All the experiments were planted using seeds from ICARDA gene bank based on the proximity of the original populations to the experimental site, both in geographical and ecological terms. Fifteen cereal wild relatives (*Triticum, Aegilops* and *Hordeum* spp.), six wild *Cicer* and *Lens* spp. and ten cultivated forage legume species (*Medicago, Lathyrus, Trifolium and Vicia*) were used (Table 31).

9.1.1. *Experimental sites*

Three ARC Douma research stations, Ain Al-Arab, Sarghaya and Yahmoul, were selected, because of their vicinity to large natural populations of wild *Triticum* in the Jebel Al Arab, the Anti-Lebanon mountains and the Jebel Samaan, respectively. However, as the experimental site at the Jebel Al Arab research station was repeatedly damaged by water logging, the experiment was cancelled after two years and, consequently, its description is not included form this report.

- Yahmoul, ARC Research Station; 510 m a.s.l., 550 mm annual rainfall.
- Serghaya, ARC Research Station; 1450 m a.s.l., 600 mm rainfall.

There were four types of treatments at different levels of complexity:

i) A mixture of morphologically distinct single plant progenies derived from single natural populations of a single species.
ii) A mixture of population bulk samples of a single species;
iii) A mixture of population bulk samples of cereal species; and
iv) A mixture of population bulk samples of cereal and legumes species.

The experiments at each station comprised 16 square plots of 100 m^2 (10 X 10 m) separated by alleys of 2m of width were used for all treatments. The plots were arranged in a randomized complete block design with two replications. Characterization of the individual treatments is presented in the sub-projects developed for each location for Yahmoul and Serghaya sites, respectively.

Population dynamics was monitored from time to time each season in five 1 m^2 quadrates of each plot. There were 8 treatments, which included genotype and species mixtures of different complexities, with two replications each. The initial planting density was 30-50 spikelets/m^2 in single-species treatments. Controlled grazing by sheep commenced in 1998 at both sites and the initial results are encouraging.

Table 31. Cereals and food legume wild relatives and pasture and forage species used in Yahmoul, Serghaya and Sweida locations.

Cereal relatives	Food Legume Relatives	*Forage and Pasture Species*
Triticum urartu	*Lens orientalis*	*Vicia sativa*
Triticum dicoccoides	*Lens odemensis*	*Vicia narbonesis*
Triticum baeoticum	*Lens ervoides*	*Vicia ervilia*
Hordeum spontaneum	*Cicer bijugum*	*Lathyrus cicera*
Aegilops searsii	*Cicer pinnatifidum*	*Lathyrus sativus*
Aegilops vavilovii	*Cicer judaicum*	*Medicago rotata*
Aegilops columnaris		*Medicago radiata*
Aegilops triuncialis		*Medicago rigidula*
Aegilops biuncialis		*Medicago polymorpha*
Aegilops peregrina		*Medicago orbicularis*
Aegilops caudata		
Aegilops kotschyi		
Aegilops speltoides var *speltoides*		
Aegilops speltoides var *ligustica*		
Aegilops geniculata		

9.1.2. *Results at Yahmoul site*

The Yahmoul experiment showed that during the first three years (vegetation seasons) mean number of plants per m^2 (average of five m^2 per plot) increased in diploid species, from approximately 30 in the first season to 95 in the third one for *T. baeoticum* and to 85 for *T. urartu* and to 45 in tetraploid *T. dicoccoides*. Diploid wild wheat *T. baeoticum* showed a consistent increase in number of plants per m^2 during the three-successive seasons regardless the environmental conditions persist. While *T. urartu* did not show any remarkable increase during 1995,1996,1998 and 2001 seasons, the remarkable increase occurred during 1997 season, which could be due to good rainfall distribution at that year. This indicates the strong ability of *T. baeoticum* followed by *T. urartu* for self-regeneration in this area. On the other hand tetraploid wheat *T. dicoccoides* showed a slight increase in the first three successive seasons and then decreased dramatically to around 18 plants per m^2 in 2001 season (Fig. 14).

Results indicate that mean plant height in diploid and tetraploid wheat under study responded negatively to excess water, mean plant height decreased in *T. baeoticum* from 125 cm in 1995 (annual rainfall 414 mm) to 58 cm in 1997 (annual rainfall 665 mm). Mean plant height decreased from around 112 cm in 1995 (annual rainfall 414 mm) to 48 cm in 1997 (annual rainfall 665 mm) in *T. urartu* and from 97 to 57 cm in *T. dicoccoides* for the same period. The same trend can be detected in number of spikes per m^2 for diploid and tetraploid species under study.

In cereals mixture plots the results indicated that diploid wheat *T. baeoticum* could compete strongly with the other wheat relatives such as *urartu, dicoccoides* and *Aegilops*. Its self-regeneration capacity increased every year. *Aegilops* spp. have a low regeneration capacity and cannot compete with other wheat relatives in that particular area. Mean plant number of wild progenitor of barley, *Hordeum spontaneum*, decreased year after year and due to low competition ability it moved out from the plots and was located on plot borders. The same trend appeared in cereal legume mixture plots, where *T. baeoticum* was dominant over the other wheat relatives followed by *T. urartu* and *T. dicoccoides*. On the other hand, wild barley progenitor *H. spontaneum* behaves differently in cereal legume mixture plots, but the population size that was well established in the first two vegetation seasons rapidly decreased in the third vegetation season. *Aegilops* spp. included in this study have low regeneration ability in both cereal mixtures and cereal legume mixtures plots. Species can survive but with very low regeneration capacity. *Vicia narbonenses, Vicia sativa, Medicago polymorpha* and *Medicago rigidula* were dominant over other pasture forage legumes. On the other hand species of wild *Cicer* and wild lentil have low regeneration capacity, this could be due to low planting density or to the fact that wild *Cicer* and lentil cannot compete with other species.

9.1.3. *Effect of grazing*

Grazing and its effect on plant growth and distribution are important components under study. The experimental plots were subjected to sheep grazing for the first time in 1998 season, where 200 sheep heads for 5 hours in 1998 season and 300 heads for 10 hours in two days (150 head/day) were allowed to graze in 1999 season. Grazing was applied to soil surface. The primary results of grazing indicate that the total biomass which was eaten by 200 sheep heads (1998 season) increased in next season to feed 300 sheep heads in 1999 season. Feeding this good number of sheep adds a lot of money to the farmers' income. Grazing influenced positively the vegetation growth in most of the species under study regarding number of plants and plant height. Plots sown with *T. baeoticum* (diploid species) were characterized by healthy, tall and vigorous plants. The plants were evenly distributed within the plot and the spikes were of normal size. Also plots sown by *T. urartu* (another diploid species) had the same features but these were somewhat lower than normal. *T. urartu* was regularly distributed but the plots were invaded with *T. baeoticum*. Observations showed that *T. dicoccoides* (tetraploid spp.) had a poor stand, the plants were thinly scattered and shorter in height, low in tillers and susceptible to rust diseases. The legume species included in this experiment showed a slight progress in terms of plant number and plant height. The results of mean plants per m^2 increases are given in Fig. 12.

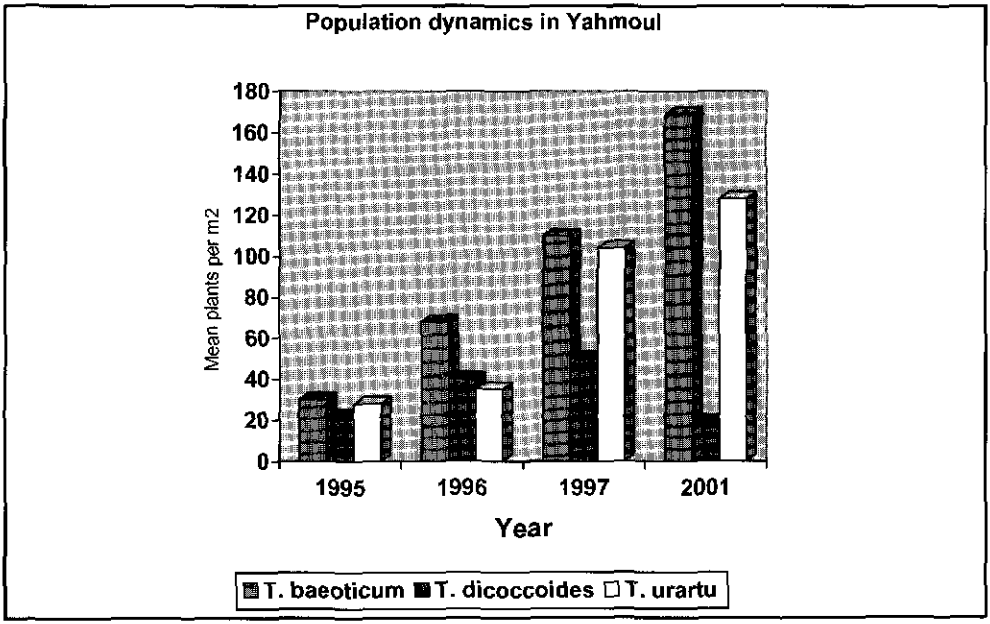


Fig. 14. Mean number of plants of wild *Triticum* spp. over the years at Yahmoul, Syria.

While it can seen from Fig 14 that the number of diploid species (*T. baeoticum* and *T. urartu*) plants have steadily increased over the years, the number of tetraploid species (*T. dicoccoides*) after a slight increase, dropped down considerably. This indicates that the diploid species are at an advantage in northern Syria, which is close to the center of domestication on einkorn (*T. monococcum*) in the Diyarbakir area in south-eastern Turkey and whose progenitor is *T. baeoticum*, whereas the tetraploid species fair better in southern Syria in the Sweida region, the center of domestication for the emmer wheat (*T. dicoccum*) whose progenitor is *T. dicoccoides*.

9.1.4. *Soil analysis*

Twenty five soil samples were taken for analysis at the Yahmoul site from the upper (0-20 cm) soil layer. In addition, at both Yahmoul and Serghaya sites four soil samples were collected from species-mixture plots in each replication, i.e., eight samples were obtained per species mixture treatment. The soil samples were analyzed for six characteristics by the Soil Laboratory at ICARDA in the Natural Resources Management Program (NRMP).

One of the results from these experiments was that the readings on Nitrogen (N), Phosphorous (P), Potassium (K), and Calcium (C) were different at the two locations (Table 2). However, their effect on the cereal mixtures by themselves and the cereal mixtures with the legume mixtures was significantly different at Yahmoul than at Serghaya. For example, in Yahmoul both the mixture types were significantly different ($P<0.01$) for N, and ($P<0.001$) for K and Organic Matter.

9.1.5. *Conclusions*

After the first six years, results at the Yahmoul site show that the diploid wild *Triticum* spp. and their mixtures, competed very successfully with the autochthonous vegetation (mostly weedy species of various families). The number of plants per m^2 increased in the diploid species *T. baeoticum* and *T. urartu* from approximately 25-30 in the first season to 130-170 at the end of 2001, and from 25 to 18 plants per m^2 in the case of tetraploid *T. dicoccoides*. It was also observed that the plant height and other morphological characters were similar to those of the natural populations of these species in the Aleppo province. The conclusions, therefore, are:

Firstly, the results so far show that self-regenerating, semi-natural ecosystems based on annual wild cereal (*Triticum*, *Hordeum* and *Avena* spp.) and forage and pasture legumes species of the Near Eastern origin can be established on cultivated land using seeds from an *ex situ* gene bank.

Secondly, they indicate that controlled grazing can be compatible with, and even beneficial for *in situ* conservation of the target species. It was concluded that an *in situ* conservation plot of $100m^2$ would be sufficient to conserve a population of 6000 to 15000 individual plants. The scientists involved continue to monitor these sites and the results will be reported in forthcoming reports.

These results and information acquired from the experiments in Syria provided valuable input in to the GEF-UNDP project on agro-biodiversity conservation in Jordan, Lebanon, the Palestinian Authority and Syria.

The complete details and results of these experiments are available in a report "**Research on *In-situ* Conservation of Wild Cereals and Legumes in Syria**", available from the Head, GRU on request.

9.2. Importance of conserving agrobiodiversity of West Asia – the GEF-UNDP Project

Background

The modern territories of the Near East (including Jordan, Lebanon, the Palestinian Authority, Syria, southeast Turkey, southern Iran and north eastern and western Iraq) encompass an area of megadiversity of important food crop and pasture species, also referred to as the 'fertile arc'. It is one of the few nuclear centers where numerous species (notably wheat, barley, lentil, chickpea and vetch) of temperate-zone agriculture originated 10,000 years ago, and where their wild relatives and landraces of enormous genetic diversity are still found. Many fruit trees such as almond, olive and pistachio also have their origins in this region and have dominated its traditional agricultural systems for centuries. They are present as a diverse range of wild relatives and local varieties. The biodiversity in this region is most outstanding for the within-species genetic diversity and the high number of endemic species. Additionally, indigenous crops and food plants of the Near East region are known for their resistance to disease and abiotic stresses, making them a valuable source of genetic material for germplasm enhancement upon which global food security depends.

The Near East region supports a human population of some 48 million with an average growth rate of over 3% per annum. For a majority of the population in this region, agricultural production is the principal economic activity. In an effort to achieve national food security through self-sufficiency, agricultural land use has been intensified and expanded, leading to degradation of vegetation, soils and water sources. Genetic diversity is seriously being eroded through the destruction of the natural habitats, intensification and expansion of cultivation and overgrazing in natural rangelands. Overgrazing is especially threatening annual herbaceous species such as, wild relatives of wheat, barley and lentils. For tree crops and their wild relatives, regeneration can be seriously impaired as a result of overgrazing. The replacement of the traditional farming system by modern agricultural practices is endangering the existence of landraces. In addition, food demands and market forces have encouraged the replacement of the locally adapted varieties (landraces and local varieties) of both fruit trees and field crops with higher-yielding cultivars in the case of cereals and food and feed legumes and hybrid varieties in the case of horticultural and vegetable crops, hence hampering the gene pools of these crops.

Conservation of dryland agrobiodiversity is receiving increasing attention with the emerging global concerns over biodiversity loss, desertification, and global warming. Dryland agrobiodiversity in West Asia sustains the livelihood of local communities and provides useful genes for plant breeding programs worldwide. ICARDA is conserving in its gene bank more than 131,000 accessions of its mandate crop plants, including landraces, obsolete varieties and their wild relatives. Conservation on site (*in situ*), in farmers' fields or protected areas, has been promoted recently as a complementary method to conserve a larger genetic base, while benefiting from natural selection and the knowledge of local communities.

A five-year project entitled "**Conservation and Sustainable Use of Dryland Agrobiodiversity**" was launched in 1999 to promote *in situ* conservation and sustainable use of dryland agrobiodiversity in Jordan, Lebanon, the Palestinian Authority and Syria. The project is funded by the Global Environment Facility (GEF) through the United National Development Program (UNDP), and is coordinated regionally by ICARDA. The Center also facilitates networking and provides technical backstopping and training, requested by national components, in cooperation with the International Plant Genetic Resources Institute (IPGRI) and the Arab Center for Studies of the Arid Zones and Dry Lands (ACSAD). The project activities are implemented at the national level by national research institutes National Center for Agriculture Research and Technology Transfer (NCARTT) in Jordan, Lebanese Agricultural Research Institute (LARI) in Lebanon, and the General Commission for Scientific Agricultural Research (GCSAR) in Syria, and the Ministry of Agriculture and the United Nations Development Program/Program of Assistance to the Palestinian People (UNDP/PAPP) in the Palestinian Authority. For a copy of the project document please see [http://www.gefweb.org/Outreach/outreach-Publications/Project_factsheet/MiddleEast_NAfrica-cons-1-bd-undp-eng-ld.pdf].

The project focuses on conservation of landraces and wild relatives of barley, wheat, lentil, *Allium* spp., feed legumes (*Lathyrus*, *Medicago*, *Trifolium* and *Vicia* spp.), and fruit trees (olive, fig, almond, pistachio, plum, peach, pear, and apple). A holistic approach based on the involvement of major stakeholders, principally farmers and herders, and on the coverage of major ecosystems and farming systems is followed. The main outputs of the project relate to: (1) assessment and monitoring of agrobiodiversity and generating knowledge about major factors contributing to its degradation; (2) demonstration of low cost technologies and ways to increase the productivity and marketability of products making use of agrobiodiversity; (3) drafting of appropriate policy and legislation reforms; (4) enhancing capacity building; (5) increasing public awareness; (6) investigation of alternative sources of income; and (7) impact assessment and contribution to the development of scientific basis for *in situ* conservation in addition to enhancing the regionality of the actions.

9.2.1. *Preliminary planning meetings*

In June 1999, following the stakeholders meeting held at ICARDA headquarters at Tel Hadya, the project began operations in Jordan, Lebanon, Palestinian Authority and Syria. ICARDA appointed Dr A. Amri from Morocco as the Regional Project Coordinator for the implementation of this project. After an initial period at GRU/ICARDA at headquarters, Dr Amri was posted in 2001 in Amman, Jordan.

The first regional technical and planning meeting of the project, held in Amman, Jordan, allowed scientists from national project components and from ICARDA, IPGRI and ACSAD to determine strategies and survey formats to assess the status and levels of degradation of agro-biodiversity with respect to specific species in target areas. Community driven and participatory approaches were adopted in the promotion of *in situ* conservation through workshops to explain the objectives and approach of the project to major local and national stakeholders. The process of site selection within target areas was initiated. ICARDA, the executing institution of the regional component, will provide the needed technical backstopping and training in cooperation with IPGRI and ACSAD.

The GEF-UNDP-funded project on "Conservation and Sustainable Use of Dryland Agrobiodiversity" completed its first year of operation in 2000.

Under the project, management units were established. Also, the selection of 24 project sites and 63 biodiversity monitoring areas was completed. Contact with local communities was made and public awareness activities were initiated. In addition, eco-geographic/botanic surveys were undertaken to assess the presence and abundance of target species under their natural habitats. The socioeconomic survey on the importance of landraces was completed in Palestine and Syria. Rapid rural appraisals were conducted at each community to gather indigenous knowledge on genetic resources of crop plants and their wild relatives, as well as on the community management of shared resources. Seeds of target crops and their wild relatives were collected from the project sites and other areas. At the same time, personnel were trained on *in situ* conservation concepts and methodologies and on natural resources management to help in implementing the objectives of the project. Farmers' workshops were organized to demonstrate the failure cases of alternative landuses that have affected the local agrobiodiversity. A regular bi-monthly Newsletter was started in 2000 [http://www.icarda.org/Gef/NewsLetter21.Html]. A report was prepared on the experiments undertaken on experiments simulating *in situ* conservation of wild relatives of crops at two Agricultural Research Center (ARC), Douma, Syria research stations and at Tel Hadya (see 9.1.). The main activities of the project can be summarized as follows:

- Selection of project sites and areas to be monitored,
- Contacts with local communities were established and public awareness activities initiated,
- Conducted socioeconomic surveys to assess the use of target species and related indigenous knowledge,
- Conducted ecogeographic and botanical surveys to assess the distribution and abundance of the target species and collecting seeds of the target crops and their wild relatives, and

- Providing training to the project staff and organizing farmer's workshops and fairs.

In the following years of 2001 and 2002, the project aimed to promote community-driven *in situ* conservation of the 16 target crop and forage species and their wild relatives. This list includes barley, wheat, lentils, vetches, grasspea, medicago, and onions, in addition to a variety of fruit trees, such as, olive, almond, pear, pistachio, prune, and fig. ICARDA's assistance is provided in cooperation with the regional CWANA office of IPGRI and ACSAD in integration of nationally executed project components, which include coordination, networking, raising awareness, technical backstopping, capacity building and training, and participation in monitoring and impact assessment of project activities. The achievements of the project in 2000 are listed below:

1 The establishment of project management units within each of the national implementing institutions.
2 Selection of project sites – twelve visits were made to target areas by the national program scientists accompanied by international experts and the Regional Coordinator, Dr Ahmed Amri. The visits led to the selection of 24 project sites and more than 63 areas for monitoring biodiversity across the major ecosystems and farming systems in the four participating countries.
3 Ecogeographic and botanical surveys were conducted in most of the areas identified in 1999 for the annual species. The preliminary results showed the negative effects of overgrazing and habitat destruction that follow agricultural encroachment leading to the loss of biodiversity for fruit trees as well as wild relatives of the target crops.
4 Two socioeconomic surveys, covering importance of landraces in Palestine and Syria, were carried out. Similar surveys were in progress in 2000 in Lebanon and Jordan. Rapid rural appraisals were also conducted in each community to gather and document indigenous knowledge on germplasm origin and selection by farmers as well as on the wild relatives of crop plants to ascertain the manner in which shared resources were managed.

9.2.2. Survey on factors affecting agrobiodiversity in West Asia region

In 2001 the project carried out a survey on factors affecting agrobiodiversity in West Asia region. The agrobiodiversity in the drylands of the West Asia is of special significance since it encompasses the diversity of plant species of global importance such as wheat, barley lentils, many forage and fruit tree species. Both landraces and the wild relatives of these species are still found under harsh environments but their acreage and abundance are increasingly reduced due to development of apple, cherry, and olive plantations that are more lucrative.

The GEF-UNDP project aims at promoting community-based *in situ* conservation of landraces and their wild relatives in two target areas in Jordan, Lebanon, Syria and the Palestinian Authority. In 2001, socioeconomic and eco-geographic surveys were conducted in 63 monitoring areas over 24 project sites during the last two years to assess the status of agrobiodiversity and the main factors responsible for its degradation.

The results of these surveys showed that landraces of wheat, barley, lentils, olives, figs, and almonds are still widely used by farmers while improved varieties are mainly used in case of apples, apricots and plums. But, the acreages of the landraces of barley, wheat and food legumes are increasingly reduced by the extension of new plantations of apples as in the case of Sweida in Syria and Ajloun in Jordan, of cherries as in the case of Aarsal in Lebanon and Berin in Syria, and of olives in Ajloun and Muwaqqar in Jordan, Jenin in the Palestinian Authority and Sweida in Syria. For the wild relatives of both field crops and fruit trees and the rangeland and pasture species (*Lathyrus*, *Medicago*, *Vicia* and *Trifolium* spp.), the number of species and their frequency and abundance were greatly affected by overgrazing and the land reclamation operated by local communities for plantation of trees mainly olives or to declare private tenancy on communal lands. The local communities reported an average of six landrace varieties for wheat and barley and more than ten for olives, grapes and figs.

The numbers of wild relative and rangeland target species revealed by the botanical surveys were far less than what was expected on the basis of data from previous surveys and flora studies. In case of wild *Triticum* species, *T. baeoticum* was not found and the abundance of both *T. dicoccoides* and *T. urartu* was highly reduced in Nabha and Ham sites in Lebanon, Sweida in Syria and Ajloun in Jordan. None of these *Triticum* species were found in the project sites in Jenin and Hebron in the Palestinian Authority. The surveys revealed, for the first time, the presence of *T. dicoccoides* at an altitude exceeding 1700 m a.s.l. that could harbor useful genes for cold tolerance and winter hardness needed for the improvement of durum wheat.

The socioeconomic studies reported the appreciation of local communities of the adaptation to harsh environments and the good quality of landraces compared to the improved varieties of barley, wheat, chickpea, lentil, olives, figs, grapes and apricots. But poor marketing opportunities are cited as major constraints for the development and widespread cultivation of the landraces. The project is working towards promoting local products as a mean for enhancing the *in situ* conservation of local agrobiodiversity through many activities including:

- Advertisement of local products through organization or participation in local and national agricultural and biodiversity fairs such as those organized in Lebanon, Ajloun in Jordan and Lattakia in Syria;

- Training of women on food processing of local products and the discussion with local communities on alternative sources of income like the development of apiculture and cultivation of medicinal plants;
- Increasing public awareness on the importance of the conservation of dryland agrobiodiversity by introducing the concept in school curricula, organization of extra curricular activities like participation in forestation efforts, organization of biodiversity clubs, painting of agrobiodiversity themes, and staging plays in theaters, etc.
- The project contacted the Departments of Forestry in each participating country to consider the use of local tree species in the forestation and landscape management efforts;
- On technical aspects, the project is demonstrating to local communities appropriate agricultural techniques that can enhance the productivity, the abundance of target species including the use of water harvesting techniques and low cost agricultural packages. The project is helping individual farmers and local NGOs develop nurseries for the multiplication of local fruit tree varieties and *in situ* conservation of their wild relative species;
- The project is also working towards the development of policies and legislation to empower local communities and ensure the implementation of international agreements (the Convention of Biological Diversity, the International Treaty for Plant Genetic Resources for Food and Agriculture).

This pilot project will also draw lessons and contribute to the strengthening of the scientific basis for the promotion of *in situ* conservation of local agrobiodiversity in the dry areas. It conducted many comparative economic analysis on the advantage and the sustainability of introduced species and improved varieties following the experiences undergone by local communities in case of the spread of apple-growing and introduction of improved varieties of olives and grapes.

9.2.3. Database of biodiversity surveys of GEF-UNDP project

An important component of GEF-UNDP project "Conservation and Sustainable Use of Dryland Biodiversity" are biodiversity surveys, which are conducted periodically in the selected monitoring sites of each country. Surveys yield comprehensive array of eco-geographical data, which help project staff to describe the dynamics of vegetation at project sites and to monitor target populations. In order to facilitate the management and use of the data from surveys as well as facilitate analysis of time-series data on the target area and regional levels the GRU of ICARDA has developed the database of biodiversity. The system is installed and used in each country while ICARDA maintains regional database, which is periodically updated with the data sent by national components of the project. Botanical surveys and the database follow standardized methodology. In each of

63 monitoring areas of 24 project sites in 4 countries, project staff collect the data on species (growth stage, cover/density, health status, etc.) growing on monitoring plots located on a transects. The data related to ecology and land use at the monitored areas are also gathered. Major factor of degradation of local agrobiodiversity was assessed at the levels of project sites and monitoring areas.

9.2.4. Community-based agrobiodiversity conservation in West Asia

During the 2002 season, the project had a significant impact at community, national and regional levels. Summaries of its achievements are given below.

The project has increased the use of wild fruit trees in reforestation efforts. More than 17,000 seedlings were planted during public-awareness campaigns run in Syria, while Forestry Departments in Jordan, Palestine and Syria increased the use of targeted species in their afforestation and reforestation programs. Wild fruit trees were used for the first time in afforestation efforts in Syria. In Jordan, the project has helped to create a biodiversity unit within the Forestry Department. Similarly, biodiversity and genetic resources units were created within the General Council for Scientific Agricultural research in Syria and the Ministry of Agriculture in Palestine. The project has also assisted local NGOs and individual farmers in Jordan, Lebanon and Syria in the creation of 11 agrobiodiversity nurseries, that focus on multiplying the seedlings of landraces and wild relatives of targeted fruit trees. Seven field gene banks and eleven *in situ* conservation sites have been developed by the project in the four countries, in addition to the enrichment of existing gene banks with more than 500 accessions of the target species.

Through eco-geographic surveys and the use of GIS/RS technologies, the project demonstrated that the main factor adversely affecting the diversity and abundance of wild relatives of fruit trees is destruction of the naturally occurring habitats as a result of reclamation of land in mountains and rangeland for agricultural use. The respective acreages of food crops and fruit tree are mainly being reduced by the spread of, and replacement with, apple, cherry and olive plantations using new varieties introduced from outside the region. The project documented the failure of these plantations at some project sites, and recommended that extension services consider the long-term economic benefits and losses before switching to new or introduced species.

The project has demonstrated the value of water harvesting techniques for the rangeland rehabilitation, and the value of seed treatment and cleaning in increasing the grain yields of cereals and legumes. In collaboration with local communities of herders, the best options for improved management of rangelands have been developed and will be tested on a large scale.

In its efforts to advise male and female collaborating farmers on alternative sources of income, the project has provided a total of 23 training courses and 21 farmer workshops on food processing, the development of apiculture and honey production (Fig. 15) and the cultivation of medicinal plants. A successful eco-tourism experience was also organized, in collaboration with the private sector in Lebanon and the local community of Ham. Additionally, a permanent agrobiodiversity store was created at Al-Haffa (Syria) and a weekly market organized at Ajloun (Jordan), both of which will allow local communities to sell products derived from their local agrobiodiversity.

Fig. 15. Women being given training in bee-keeping and its economics in Jordan.

The project has also been very active with regard to increasing public awareness of the importance of conserving dryland agrobiodiversity. This has been achieved through:

- organization of agrobiodiversity fairs in Jordan, Lebanon and Syria;
- participation in agricultural fairs organized in Syria and Jordan;
- introduction of biodiversity conservation into education systems (school curricula development is in progress, biodiversity clubs are being created in Palestine, and school gardens have been created, painting contests have been organized. Six MSc and 2 BSc scholarships have also been created in areas related to the conservation of target species);
- distribution of t-shirts, hats and calendars;
- collaboration with a rural theater, in order to prepare a play entitled "Life Box", and featured the agrobiodiversity of the project sites at which it was performed;
- participation in more than 25 radio and TV interviews, and the development, in collaboration with UN TV in Geneva, Switzerland, of a regional documentary film on the importance of preserving West Asian Agrobiodiversity. This will be broadcasted by 77 international channels;
- contributions to more than 10 regional and international conferences, where project managers and the regional coordinator highlighted the approach and achievements of the project.

The project is currently contributing information and expertise towards the development of different national policies and pieces of legislation in the participating countries. With the help of an FAO expert, the Syrian component of the project has drafted legislation regarding access to and exchange of genetic resources. The FAO will extend this expertise to the other three components in order to achieve this goal in their respective countries. The Regional Component organized (in collaboration with ACSAD, ICARDA, IPGRI, UNEP-Regional Office for West Asia (ROWA), FAO and the Arab Organization for Agricultural Development (AOAD)), the first Arab workshop titled "The Implications of International Agreements on the Development of National Policies and Legislations Related to Biodiversity Conservation". This was held at the Arab League headquarters in Cairo (28-30 May 2002). The Workshop was attended by invited speakers, and more than 55 participants representing the governments of Egypt, Saudi Arabia, Oman, Sudan, Lebanon, Syria, Palestine and Iraq, and the GEF-UNDP projects in Morocco, Tunisia and Algeria. Important recommendations were made to the Arab League by participants whose aim is the better coordination of efforts to conserve agrobiodiversity in the Arab world.

In addition, Project Managers have been very active with regard to empowering local communities. They helped to create local cooperatives (in Lebanon, for example), organized donor visits to project sites, and submitted proposals and obtained small GEF grants to support local communities and collaboration with other projects.

In Syria, 300,000 seedlings of target species were multiplied in 2003, compared to 30,000 in 1999. Awareness is increasing at all levels regarding the need to conserve agrobiodiversity. This has facilitated collaboration with tourism and education ministries and with other projects and nongovernmental organizations. Sites rich in agrobiodiversity have been identified for designation by governments in consultation with the local communities.

The project continued its efforts to develop the scientific basis underpinning the *in situ* conservation of agrobiodiversity, and has contributed to the development of new proposals focusing on the conservation and sustainable use of dryland agrobiodiversity in the participating countries.

In 2003, the GEF-UNDP West Asia Dryland Agrobiodiversity Project continued its efforts in Jordan, Lebanon, the Palestinian Authority and Syria in promoting the conservation and sustainable use of landraces and wild species of species of global importance originating from the Fertile Crescent diversity center. During the fourth year, the achievements and impacts of the project were consolidated while the actions to sustain the ultimate goals of the project and to involve more local communities were stressed.

9.2.5. *Governments move to implement recommendations*
At the national level, directives from the Ministries of Agriculture were given to the Forestry Departments and Services to use indigenous tree species in the afforestation efforts. More than 210,000 seedlings and plantlets were increased by private, community or government nurseries created or collaborating with the project and more than 3.5 million of these species were multiplied in Syria, Jordan and Palestine by Forestry Departments. The Palestinian Component distributed more than 32 tons of seeds of landraces of cereals, food and feed legumes to collaborating farmers and most of the harvest is sold as seeds to neighboring farmers.

9.2.6. *In situ conservation and rehabilitation of rangelands*
The project selected 15 sites rich in biodiversity of wild relatives of targeted species and their management plans were developed. Discussions are on-going with local communities and government institutions for the designation of the sites for an effective *in situ* conservation of their diversity. The project has also created two additional simulated *in situ* conservation sites for the development of scientific basis, and three gene banks for the conservation of landraces of fruit trees. The exploration missions undertaken with the collaboration of GRU/ICARDA permitted the collection of 48 populations of the wild progenitor of wheat, *Triticum dicoccoides,* from Jordan, Lebanon and Syria.

The following technologies were demonstrated and used: the rangeland rehabilitation options based on reseeding with native legumes, application of phosphorous, and the plantation of shrubs, combined with water harvesting techniques were implemented in large areas exceeding 50 ha per component. These efforts were carried out with increasing involvement of local communities in Mahareb (Jordan), Aarsal and Nabha (Lebanon), Dahriya and Al Ganoub (West Bank) and Saana and Mushanaf (Syria). The deferred grazing in more than 1500 ha in Sweida region of Syria south of Damascus continued allowing for the conservation of large populations of wild cereal and feed legume species. Feed block technology, using the by-products of local agrobiodiversity, is advertised to take the pressure out of the rangelands. The trials at actual farmer's fields and experiment stations allowed the collaborating farmers to realize the potential gains in grain yield of cereal and legume landraces (ranging from 17-82%) by utilizing improved seed cleaning and seed treatment techniques. The project provided incentives to buy seed cleaning and seed treatment equipment for use by individual farmers or communities to initiate the development of an efficient informal seed increase initiative. Communities and individual farmers were also trained and continuously advised on the development of nurseries for landraces and local varieties of fruit trees. The positive impacts of different water harvesting techniques and integrated pest management (IPM) techniques were also demonstrated to collaborating farmers.

9.2.7. *Value-added incentives to local communities and initiation of eco-tourism*

The project has increased its activities on added-value technologies and on alternative sources of income through training, continuous technical backstopping and providing incentives to members of local communities and specifically women (Fig. 16). The areas of support included, the creation of fruit tree nurseries, fruits-based products (such as jams, syrups, compotes, dry fruits, etc.) and even use of wild fruits, cultivation of medicinal and herbal plants, production of dairy products, honey and mushrooms, and the initiation of eco-tourism (e.g., in Lebanon). The project introduced the practice of making jam out of *Zizyphus* and wild *Pyrus* fruits and helped set up agrobiodiversity shops in Ajloun and Al-Haffeh, both historical and touristic sites, in Jordan and Syria, respectively, to promote the sale of local products. Opportunities were provided to local communities to advertise these indigenous products through farmer participation in agricultural fairs and facilitate marketing of the products through links with the private sector. Also, the permanent weekly market created at Ajloun Castle gives an opportunity for the farmers to sell their value-added products directly to the public.

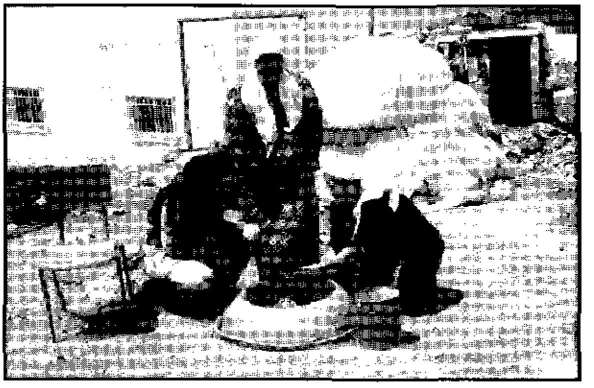


Fig. 16. Farmers, and especially women, are the end users of agrobiodiversity for value-added farm products (Palestine).

The Palestinian and Lebanese components organized agrobiodiversity fairs that have allowed individual farmers and local cooperatives and NGOs to present the products of local agrobiodiversity and handcrafts. Certain collaborating communities, NGOs, farmers and particularly women, have already reaped preliminary financial benefits emanating out of these initiatives of the project.

9.2.8. *Training activity of the GEF-UNDP project*

On aspects related to capacity building and increasing public awareness, the project organized seven regional courses. In addition, 38 national training and workshops were organized and that benefited directly more than 1430 participants including 48 women. Thirteen new MSc students graduated, and most of them are actually involved in the project. The first women and herder traveling workshops allowed, respectively, 21 women and 14 participants to exchange their experiences during the visits to the project sites in Jordan, Lebanon, Syria, ICARDA headquarters at Tel Hadya, and to several income generating activities of different projects. The technical backstopping was provided through more than 55 visits of the Regional Coordinator to the project components, and more than 25 international expertise provided by ICARDA, ACSAD and IPGRI scientists and many prominent visiting world experts.

Some 34 undergraduate students were supported in their studies and national and regional training courses were conducted for project team members, the staff of national executing institutions, extension staff, and forestry departments. The training covered use of DNA molecular tools and geographic information systems and remote sensing in assessing agrobiodiversity and genetic diversity; ecogeographic/botanic conservation; taxonomy and identification of target species; participatory breeding; *in situ* conservation and gene bank management; rangeland and livestock management; water harvesting; food processing; and other related topics.

Three thematic meetings on rangeland and livestock management, biodiversity and education, and on community participation and sustainable livelihood approaches were very instrumental in assessing the progress and in enhancing the regional integration and networking. The briefing on project strategy, aims and activities reached more than 5000 persons during the public awareness events including workshops, fairs, conferences, etc.

In addition, efforts continue with the Ministries of Education in the participating countries to include instruction on the importance of conserving biodiversity within the educational systems. In this regard, the biodiversity concept matrices, teaching methods and scientific guides have been drafted. Training to schoolteachers and education specialists was provided. Several of these kinds of activities were conducted with schools in targeted areas including creation of school gardens, documentation of local, parents' and indigenous knowledge on landraces and land uses, painting contests and discussion within environmental clubs. The school theater in Jordan and Palestine and rural theater in Syria performed plays on the importance of conserving local agrobiodiversity and conserving indigenous knowledge in many villages. The project has used mass media and produced posters, publications, t-shirts, postcards and calendars to increase general public awareness. A regional documentary film was produced in English, French and Arabic versions. The Palestinian component produced a documentary film on conservation of agrobiodiversity that was shown several times on the national and private television and cable channels. Several features from this film were shown as spots on Lebanese and Palestinian television programs.

9.2.9. ***Policy development on agrobiodiversity access, conservation and use***
In connection with the development of a national agrobiodiversity policy and legislation, the components of Jordan, Palestine and Syria drafted the technical, socioeconomic and institutional options that are either presented to Parliament, as in case of Syria, or under discussion by multi-institutional committees. With the help of the FAO, the collaborating countries will be assisted in developing national policies and legislations on access to and use of plant genetic resources. The achievements of this project and its output will require longer time to allow for more discussion at the level of local communities and to draw up legislation by respective the governments.

On the efforts to sustain the project strategy and activities, the Ministries of Agriculture in the four countries and the Directors of the National Executing Institutions asked for the continuation of this coordinated effort between international, national and local stakeholders and demonstrated their full commitment to contribute towards supporting more of the project activities and to replicate the approach in several other ecosystems. The project provided biodiversity enhancing in-kind incentives to lead farmers and local communities and helped local NGOs to get additional financial resources from GEF Small Grants program and from other donors. The initiated collaboration with the Ministries of Education, Environments and Tourism will help in the future to sustain the use of the agrobiodiversity as an educational, sustainable, and resource-generating tool.

9.2.10. ***Reforms of national biodiversity policies and legislation***
The project was able to develop a framework that includes steps to follow in the development of national biodiversity policies and legislation. The framework is actually shared with many projects and with biodiversity national experts from 14 Arab countries who participated in the "First Arab Workshop on the Implications of International Agreements on the Development of National Policies and Legislation Related to Biodiversity Conservation," organized by the project at the Arab League headquarters in Cairo, Egypt. The project is seeking the expertise of the Food and Agriculture Organization of the United Nations (FAO) for assistance in drafting national policies on collection, access and exchange of genetic resources. And with this assistance, the national components of Jordan, Palestinian Authority, and Syria drafted technical, socioeconomic and institutional options to be presented to their respective governing bodies or parliaments (in the case of Syria) for discussion and adoption.

9.2.11. ***Agrobiodiversity project's approached adopted by others***
The project's approach to work with local communities and to use local species is increasingly adopted by more than 47 other collaborating projects and NGOs

which are partnering in several of the project activities. The progress and success of the project in putting the pillars for a sound community-based biodiversity conservation approach and the significant preliminary impacts of the project were acknowledged during the Fifth Regional Technical/Planning and Regional Steering Committee meeting held in Lebanon in September 2003 [http://www.icarda.org/News/2003News/4Sep03.htm]. The meeting was inaugurated by their Excellencies the Ministers of Agriculture of Lebanon and Syria. In the light of this progress, some NARSs in WANA region have approached ICARDA to develop similar projects in order to benefit from the achievements and lessons learned within the West Asia regional dryland agrobiodiversity project. Letters requesting such collaborative projects were received from the NARSs of Algeria, Morocco and Tunisia. ICARDA is working towards the development of concept notes for undertaking these projects in the near future.

9.2.12. *Project impact so far and plans for 2004*

Over 3.5 million indigenous tree species were multiplied in Syria, Jordan and Palestine by the respective Forestry Departments. These will be used in the afforestation efforts in 2004. Fifteen sites that are rich in biodiversity of wild relatives of the target species have been selected and their management for *in situ* conservation is being developed and finalized. Rangeland rehabilitation options were demonstrated to the farmers and local communities. Awareness on better management of seed cleaning and treatment procedures resulted in increase of cereal landrace yields in the participating countries from 17 to 82%.

The promotion of activities based on value-added technologies and alternate sources of income increased through training and continuous back-stopping. Research and extension efforts are contributing to the promotion of conservation and sustainable use of dryland agrobiodiversity.

Further success will be achieved if the role of local communities is fully recognized, evidenced by their full participation, empowerment, and sharing in resulting benefits.

The project has highlighted activities and actions that will contribute to the ultimate goal of improving the livelihood of local communities while conserving agrobiodiversity, but greater national and international support might be needed to conserve endangered agrobiodiversity. Lessons should be drawn from the failed expansion of alternative crops promoted at the expense of rich local agrobiodiversity.

International Conference in April 2005

An international conference on "Promoting Community-driven Conservation and Sustainable Use of Dryland Agrobiodiversity" will be held at ICARDA 18-21 April

2005. The meeting will highlight the achievements of the GEF-UNDP funded project, and at the same time bring forth lessons learnt on some of the aspects of community-supported *in situ* conservation. The proposed themes are given below:

1. Understanding the status and current trends of dryland agrobiodiversity conservation utilizing a participatory and gender-sensitive approach;
2. Documentation of local agrobiodiversity in the livelihoods of local communities, indigenous knowledge, major factors of degradation and through the use of GIS/RS tools;
3. Technological and management options of agrobiodiversity within natural and semi-natural habitats including rangelands, forests and protected areas;
4. Technological and management options for managing agrobiodiversity inside farmers fields;
5. Added-value and alternative sources of income for the improving the livelihoods of the local custodians of agrobiodiversity;
6. Public awareness activities for promoting agrobiodiversity conservation through mass media and other means;
7. Valuation of dryland agrobiodiversity including uses such as genetic resources;
8. Enabling policies and legislations on access to agrobiodiversity, including national strategies and aspects related to benefit-sharing and intellectual property rights;
9. Impacts of global constraints and challenges on dryland agrobiodiversity conservation.

An invited speaker will deliver a plenary lecture for each of the above themes, followed by selected oral presentations and poster sessions. The refereed proceedings of the meeting will be published in 2006.

10. RESEARCH ON VARIATION AND EVOLUTION OF GENETIC RESOURCES

Scientists involved: Dr Kamel Chabane and Dr Jan Valkoun (GRU), and collaborators Dr Tsuneo Sasanuma (Kihara Institute, Yokohama, Japan) and Dr Takashi R. Endo (Kyoto University, Kyoto, Japan), Dr J.H.A. Barker and Dr A. Karp (University of Bristol, Bristol, UK), Dr Brian V. Ford-Lloyd, Dr Nigel Maxted, and M. van de Wouw (University of Birmingham, Birmingham, UK).

10.1. Taxonomic studies in the *Vicia sativa* aggregate;
10.2. Molecular characterization of cereal germplasm;
10.3. Collaboration with University of California, Davis.

Research related to unraveling the mysteries of variation and evolution by study of diversity patterns in populations of genetic resources using advanced techniques has been one of strengths of the Genetic Resources Unit. Dr K. Chabane, GRU Biotechnologist, and his group have been carrying out this research since 1997 in collaboration with advanced institutions. Molecular markers and use of electrophoresis to study variation patters in accessions of wheat, barley, and legumes has been carried out by Dr Chabane and his team and their findings are given in this chapter.

Collaboration with advanced institutions
Collaboration with advanced institutions to remain up-to-date and sharpen skills as been established with the following:

Collaboration with Kyoto University (Japan) to detect through AFLP fragment from *Aegilops* spp. and define microsatellites. Several microsatellites were found recently and on going work for constructing specific primer is undertaken.

Collaboration with University of Bristol (UK) for evaluation of genetic diversity in wild diploid and tetraploid wheats using AFLP markers.

Collaboration with University of Birmingham (UK) in molecular taxonomy of *Vicia* spp. based on AFLP.

Collaboration with Lismore University (Australia) for developing ESTs for barley is undertaken and we are expecting by the end of this year to get the sequences for using them for characterization of traits.

Collaboration with IPGRI (CWANA) for characterization of wild collection of pistachio from Syria using AFLP marker and characterization of *Vicia* spp using RAPD marker are on going work for year 2001.

Collaboration with Institut National de la Recherche Agronomique (INRA)-Ecole Nationale Supérieuren d'Agronomie Montpellier (ENSAM), Montpellier, France, for survey of functional diversity for drought tolerance and seed quality traits in Triticeae using microsatellite markers

Collaboration with University of California (Davis, USA) for study of genomic patters of wheat using microsatellites and molecular organization in Lens using AFLP abanalysis.

The year-by-year activities of the genetic resources related research project is reported below.

10.1. *Taxonomic studies in the* Vicia sativa *aggregate*

In 1998, DNA was extracted from 520 accessions of *Vicia* sativa, forming the tentative core collection of this species. The DNA was used for molecular fingerprinting of the accessions in a study to map the genetic variation of the species to identify gaps in the collection and possible *in-situ* conservation sites. This core collection of *Vicia sativa* was also planted in the field so that morphological characterization and basic evaluation data can be added to the fingerprinting data. Around 100 accessions were planted in pots for a study on the taxonomy of the *Vicia sativa* aggregate. This includes several accessions, which were acquired from outside of ICARDA representing taxa not yet included in the ICARDA collection. Besides the more traditional taxonomic data, also genetic fingerprinting data (AFLPs) will be used in an attempt to clarify the confusion that exists in the taxonomy of the species aggregate. Extraction of DNA has been completed and a start has been made with the molecular markers.

In 1998 GRU also received two masters' degree students for training in molecular genetics from Lebanon and Eritrea. The student from Lebanon defended her MSc thesis at the University of Beirut with distinction and was awarded her degree in 2000. The student from Eritrea finished his work in 1999 and returned to Eritrea to write up and subsequently defend his thesis.

In 1999 the taxonomic studies in the *Vicia sativa* aggregate continued from the pervious year. The core collection of 520 *Vicia sativa* accessions was planted in the field so that morphological characterization and basic evaluation data could be added to the fingerprinting data by AFLP. Around 100 accessions were planted in pots for a study on the taxonomy of the *Vicia sativa* aggregate. The study will be completed in 2000.

In 2000, 129 accessions representing the taxa in the series and originating from a very wide geographic area were evaluated using two primer combinations in an attempt to clarify its taxonomy. The accessions were analyzed for the first time using

AFLPs to study *Vicia sativa* and related species. The study concluded that four species exist in the series. *Vicia incisa* should be considered as a separate taxon and does not belong to the *Vicia sativa* aggregate. Within the series *Vicia pyrenaica* appears to be the most closely related to the *Vicia sativa* aggregate. Within the aggregate 6 taxa can be recognized. They are very closely related and for none of the taxa in the aggregate is there a taxon-specific absence or presence of AFLP bands.

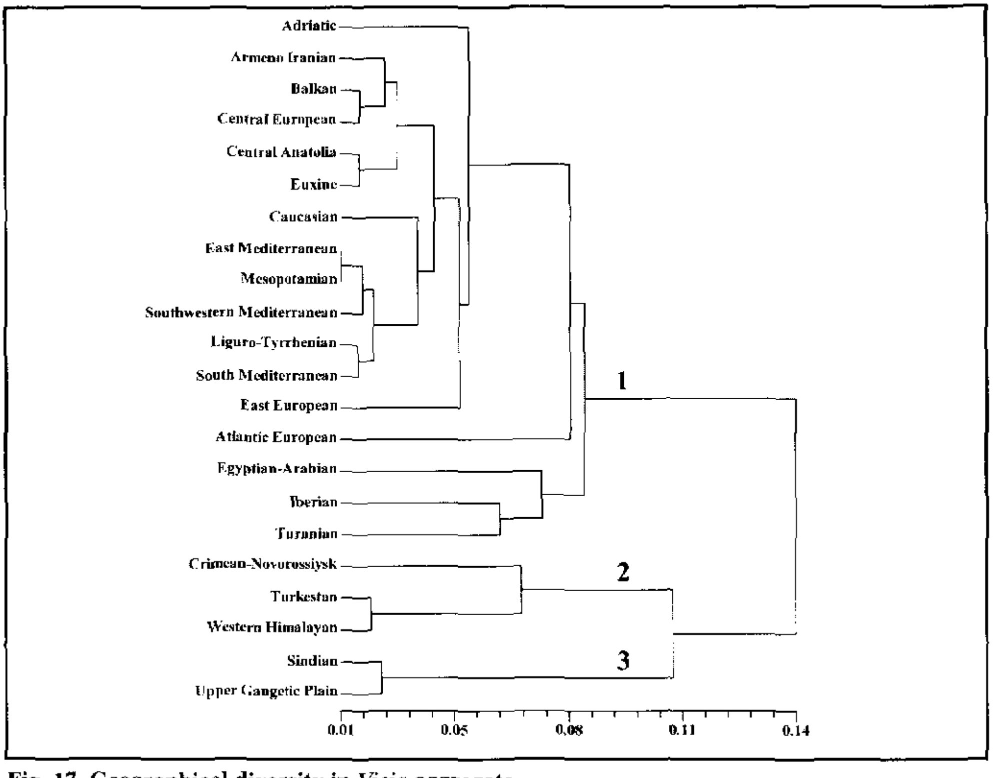


Fig. 17. Geographical diversity in *Vicia* aggregate

The major difference in University of Birmingham (UK) scientist Nigel Maxted's classification of the *Vicia sativa* aggregate compared with other classifications is the lumping together of three taxa (*V. angustifolia* Reichard subsp. *angustifolia, V. angustifolia* subsp. *segetalis* (Thuill.) Gaud. and *V. cordata* Wulf.) into one subspecies *nigra*. The different groups found in this study within subsp. *nigra* can be related to these other taxa, whereby group 1 refers to subsp. *angustifolia*, group 2 relates to subsp. *cordata* and group 3 is subsp. *segetalis*. These three groups appear to be quite different genetically. The fact that the three taxa are genetically distinct and do not even cluster together is evidence that they should be recognized as separate groups. The current study therefore does not show any evidence that would validate lumping of some of the taxa in the aggregate. All taxa appear more or less equally distant from each other. This study has shown that to separate more distantly related different species one primer combination can be sufficient for reliable distinction of taxa. However, for more closely related taxa, like the members of the *Vicia sativa* aggregate, the results of only one primer combination still provide some misclassifications, so in this case a minimum of 2 primer combinations is necessary for reliable results. This work has been published in the journal Plant Systematics and Evolution 229: 95-100 (2001).

10.1.2. *Patterns of genetic and taxon diversity in the* Vicia sativa *aggregate*

ICARDA's researchers used AFLPs to study the geographic distribution of genetic diversity in the *Vicia sativa* aggregate, a complex of six closely related taxa. The study demonstrated that the centre of diversity for the aggregate is located in the Mediterranean (Fig. 17). The highest level of diversity and a relatively high concentration of rare alleles were found in the South Mediterranean floristic province, particularly north of Tunisia. The East Mediterranean floristic province was also found to have a high level of diversity. A genetic bottleneck was observed in South Asia, with low diversity and no rare alleles being found east of Iraq. A significant correlation was found between the number of subspecies present in an area and the average diversity within the subspecies. This indicates that, for the *Vicia sativa* aggregate, the number of subspecies in a region can be used as a predictor for genetic diversity levels.

10.2. Molecular characterization of cereal germplasm

The recently developed molecular-marker systems at ICARDA based on DNA amplification have facilitated and enhanced germplasm characterization in 1998. Two well-established methods, RAPD and AFLP, were used for molecular characterization of gene bank materials and natural populations of wild relatives of crop plants as well as landraces. Populations of wild wheat *Triticum urartu*, *T. dicoccoides* and obsolete wheat *T. monococcum* from Syria, Lebanon and landraces of barley from Ethiopian, Eritrea and Yemen countries were analyzed by RAPD analysis. Genetic diversity among the same populations using AFLP fingerprinting by methylation sensitive (PstI: MseI) or methylation insensitive (EcoRI: MseI) primer combinations have been tested for comparing the both data deriving from RAPDs and Alp's analysis. The results of this research provided useful information on the geographical pattern of genetic diversity and its distribution among and within naturally occurring populations or within landraces. A small project on characterization of different populations of *Triticum* from the Fertile Crescent arc has been started and will continue in to 1999. This fresh knowledge will help to optimize collection and *in situ* conservation strategy in the future. In addition, populations of *Vicia sativa* were also tested for taxonomic study using methylation insensitive AFLPs.

10.2.1. Evaluation of genetic diversity in wild diploid wheat

Populations of wild wheat *Triticum urartu*, *T. dicoccoides* and obsolete wheat *T. monococcum* from Syria, Lebanon and landraces of barley from Ethiopian, Eritrea and Yemen countries have been analyzed by RAPD and AFLP analysis. A work on characterization of different populations of *Triticum* from the Fertile Crescent continued and will be completed in 2000. A student from Eritrea completed the MSc research work at GRU and defended his thesis in 1999.

Evaluation of genetic diversity in wild diploid wheat using AFLP markers

The recently developed molecular marker systems based on PCR amplification have facilitated and enhanced fundamental and applied biological studies. Although DNA amplified-derived techniques are in general more advantageous than classical markers, all have their limitations and specific applications. If the objective is to assess genetic diversity, method with a high multiplex ratio such as AFLP is most appropriate. Amplified fragment length polymorphisms (AFLP) markers were used to study genetic diversity of six accessions of wild wheat, *Triticum urartu*, collected in the Aleppo and Suweida provinces of northern and southern Syria. AFLP data analysis on 18 genotypes of T. urartu, using different combinations of selective primers PSt/Mse show a high information bonding pattern. Selective PCR amplification produce 50 to 100 bands. An average of 50 bands have molecular weight ranging between 50 to 300 bp. A total of 176 bands, with molecular weight 50 to 300 bp were scored. Midpoint-rooted NJOIN and principal component analysis of AFLP data show two distinct clusters of six accessions. Analysis of molecular variance and Genstat® statistical analysis package were similar. The two populations from Aleppo and Suweida showed distinct patterns of variability. The within population diversity in both samples from Aleppo was greater then those samples from the Suweida province. However, the samples from Suweida showed a higher degree of variation among themselves. Data of AFLP analysis using individual samples of *T. urartu* show variability among the regions and within the populations with four primers Pst/Mse combinations. This variability suggests that there are members of each group that can be identified as distinct accessions. The high frequency of identifiable AFLP polymorphisms make AFLP DNA analysis a useful technique for identifying polymorphisms for plant genetic resources characterization and for determining linkages by analyzing individuals from a segregating population. An AFLP data analysis with Analysis of Molecular Variance (AMOVA) of the natural populations of wild *Triticum* species may be a useful tool for optimization of strategy for the collection and *in situ* conservation of this important component of the wheat gene pool Table 32). This research has been published in December 1999 in Al Awamia journal 100: 9-18.

Table 32. Variance components from AMOVA analysis of the natural populations of wild *Triticum* spp.

Nested Analysis		
Variance among regions	V(A):	(17.13 %)
Variance among populations within regions	V(B)	(15.05 %)
Variance within populations	V(C)	(67.81 %)
PHI-statistics: PHIst = 0.332 PHIsc = 0.182 PHIct = 0.171		
Analysis Among Populations		
Variance among populations	V(A):	(26.29 %)
Variance within populations	V(B):	(73.71 %)
Analysis Among Regions		
Variance among regions	V(A):	(21.27 %)
Variance within regions	V(B):	(78.73 %)

10.2.2. Molecular characterization of barley landraces from Ethiopia, Eritrea and Yemen

In 2000, genetic diversity was assessed in a set of 30 barley landrace accessions of diverse geographic origin from Ethiopia, Eritrea and Yemen using amplified fragment length polymorphism (AFLP) markers. The main purpose of the study based on this ICARDA gene bank material was to obtain fresh evidence on the geographical pattern and structure of the diversity. Analysis of molecular variance (AMOVA) of AFLP data indicated that a major proportion (65 %) of the variation was among accessions, but within-accession diversity was also relatively high (35 %). Cluster analysis of AFLP data using unweighted pair-group method with arithmetic averages (UPGMA) revealed four main clusters, reflecting main source of origin of barley types. One cluster was constituted by the two rows barley. The other three clusters showed a mixture of two and six rows barley from diverse origin. The AFLP primer combinations revealed between 15 to 25 % of polymorphic markers. The results of AFLP analysis of the all pair of combinations tested, were compared using the normalized Mantel test, showed a high correlation between the pair of primers (99%). It is concluded that the landraces accessions substantially differ in within-accession diversity. The molecular characterization technique tested proved to be a useful marker technology for characterizing genetic diversity in barley and AFLP analysis should be the most appropriate marker system for genetic variation among barley landraces. This research has been reported at the First International Conference on Biotechnology Applications for the Arid Regions held at Kuwait Institute for Scientific Research (KISR) in Kuwait, pp.173-179.

10.2.4. Genetic diversity of wild wheat populations from Lebanon as revealed by RAPD and AFLP markers

To develop a scientific base for genetic resources conservation in Lebanon, a study of genetic diversity of wild wheats, *Triticum urartu* and *T. dicoccoides*, collected in the country from natural populations, was carried out using the RAPD and AFLP techniques. Dendrograms generated by UPGMA method from similarity matrices computed from Nei's distance coefficients, and results of AMOVA (analysis of molecular variance) revealed a pattern of among- and within-population diversity. Both in *T. urartu* and *T. dicoccoides* populations the RAPD and AFLP Nei's distance matrices were significantly correlated (r=0.54, P = 0.98 and r=0.25, P = 0.95, respectively). Variance partitioning by AMOVA revealed a major difference between RAPD and AFLP genetic diversity estimates in the proportion of among- and within-population variance components. The among-population component of the total variance by RAPD amounted to 55.5% and 61.4%, whereas that by AFLP was only 7.9% and 5.1% in *T. urartu* and *T. dicoccoides*, respectively. The within-population component was about ten times higher in the AFLP analysis in both species. A pattern of the molecular diversity differentiation was assessed in both species from dendrograms produced by the neighbor-joining (NJ) method of Nei's distance data. It is concluded that results of both the RAPD and AFLP analyses have provided useful information for decisions on wild wheat conservation strategy in Lebanon and on the utilization of these indigenous wild wheats in research and breeding.

10.2.5. *Molecular characterization and diversity studies of wild wheat species from the Near East*

The GRU of ICARDA has one of the largest and most comprehensive germplasm collections of wild progenitors of wheat and other wild relatives. In 2001, 26 accessions from the gene bank that represented natural populations of four wild *Triticum* spp. (*Triticum dicoccoides*, *T. araraticum*, *T. urartu*, and *T. baeoticum*) and five *Aegilops* spp. (*Ae. geniculata*, *Ae. triuncialis*, *Ae. speltoides*, *Ae. tauschii*, and *Ae. vavilovii*) were analyzed using amplified fragment length polymorphisms (AFLP) marker technique in order to shed light on the evolution and geographical distribution of genetic diversity of wild relatives of wheat in the Near East. To investigate genetic variation within and among populations, 10 individual plants were accession were selected and analyzed using four different combinations of primer. Nucleotide diversity (ë) was estimated by calculating the means of the estimated numbers of nucleotide substitutions per site. Variations within populations were detected in all accessions. For most of the species, the level of nucleotide polymorphism within populations was relatively low ($\pi < 0.005$). However, *Ae. speltoides* had relatively high levels of variation within two populations ($\pi = 0.0151$ and 0.0233). This species also had the highest value of nucleotide variation between accessions ($\pi = 0.0319$). In the *Triticum* species, the level of variation within populations was relatively low in *T. urartu* and *T. baeoticum*. Two tetraploid *Triticum* species had relatively high levels of variation within accessions ($\pi = 0.005$) but divergence between *T. dicoccoides* and *T. araraticum* was not complete in the phylogenetic tree. Even if the genetic variation in the gene bank accessions did not always reflect the genetic diversity of their original natural population (because of numerous multiplications in a different environment and the small number of plants sampled from the original population or while they were multiplied), AFLP analysis revealed considerable variation in all accessions used in this study. The conservation of such genetic variation in natural populations will be important for future utilization of the genetic resources of these wild wheat relatives. A part of this research, carried out in collaboration with scientists from the Laboratory of Plant Genetics, Kyoto University, Japan, was published in Euphytica 127: 81-93 (2002).

10.2.6. *Molecular analysis of ICARDA's wild barley core collection*

Out of the total collection of 1679 accessions of barley's wild progenitor, *Hordeum vulgare* subsp. *spontaneum*, at ICARDA, a core collection was established in 2002 consisting of 150 accessions with origins from 17 countries. The genetic diversity of the core collection was studied using AFLP (amplified fragment length polymorphism) molecular markers. Accessions were grouped by origin into 22 geographic sub-regions, and the total genetic variation of the samples was partitioned by analysis of molecular variance (AMOVA). Twenty three percent of the total variance occurred among the different geographic groups, whilst a much larger variance (77%) occurred within the groups. Discriminant analysis showed a well-defined geographic pattern of genetic diversity in wild barley, as 94% of the original, grouped cases were correctly classified and, in the 17 subregions, all the accessions were properly allocated. The genetic distance matrix (Euclidean squared distances) was computed from canonical discriminant functions evaluated using the group means and hierarchical cluster analysis (UPGMA) was performed using the SPSS software package (Fig. 18).

Accessions from southern Jordan and Palestine were found to be genetically distant from the wild barley collected in Syria and northern Jordan, while the geographically remote germplasm from the Central Asia sub-region (Pakistan, Afghanistan and Tajikistan) and from Libya were found to be relatively closely related to accessions from western Syria, northern and central Jordan, Iraq and southern Iran. This indicates that wild barley spread outwards from the nuclear Near East area with cultivated cereals, moving eastward along the ancient 'Silk

Road' trade route and westward to Libya by sea. Accessions from Jordan and Syria were found to be more diverse than those from Iran, Central Asia and Turkey. The results of this study suggest that the genetic variation found in the ICARDA *H. spontaneum* core collection is geographically structured, with a major part of that diversity being found within the geographical sub-regions.

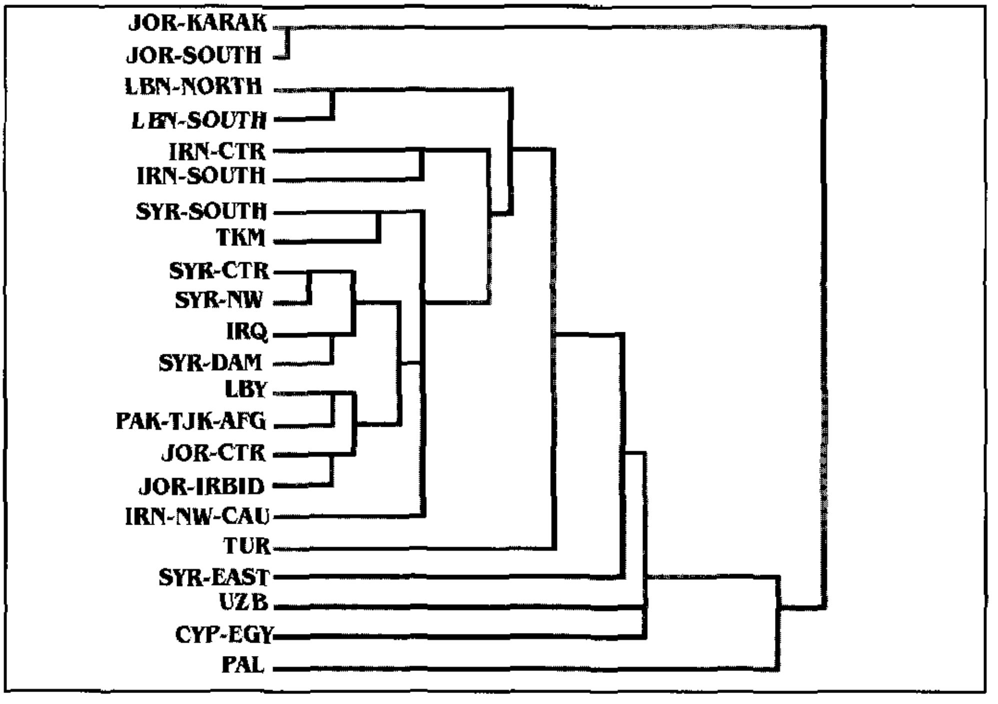


Fig. 18. Dendrogram for sub-regions of wild barley origin based on UPGMA hierarchical cluster analysis of AFLP marker data.

10.2.7. *Genetic diversity and phylogenetic relationship of diploid* Aegilops *species characterized by AFLP*

Aegilops species, also commonly known as goat grass, was the donor of the D genome in the evolution of bread wheat, making study of its genetic diversity very important in order to utilize this genetic resource for crop improvement. In 2002 the genetic diversity of the genus *Aegilops* was evaluated and its phylogeny clarified. To this end, the genetic variation of diploid *Aegilops* species was investigated using the AFLP technique. Four primer combinations were used to analyze intraspecific genetic diversity, while 15 primer combinations were used to analyze interspecific phylogenetic relationships. Genetic diversity within the *Aegilops* species was categorized into three classes based on the level of diversity found: i.e., 1) the highly variable species (*Ae. speltoides* and *Ae. mutica*), 2) species with a medium level of variation (*Ae. umbellulata, Ae. caudata, Ae. bicornis* and *Ae. searsii*), and 3) species with a low level of variation (*Ae. tauschii*). In general, geographical relationships amongst populations were detected for each species. With respect to the interspecific phylogenetic relationships, three Sitopsis species (*Ae. bicornis, Ae. searsii* and *Ae. speltoides*) were found to form a cluster. The C and U genome species (*Ae. caudata* and *Ae. umbellulata*) formed another cluster

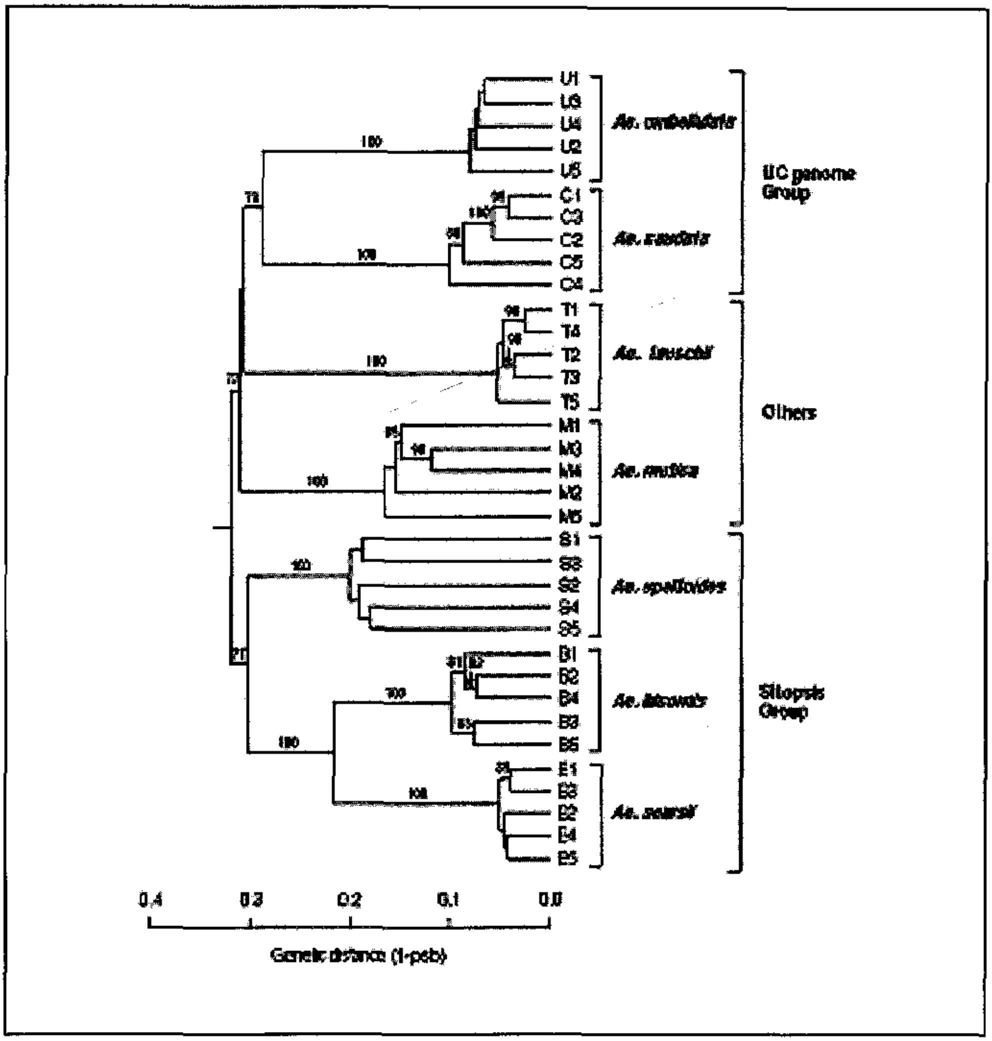


Fig. 19. Dendrogram for 35 accessions of seven *Aegilops* species reconstructed by UPGMA. [from Sasanuma T., K. Chabane, T.R. Endo, and J. Valkoun. 2004, Theor. Appl. Genet. 108: 612-618].

in the phylogenetic trees (Fig. 19). These results are more consistent with results obtained from cytological genome analysis than they are with those obtained by molecular plasmon analysis, suggesting that the nuclear genomes have evolved differently from the cytoplasmic genomes in the genus *Aegilops*.

10.2.8. *Comparison of EST with genomic derived microsatellites markers for genotyping wild and cultivated barley*

In 2003, genetic variation present in wild and cultivated barley populations was investigated using two sources of microsatellite markers; EST-derived SSRs (for Expressed Sequence Tag; EST's are used both to identify transcribed regions in genomic sequence and to characterize patterns of gene expression in the tissue that was the source of the cDNA) and SSRs (A microsatellite consisting of a specific sequence of DNA bases or nucleotides which contains mono, di, tri, or tetra tandem repeats) isolated from genomic DNA. A cDNA library and the International Triticeae Consortium (ITEC) database were used to source sequences for the EST-derived SSRs. Oligonucleotide primers were designed to sequences flanking these SSRs. Microsatellites derived from genomic libraries detected a higher level of polymorphism than those derived from ESTs. Polymorphism Information Content (PIC) was higher in genomic library-derived microsatellites than in their counterpart ESTs. This study showed that the EST-derived SSR markers developed in cultivated barley are polymorphic in wild, landraces and improved varieties and produced high quality markers. Eight of nine functional primers were polymorphic across the accessions studied. EST markers indicated clearer separation between wild and cultivated barley than SSRs from genomic DNA. The results showed that the populations that originated from the Fertile Crescent group were more diverse than those from other regions. As the EST-derived microsatellites are within transcribed regions of the DNA, it is expected that these markers are more transferable than anonymous SSRs. In genetic resources, the evaluation of the variation within collections is critical and could be enhanced by using molecular genotyping tools. The use of EST-SSRs could enhance the role of genetic markers by assaying variation in transcribed and known function genes. The EST-derived SSRs obtained in our study provides a resource, which can be exploited quickly to many aspects of barley genetics.

10.3. Collaboration with University of California, Davis

Under collaboration with advanced institutions and to bring the latest techniques and know-how to ICARDA, a project for the evaluation of *Triticum* spp. using AFLP markers was developed with the Department of Agronomy and Range Science, University of California at Davis (UCD), USA and GRU/ICARDA on molecular genetics. Under this project, K. Chabane visited the laboratory of

Professor Jan Dvorák at UCD in July 2002 and July to December 2003 for this research.

10.3.1. ***Molecular characterization of genetic diversity in*** **Aegilops** ***ssp.***
At UC Davis, Dr Chabane tested fifteen microsatellites on *Aegilops* spp from the GRU/ICARDA collections in 2002. Two hundred accessions of *Aegilops tauschii, Ae. crassa, Ae. cylindrica* and *Ae. triuncialis* from different origins in the fertile arc and Central Asia were used in this study. ABI Biosystems 3100 is being used to collect the data and analyze the results which will be published after this study is completed in 2005.

10.3.2. ***Molecular and phenotypic organization of genetic diversity in legumes domesticated in the Southwest Asia***
During his stays at UC Davis in 2003, K. Chabane's work was based on the test of two enzymatic systems for AFLP analysis on lentil collections of GRU/ICARDA and the United States Department of Agriculture (USDA). Three hundred accessions of cultivated and wild lentil from different origins were used in this study. The first restriction enzymatic system tested was Pst I and Mse I. The results were not reproducible from one test to another test. Subsequently, a second restriction enzymatic system using EcoRI/Mse I, was tested. The kit of ABI Biosystems was used. Twenty-six combinations of primers from the ABI kit were tested. Three of them were finally chosen for characterizing the collection. ABI 3100 is being used to collect the data. This research is still on-going at this time and results of these studies will be analyzed and published in 2005.

11. PRE-BREEDING FOR WHEAT IMPROVEMENT

Scientists involved: Dr Jan Valkoun and Dr Kamel Chabane (GRU), Dr Mustapha El-Bouhssini, Dr Amor Yahyaoui, Dr Osman Abdalla, Dr Miloudi Nachit (GP) and Mr Takahiro Sato (JICA)

11.1. New durum wheat genes from wide crosses
11.2. Wheat germplasm with new genes from wild relatives

Background

Pre-breeding or germplasm enhancement is necessary because even simply inherited traits can be masked by other genetic effects such as maturity response. Furthermore, several cycles of recombinations and selections may be required to develop gene pools that are sufficiently adapted to the target environment. Clearly pre-breeding activity that allows the recombination and evaluation of characters under complex genetic control is a time-consuming and difficult process. However, willingness to invest time, costs and energy in long term breeding programs using exotic germplasm or wild relatives will depend largely on the success of relatively modest, shorter term pre-breeding research programs to identify potentially useful traits that can justify long-term breeding efforts.

Why is pre-breeding thought of as a new requirement in plant breeding? Since all crop cultivars came originally from wild species, genetic enhancement, that is, selection toward useful cultivar types, was surely needed for the original modification of the wild species. What is the difference between then and now? The difference is that 10,000 years ago when agriculture began, or even 1,000 years ago, there were no obvious divisions between highly selected, elite cultivars and purposely introduced, grossly unadapted exotics. Farmer selectors worked with whatever materials they found locally, and imperceptibly, generation after generation, they selected towards the genotypes they needed. They continually and gradually enhanced genetic materials at hand through selection, slowly making them more amenable to cultivation for human use.

11.1. ***New Durum wheat genes from wide crosses***

More than 2000 BC_2 and F_1BC_1 plants, derived from crosses of durum wheat cultivars, 'Haurani', a local landrace variety originally from the Hauran plain of Syria, and 'Cham 5' an improved durum wheat variety released by ICARDA, with wild progenitors of wheat and other close relatives, were evaluated in the field for disease resistance under severe natural epidemics on both yellow rust and leaf rust. The initial crosses of durum wheat with *Triticum urartu*, *T. baeoticum*, *T.*

dicoccoides, and *Aegilops speltoides* were produced in 1994/95 season, and the subsequent backcross generations were produced in the greenhouse [this work was initiated by the Italy-funded special project on pre-breeding titled "Enhancing Wheat Productivity in Stress Environments Utilizing Wild Progenitors and Primitive Forms" whose principal investigator and principal scientist was J. Valkoun and A. Damania (ex-Cereal Curator), respectively.

In the 1997/98 season, the wide hybridization products were first exposed to biotic and abiotic stresses in the field. The hybrid plants, as expected, displayed a wide range of phenotypic variation in comparison with the respective durum wheat parent for a number of agronomic traits such as, plant height, tillering capacity, and number of spikelets per spike. Fully fertile plants with a gene(s) conferring high resistance to yellow rust were detected in crosses of 'Cham 5' with *T. dicoccoides* ICWT 601116 and ICWT 600117, collected from southern Syria. Yellow rust resistance was also found in fully fertile plants as a result of crosses of durum wheat and diploid wild wheats: 'Cham 5' with *T. baeoticum* ICWT 500647, and 'Haurani' with *T. baeoticum* ICWT 500647, as well as 'Haurani' with *T. urartu* ICWT 500530. This was, as far as ICARDA is concerned, the first transfer of yellow rust resistance from wild diploid to tetraploid cultivated wheat. In the latter crosses plants with both yellow and leaf rusts were identified and were of interest to breeders. Certain BC_2 plants from crosses of 'Cham 5' and *Ae. speltoides* were immune to yellow and leaf rusts as well as to powdery mildew and stem rust. However, all the *Ae. speltoides* derivatives were sterile and had to be further backcrossed to the durum wheat parent.

Materials derived from the initial 1994/95 crosses of durum wheat with *Triticum urartu, Triticum baeoticum, Triticum dicoccoides, Aegilops speltoides* and *Aegilops tauschii* were planted in the field at Tel Hadya for multiplication, further evaluation and crossing with cultivated wheat during the 1998/1999 season. The presence of a gene(s) conferring high resistance to yellow rust was confirmed in crosses of 'Cham 5' with *T. dicoccoides* ICWT 601116 and ICWT 600117, originating from southern Syria. F1 plants from crosses of synthetic hexaploids ('Haurani' x *Ae. tauschii*) with different bread wheat cultivars were backcrossed to the respective bread wheat parents. Strong hybrid necrosis resulted in total lethality of F1 seedlings in some combinations.

Durum wheat lines were developed in 1999/2000 that introgressed genes from wild diploid relatives, such as *Triticum urartu, T. baeoticum, Aegilops speltoides* and *Ae. Tauschii,* and tetraploid *T. dicoccoides*. From the resulting progenies, yellow rust and leaf rust resistance lines were identified, both in the field as well as in the greenhouse. This project was undertaken in collaboration with GP scientists from the wheat improvement program. The above results demonstrate that wild progenitors of wheat can be a valuable and readily accessible genetic resource to improve diversity of modern wheats. This work and its results were published in Euphytica 119:17-23 (2001). In addition to these lines, a total of 25,865 accessions were distributed from the GRU collections of which 17,533 were dispatched to users outside ICARDA. There was considerable demand for samples from ICARDA scientists showing optimum use of the Center's genetic resources collections.

11.2. *Wheat germplasm with new genes from wild relatives*

Homogenous durum wheat lines with new stripe rust resistance genes introgressed from wild relatives were made available for genetical studies. A total of 458 lines developed by GRU/ICARDA were distributed to GP entomologist M. El-Bouhssini (257 lines), GP Plant Pathologist A. Yahyaoui (138 lines), winter and facultative bread wheat breeder O. Abdalla (46 lines), durum wheat breeder M. Nachit (41 lines) and visiting scientist at GP from Japan International Cooperative Agency (JICA), T. Sato (22 lines). Since additional new resistances to stripe rust, and probably also to insect pests, were transferred from wild relatives to cultivated wheat successfully at GRU/ICARDA, external funding will be sought through donor agencies in 2004 for a more comprehensive study of these genetic transfers and their stability under actual growing conditions.

Plant breeding utilizing pre-bred material, such as that developed at the GRU, will be used to create new intensive-culture crops from wild or weedy species, or from landraces or obsolete forms with desirable genes.

In future, biotechnology will provide essential and innovative support to standard plant breeding, bringing in new generic systems, new techniques for selection and identification of genotypes, new ways of making hybrid crops, and, most importantly, deeper understanding of plant gene action, biochemistry and physiology [See chapter 10 of this report].

In conclusion, plant pre-breeding, defined as cultivar development based on genetically-enhanced breeding materials and assisted by deep understanding of genetic processes at the molecular level, has a vital role to play in agriculture especially in the development of new crop varieties of the future.

12. PLANT GENETIC RESOURCES CONSERVATION PROJECTS SUPPORTED BY AUSTRALIA

Scientists involved: Dr Kenneth Street, Dr Jan Valkoun and Mr Jan Konopka (GRU), plus other scientists mentioned under each project.

12.1. Project One: International Evaluation of *Vicia faba* Germplasm at ICARDA

12.2. Project Two: Offshore Evaluation of International Field Pea Germplasm for Resistance to Black Spot (*Mycosphaella pinodes*) and Agronomic Merit

12.3. Project Three: Conservation and Preservation of Grain Legume Genetic Resources from the Eastern Mediterranean Region

12.4. Project Four: International Linkages for Crop Genetic Resources

12.5. Project Five: Technologies for the Targeted Exploitation of the N. I. Vavilov Institute of Plant Industry (VIR), ICARDA and Australian Bread Wheat Landrace Germplasm for the Benefit of the Wheat Breeding Programs of the Partners

12.6. Project Six: Development and Conservation of Plant Genetic Resources from the Central Asian Republics and Associated Regions

12.7. Project Seven: Conservation, Evaluation and Utilization of Plant Genetic Resources from Central Asia and the Caucasus

Background
Australia has traditionally been a strong supporter of agricultural research both at home and abroad. For the financial year 2002-2003 Australia contributed US$139,000 to the core budget of ICARDA and $542,000 towards special projects. But perhaps even more important than this significant financial contribution to the Center's budget is the sharing of skills, experience and advanced techniques between ICARDA and the Australian scientists involved in collaborative projects. In addition, Australian scientists at ICARDA have played an important role in the Center's research, providing leadership and vision as the Center has grown since its inception in 1979. In fact, Australian institutions and their scientists have brought considerable expertise, experience and resources to bear on the pressing problems of increasing food and feed production in Central and West Asia and North Africa (CWANA) regions.

Although to a majority of Australians, the problems in CWANA region where ICARDA's research is focused may appear distant and irrelevant. However, in the context of globalization of economies, the CWANA region is very important to Australian agriculture, both as a trading partner and because of strong climatic similarities between CWANA and the Australian continent. This means that crop varieties and farming practices that are appropriate for the CWANA region are often also appropriate for parts of Australia and vice versa.

A large part of South Australia experiences the same kind of variable Mediterranean type of climate found in much of the WANA region. Due to this fact, agriculture in both regions is cereal-based, principally wheat and barley, with a considerable livestock component, especially small ruminants. However, in recent years ICARDA-Australia collaboration has also promoted food legumes, like lentil, chickpea and forages such as *Lathyrus* spp. The former two food legumes provide Australia with a healthy export market and the latter forage is mostly for local consumption as feed and for improving soil fertility as tillage.

For plant breeders all over the world working to develop new varieties, the fertile arc and CWANA regions are an indispensable source of valuable genetic material. In fact, the evolution and domestication of such different crops as barley, wheat, lupins, lentil, chickpea, faba bean, annual legume grains, pulses, subterranean clover, phalaris, vetches and fescue all took place in the CWANA region that includes the fertile crescent. Domestication of small ruminants such as sheep and goats is also believed to have occurred in this region as hunter-gathers forsook their roaming lifestyle to become agricultural pastoralists about 10,000 years ago. Only the smooth-shelled macadamia nut, (*Macadamia integrifolia*), is native to Australia. All other crops and the small ruminants had their origin elsewhere, making Australian crop improvement programs heavily dependent upon genetic resources originating from the CWANA region.

GRU/ICARDA has been actively exploring, collecting and conserving genetic resources of its mandate crops in the WANA region since 1983. Several of these crops are important to Australian agricultural and livestock production. Indeed, the GRU holds one of the most comprehensive collections of genetic material in the entire region. Australian scientists frequently requested and continue to request germplasm samples from ICARDA. In fact, a collection of 2000 breeding lines of chickpea sent by ICARDA to Australia in 1999 has formed the basis for the development of large-seeded Kabuli chickpea variety, which will be released soon. More examples of Australian crop varieties selected from ICARDA-developed germplasm are also available (See ICARDA 2004. Australia and ICARDA – Ties that Bind, No. 3, ICARDA, Aleppo, Syria).

The benefits of germplasm exchange are mutual. For example, an ICARDA-improved barley line was released in Western Australia as ‘Yagan’, and ‘Corvette’ a South Australian variety of barley was released in Syria. Australia has become one of the lentil and chickpea exporting countries, whereas only 20 years ago these crops were hardly grown in Australia. With this background, Australian contribution to ICARDA's core funding has increased steadily and since 1994 seven special projects are being conducted through ICARDA's GRU that are supported by Australia. The details of these projects are briefly reported below:

12.1. Project One: International Evaluation of *Vicia faba* Germplasm at ICARDA

Project duration: 1994–1999

Funding agency – Grains Research and Development Corporation (GRDC) Australia.

Key Scientists involved

Name	Agency	Position
C.M. Francis Supervisor	CLIMA[1]	Deputy
Director L. Robertson Supervisor	ICARDA	Curator Legumes GRU
M. Munzar	ICARDA	R.O. GRU
G. Paull	WAITE[2]	Faba Bean Breeder
J. van Leur	Ag NSW[3]	Pathologist

[1]Center for Legumes in Mediterranean Agriculture, Australia
[2]Waite Agricultural Research Institute, at University of Adelaide
[3]Department of Agriculture - New South Wales, Australia

Background to the Project

Faba beans have been called the poor man's meat (due to its relatively high protein content) and are an important crop in the CWANA region and of emerging importance in Australia. They have adaptation to a wide range of soils including some that are less well drained. However, the current Australian faba bean area is sown with cultivars of a narrow genetic base and thus susceptible to diseases. Disease resistance and agronomic adaptation have to be improved to realize high and stable yields, and to make faba bean an attractive crop. In fact in southern Australia the reliability of yield has been restricted particularly by chocolate spot (*Botrytis cinerea*) and ascochyta blight (*Ascochyta fabae*) which effect not only the yield but also the size and appearance and hence marketability of the grain. These diseases also limit production regionally. However, resistance to chocolate spot is very limited in availability and has only recently become available in one variety 'Icarus' which is too late maturing for general use in Southern Australia. New sources of resistance incorporated into earlier varieties are a high priority of the Australian National Breeding Program to ensure greater stability of yield in the southern states. Identifying these sources of resistance and understanding the useful variation of the ICARDA faba bean collection is also congruent with the mandate of the GRU.

Project aims

- To screen the ICARDA faba bean collection for disease resistance, especially chocolate spot and ascochyta, as well as to assess the variation in agronomic potential.
- To transfer selected elite germplasm directly to the National Breeding Program in Australia.

Summary of results

The project utilized screening facilities in the coastal Mediterranean climate at Lattakia in Syria, and a series of international linkages to locate new sources of chocolate spot (*Botrytis cinerea* and ascochyta (*Ascochyta fabae*) resistance in faba bean. To locate the chocolate spot resistance GRDC funded a collection tour of Ecuador, which was then the only known source of resistance to the disease. Widespread occurrence of chocolate spot resistance in the landrace material collected in Ecuador has been a feature of the research. It represents a most important contribution to the project especially in the light of devastating outbreaks of the disease in 1998 in Western and South Australia. Aided by the excellent site and facilities for disease and agronomic screening provided by ICARDA at Lattakia, the program has resulted in the early achievement of the immediate targets of improved chocolate spot and ascochyta resistance. In this successful project the addition of rust resistance, often linked to chocolate spot resistance in the Ecuadorian germplasm, has been a bonus. Improved faba beans in the form of pure breeding lines are now being introduced to Australia from ICARDA and are of immense benefit to the Australian breeding program. This process saves many years of research and breeding effort in Australia and will save more than $1 million dollars in quarantine and handling costs. Though the project was initially directed to southern Australia it has benefited the entire faba bean growing range. A linkage with an Australian Center for International Agricultural Research (ACIAR) project (H. Marcellos) has resulted in the addition of germplasm from China and new sources of variation not hitherto available to the Australian or ICARDA breeding programs.

In all over 5000 lines were screened in Syria under the supervision of Dr Larry Robertson of ICARDA, with the contribution of J. van Leur of AgNSW and G. Paull of the WAITE Institute during the disease screening process. As a result of this screening over 500 disease resistant and agronomically promising lines were identified. This elite material was subsequently sent to Australia. The introductions consisted of three basic types (1) bulk populations, i.e. the lines that were collected in Ecuador, China, Spain, Morocco etc (2) single plant selections (F2) were made at Lattakia in early 1997 for combined chocolate spot and *Ascochyta* resistance. (3) Pure breeding lines BPL developed originally as part of Dr Robertson's breeding program in Morocco.

One of the features of the success of this project was the access to the PBL (pure breeding lines) developed by ICARDA. These often incorporated parents from countries with Mediterranean climates and shorter growing seasons such as Spain and Morocco. Use of PBL lines added not only to the precision of the disease assessment but also to the agronomic value of the project. Their availability represents a breeding short cut for the breeding community globally.

Many of the Ecuadorian accessions have dual resistance to rust and chocolate spot, but most are late flowering and were thus incorporated into crosses with earlier Mediterranean material. Thus the nurseries in consequence comprise lines reselected for dual, or even triples resistance, and comprise a composite of Ecuador, Morocco, Tunisia, Algeria, Cyprus, Turkey, China and ICARDA lines. These promise to provide a rich source of variation for years to come for faba bean breeding programs.

12.2. Project Two: Offshore Evaluation of International Field Pea Germplasm for Resistance to Black Spot (*Mycosphaella pinodes*) and Agronomic Merit

Project duration: 1994–1999

Funding agency – Grains Research and Development Corporation (GRDC –Australia)

Key Scientists involved

Name	Organization
C.M. Francis	CLIMA
T. Khan	CLIMA
A. Brown	CLIMA
L. Robertson	ICARDA
G. Bejiga	EARO[1]
D. Gorfu	Biodiversity Institute, Addis Ababa
V. Serduk	VIR[2]
L. Priljouk	VIR

[1] Ethiopian Agricultural Research Organization, Addis Ababa
[2] N.I. Vavilov Institute of Plant Industry, St Petersburg, Russia

Background to the Project

The black spot blight, *Mycosphaerella pinodes* (Berk. Et Blox.) is the most widespread disease of green peas in most European countries, Australia, North Africa and Ethiopia. The conidial stage of the pathogen is considered to be the most damaging; and has the potential to cause the complete destruction of a crop. In Australia black spot of peas frequently devastates pea crops in Western Australia and is a serious problem in South Australia and Victoria. Despite the yield potential of peas, favorable prices, and the widespread soil adaptation of the crop, Western Australian farmers find the crop too risky and the area planted to field peas has remained static at around 30,000 hectares despite a potential of at least 200,000 hectares. The disease can render the crop un-harvestable. Paradoxically, the problem is worst in the best seasons when yield potential is highest. The recommended measures for disease management include wide rotations and late planting which in themselves greatly limit the yield potential and the area of peas, which can be cultivated. Black spot resistance would dramatically change the place of peas in the agricultural systems of southern Australia and Western Australia in particular. Ethiopian germplasm is well adapted in maturity terms to conditions in Western Australia. In turn, material selected in the Australian breeding programs should perform well in Ethiopia and thus the project will have mutual benefit

Breeding has so far not resulted in the release of a variety with a high level of resistance although some progress is reported by recombination of lines with differential resistance. Pea breeding programs have revolved largely around germplasm from Western Europe. In an attempt to greatly widen the genetic base samples were chosen to represent diverse countries of origin. Specific targets were the eastern Mediterranean countries, Central Asian Republics, Eastern Europe, former Soviet Union States and China. Germplasm from these countries is not widely included in breeding programs in Western Europe and Australia. It is however held in substantial numbers by VIR. This seemed to offer considerable potential to find new sources of resistance which if not of immediate value in their own right would at least be of value in building resistance levels.

There are very large numbers of accessions in the Vavilov collection (over 6000), much of which are from the target areas. It represents a different gene base than represented in the Australian breeding lines because they are largely based on the Western European genepools. A screening program was thus arranged in collaboration with CLIMA based on the highly successful screening for chocolate spot resistance in faba beans conducted at Lattakia in Syria and for ascochyta resistance in chickpea in Izmir, Turkey.

Project aims

To screen pea material from a wide range of sources for resistance to blackspot and agronomic merits at ICARDA and Hottela in Ethiopia.
Delivery of final set of promising lines to national breeding programs of the partner countries.

Summary of results

The movement of nearly 3500 pea accessions through a 4-way collaborative effort between CLIMA, VIR, EARO, Ethiopia and ICARDA was in itself a major achievement of this project

Of the 3500 accessions screened, 210 pea lines with a level of resistance or special agronomic characters were identified which were distributed to the partner countries if they didn't already have them.

Promising levels of resistance were found in germplasm from the Central Asian Republics (CARs) where more than 14 percent of over 200 lines tested showed significant levels of resistance to black spot. The region, which includes Afghanistan, Kazakhstan and Kyrgyzstan, is outstanding as a region of significance

The Eastern Mediterranean (notably Greece 14.5%), China (13%) and states of the former Soviet Union (e.g. Georgia, Ukraine, Belarus - mean 19%) produced much higher levels of resistance than the Western Mediterranean (4-5%) – the main source of Australian cultivars

All lines performing well in Ethiopia were retested in Perth or Eastern states by the spring of 2001.

The best lines were planted in Perth in 2001 for intercrossing with best Australian breeding lines, and wild relatives, as part of PhD project UWA 356 at the University of Western Australia.

12.3. Project Three: Conservation and Preservation of Grain Legume Genetic Resources from the Eastern Mediterranean Region

Project duration: 1994-1998

Funding agency - Grains Research and Development Corporation (GRDC –Australia)

Key Scientists involved:

Personnel	Organization
Planning and administration	
A. Tan	AARI[1]
C.M. Francis	CLIMA
N. Stavropoulos	GGB[2]
Collection Missions	
A. Kiticki	AARI
C. Sebanci	AARI
H. Ozpinar	AARI
N. Maxted	University of Birmingham, UK
H. Shackle	University of Birmingham, UK
C. M. Francis	CLIMA
S. Bennett	CLIMA
G Auricht	SARDI[3]
S. Hughes	SARDI
K. Reed	PVRI Hamilton Vic
K. Snowball	AgWA[4]/CLIMA
S. Samaras	GGB
S. Kyriakakis	GGB

[1]Aegean Agricultural Research Institute, Izmir, Turkey
[2]Greek Gene Bank, Thessalonica, Greece
[3]South Australian Research and Development Institute, Adelaide
[4]Department of Agriculture - Western Australia

Background to the Project

Turkey is one of the richest countries in the world in terms of the diversity of its legume genetic resources. Given the recent sensitivity over exploitation of plant genetic resources by developed countries, Turkey was not prepared to sanction collection missions without an agreement in place and clear establishment of mutual benefit in any resultant projects. This Grains Research and Development Corporation (GRDC) project was thus designed to provide benefit to the Turkish gene bank involved as well as opening the door to the invaluable gene pool in a way mutually beneficial to all parties involved in the project.

Previous germplasm missions to Turkey have lead directly to the release of new cultivars of balansa clover (*Trifolium michelianum* - a hairless, semi-erect annual legume), Persian clover (*Trifolium resupinatum* – an annual pasture legume) and subterranean clover (*Trifolium subterraneum, T. brachycalcycinum*, and *T. yanninicumin*) in Australia. Faba bean, chick peas and peas have been widely used in breeding programs and an early red seeded lentil recently released by the Center for Legumes In the Mediterranean Areas (CLIMA) based in Perth, Australia.

Previous missions however have not been systematic and only occasional. The set of mission undertaken for this project aimed to cover all the more temperate winter rainfall areas of Turkey most likely to yield germplasm of value to similar ecological zones in the region as well as southern Australia.

Project Aims

In collaboration with the Aegean Agricultural Research Institute (AARI) Izmir, access, document and evaluate in Turkey and in Australia, collections from a country that has one of the richest sources of grain and forage legumes in the world.

In the course of the collections to select forage and grain legumes adapted to heavier and alkaline soils.

Summary of results

During 5 collection trips this highly successful project has completed a circuit of the winter rainfall regions of Turkey and adjacent Greek Islands. A total of 4319 legume accessions are available to regional, ICARDA and Australian. This is the most comprehensive legume plant collection series yet undertaken by Australian funded projects in the region. It will have lasting impact on not only Australia's germplasm base of grain, forage and pasture legumes but to the global scientific community as a whole.

Although primarily aimed at potential grain legumes, pasture legumes were collected strategically in line with national objectives. Amongst the grain legumes, the faba beans from Crete have demonstrated earliness and vigour and resistance to the ascochyta in GRDC supported trials at Lattakia in Syria. The 57 lines collected in Turkey were evaluated for chocolate spot resistance in these trials in October 1998. There is a broad range of Kabuli chickpea pea germplasm with large seed. Several are demonstrated ascochyta resistance in a new GRDC funded project conducted at Izmir. Peas collected were introduced to a project in Ethiopia in the quest for black spot resistance. *Lupins albus* line from Crete were utilized as parents in an Australian breeding program because of their resistance to brown spot, vigor and seed quality. Lentils from Turkey are bold seeded reds and thus were included in early generation trails. Another feature of the material collected is the diversity of *Vicia* and *Lathyrus* species. Of particular interest to the Australian vetch breeding program is the number of large seeded vetches (var *macrocarpa*) and non-shattering lines from Crete.

Amongst the pastures species adapted to alkaline soils as an alternative to annual medics were targeted. *Trifolium purpureum*, *T. pallidum*, *T. echinatum*, *T.*

resupinatum and *T. lappaceum* as well as *Trigonella* and *Lotus* species are good prospects. One variety of *T. resupinatum* from Turkey previously introduced to Australia has been released as the commercial variety named "Prolific".

As a result of the project, strong linkages have been developed with the Turkish Gene bank in Izmir and the Greek Gene bank in Thessaloniki. These will ensure continuing mutually beneficial germplasm exchange in an era where there is considerable sensitivity over the acquisition and transfer of plant genetic resources. In addition the project facilitated a formal linkage with The Genetic Resources Program at the University of Birmingham lead by N. Maxted. This linkage and the association with Dr Maxted has provided an excellent training ground for younger scientists interested in plant genetic resources.

12.4. Project Four: International Linkages for Crop Genetic Resources

Project duration: 1999-2003

Funding agency – Grains Research and Development Corporation (GRDC - Australia)

Key Scientists involved

Name/Title	Organization
C.M. Francis	CLIMA
K. Street	ICARDA
J. Konopka	ICARDA
M. Vishnyakova	VIR
S. Alexanian	VIR
J. Valkoun	ICARDA
O. Mitrafanova	VIR
M. Mackay	NSW Ag
R. Redden	VIDA
S. Bulyntsev	VIR
T. Smekalova	VIR
L. Kartuzova	VIR
O. Lygpanova	VIR
O. Kovaleva	VIR
M. Campbell	CLIMA

Background to the Project

The fabulous collection of cereal, grain legume and pasture species germplasm initiated by the father of modern plant genetic resource conservation, N.I. Vavilov, has more than 350,000 accessions in the chain of collections throughout the former USSR. Germplasm from the regions of the former USSR are not well represented in other collections. ICARDA for example has only 60 accessions of more than 3000 *Pisum* lines and Australia just 11. Western breeding programs including the international centers had very limited access to former USSR and Eastern European Germplasm. Entire breeding programs like peas have been based entirely on western Mediterranean germplasm. Other programs lack a substantial germplasm base from the central Asian centers of origin of such species as durum wheats, barley, *Pisum, Lens, Vicia* and *Cicer*. The reasons are many fold. There were always difficulties in communications and organization before the fall of the communist government. Since then, despite the good will of the curators, severe budgetary problems have not allowed the collections to fully maintain their accessions let alone distribute seed. The tragedy is that the doors of one the world's greatest collection is closed in an era when new germplasm is most needed to fight new diseases and improve yields.

A unique feature of the Vavilov collection is the diversity of land races and primitive forms of *Pisum, Cicer* and *Lens* as well as wheat and barley. Grain legumes, barley, and wheat will be targets for the project.

In the case of peas in Australia and especially in western Australia, black spot *Mycosphaerella pinoides* is devastating and no substantial resistance has been found in existing Australian programs that are based almost entirely on western European material. Thus a national priority is to rapidly obtain as much diversity as possible for screening for of resistance to black spot. The best way to do this is to tap directly into the massive existing collection rather than collection missions per se.

Ascochyta rabei is the most important disease of chick peas in the world and is a major breeding focus at ICARDA. Its presence in Australia also appears imminent. Germplasm with diverse resistance needs to be developed as a preemptive measure.

Further, the Russians have been world leaders in the breeding and development of yellow lupin (*L. luteus*) and White lupin (*L. albus*) in particular. The good linkages established over the years by Drs Cowling and Gladstones in the former soviet states have not yielded the expected benefits to Australia as the programs are greatly restricted by finance and have been unable to repatriate much of their genetic resource base to Australia.

Project aims

To couple the ICARDA network countries with VIR to develop an Australian linked network of genetic resource centers and scientists.

Through this network gain access to regions with the richest sources of crop and forage germplasm and to assist host countries in the improvement of their germplasm base and infrastructure.

Facilitate germplasm exchange, strategic collection missions, screening and characterization of germplasm of interest to the project partners through ICARDA.

Project activities included: characterization and screening of selected VIR germplasm at ICARDA by VIR scientists, aligning the ICARDA database with that of VIR's, provision of computers and computer training to VIR curators, strategic collection missions, scientific interchange and visits between VIR, Australian and ICARDA scientists.

Summary of results

Germplasm exchange and characterizaion

Prior to this project ICARDA and Australian collections had very little VIR material duplicated in their collections. This project involved large movements of germplasm mostly from VIR into the ICARDA collection. The table below summarizes the germplasm that was introduced to the ICARDA collection and subsequently characterized:

Crop type	**Accessions**
Wheat	701
Barley	183
Chickpea	344
Lentil	172
Faba bean	37
Peas	107

This material is unique in that much of it was collected in regions such as central Asia that are under represented in the ICARDA collection and more collections are needed to rectify this gap which this project has addressed (Fig. 20). In addition, this was landrace material that was collected early in the 20th century before modern varieties began widley displacing them. In many cases these genotypes no longer exist out side of *ex situ* collections. Therefore, it is imperative that it is saftey duplicated outside of the VIR gene banks.

This project also provided VIR curators with the opportunity to regenerate and characterize their material under well resourced conditions. This was important given the current under-resourced conditions that exit at VIR.

Due to the poor financial situation currently prevailing at VIR, their scientists have had little opportunity to visit and interact with scientists and institutes outside of their country. Thus many of them have felt isolated from the international scientific community. This project gave them the opportunity to attend conferences, live and work for short periods at ICARDA and visit leading Australian research institutes. The goodwill and linkages developed through these interchanges will realize benefits long after the completion of this project.

As pointed out above, during the difficult post Soviet transition phase VIR has been all but crippled by financial constraints. This project provided much-needed operating funds computers and sundry equipment for the departments participating in the project. One lasting benefit to these departments has been the provision of computers and training. Prior to this project the computing department at VIR handled most computing work. Now with the alignment of the ICARDA and VIR databases the curators in the legume and wheat departments can directly interact with a database populated with information related to the accessions that they work with. They are also able to electronically exchange information with international counterparts and collaborators, which is something that has put them on a more compatible footing with the international community.

Fig. 20. ICARDA collector together with collectors from VIR and the National program of Tajikistan exploring the rangelands for forage germplasm.

Plant seed collecting is still high on the list of priority activities at VIR. This project has contributed to a total of 9 collection missions in which VIR scientists have been involved in planning and participation. The target species were VIR and

ICARDA mandate crops and their wild relatives. The details of these missions are to be found in Chapter 2 in this report. However, the missions' collections are summarized below:

Year	Country	Accessions
1998	Uzbekistan	208
1999	Turkmenistan	119
1999	Armenia	237
2000	Kazakhstan, Kyrgyzstan	330
2000	Tajikistan	154
2001	Portugal	492
2001	Azerbaijan, Georgia	397
2002	Turkmenistan	413
2002	Romania	180

These missions have significantly increased the representation in the ICARDA and VIR collections of material from the Central Asian and Caucasus.

12.5. Project Five: Technologies for the Targeted Exploitation of the N. I. Vavilov Institute of Plant Industry (VIR), ICARDA and Australian Bread Wheat Landrace Germplasm for the Benefit of the Wheat Breeding Programs of the Partners

Project duration: 2001-2005

Funding agency – Grains Research and Development Corporation (GRDC –Australia)

Key Scientists involved:

Name/Title	Organization
Project Supervisor	
K. Street	ICARDA
Research Staff	
M. Mackay	AWCC
J. Valkoun	ICARDA
J. Konopka	ICARDA
O. Mitrofanova - Senior researcher	VIR
E. Zuev - Senior researcher	VIR
A. Brykova – Researcher	VIR
O. Liapounova - Senior researcher.	VIR
A. Afonin - Senior researcher.	VIR
I. Chukhina - Research Fellow	VIR

Project background and aims
The wheat industries of Australia, Russia, the countries of Central Asia, the Caucuses, West Asia and North Africa require access to, and the efficient exploitation of, germplasm to meet current and future challenges to economic sustainability. VIR, ICARDA and the Australian Winter Cereals Collection (AWCC) house an impressive combined collection of over 15,000 bread wheat landrace accessions some of which were collected in the early 20th century from a diverse range of environments to which they were adapted. This unique set of germplasm is the focus of this proposal.

This project seeks to develop cost effective strategies to identify specific attributes in the combined collection. This will be achieved by first compiling, capturing and/or deriving data associated with the accessions in the collection. This data will be collated into a single relational database that in itself is a significant and useful output. Various analytical techniques will be applied to the data set to gain an understanding of the patterns of genetic variation in the collection as a whole. This information will then be used to identify a subset of genotypes that is representative of the variation in the combined collection. To more accurately define the structure of variation within this representative subset it will be characterized at ICARDA using both molecular techniques and standard agro-morphological descriptors. In addition to the representative subset, further subsets will be identified with potential variation for resistance to various abiotic constraints. These trait specific subsets of accessions would then be evaluated for the constraint in question.

A significant output of this project, which could be directly utilized by research providers, will be an information package featuring a web-based application. The application will include the information generated in this project. That is, it will have the identified representative subset and trait specific subsets built into the relational database. It would also allow the user to efficiently interrogate the data associated with over 15,000 accessions giving them the capacity to identify custom subsets of accessions with single and multiple trait(s) that may be of importance to breeding programs. This information package can be used as a powerful tool to enhance the effectiveness and efficiency of breeding programs to address current and future challenges.

Finally, this project will continue to strengthen the goodwill and linkages that exist between the project partners thereby promoting the ongoing exchange of germplasm.

***Summary of major achievements to date*:**
A database has been compiled containing information on over 15,000 landrace accessions held at ICARDA, VIR and AWCC.

Over 8000 collection sites have been geo-referenced and the coordinates were painstakingly validated so that we are confident of their accuracy.

Agro-climatic data for the northern hemisphere (covering all collection sites) has been derived and captured into the database.

An Agro-ecological Zoning System was developed and validated using satellite images.

A representative "core collection" of 750 accessions has been identified and planted in the field at Tel Hadya for seed increase pending further screening.

A subset of accessions, with a high probability of containing drought tolerance, has been identified and planted in the field at Tel Hadya for seed increase prior to screening for drought tolerance.

VIR physiologist visited Rana Munns at CSIRO to learn latest Salt/Drought tolerance screening methodology. The equipment to undertake this screening using these methods has been set up at VIR.

Comparative study on molecular fingerprint techniques to assess genetic variation of the representative subsets has been undertaken and 1 paper prepared for publication and results presented as a poster at a conference.

A proto-type software package to web-enable the database featuring a powerful interrogation engine has been developed and is currently being tested.

The Focused Identification of Germplasm Strategy (FIGS) developed in this package has been presented at a number of international conferences. Enthusiastic support has been expressed from a number of institutions holding germplasm collections. This is already leading to collaborative works that will enhance the outputs of this project.

The Central Asian and Caucasus projects

The Problem

In Australia and in Central Asia and the Caucasus (CAC) agricultural production must take place in challenging environments that often feature rapidly shifting biotic, abiotic and economic constraints to production. For example, habitat destruction, loss of arable land to salinity, urbanization, desertification and the looming threat of global warming and climate change are increasingly important challenges faced by both developing and developed countries alike.

The effective utilization of agro-biodiversity in mitigating these threats requires access by the scientific community to sources of useful genetic variation. CAC region is a rich centre of genetic diversity and crop origin for a large number of globally important agricultural species. However, genetic erosion is occurring at an alarming pace exacerbated by the rapid transition that the region is going through following the break-up of the former Soviet Union. Thus, there is a clear and present need to take steps to arrest this genetic erosion and ensure the long-term security of the region's globally important biodiversity for the long-term benefit of both regional and international plant breeding initiatives.

With the collapse of the former Soviet Union, the countries of CAC, namely Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan in Central Asia, and Armenia, Azerbaijan and Georgia in the Caucasus, entered into a tumultuous transition process. This process has led to a massive disruption of agricultural production, trade and public sector services. One sector that has been severely compromised is the agricultural research and development providers. Given that more than 50% of the population in the region relies exclusively on agricultural production this has disastrous implications. Thus, effective agricultural research and development is of paramount importance to alleviate the escalating rural poverty and threats to basic food security caused by the transition phase.

A major challenge facing agricultural scientists in the area is to develop staple field crop varieties that are adapted to local conditions and constraints. Additionally, they must be in a position to respond effectively to the growing constraints imposed by global climate change. One source of genes to meet these challenges is the genetic diversity within indigenous field crop landrace material and their wild relatives.

The region is richly endowed with plant genetic resources. In fact, the CAC region encompasses two out of eight of Vavilov's major centres of crop origin and diversity. Among those crop gene pools that originated or diversified in the region, are cereals (wheat, barley, and rye), food legumes (lentils, chickpea, faba bean, and pea), forage legumes (medics, *Trigonella, Trifolium, Onobrychis, Vicia,* and *Lathyrus*), as well as a host of horticultural and medicinal species. These gene pools are of incalculable value to the region and to the world at large.

However, wide spread genetic erosion is occurring at an alarming rate in the area, due to a number of reasons including:

- Introduction of uniform new varieties that replace endemic forms
- Increased mechanization which has a having negative impact on the area under cultivation of local varieties
- A trend towards mono-cropping and a reduction in the traditional diversified farming systems
- Degradation of arable land due to intensification of cropping without adequate use of rotations, soil management and other inputs

- Salinization of soils caused by inappropriate irrigation practices
- Pollution of the environment (water, soil, air) due to the inappropriate use of fertilizers and pesticides
- Uncontrolled forest logging
- Breakdown of traditional pastoral systems resulting in both over-grazing and under-grazing, both of which result in changes in rangeland vegetation
- Recurrent periods of drought that are likely to become more frequent or prolonged as a result of global warming and climate change
- Retreat of the Aral Sea, which is a major environmental disaster for the whole region. Saline dust storms increasingly affect plant ecosystems in the region

Local botanists and international scientists have documented a massive regional loss of agro-biodiversity over the last 10 years. For example, local botanists have registered over 400 plant species as endangered in their national "Red Books". Thus the conservation and effective use of these genetic resources are of immediate and vital importance. This has been recognized and highly prioritized for action in regional meetings involving national programs and international organizations (ICARDA, CIMMYT, IPGRI, FAO) in the period from 1996 to 2003.

During the Soviet era collection, conservation and use of the region's agro biodiversity was headed and coordinated by the All-Union Research Institute of Plant Industry located at Leningrad, now named the N.I. Vavilov Research Institute of Plant Industry (VIR), St Petersburg. After the collapse of the Soviet Union, PGR work has been largely neglected due to lack of experience and resources. Therefore what is now needed is to facilitate the development of sustainable national programs to methodically document, collect, conserve and evaluate the regions genetic resources so they are firstly saved from extinction and then made readily available to the scientific community both regionally and to the world at large.

Two Australia-funded special projects entitled "Development and Conservation of Plant Genetic Resources from the Central Asian Republics and Associated Regions" and "International Linkages for Crop Plant Genetic Resources" have been able to make an important contribution to strengthening the national seed programs in ICARDA's mandate region and also to GRU staff strength. Dr Ken Street was appointed as the coordinator for these projects. For the purposes of this report their aims and outcomes will be summarized and combined.

12.6. Project Six: Development and Conservation of Plant Genetic Resources from the Central Asian Republics and Associated Regions

Project duration: 1998-2001

Funding agency – Australia Center for International Agricultural Research – ACIAR)

Key Scientists involved:

Name/title	Organization
J. Valkoun	ICARDA
K. Street	ICARDA
J. Konopka	ICARDA
C.M. Francis	CLIMA
M. Mackay	AWCC
A.A. Abdukarimov	Academy of Sciences, Tashkent, Uzbekistan
R. Tillaev	UzRIPI[1]
S. Khusainov	Chelkar Research Station, Kazakhstan
J. Akimaliev	Agrarian Academy, Bishkek, Kyrgyzstan
L. Ruhkyan	AAI[2]
G. Agladze	Georgian Academy of Agricultural Sciences A.
Mumladze	Research Institute of Crop Husbandary, Georgia
D. Aliev	Azerbaijan Agrarian Academy, Baku, Azerbaijan
A. Musaev	Scientific Production Association, Baku, Azerbaijan
S. Alexanian	VIR

[1]Uzbek Research Institute for Plant Industries, Taskkent, Uzbekistan
[2]Armenian Agricultural Institute, Baku, Armenia

12.7. Project Seven: Conservation, Evaluation and Utilization of Plant Genetic Resources from Central Asia and the Caucasus

Project duration: 2001-2003

Funding agency – Australia Center for International Agricultural Research – ACIAR)

Key Scientists involved:

Name/title	Organization
J. Valkoun	ICARDA
K. Street	ICARDA
J. Konopka	ICARDA
C.M. Francis	CLIMA
M. Mackay	AWCC
A.A. Abdukarimov	Academy of Sciences, Tashkent, Uzbekistan
R. Tillaev	UzRIPI[1]
S. Khusainov	Chelkar Research Station, Kazakhstan
J. Akimaliev	Agrarian Academy, Bishkek, Kyrgyzstan
L. Ruhkyan	AAI[2]
G. Agladze	Georgian Academy of Agricultural Sciences
A. Mumladze	Research Institute of Crop Husbandary, Georgia
D. Aliev	Azerbaijan Agrarian Academy, Baku, Azerbaijan
A. Musaev	Scientific Production Association, Baku, Azerbaijan
S. Alexanian	VIR

[1]Uzbek Research Institute for Plant Industries, Taskkent, Uzbekistan
[2]Armenian Agricultural Institute, Baku, Armenia

Project Aims

- To upgrade the human resource skills and capacity of the PGR programs in the CAC republics. Primarily this will be achieved by supporting the formation of mini genetic resource units in each of the 8 CAC countries.
- To document, in a database, all *ex situ* PGR holdings in the CAC region
- To support the installation of seed storage facilities in the CAC region.
- To document, in a database, all *ex situ* PGR holdings in the CAC region.
- To increase the representation of accessions from CAC republics of cereal, forage and food legumes and their wild relatives in the genetic resource collections of the collaborating partners.
- To undertake strategic plant collection missions in CAC localities missing from the data sets or in those regions where the germplasm has proven most promising in the field evaluations.
- To characterize and document the germplasm collected on the missions.
- To carry out preliminary agronomic evaluation for important quality traits and production factors on germplasm arising from the CAC region.
- To compile reports on salt tolerance screenings for both food crop and pasture species carried out in the CAC republics.
- To compile reports on *Lucerne* breeding and performance trials carried out in the CAC republics.
- To study the variation in the collected materials and attempt to relate this variation to the biotic and abiotic constraints in the environments from which the material originated. This information will make the germplasm more useful to breeders when selecting material for their improvement programs.
- To undertake climatic homocline work to compare CAC agro-ecological environments with Australian environments
- To re-vitalize linkages between the Republics and VIR in St Petersburg, ICARDA and Australian institutions to promote lasting avenues for exchange of germplasm and information.

Approach used to undertake PGR development in the area

Supported by funding from the project detailed above, ICARDA, has employed a three-pronged approach to its plant genetic resource work in Central Asia and the Caucasus. First, it supports direct action to collect, conserve, document and evaluate the current agro-biodiversity. Thus, there is a consistent and ongoing plant genetic resources program in the region to offset the ongoing genetic erosion in the area.

The second and interlinked strategy has been to develop the capacity of national programs so that they are able to undertake the collection, conservation documentation and evaluation of plant genetic resources for themselves. The approach ICARDA has taken is to foster and support the development of small genetic resource units within each country composed of junior scientists who will undertake the actual "coal face" work. Thus the various training, human resource development and coordination efforts have been focused towards the members of these units and to some extent towards the institutes where they are situated. plant genetic resources focused projects, such as those supported by ACIAR, have supplied funds to support the activities of these units.

The third approach has been to garner lasting support and commitment towards plant genetic resources conservation and utilization at the policy-making level by raising the awareness of the importance of plant genetic resources conservation. This is done in parallel with the two more grass roots strategies. In fact, these activities support one another. When policy-makers see that the genetic resource units are undertaking activities with tangible and useful outputs they are more inclined to invest in supporting an ongoing plant genetic resources conservation and utilization program well after the life of ICARDA-run projects. In fact, this process is well underway. In Kazakhstan, for example, the government has earmarked 10 million dollars for the development of a high tech gene bank while Azerbaijan has secured a World Bank loan to support the establishment of a plant genetic resources institute. Table below details some of actions that ICARDA has facilitated since 1998. These activities have laid a solid foundation in terms of local capacity to build-upon in the long term.

Summary of project achievements

Activity	***Description***
Development of national PGR units.	All eight countries now have a Plant Genetic Resource unit containing a minimum of 3 people who are focused on PGR work.
Inventories of *ex situ* seed collections	*Ex situ* inventories are now complete for Armenia, Georgia, Azerbaijan, Uzbekistan and Kyrgyzstan and partially complete for the other countries. These inventories are captured into a database.
Coordination meetings	Annual regional coordination meetings to promote PGR conservation in the region
Scientific visits	Key personnel from each country supported to make scientific visits for training and program coordination

Training	24 scientists trained to support PGR work. English language, collection mission procedures, database management, using GIS tools, web-page development, gene bank management, field characterization methods, molecular characterization, and general computer skills.
Provision of capital items	Computers and associated equipment, a collection mission vehicle, GPS units, seed storage packets, cooling and shelving for seed storage provided to national programs.
Collection missions	9 separate missions covering all 8 countries have collected over 2300 accessions of crop wild relatives, landraces and forage, pasture and range species.
Field and laboratory characterization and evaluation or CAC material	Accessions from CAC evaluated for useful traits at ICARDA. A significant level of rust resistance discovered in cereal materials.
Technical backstopping for seed storage facilities	ICARDA supported by this project attracted funding and providing technical expertise to upgrade the storage for CAC largest *ex situ* collection based in Uzbekistan. Development of storage facilities is currently underway in Azerbaijan, Georgia, Kyrgyzstan and Tajikistan.
Web page development	ICARDA facilitated the development of a web-page on PGR in CAC region/countries to act as a Networking tool to promote conservation, funding opportunities and highlight current conservation efforts in the region.
Funding proposal development	ICARDA personnel in collaboration with national programs have developed funding proposals to attract resources to support the ongoing PGR conservation work in the area.

One of the outcomes of the above activities is an increased awareness by decision-makers in the region of the importance of plant genetic resources conservation and an increased willingness to invest in it. A web-site listing all the national components of PGR conservation in the CAC countries has also been developed [http://www.cac-biodiversity.org/].

Recommendation fulfilled

These projects have basically safeguarded and evaluated the precious genetic resources at VIR and in the CAC countries, developed and/or upgraded the genetic resources units in the CAC countries, and at the same time made the unique genetic resources of those countries available to Australian, ICARDA and other breeders for possible utilization crop improvement. Thus, the recommendation No. 9 emanating from the Harlan Symposium on "**Origins of Agriculture and the Domestication of Crop plants in the Near-East**", held at ICARDA 10-14 May, 1997, pertaining to assistance to VIR and to the Republic of Armenia to rescue, rejuvenate and evaluate the precious collections of VIR (including the CAC countries of the former Soviet Union) has been fulfilled.

13. ICARDA'S CURRENT GENE BANK HOLDINGS

Scientists involved: Dr Jan Valkoun and Mr Jan Konopka

The number of accessions (accs.) in ICARDA's gene bank increased each year as a result of collection missions and fresh acquisitions. Donations, particularly from the N.I. Vavilov Institute of Plant Industry (VIR), other institutions, or ICARDA's own scientists, as well as through exploration and collection mission in Syria and the Central Asia, West Asia and North Africa (CWANA) region were mainly responsible for this increase. At the end of December 2003, the holdings of the GRU/ICARDA gene bank totaled 131,017 accessions, an increase of 13% over 1997, when the total collection was 115,808 (see GRU Annual Report for 1996 and 1997). The ICARDA gene bank holdings are given below (Table 33) in easy to read tabular format.

Table 33. Status of GRU/ICARDA collections by origin (December 2003)

	Cereals	Food legumes	Forage legumes	Total
CWANA	**42419**	**23853**	**23334**	**89606**
Afghanistan	889	1365	363	2617
Algeria	1819	161	1733	3713
Armenia	435	108	320	863
Azerbaijan	690	182	192	1064
Bahrain	-	-	2	2
Cyprus	178	178	412	768
Egypt	602	346	204	1152
Eritrea	80	-	1	81
Ethiopia	9976	1081	723	11780
Georgia	365	42	154	561
Iran	2964	2968	677	6609
Iraq	611	155	272	1038
Jordan	1533	655	2295	4483
Kazakhstan	294	19	165	478
Kyrgyzstan	77	12	134	223
Lebanon	413	184	844	1441
Libyan Arab Jamahiriya	278	47	249	574
Morocco	1437	586	2425	4448
Oman	113	3	197	313
Pakistan	1188	603	245	2036
Palestine	1098	122	119	1339
Saudi Arabia	36	3	8	47
Syrian Arab Republic	2213	1797	5658	9668
Tajikistan	390	275	363	1028

Table 33. (Continued)

	Cereals	Food legumes	Forage legumes	Total
Tunisia	2396	334	1553	4283
Turkey	5731	2033	3602	11366
Turkmenistan	349	31	183	563
United Arab Emirates	3	-	127	130
Uzbekistan	370	335	96	801
Yemen	195	87	16	298
ICARDA breeding material	5696	10141	2	15839
EUROPE	**9478**	**3251**	**6960**	**19689**
Albania	43	2	21	66
Austria	314	1	5	320
Belarus	15	3	14	32
Belgium	17	3	28	48
Bosnia and Herzegovina	36	4	-	40
Bulgaria	295	303	167	765
Croatia	11	17	4	32
Czech Republic	197	75	136	408
Former Czechoslovakia	100	2	1	103
Denmark	145	-	31	176
Estonia	4	-	5	9
Europe	2	-	9	11
Finland	43	-	34	77
France	219	77	256	552
Germany	593	187	491	1271
Greece	1357	177	682	2216
Hungary	193	47	393	633
Ireland	2	-	1	3
Italy	513	186	1155	1854
Latvia	6	5	13	24
Lithuania	8	3	7	18
Macedonia	291	24	10	325
Malta	7	-	26	33
Moldova, Republic of	23	23	6	52
Netherlands	56	44	133	233
Norway	10	1	7	18
Poland	126	58	113	297
Portugal	757	313	272	1342
Romania	122	57	286	465
Russian Federation	1560	419	861	2840
San Marino	3	-	-	3
Slovakia	18	7	13	38

Table 33. (Continued)

	Cereals	Food legumes	Forage legumes	Total
Slovenia	-	1	-	1
Spain	535	871	800	2206
Sweden	97	8	372	477
Switzerland	757	2	7	766
Ukraine	640	187	203	1030
Former Soviet Union*	32	-	-	32
United Kingdom	129	95	349	573
Yugoslavia	202	49	49	300
ASIA	**5403**	**3760**	**1926**	**11089**
Bangladesh	-	122	1127	1249
Bhutan	29	-	1	30
China	3423	497	121	4041
India	743	2548	311	3602
Indonesia	1	-	-	1
Japan	462	10	50	522
Korea	197	-	-	197
Mongolia	49	-	13	62
Myanmar	1	-	-	1
Nepal	498	580	302	1380
Sri Lanka	-	2	-	2
Thailand	-	-	1	1
Viet Nam	-	1	-	1
AFRICA	**235**	**136**	**76**	**447**
Burundi	-	-	1	1
Central African Republic	1	-	-	1
Congo	-	-	1	1
Gabon	-	-	1	1
Guinea-Bissau	-	-	1	1
Kenya	24	6	11	41
Madagascar	-	-	1	1
Malawi	-	3	-	3
Mali	-	-	2	2
Nigeria	-	1	5	6
Rwanda	2	-	-	2
Senegal	-	-	1	1
South Africa	181	-	8	189
Sudan	13	126	36	175
Swaziland	-	-	4	4
Tanzania	2	-	-	2
Uganda	-	-	4	4
Zimbabwe	12	-	-	12

Table 33. (Continued)

	Cereals	Food legumes	Forage legumes	Total
AMERICAS	**4252**	**1888**	**1071**	**7211**
Argentina	88	23	11	122
Bolivia	28	6	15	49
Brazil	66	3	7	76
Canada	360	293	81	734
Chile	62	746	42	850
Colombia	579	57	3	639
Costa Rica	-	2	1	3
Cuba	-	4	-	4
Ecuador	65	299	36	400
Falkland Islands	-	2	-	2
Guatemala	4	4	2	10
Haiti	-	-	1	1
Mexico	366	230	7	603
Netherlands Antilles	-	-	3	3
Paraguay	4	-	1	5
Peru	133	47	10	190
United States of America	2472	168	836	3476
Uruguay	17	4	12	33
Venezuela	8	-	3	11
OCEANIA	**176**	**10**	**535**	**721**
Australia	176	9	486	671
New Zealand	-	1	49	50
Unknown origins	756	559	939	2254
Grand total	**62719**	**33457**	**34841**	**131017**

* accs. that could not be attributed to any of the new Republics or Russian Federation due to lack of provenance information

14. LIST OF PUBLICATIONS

Scientists involved: GRU staff and their associates

The GRU staff maintained a prolific record of publications and presentations at conferences and preparing discussion papers. In total, 126 publications were produced during the period covered by this report. All publications authored or co-authored by GRU staff are reported here on yearly basis from 1998 to 2003. Some ex-GRU staff members continue to publish scientific articles based upon their research done and experience gained at ICARDA and these papers and articles have been reported here with the consent of the authors. Publications that were missed being reported in 1996 and 1997 GRU Annual Report are also included in this list. Two publications were accepted in early 2003 but did not appear in print till mid 2004 are reported here for the sake of completeness. A summary of reports, and other mass media and awareness efforts generated by the regional and country-components of the GEF-UNDP Project on *Conservation and Sustainable Use of Dryland Agrobiodiversity* are listed in APPENDIX 17E.

The individual publications are listed below in an alphabetical order based on last name of the author or senior author. While the refereed journal names are abbreviated and italicized, the newsletter names are not.

Abidou, H., A. El-Ahmad, A. Yahyaoui, and R. Rivoal. 2003. Occurrence of cereal cyst nematode on wheat and barley in Syria. Presented at the Eighth Arab Congress of Plant Protection, 12-16 October, 2003. Omar Al-Mukhtar University, El-Beida, Libya.

Abu-Zanat, M., A. Amri, S. hamadeh, S. Al-Laham, and B. Mawlawi. 2003. Promoting agrobiodiversity conservation in rangelands of dry areas. *In*: Sustainable development and management of dry lands in the 21st century. Abstracts of the Seventh International Conference on Development of Dry Lands, 14-17 September 2003, Tehran, Iran, pp. 44-45.

Ajlouni, M.M. and A. Amri. 2002. Lessons learned from West Asia Dryland Agrobiodiversity Project. Presented at the International Conference on Promoting Best Practices for Conservation and Sustainable Use of Biodiversity of Global Significance in Arid and Semi-Arid Zones, Cairo, Egypt.

Ajlouni, M.M. and A. Amri. 2002. The importance of conservation and sustainable use of dryland agro-biodiversity in West Asia. Presented at the Second Jordanian Environmental Conference on Environmental Culture and Sustainable Development, Amman, Jordan.

Ajlouni, M.M. and A. Amri. 2003. Lessons learned for policy and legislation reforms to promote dryland agro-biodiversity conservation in West Asia: the case of Jordan. Presented at the International Conference on Implementing Programs to Conserve Biodiversity in Arid and Semi-Arid Regions in Developing Countries, Rabat, Morocco.

Amri, A., M. Boujnah, N. Nsarellah, M. Taghouti, and M. Nachit. 2000. Genetic and agronomic approaches to improve durum wheat quality in Morocco. *In:* C. Royo, M. Nachit, M. di Fonzo, and J.L. Araus (Eds.) Durum Wheat Improvement in the Mediterranean Region: New Challenges, 12-14 April 2000, Zaragoza, Spain. pp. 543-548.

Amri, A. and A. Shehadeh. 2000. Community based *in-situ* conservation of dry-land agrobiodiversity in Jordan, Lebanon, Palestinian Authority and Syria. Presented at the Agrobiodiversity Fair, Beirut, Lebanon.

Amri, A., J. Valkoun, and A. Shehadeh. 2002. Promoting *in-situ* conservation of agrobiodiversity in West Asia. Caravan **17**: 31-33.

Amri, A., J. Valkoun, and A. Shehadeh. 2003. Efforts to promote *in situ* conservation of agrobiodiversity in West Asia. Presented at Tashkent meetings in May 2003.

Amri, A., J. Valkoun, M. Ajlouni, R. Assi, Y. Sbeith, and A. Saad. 2003. Promotion of in-situ conservation of dryland agrobiodiversity in West Asia. *In*: Sustainable development and management of dry lands in the 21st century. Abstracts of the Seventh International Conference on Development of Dry Lands, 14-17 September 2003, Tehran, Iran, pp. 38-39.

Asaad, S. 2000. Inheritance of Resistance in Barley to Stripe Disease *Pyrenophora graminea* and Environmental Effect on Seed Infection and Symptoms Expression. PhD Thesis, University of Aleppo, Syria. 195 p.

Asaad, S. and A. El-Ahmed. 1999. Improved Method for Detection of *Pyrenophora graminea* in barley seed. *Phytopathol. Mediterr.* **38**: 144-148.

Asaad, S. and A. El-Ahmed. 1999. An improved method for detection of *Pyrenophora graminea* in barley seeds. Presented at the International Seed Testing Association (ISTA)-Plant Disease Committee (PDC) meeting, 16-19 August, Ames, Iowa, USA.

Asaad, S. and A. El-Ahmed. 2000. Effect of barley dressing on infection with *Pyrenophora graminea* at ICARDA. *In*: A.K. Bader and H.S. Hasan (Eds.) Book of Abstracts. Presented at the Seventh Arab congress of Plant Protection, 22-26 Oct. 2000, Amman, Jordan. pp 171. (Ar;En)

Asaad, S., A. El-Ahmed, and J. Valkoun. 2002. Pathogens diversity on imported seed to ICARDA/Syria. Presented at the Fourth International Seed Testing Association (ISTA)-Plant Disease Committee (PDC) Symposium Healthy Seeds –

The Basis for Sustainable Farming, April 29-May 1, 2002, Wageningen, The Netherlands.

Asaad, S., A. El-Ahmed, and M. Nachit. 2003. Reaction of the Durum Recombinant Inbread Lines (Ril) Sw Alger/Gidara to Septoria Leaf Blotch *(Septoria tritici)*. *In*: B. Bayaa, K.M. Makkouk, S.G. Kumari, and I. El-Ghariani (Eds.) Abstract Book. Presented at the Eighth Arab Congress of Plant Protection, 12-16 October, 2003. Omar Al-Mukhtar University, El-Beida, Libya. pp. 37-E and 39-A.

Azzam, A., S. Azzam, S. Lhaloui, A. Amri, M. El-Bouhssini, and M. Moussaoui. 1997. Economic returns to research in Hessian fly (Diptera: Cecidomyiidae) resistant bread-wheat varieties in Morocco. *J. Econ. Entomology* **90**(1): 1-5.

Bari, A., A. Della, and J. Konopka. 1998. Locating diversity using germplasm passport data and herbarium records: case of *Aegilops* in Cyprus. *In:* A.A. Jaradat (Ed.), Triticeae III. Science Publishers, Inc., Enfield, NH, USA, pp. 53-56.

Belaid, A., N. Nsarellah, A. Laamari, M. Nachit, and A. Amri. 2001. Durum improvement research in Morocco: a worthwhile investment. Caravan **15**: 24-26.

Benbelkacem, A., M. Boulif, A. Amri, and S. Ceccarelli. 2000. Variation in the pathogenicity of 20 Algerian isolates of *Pyrenophora graminea* Ito and Kur. on nine barley (*Hordeum vulgare* L.) varieties. *Phytopathol. Medit.* **39**: 389-395.

Benbelkacem, A., M. Boulif, A. Amri, and S. Ceccarelli. 2000. Pathogenic variability of 20 Algerian isolates of *Pyrenophora graminea* Ito and Kurde. on nine barley (*Hordeum vulgare* L.) varieties. *In*: S. Logue (Ed.) Barley Genetics VIII, Volume II – Contributed Papers. Proceedings of the 8th International Barley Genetics Symposium, 22-27 October 2000, Adelaide, Australia. Department of Plant Science, Waite Campus, Adelaide University, Glen Osmond, Australia. pp. 78-79.

Berger, J.D., L.D. Robertson, and P.S. Cocks. 2002. Agricultural potential of Mediterranean grain and forage legumes: key differences between and within *Vicia* species in terms of phenology and yield, and agronomy give insight into plant adaptation to semi-arid environments. *Genet. Resources & Crop Evol.* **49**: 313-325.

Berger, J.D., L.D. Robertson, and P.S. Cocks. 2003. Agricultural potential of Mediterranean grain and forage legumes: anti-nutritional factor concentrations in the genus *Vicia*. *Genet. Resources & Crop Evol.* **50**: 201-212.

Bounejmate, M., G. Gintzburger, S. Christiansen, L.D. Robertson, A. Abd El Moneim, and J. Konopka. 1999. Forage and pasture legume genetic resources at ICARDA. *In*: P.S. Cocks and S.J. Bennett (Eds.), Genetic Resources of Mediterranean Pasture and Forage Legumes, 14-18 October 1996, York, Australia. Kluwer Academic Publishers, Dordrecht, The Netherlands, pp. 163-170.

Ceccarelli, S., S. Grando, E. Bailey, A. Amri, M. El-Felah, F. Nassif, S. Rezgui, and A. Yahyaoui. 2001. Farmer participation in barley breeding in Syria, Morocco, and Tunisia. 2001. *Euphytica* **122**(3): 521-536.

Ceccarelli, S., S. Grando, A. Amri, F.A. Asaad, A. Benbelkacem, M. Harrabi, M. Maatougui, M.S. Mekni, H. Mimoun, R.A. El-Einen, M. El-Felah, A.F. El-Sayed, A.S. Shreidi, and A. Yahyaoui. 2001. Decentralized and participatory plant breeding for marginal environments. In: H.D. Cooper, C. Spillane, and T. Hodgkin (Eds.), Broadening the Genetic Base of Crop Production, IPGRI, Rome, Italy, pp. 115-135.

Chabane, K. and J. Valkoun. 1998. Standardization of RAPD marker technique to determine the diversity of diploid wheat: *Triticum urartu*. *In:* A.A. Jaradat (Ed.), Triticeae III. Science Publishers, Inc., Enfield, NH, USA, pp. 155-158.

Chabane, K., A. Mahdere, J. Valkoun, and S. Ceccarelli. 2000. Characterization of genetic diversity in barley (*Hordeum vulgare* L.) using RAPD and AFLP markers. *In*: S. Logue (Ed.) Barley Genetics VIII, Volume II – Contributed Papers. Proceedings of the 8th International Barley Genetics Symposium, 22-27 October 2000, Adelaide, Australia. Department of Plant Science, Waite Campus, Adelaide University, Glen Osmond, Australia. pp. 6-7.

Chabane, K., R. Kassis, and J. Valkoun. 2000. Genetic diversity of Lebanese wild wheat populations revealed by RAPD and AFLP markers. *In*: Proceedings of the International Conference on Science and Technology for Managing Plant Genetic Diversity. Kuala Lumpur, Malaysia, 12-16 June, 2000. pp 10.

Chabane, K., J.H. Barker, A. Karp, and J. Valkoun, 2000. Evaluation of genetic diversity in diploid wheat *Triticum urartu using* AFLP markers. *El Awamia* **100**: 3-19.

Chabane, K. and J. Valkoun. 2001. Molecular characterization of wild and cultivated tetraploid wheat of the Near East origin. In: P. Hernández, M.T. Moreno, J.I. Cubero and A. Martín (Eds.), Triticeae IV - Proceedings of the 4th International Triticeae Symposium, 10-12 September, 2001. Córdoba, Spain, pp. 131-134.

Chabane, K., R. Kassis, and J. Valkoun. 2002. Genetic diversity of Lebanese wild wheat populations: RAPD and AFLP fingerprinting. In: J. Ryan (Ed.), Desert and Dryland Development: Challenges and Potential in the New Millenium. Proceedings of the Sixth International Conference on the Development of Dry Lands, 22-27 August, 1999, Cairo, Egypt. ICARDA, Aleppo, Syria. pp. 293-297.

Chabane, K. and J. Valkoun. 2002. Evaluation of genetic diversity of barley (*Hordeum vulgare L.*) from Ethiopia, Eritrea and Yemen using AFLP markers. *In*: Y.A. Al-Shayji, J.S. Sidhu, M. Saleem, and K. Guerinik (Eds.) Biotechnology

Applications for the Arid Regions. Kuwait Institute for Scientific Research (KISR), Kuwait, pp. 173-179.

Chabane, K. and J. Valkoun. 2003. AFLP analysis of wild barley core collection. *In*: C. Marè, P. Facciolo and A.M. Stanca (Eds.) From Biodiversity to Genomics: Breeding Strategies for Small Grain Cereals in the Third Millennium. Proceedings of the Cereal Section Meeting of the European Association for Research on Plant Breeding (EUCARPIA), 21-25 November 2002, Salsomaggiore, Italy. Experimental Institute for Cereal Research, Fiorenzuola d'Arda (PC), Italy, pp. 64-65.

Chabane, K., G.A. Ablett, G.M. Cordeiro, J. Valkoun and R.J. Henry. 2003. EST versus genomic derived microsatellites for genotyping wild and cultivated barley. *In*: C. Marè, P. Facciolo and A.M. Stanca (Eds.) From Biodiversity to Genomics: Breeding Strategies for Small Grain Cereals in the Third Millennium. Proceedings of the Cereal Section Meeting of the European Association for Research on Plant Breeding (EUCARPIA), 21-25 November 2002, Salsomaggiore, Italy. Experimental Institute for Cereal Research, Fiorenzuola d'Arda (PC), Italy, pp. 9-10.

Chabane, K., G.A. Ablett, G.M. Cordeiro, J. Valkoun, and R.J. Henry. 2004. EST versus genomic derived microsatellites for genotyping wild and cultivated barley. *Genet. Resources & Crop Evol.* **51**: 1-7.

Choumane, W., S. Achtar, J. Valkoun, and F. Weigand. 1998. Genetic variation in core and base collections from WANA as revealed by RAPDs. *In*: A.A. Jaradat (Ed.) Triticeae III. Science Publishers, Inc., Enfield, NH, USA, 159-163 pp.

Damania, A.B., J. Valkoun, G. Willcox, and C.O. Qualset (Eds). 1998. The Origins of Agriculture and Crop Domestication - The Harlan Symposium. ICARDA, Aleppo, Syria, 352 p.

Damania, A.B. 1998. Diversity of major cultivated plants domesticated in the Near-East. *In*: A.B. Damania, J. Valkoun, G. Wilcox and C.O. Qualset (Eds.), The Origins of Agriculture and Crop Domestication - The Harlan Symposium. ICARDA, Aleppo, Syria, pp. 51-64.

Damania, A.B. 1998. Domestication of cereal crop plants and *in situ* conservation of their genetic resources in the Fertile Crescent. *In*: A.B. Damania, J. Valkoun, G. Wilcox and C.O. Qualset (Eds.), The Origins of Agriculture and Crop Domestication - The Harlan Symposium. ICARDA, Aleppo, Syria, pp. 307-316.

Damania, A.B. 2002. The Hindustani center of origin of important plants. *Asian Agri-History* **6**(4): 333-341.

El-Ahmed, A. 1999. Facilities and safeguards with emphasis on seed at the International Center for Agricultural Research in the Dry Areas (ICARDA). *In*:

R.P. Kahn and S.B. Mathur (Eds.), Exotic Pest and Pathogen Exclusion: Containment Facilities and Safeguards for Imported Seeds, Plants and Biological Control Organisms. APS Press, St. Paul, Minnesota, USA, pp. 45-53.

El-Ahmed, A., S. Asaad, and M. Nachit. 2000. Screening of durum recombinant inbred lines against black point and wheat gall nematode. *In*: A.K. Bader and H.S. Hasan (Eds.) Book of Abstracts. Presented at the Seventh Arab congress of Plant Protection, 22-26 Oct. 2000, Amman, Jordan. pp 159. (Ar;En)

El-Haddoury, J., A. Amri, A. Baidani, H. Chlyah, and N. Nsarellah. 2000. *In vitro* androgenesis response of durum wheat disomic substitution lines. *Life Sciences* **323**: 251-255 (Fr.).

El-Khalifeh, M., A. El-Ahmed, and N. Bek. 2002. Field survey of the black disease on wheat crop and its development under storage conditions at Raqqa province, Syria. *Arab J. Pl. Prot.* **20**(2): 137-144.

El-Naeb, R., A. Yahyaoui, A. El-Ahmed, and M. Nachit. 2002. Survey on common root rot of wheat and barley in Aleppo and Idleb Governorates (Northern Syria). *Arab J. Pl. Prot.* **20**(2): 131-136.

Ferguson, M.E., N. Acikgoz, S. Cinsoy, and A. Ismail. 1996. Ecogeographic survey of wild *Lens* in south west Turkey. *Anadolu* (Journal of AARI) **6**: 159-166.

Ferguson, M.E. 1997. *Lens* species: conserved resources, priorities for collection and future prospects. Presented at the International Food Legume Research Conference III, 22-26 September 1997, Adelaide, Australia.

Ferguson, M.E., B.V. Ford-Lloyd, L.D. Robertson, N. Maxted, and H. J. Newbury. 1997. Mapping the geographical distribution of genetic variation in *Lens culinaris* subsp. *orientalis* (Boiss.) Ponert for the enhanced conservation of germplasm diversity. Presented at Advances in Plant Molecular Systematics, 12-15 August 1997, University of Glasgow, UK.

Ferguson, M.E., B.V. Ford-Lloyd, L.D. Robertson, N. Maxted, and H.J. Newbury. 1998. Mapping the geographical distribution of genetic variation in the genus *Lens* for the enhanced conservation of plant genetic diversity. *Mol. Ecol.* **7**: 1743-1755.

Ferguson, M.E., H.J. Newbury, N. Maxted, B.V. Ford-Lloyd, and L.D. Robertson. 1998. Population genetic structure of *Lens* taxa revealed by isozyme and RAPD analysis. *Genet. Resources & Crop Evol.* **45**: 549-559.

Ferguson, M.E., L.D. Robertson, B.V. Ford-Lloyd, H.J. Newbury, and N. Maxted. 1998. Contrasting genetic variation amongst lentil landraces from different geographical origins. *Euphytica* **102**: 265-273.

Ferguson, M.E. 1998. *Lens* species: conserved resources, priorities for collection and future prospects. *In*: R. Knight (Ed.), Linking Research and Marketing Opportunities for Pulses in 21st Century. Kluwer, Dordrecht, The Netherlands, pp. 613-620.

Ferguson, M.E. and L.D. Robertson. 1999. Morphological and phonological variation in the wild relatives of lentil. *Genet. Resources & Crop Evol.* **46**(1): 3-12.

Ferguson, M.E., N. Maxted, M. van Slageren, and L.D. Robertson. 2000. A re-assessment of the taxonomy of *Lens* Mill. (Leguminosae, Papilionoideae, Vicieae). *Bot. J. Linn Soc.* **133**: 41-59.

Ferguson, M.E. and W. Erskine. 2000. Lentils (*Lens* L.). *In*: N. Maxted and S.J. Bennett (Eds.), Plant Genetic Resources of the Mediterranean. Kluwer Academic Publishers, Dordrecht, The Netherlands, pp. 125-133.

Hakim, M.S. and A. El-Ahmed. 1998. The physiological races of wheat yellow rust *Puccinia striiformis* f.sp. *tritici* in Syria during the period 1994-1996. *Arab J. Pl. Prot.* **16**(1): 7-11.

Hannan, R., N. Acikgoz, and L.D. Robertson. 2001. Chickpeas (*Cicer* L.). *In*: N. Maxted and S.J. Bennett (Eds.), Plant Genetic Resources of the Mediterranean. Kluwer Academic Publishers, Dordrecht, The Netherlands, pp. 115-124.

Hamouieh, A., K. Makkouk, B. Debs, and A. El-Ahmed. 1999. Production of specific antiserum to *Pseudomonas syringae* pv. *pisi* the casual organism of bacterial blight of pea in Syria. *Arab J. Pl. Prot.* **17** (1): 26-30.

Hamouieh, A., K.M. Makkouk, and A. El-Ahmed. 2000. Detection of *Pseudomonas syringae* pv. *pisi*, the casual organism of bacterial blight of pea, by the Dot-Blot Immunoassay in comparison with serological tests. Presented at the Seventh Arab congress of Plant Protection, 22-26 October 2000, Amman, Jordan.

Hegde, S.G., J. Valkoun, and J.G. Waines. 2000. Genetic diversity in wild wheats and goat grass. *Theor. Appl. Genet.* **101**: 309-316.

Hegde, S.G., J. Valkoun, and J.G. Waines. 2002. Genetic diversity in wild and weedy *Aegilops*, *Amblyopyrum*, and *Secale* species. – A Preliminray survey. *Crop Sci.* **42**(2): 608-614.

Ismaiel, M.F., A. El-Ahmed, and M.H. Al-Zainab. 2000. A field survey of wheat seed gall nematode (*Anguina triticii*) in Aleppo and Raqqa provinces, Syria. *Arab J. Pl. Prot.* **18** (1): 9-16.

Ismaiel, M.F., M.H. Al-Zainab, and A. El-Ahmed. 2003. A field survey of plant parasitic nematodes in lentil fields in Aleppo and Idleb provinces, Syria. Presented at the Eighth Arab Congress of Plant Protection, 12-16 October 2003. Omar Al-Mukhtar University, El-Beida, Libya.

Kayali, M., A. El-Ahmed, B. Debs, K.M. Makkouk, S. Asaad, S.G. Kumari, and N. Attar. 2004. Production of specific antiserum to *Xanthomonas translucens* pv. *undulosa* the causal organism of bacterial stripe on wheat in Syria. *Arab J. Pl. Prot.* **22**(1): (in press).

Khalikulov, Z., R. Movlaynova, J. Konopka, P. Khodjaev, K. Street, and F. Abdullaev. 2000. Nuturing the Vavilov legacy. Caravan **13**: 14-15.

Koo, B., P.G. Pardey, J. Valkoun, and B.D. Wright. 2002. Cost of conserving genetic resources at *ex situ* genebanks: an example of the ICARDA genebank. *In:* R.E. Evenson, V. Santaniello and D. Zilberman (Eds.), Economic and Social Issues in Agricultural Biotechnology. CAB International, Oxford, UK, pp. 137-158.

Lazaro, A., M. Campbell, C. Francis, L. Robertson, and C. de la Cuadra. 2002. Collecting biodiversity of important legumes in Spain. Plant Genet. Resources Newsletter **129**: 11-16.

Malhotra, R.S., W. Erskine, and J. Konopka. 1999. Genetic resources of chickpea. Grain Legumes **25**: 16-17.

Maxted, N., W. Erskine, D.P. Singh, L.D. Robertson and A.N. Asthana. 2000. Are our germplasm collections museum items? *In*: R. Knight (Ed.), Proceedings of the Third International Food Legumes Research Conference: Linking Research and Marketing Opportunities for Pulses in the 21st Century (Current Plant Science and Biotechnology in Agriculture; V. 34), Adelaide, Australia, 22-26 September 1997. Kluwer Academic Publishers, Dordrecht, The Netherlands, pp. 589-602.

Maxted, N., A. Tan, A. Amri, and J. Valkoun. 2000. *In situ* conservation. *In:* N. Maxted and S. Bennet (Eds.), Plant Genetic Resources of Legumes in the Mediterranean. Kluwer Academic Publishers, Dordrecht, Netherlands, pp. 292-310.

Maxted, N., L. Guarino, and A. Shehadeh. 2002. *In Situ* Techniques for Efficient Genetic Conservation and Use: A Case Study for *Lathyrus*. *In*: P. Forsline (Convenor), Plant Genetic Resources: the Fabric of Horticulture's Future, International Horticultural Congress, 12-16 August 2002, Toronto, Canada.

Naeb, R., A. El- Ahmed, A. Yahyaoui, and M. Nachit. 2003. Search for sources of resistance in barley and wheat genotypes against common root rot disease. Presented at the Eighth Arab Congress of Plant Protection, 12-16 October, 2003. Omar Al-Mukhtar University, El-Beida, Libya.

Nassif, F. and A. Amri. 2003. Linking *in situ* conservation research and participatory plant breeding: the case of barley in Morocco. *In*: Sustainable development and management of dry lands in the 21st century. Abstracts of the Seventh

International Conference on Development of Dry Lands. 14-17 September 2003, Tehran, Iran, pp. 45-46.

Nassif, F., A. Amri, and S. Ceccarelli. 2003. Participatory plant breeding: the case of barley in Morocco. *In*: Sustainable development and management of dry lands in the 21st century. Abstracts of the Seventh International Conference on Development of Dry Lands, 14-17 September 2003, Tehran, Iran, pp. 129-130.

Nsarellah, N., A. Amri, M.M. Nachit, M. El Bouhssini, and S. Lhaloui. 2003. New durum wheat with hessian fly resistance from *Triticum araraticum* and *T. Carthlicum* in Morocco. *Plant Breeding* **122**: 435-437.

Ocampo, B., L.D. Robertson, and K.B. Singh. 1998. Variation in seed protein content in the annual wild *Cicer* species. *J. Sci. Food & Agric.* **78**: 220-224.

Peacock, J.M., M.E. Ferguson, G.A. Alhadrami, I.R. McCann, A. Al Hajoj, A. Saleh, and R. Karnik. 2003. Conservation through utilization: a case study of the indigenous forage grasses of the Arabian Peninsula. *J. Arid Environments* **54**(1): 15-28.

Robertson, L.D., B. Ocampo, and K.B. Singh. 1997. Morphological variation in wild annual *Cicer* species in comparison to the cultigen. *Euphytica* **95**(3): 309-319.

Robertson, L.D. and M. Bounejmate, 1999. Genetic erosion of pasture and forage legumes in the Mediterranean basin. *In*: P.S. Cocks and S.J. Bennett (Eds.), Genetic Resources of Mediterranean Pasture and Forage Legumes, 14-18 October 1996, York, Australia. Kluwer Academic Publishers, Dordrecht, The Netherlands, pp. 67-77.

Robertson, L.D., M. Sadiki, R. Matic, and Li-juan Lang. 2000. *Vicia* spp: Conserved resources, priorities for collection and future prospects. *In*: R. Knight (Ed.), Proceedings of the Third International Food Legumes Research Conference: Linking Research and Marketing Opportunities for Pulses in the 21st Century (Current Plant Science and Biotechnology in Agriculture; V. 34), Adelaide, Australia, 22-26 September 1997. Kluwer Academic Publishers, Dordrecht, The Netherlands, pp. 623-633.

Robertson L.D. and N. Maxted. 2001. *Ex situ* conservation of grain legumes. *In*: N. Maxted and S.J. Bennett (Eds.), Plant Genetic Resources of the Mediterranean. Kluwer Academic Publishers, Dordrecht, The Netherlands, pp. 245-262.

Sarker, A., L.D. Robertson, and C.G. Campbell. 2000. *Lathyrus* spp: Conserved resources, priorities for collection and future prospects. *In*: R. Knight (Ed.), Proceedings of the Third International Food Legumes Research Conference:

Linking Research and Marketing Opportunities for Pulses in the 21st Century (Current Plant Science and Biotechnology in Agriculture; V. 34), Adelaide, Australia, 22-26 September 1997. Kluwer Academic Publishers, Dordrecht, The Netherlands, pp. 645-654.

Sasanuma, T., K. Chabane, and J. Valkoun. 2000. Genetic diversity of wild wheat and its relatives in the Near East detected by AFLP. *In*: The Proceedings of the 72nd Annual Meeting of Genetics Society of Japan, Kyoto, Japan, November 2000.

Sasanuma, T., K.Chabane, and J. Valkoun. 2001. Genetic diversity of seven diploid *Aegilops* species detected by AFLP. *In*: The Proceedings of the Annual Meeting of Genetic Society of Japan, September 2001.

Sasanuma, T., K. Chabane, T.R. Endo, and J. Valkoun. 2002. Genetic diversity of wheat wild relatives in the Near East detected by AFLP. *Euphytica* **127**: 81-93.

Sasanuma, T., K. Chabane, and J. Valkoun. 2003. AFLP analysis on genetic diversity of wild tetraploid wheat in the Near East. Presented at the 104th Meeting of the Japanese Society of Breeding, August 20, 2003, Kobe, Japan.

Sasanuma, T., K. Chabane, T.R. Endo, and J. Valkoun. 2004. Characterization of genetic variation in and phylogenetic relationships among diploid *Aegilops* species by AFLP: incongruity of chloroplast and nuclear data. *Theor. Appl. Genet.* **108**: 612-618.

Shamsi, R., A. El-Ahmed, Y. Idrees, R. Malhotra, and S. Asaad. 2003. Radiometeric spectral reflectance as a tool to monitor Ascochyta blight development in chickpea fields. *In*: B. Bayaa, K.M. Makkouk, S.G. Kumari, and I. El-Ghariani (Eds.), Abstract Book. Presented at the Eighth Arab Congress of Plant Protection, 12-16 October, 2003. Omar Al-Mukhtar University, El-Beida, Libya. pp. 38-A and 36-E.

Shehadeh, A. and J. Valkoun. 2000. *Trifolium* Germplasm Collection at ICARDA. Presented in the Sixteenth Trifolium Conference, June 20-22, 2000, Pipetstem State Park, West Virginia, USA.

Singh, K.B., B. Ocampo, and L.D. Robertson. 1998. Diversity for abiotic and biotic stress resistance in the wild annual *Cicer* species. *Genet. Resources & Crop Evol.* **45**: 9-17.

Solh, M., A. Amri, T. Ngaido and J. Valkoun. 2003. Policy and education reform needs for conservation of dryland biodiversity. *J. Arid Environ.* **54**: 5-13.

Street K. and M. Bounejmate. 2000. The hunt for green gold in Central Asia and the Caucasus. Caravan **13**: 12-13.

Street, K.A., L.D. Robertson and N. Maxted. 2001. Utilization of pasture legume diversity. *In*: N. Maxted and S.J. Bennett (Eds.), Plant Genetic Resources of the Mediterranean. Kluwer Academic Publishers, Dordrecht, The Netherlands, pp. 327-355.

Street, K., A. Shehadeh, J. Valkoun, and Z. Khalikulov. 2003. Collecting green gold in the footsteps of NI Vavilov. ICARDA, Aleppo, Syria.

Street, K., P.S. Cocks, and A.M. Abd El Moneim. 2003. Subterranean vetch (*Vicia sativa* spp. *amphicarpa*) maintains its production capacity under competitive stress and at different moisture regimes. *Turkish J. Agric. & Forestry* (In Press).

Street, K., P.S. Cocks, and A.M. Abd El Moneim. 2003. Adaptation of. subterranean vetch (*Vicia sativa* spp. *amphicarpa*) to conditions in Syria: influence of eight years protection from grazing. *J. Appl. Ecology* (In Press).

Street, K., P.S. Cocks, and A.M. Abd El Moneim. 2003. Subterranean vetch (*Vicia sativa* spp. *amphicarpa*) a Mediterranean species adapted to dry, disturbed environments which maintains its reproductive capacity under moisture and competitive stress. *J. Appl. Ecology* (In Press).

Street, K., P.S. Cocks, and A.M. Abd El Moneim. 2003. The pattern of dormancy loss for aerial and under grouped seeds of subterranean vetch (*Vicia sativa* spp. *amphicarpa*) when buried at different depths. *J. Appl. Ecology* (In Press).

Udupa, S.M., L.D. Robertson, F. Weigand, M. Baum, and G. Kahl. 1999. Allelic variation at (TAA) in microsatellite loci in a world collection of chickpea (*Cicer arietinum* L.) germplasm. *Mol. & General Genet.* **261**: 354-363.

Valkoun, J., S. Ceccarelli, and J. Konopka. 1997. Barley. *In*: D. Fuccillo, L. Sears, and P. Stapleton (Eds.), Biodiversity in Trust: Conservation and Use of Plant Genetic Resources in CGIAR Centers. Cambridge Univ. Press, Cambridge, UK, pp. 191-212.

Valkoun, J., J. Konopka, A.B. Damania, B.O. Humeid, and S. Ceccarelli. 1998. Barley Germplasm Catalog. Part III – 1998. ICARDA, Aleppo, Syria, 556 p.

Valkoun, J., A. Belaid and K. Chabane. 1998. Biosphere reserves and conservation of agro-biodiversity in semi-arid and arid regions of Arab countries. Paper presented at the workshop on Biodiversity Reserves in Arab Countries, October 1998, Tunisia.

Valkoun, J. 1998. Strategy for plant agrobiodiversity conservation in Yemen. (Discussion paper, 11 pages).

Valkoun, J., J. Giles Waines, and J. Konopka. 1998. Current geographical distribution and habitat of wild wheats and barley. *In*: A.B. Damania, J. Valkoun, G. Wilcox and C.O. Qualset (Eds.), The Origins of Agriculture and Crop Domestication - The Harlan Symposium. ICARDA, Aleppo, Syria, pp. 293-299.

Valkoun, J., B.O. Humeid, J. Konopka, O. Abdallah, and A.B. Damania. 1999. Bread Wheat Germplasm Catalog. ICARDA, Aleppo, Syria, 488 p.

Valkoun, J. and A.B. Damania. 1999. Collecting genetic resources: Principles learnt from H.V. Harlan, N.I. Vavilov and J.R. Harlan. Invited paper presented at the Crop Science Society of America annual meeting, 31 Oct.–4 Nov. 1999, Salt Lake City, Utah, U.S.A.

Valkoun, J.J. 2001. Wheat pre-breeding using wild progenitors. *Euphytica* **119**: 17-23.

Valkoun, J. 2001. The geographical distribution of wild wheats in their historical setting and current context. *In:* P.D.S. Caligari and P.E. Brandham (Eds.), Wheat Taxonomy: the Legacy of John Percival . The Linnean Special Issue No. **3**: 81-94.

Valkoun, J. 2002. Collecting and conserving genetic resources to meet future needs. Caravan **17**: 28-30.

Valkoun, J., Konopka, J., Amri, A. and A. Shehadeh. 2002. Ecological characterization of wild *Triticum* and *Aegilops* species in Syria using GIS tools. *In*: P. Hernández, M.T. Moreno, J.I. Cubero and A. Martín (Eds.) Triticeae IV - Proceedings of the 4th International Triticeae Symposium, 10-12 September, 2001. Córdoba, Spain, pp. 131-134.

Valkoun, J. and B. Humeid. 2003. Photothermal response in wild *Triticum* species from Jordan and Syria. *In*: C. Marè, P. Facciolo and A.M. Stanca (Eds.) From Biodiversity to Genomics: Breeding Strategies for Small Grain Cereals in the Third Millennium. Proceedings of the Cereal Section Meeting of the European Association for Research on Plant Breeding (EUCARPIA), 21-25 November 2002, Salsomaggiore, Italy. Experimental Institute for Cereal Research, Fiorenzuola d'Arda (PC), Italy, pp. 31-33.

Waines, J.G., S. Hedge, and J. Valkoun. 1998. Diversity in wild wheats from northern Syria. *In*: A.A. Jaradat (Ed.) Triticeae III. Science Publishers, Inc., Enfield, NH, USA, pp. 185-190.

Van de Wouw, M.; J. Hanson, and J. Nokoe. 1999. Observation strategies for morphological characterization of forages. *Gen. Resources & Crop Evol.* **46** (1): 63-71.

Van de Wouw, M., N. Maxted, K. Chabane, and B.V. Ford-Lloyd. 2001. Molecular taxonomy of *Vicia* ser. *Vicia* based on amplified fragment length polymorphisms. *Plant Syst. Evol.* **229**: 95-105.

Van de Wouw, M., D. Enneking, L.D. Robertson, and N. Maxted. 2001. Vetches (*Vicia* L.). *In*: N. Maxted and S.J. Bennett, Plant Genetic Resources of the Mediterranean. Kluwer Academic Publishers, Dordrecht, The Netherlands, pp. 134-158.

Van de Wouw, M., N. Maxted, and B.V. Ford-Lloyd. 2003. A multivariate and cladistic study of *Vicia* L. ser. *Vicia* (Fabaceae) based on analysis of morphological characters. *Plant Syst. & Evol.* **237**(1-2): 19-39.

Yahyaoui, A.H., J. Valkoun, K. Chabane, and K. Street. 2003. Identification of resistance to rusts in wheat wild relatives. Presented at APS Annual Meeting, 9-13 August 2003, Charlotte, NC, USA.

Yahyaoui, A., K. Street, J. Valkoun, and J. Konopka. 2003. Basic and applied genetics of resistance to pathogens: characterization of sources of resistance to yellow rust among wild relatives of wheat. *In*: C. Marè, P. Facciolo and A.M. Stanca (Eds.) From Biodiversity to Genomics: Breeding Strategies for Small Grain Cereals in the Third Millennium. Proceedings of the Cereal Section Meeting of the European Association for Research on Plant Breeding (EUCARPIA), 21-25 November 2002, Salsomaggiore, Italy. Experimental Institute for Cereal Research, Fiorenzuola d'Arda (PC), Italy, pp. 237-242.

Yau, S.K. and J. Valkoun. 1997. Screening durum wheat accessions for boron-toxicity tolerance. *Annual Wheat Newsl.* **43**: 219-220.

Zaharieva, M., P. Monneveux, M. Henry, R. Rivoal, J. Valkoun, and M. Nachit. 2001. Evaluation of wild wheat relative *Aegilops geniculata* Roth. and identification of potential sources for useful traits. *Euphytica* **119**: 33-38.

Unpublished Reports

Amri, A. 2000. Conservation and sustainable use of dryland and agrobiodiversity in Jordan, Lebanon, Syria and Palestinian Authority. 6p. (Ar; En)

Amri, A. and A. Shehadeh. 2000. Community based *in-situ* conservation of dryland agrobiodiversity in Jordan, Lebanon, Syria and Palestinian Authority. 1p. (En).

Humeid, B. 2003. The feasibility study on establishment of a gene bank for plant genetic resources in the Arab world. Presented at the International Conference on Sustainable Agriculture and Environment in the Arab Region. Amman, Jordan, October 14-16, 2003. (En.)

Singh, M., K. Chabane, J. Valkoun and J. Blake. 2003. Optimum Sample Size for Estimating gene Diversity in Wild Wheat Using AFLP Markers. Biometric Report 1/2003. ICARDA, Aleppo, Syria. 24 p. (En.)

Valkoun, J. et al. 2001. Research on *In-situ* Conservation of Wild Cereals and Legumes in Syria – Collaborative Research Project between Agricultural Research Center (ARC), Douma, Syria and The International Center for Agricultural Research in the Dry Areas (ICARDA), Aleppo, Syria. Period Reported: 1994-2001. (En.)

15. THE GRU STAFF LIST

GRU Staff List (as at June 2004)

Dr Jan Valkoun	Unit Head
Genetic Resources	
Dr Larry Robertson	Legume Germplasm Curator **1–**
Dr Bonnie Furman	Legume Germplasm Curator **3+**
Dr Ahmed Amri	Biodiversity Project Coordinator **2+**
Dr Kamel Chabane	Biotechnologist
Dr Kenneth Street	CAC Projects Coordinator **2+**
Mr Jan Konopka	Germplasm Documentation Specialist
Mr Bilal Humeid	Research Associate
Mr Ali Ismail	Research Associate
Mr Ali Shehadeh	Research Associate
Ms Elena Iacono	Research Fellow (Italy) **1–**
Mr Fawzi Sweid	Research Assistant-II
Mr Mohammed Hamran	Research Technician-II
Mr Munzer Kabakebji	Research Assistant-II **2-**
Mr Issam Abu Meizar	Research Technician-I **1–**
Ms Sumaya Jankieh	Germplasm Documentation Assistant
Ms Hasna Boustani	Senior Secretary **1+**
Ms Nuha Sadeck	Secretary **1–**
Seed Health Laboratory	
Dr Ahmed El-Ahmed	Seed Pathologist
Dr Siham Assad	Research Associate
Mr Mohammed Hayani	Research Technician II

1+ Joined during 1998
1– Left during 1998
2- Left during 2002
2+ Joined during 1999
3+ Joined during 2004

16. ACKNOWLEDGEMENTS

This report for 1998-2003 resulted from the joint efforts of all Genetic Resources Unit (GRU) scientists, support staff, as well as their collaborators at ICARDA and in the NARSs of the Central and West Asia and North Africa regions. Thanks to Mr Mohamed Salem, Research Associate in the Natural Resources Management Program (NRMP) for providing detailed meteorological data for Tel Hadya as in previous years for past GRU Annual Reports.

The efforts of Dr Adi Damania, Genetic Resources Conservation Program, University of California, are appreciated for assisting the GRU staff in compiling and editing this report.

We would also like to acknowledge the expertise of the staff of Communication, Documentation and Information Services (CODIS) at ICARDA, for editing, designing, and printing this report.

17. APPENDICES

APPENDIX 17A. Meteorological information for Tel Hadya farm for seasons 1997-1998 to 2002-2003

Table A1. Monthly precipitation (mm) during the 1997-1998 season at Tel Hadya

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Total
1997-1998 season	18.1	36.3	37.9	62.3	83.6	37.6	59.3	63.7	11.7	0.0	0.0	0.0	410.5
Long term aver. (26 seasons)	2.5	22.4	45.3	58.5	63.0	54.7	50.6	33.0	16.8	2.2	0.0	0.0	349.5
% of long term average	724	162	84	106	132	68	117	193	70	0	0	0	117

Table A2. Monthly air temperature (°C) during the 1997-1998 season at Tel Hadya

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Mean maximum	33.1	27.3	20.2	13.6	11.0	14.4	17.0	24.6	28.9	36.0	39.1	40.6
Mean minimum	14.8	13.4	7.1	4.4	2.2	0.9	3.9	7.8	11.9	17.5	21.8	21.4
Average	23.9	20.3	13.6	9.0	6.6	7.6	10.4	16.2	20.4	26.7	30.3	31.0
Absolute maximum	38.0	36.4	24.8	18.2	17.4	20.8	25.9	34.1	35.5	41.5	48.0	44.8
Absolute minimum	9.4	7.8	0.8	-3.3	-5.8	-6.2	-1.1	3.7	7.0	11.9	18.6	15.7

Table A3. Frost events during the 1997-1998 season at Tel Hadya

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Total for Season
Number of frost days	-	6	7	13	4	-	-	30
Absolute minimum (°C)	0.8	-3.3	-5.8	-6.2	-1.1	3.7	7.0	-6.2
No. of frost events at 5 cm above ground	-	7	7	14	10	-	-	38
Absolute minimum (°) at 5 cm above ground	-	-4.5	6.9	-7.7	-1.7	-	-	-7.7

Table B1. Monthly precipitation (mm) during the 1998-1999 season at Tel Hadya

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Total
1998-1999 season	0.0	2.2	38.6	88.4	39.5	51.4	62.0	25.1	0.0	0.0	0.0	0.0	307.2
Long term aver. (26 seasons)	2.5	22.4	45.3	58.5	63.0	54.7	50.6	33.0	16.8	2.2	0.0	0.0	349.5
% of long term average	-	10	85	151	63	94	122	76	0.0	0.0	0.0	0.0	88

Table B2. Monthly air temperature (°C) during the 1998-1999 season at Tel Hadya

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Mean maximum	35.0	30.3	23.3	14.4	13.2	15.7	18.9	24.6	28.9	36.0	39.1	40.6
Mean minimum	17.4	10.5	8.4	5.0	2.2	2.5	4.6	8.2	12.4	18.8	22.7	22.5
Average	26.2	20.4	15.8	9.7	7.7	9.1	11.7	16.4	20.6	27.3	30.9	31.5
Absolute maximum	43.1	34.6	28.2	19.0	16.6	20.0	25.5	33.9	40.0	38.8	41.4	44.9
Absolute minimum	11.6	6.0	4.4	-2.8	-3.0	-4.4	-0.5	2.5	6.7	13.2	18.4	16.2

Table B3. Frost events during the 1998-1999 season at Tel Hadya

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Total for Season
Number of frost days	-	-	-	3	9	6	3	21
Absolute minimum (°C)	4.4	-2.8	-3.0	-4.4	-0.5	2.5	6.7	-4.4
No. of frost events at 5 cm above ground	-	3	7	6	6	-	-	22
Absolute minimum (°) at 5 cm above ground	-	-3.7	-2.5	-5.5	1.9	-	-	-5.5

Table C1. Monthly precipitation (mm) during the 1999-2000 season at Tel Hadya

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Total
1999-2000 season	0.7	10.1	7.6	22.4	110.3	38.1	41.3	29.9	0.3	0.0	0.0	0.0	260.7
Long term aver. (26 seasons)	*2.5*	*22.4*	*45.3*	*58.5*	*63.0*	*54.7*	*50.6*	*33.0*	*16.8*	*2.2*	*0.0*	*0.0*	*349.5*
% of long term average	28	45	17	38	175	69	81	90	2	0	0	0	75

Table C2. Monthly air temperature (°C) during the 1999-2000 season at Tel Hadya

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Mean maximum	34.3	29.2	21.4	16.5	11.5	14.0	18.1	24.5	30.3	36.3	41.0	37.7
Mean minimum	16.5	12.7	4.0	0.8	0.1	0.0	3.1	10.0	11.7	17.6	21.2	21.4
Average	25.4	20.9	12.7	8.6	5.8	7.0	10.6	17.2	21.0	26.9	31.1	29.5
Absolute maximum	38.0	38.0	26.0	19.8	18.5	17.0	26.6	31.5	35.0	41.7	45.5	42.0
Absolute minimum	10.0	3.5	-6.8	-5.5	-8.7	-5.5	-4.0	1.0	5.5	11.4	12.8	13.5

Table C3. Frost events during the 1999-2000 season at Tel Hadya

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Total for Season
Number of frost days	0	0	5	13	16	14	5	53
Absolute minimum (°C)	-6.8	-5.5	-8.7	-5.5	-4.0	1.0	5.5	-8.7
No. of frost events at 5 cm above ground	*7*	*14*	*13*	*13*	*7*	-	-	54
Absolute minimum (°) at 5 cm above ground	-6.3	-6.5	-8.7	-5.5	-5.6	-	-	-8.7

Table D1. Monthly precipitation (mm) during the 2000-2001 season at Tel Hadya

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Total
2000-2001 season	11.0	2.3	23.4	72.4	35.0	81.7	44.1	67.9	90.8	0.0	0.0	0.0	428.6
Long term aver. (26 seasons)	2.5	22.4	45.3	58.5	63.0	54.7	50.6	33.0	16.8	2.2	0.0	0.0	349.5
% of long term average	440	10	52	124	55	149	87	206	540	0	0	0	123

Table D2. Monthly air temperature (°C) during the 2000-2001 season at Tel Hadya

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Mean maximum	33.7	27.0	21.6	12.1	11.8	14.6	21.2	24.3	28.2	35.8	38.1	37.6
Mean minimum	16.8	11.4	4.7	4.2	3.3	3.4	7.0	9.4	11.3	17.5	22.2	22.5
Average	25.2	19.2	13.1	8.1	7.5	9.0	14.1	16.8	19.7	26.6	30.1	30.0
Absolute maximum	38.2	33.1	27.5	17.6	16.3	19.7	27.4	34.3	37.8	41.9	43.5	41.6
Absolute minimum	10.0	5.7	-0.2	-1.6	-4.3	-1.6	3.0	4.7	7.2	12.9	19.6	18.2

Table D3. Frost events during the 2000-2001 season at Tel Hadya

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Total for Season
Number of frost days	1	4	7	5	-	-	-	17
Absolute minimum (°C)	-0.2	-1.6	-4.3	-1.6	3.0	4.7	7.2	-4.3
No. of frost events at 5 cm above ground	2	5	7	8	-	-	-	22
Absolute minimum (°) at 5 cm above ground	-1.4	-2.1	-5.5	-2.8	-	-	-	-5.5

Table E1. Monthly precipitation (mm) during the 2001-2002 season at Tel Hadya

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Total
2001-2002 season	0.0	37.0	44.9	119.6	52.0	54.8	55.0	17.8	22.9	0.7	0.0	0.0	404.7
Long term aver. (26 seasons)	2.5	22.4	45.3	58.5	63.0	54.7	50.6	33.0	16.8	2.2	0.0	0.0	349.5
% of long term average	0	165	99	204	83	100	109	54	136	32	0	0	116

Table E2. Monthly air temperature (°C) during the 2001-2002 season at Tel Hadya

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Mean maximum	34.9	28.4	17.5	12.1	11.1	16.6	19.5	21.9	28.9	35.0	38.1	36.5
Mean minimum	18.3	12.1	5.6	5.4	0.4	2.4	5.1	8.0	11.3	17.7	22.2	22.0
Average	26.6	20.2	11.5	8.7	5.7	9.5	26.6	14.9	20.1	26.3	30.1	29.2
Absolute maximum	39.0	35.0	24.5	15.5	18.5	20.5	26.1	28.2	37.0	41.0	43.6	44.0
Absolute minimum	14.4	6.4	-5.8	-2.1	-5.5	-3.8	0.3	3.1	5.8	9.7	15.1	17.0

Table E3. Frost events during the 2001-2002 season at Tel Hadya

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Total for Season
Number of frost days	4	1	18	7	-	-	-	30
Absolute minimum (°C)	-5.8	-2.1	-5.5	-3.8	0.3	3.1	5.8	-5.8
No. of frost events at 5 cm above ground	3	3	18	9	3	-	-	36
Absolute minimum (°) at 5 cm above ground	-5.5	-3.5	-6.4	-4.9	-1.1	-	-	-6.4

Table F1. Monthly precipitation (mm) during the 2002-2003 season at Tel Hadya

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Total
2002-2003 season	0.5	6.9	43.8	80.8	67.2	111.2	122.6	44.2	5.8	9.0	0.0	0.0	492.0
Long term aver. (26 seasons)	2.5	22.4	45.3	58.5	63.0	54.7	50.6	33.0	16.8	2.2	0.0	0.0	349.5
% of long term average	20	30.8	97	138	107	203	242	201	34.5	409	0	0	141

Table F2. Monthly air temperature (°C) during the 2002-2003 season at Tel Hadya

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Mean maximum	33.9	29.3	21.6	9.8	11.9	10.7	15.4	21.8	31.7	35.1	37.2	38.3
Mean minimum	17.8	13.1	6.3	2.0	4.0	2.7	4.0	8.6	12.4	17.3	21.7	21.9
Average	25.8	21.2	13.9	5.9	7.9	6.7	9.7	15.2	22.0	26.2	29.3	30.1
Absolute maximum	37.9	37.7	26.6	17.4	20.8	15.1	21.0	28.1	36.4	38.8	41.7	42.3
Absolute minimum	12.4	4.5	0.2	-5.5	-2.7	-2.0	1.5	2.0	3.5	12.0	16.7	22.4

Table F3. Frost events during the 2002-2003 season at Tel Hadya

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Total for Season
Number of frost days	-	8	4	4	-	-	-	16
Absolute minimum (°C)	0.2	-5.5	-2.7	-2.0	1.5	2.0	3.5	-5.5
No. of frost events at 5 cm above ground	4	8	4	5	7	-	-	28
Absolute minimum (°) at 5 cm above ground	-1.2	-6.9	3.8	-2.5	-2.3	-	-	-6.9

APPENDIX 17B. Material Transfer Agreement

The Material Transfer Agreement (MTA) covers materials that are being transferred before the entry into force of the International Treaty on Plant Genetic Resources for Food and Agriculture. The Treaty envisages that ICARDA will enter into an agreement with the Governing Body of the Treaty, once the Treaty enters into force. ICARDA has indicated its intention to conclude such an agreement with the Governing Body. This agreement, in line with the Treaty, will provide for new MTAs and benefit-sharing arrangements for materials transferred after the entry into force of the agreement.

MATERIAL TRANSFER AGREEMENT
FOR PLANT GENETIC RESOURCES HELD IN TRUST
BY THE
INTERNATIONAL CENTER FOR AGRICULTURAL RESEARCH IN THE DRY AREAS (ICARDA)[1]

The plant genetic resources (hereinafter referred to as the "material") contained herein are being furnished by ICARDA under the following conditions:

ICARDA is making the material described in the attached list available as part of its policy of maximizing the utilization of material for research, breeding and training. The material was either developed by ICARDA; or was acquired prior to the entry into force of the Convention on Biological Diversity; or if it was acquired after the entering into force of the Convention on Biological Diversity, it was obtained with the understanding that it could be made available for any agricultural research, breeding and training purposes under the terms and conditions set out in the agreement between ICARDA and FAO dated 26 October 1994.

The material is held in trust under the terms of this agreement, and the recipient has no rights to obtain Intellectual Property Rights (IPRs) on the material or related information.

The recipient may utilize and conserve the material for research, breeding and training and may distribute it to other parties provided such other parties accept the terms and conditions of this agreement[2].

---

[1] The attention of the recipient is drawn to the fact that the details of the MTA, including the identity of the recipient, will be made publicly available.

[2] This does not prevent the recipients from releasing the material for purposes of making it directly available to farmers or consumers for cultivation, provided that the other conditions set out in this MTA are complied with.

The recipient, therefore, hereby agrees not to claim ownership over the material, nor to seek IPRs over that material, or its genetic parts or components, in the form received. The recipient also agrees not to seek IPRs over related information received.

The recipient further agrees to ensure that any subsequent person or institution to whom he/she may make samples of the material available, is bound by the same provisions and undertakes to pass on the same obligations to future recipients of the material.

ICARDA makes no warranties as to the safety or title of the material, nor as to the accuracy or correctness of any passport or other data provided with the material. Neither does it make any warranties as to the quality, viability, or purity (genetic or mechanical) of the material being furnished. The phytosanitary condition of the material is warranted only as described in the attached phytosanitary certificate. The recipient assumes full responsibility for complying with the recipient nation's quarantine and biosafety regulations and rules as to import or release of genetic material.

Upon request, ICARDA will furnish information that may be available in addition to whatever is furnished with the material. Recipients are requested to furnish ICARDA with related data and information collected during evaluation and utilization.

The recipient of material provided under this MTA is encouraged to share the benefits accruing from its use, including commercial use, through the mechanisms of exchange of information, access to and transfer of technology, capacity building and sharing of benefits arising from commercialization. ICARDA is prepared to facilitate the sharing of such benefits by directing them to the conservation and sustainable use of the plant genetic resources in question, particularly in national and regional programs in developing countries and countries with economies in transition, especially in centers of diversity and the least developed countries.

The material is supplied expressly conditional on acceptance of the terms of this Agreement. The recipient's acceptance of the material constitutes acceptance of the terms of this Agreement.

APPENDIX 17C. Genetic Resources Collection Permit

In the past clearance from the national program was sufficient for GRU/ICARDA scientists to go and collect germplasm from each country. At the present time a Genetic Resources Collection Permit has been instituted in order to formalize this agreement. A copy of this Permit is given below.

Permission to collect germplasm in *(Country) (Date)*

The *(Host Country Institution Name) of (Country)* grants permission to representatives of *(institution names)* to collect the following classes of germplasm: *(GP classes)* in the following areas of *(country)*: *(provinces)* in *(year)* under the following set of conditions:

That the collectors adhere to the International Code of Conduct for Plant Germplasm Collecting and Transfer, here attached.

That the seeds collected will be divided among mission participants according to the interests of the participants.

That ICARDA will multiply the seed collected and conserve it in its gene bank where it will be made freely available for scientific research purposes under he conditions outlined in a Material Transfer Agreement, here attached, and as per the International Treaty on Plant Genetic Resources for Food and Agriculture also attached.

(Any other conditions that the host country requires)

(Signature of authorized signatory)

(Name and position of authorized signatory)

APPENDIX 17D. GRU Training Courses and Participants 1998-2003

1998

Headquarters Training Courses
Plant Genetic Resources Documentation and Information Management/GRU, IPGRI (22 Nov. to 3 Dec. 1998)

01 Salah Yassa/Algeria
02 Taha Sayed Taha Hussein/Egypt
03 Raad M. Salman/Iraq
04 Sadvakassov Serik/Kazakhstan
05 Gommah F. Gibrel/Libya
06 Samer Titi/Palestine
07 Saleh Ali Said Al-Hinai/Oman
08 Maysoun Saleh/Syria
09 Yakubov Mirakbar/Uzbekistan

Non-headquarters Short-term Training Course
Germplasm Collection and Maintenance/GRU, IPGRI (28 Feb. to 4 March 1998) held in United Arab Emirates

01 Hasan S. Ali/Bahrain
02 Sayed N. Nasser/Bahrain
03 Samir Rizk Metwaly El-Sisi/Egypt
04 Kamal Khairallah Abu Salah/Jordan
05 Tareque A. Madouh/Kuwait
06 Younis Sbeih/Palestine
07 Abdullah J. Mohamed Al-Buainain/Qatar
08 Hassan Jassim Al-Shamlan/Qatar
09 Abdulaziz A. Al-Jowayed/Saudi Arabia
10 Masood Harith Al-Adawey/Oman
11 Safa'a Mohammed Al-Farsi/Oman
12 Mohamed Neffati/Tunisia
13 Saeed Mokpel Dahan/Yemen
14 Saeed Saif/Yemen
15 Ali Ahmed Saleh Al-Mehrizi/UAE
16 Rashed Ahmed Ali Saeed Al-Hantoby/UAE

Conservation and Utilization of Plant Genetic Resources/GRU, University of Birmingham, UK (28 April to 13 May, 1998).

01 Sebonego Mosarwe/Botswana
02 Mahesh Ghimiray/Bhutan
03 Elisabeth Kaundinya/Germany
04 Roubina Basous/Jordan
05 Rajendri Kistnasamy/Mauritania
06 Carla Torre do Vale/Mozambique
07 Sabine Austaller/Namibia
08 Sonja Loots/Namibia
09 Andre Lezar/South Africa
10 Louise Daugherty/South Africa
11 Za'eda Sulaiman/Syria
12 Fawzi Gaith/Syria
13 Jane Kloda/UK
14 Helen Heyes/UK
15 Kate Simpson/UK
16 Angela Hughes/UK
17 Harriet Shackle/UK
18 Jonathan Mallabar/UK
19 Thomas Osborn/UK
20 Richard Anthony/UK
21 Abisai Mafa/Zimbabwe
22 Dickson Ng'uni/Zambia

Individual Non-degree training

01 Assefa Mekonnen Amanu/ Ethiopia	Germplasm management	12 Apr98-2 Jan99
02 Ali Malihipour/Iran	Seed health testing	24 July-24 Aug
03 Khalid Mohamed Abu Leila/Jordan	Management and germplasm characterization data	10-14 May
04 Ahmed Ayad Shamakhi/ Libya	Evaluation of forage crop	17-31 May
05 Suliamn El Medi Abulker/ Libya	Germplasm conservation	11-18 Sept
06 Ensherah Mohamed Ahmar/ Syria	Germplasm data management	3 -7 May
07 Fawzi Alias Al-Ghaith/Syria	Identification of wild forage	29 April-12 May
08 Khalid Said Obari/Syria	Wheat wild relatives enhancement	23-25 May

09 Majed Al Hamdieh/Syria	Seed health testing	3-6 Aug.
10 Reem Karbouj/Syria	Wheat protein identification	2-19 Feb.
11 *Zaieda Salim Sayd* Suliman/Syria	Identification of wild forage	28 April-12 May
12 Bechir Bouzrida/Tunisia	Germplasm conservation	18-30 June
13 Kardi Ammar/Tunisia	Germplasm documentation	18-30 June

Individual Degree

Name/Country	**Univ.**	**Level**	**Period**
01 Siham Asaad/Syria	Aleppo Univ.	PhD	1993-1999
02 Amanuel Mahdere Zerezghi/Eritrea	Denmark Univ.	MSc	1998-1999

1999

Headquarters Short-term Training Courses
Human Resource Development on Biodiversity Conservation/GRU, IPGRI (7-11 March 1999) at ICARDA

01 Dalia Mohamed Ibrahim/Egypt
02 Amir Dawood Sulieman/Iraq
03 *Farah Abdul Kader Ibrahim/Kuwait*
04 Sidi Ahmed El Habib bin El sheikh Al Hussein/Mauritania
05 Fatou Benjelloum/Morocco
06 Ashraf Omer Ahaneh/Palestine
07 Tariq Abdul wahab Ismail/Saudi Arabia
08 Nasser Issa Al-Maskari/Oman
09 Sawsan Khair El seed Abed Raheem/Sudan
10 *Afra'a Khalel Nouh/Syria*
11 Mohamed Said El-Nafous/Syria
12 Shaghaf Mohamed Adeb Nahawi/Syria
13 Abul Salam Hammami/Tunisia
14 Mohamed Ali Kal-Khawlani/Yemen
15 Ali Awadh Banoubi/UAE

Conservation and Utilization of Plant Genetic Research (May 2-15, 1999)
Jointly organized with GRU, University of Birmingham, UK

01 Kiflu Tarekegn/Ethiopia
02 Tsion Tekabe Deribe/Ethiopia
03 Magdalena Du Plessis/S. Africa
04 Diab Al Mousa/Syria
05 Fakhri al Mousa/Syria
06 Ghaida Mir Ali/Syria

07 Bilgin Oguz/Turkey
08 Paul Knaggs/U.K.
09 Tracey Louise Nowell/U.K.
10 Oliver Mawere/Zambia

Molecular tools for biodiversity studies/GRU, IPGRI (4-15 July 1999)
01 Meriem Laouar/Algeria
02 Babak Behnam/Iran
03 Faddel Mohammad Ismail/Jordan
04 Mamoon Mustafa Al-Rshaidat/Jordan
05 Omar Ahmed El-Toumi/Libya
06 Shaharudin Saamin/Malaysia
07 Oumar Abou Ngam/Mauritania
08 Sultan Al-Yehia/Syria
09 Ali Shihadeh/Syria
10 Ben Hamida Wafa/Tunisia
11 Mirkbar Yokubov/Uzbekistan

Seed Bank Management/GRU/IPGRI (September 12-27, 1999)
01 Abdel Moneim Abdel Rahman Abd El- Salam El Hendwy/Egypt
02 Tamar Jinikhadze/Georgia
03 Mohamed Saleh Alidrisi/Libya
04 Ali Hussein Al-Lawat/Oman
05 Ensherah Mouhamad Nazzer Al-Ahmar/Syria
06 Maysoun Muhammad Saleh/Syria
07 Abdullah Hosein Ali Mohamed All Naggar/Yemen

Non-headquarters Training Courses
Seed Health Testing/Seed Unit, GRU (5-12 April 1999) held in GOSM, Aleppo, Syria
01 Ahmed Kalaagi/Syria
02 A'mira Al-Houssen/Syria
03 Barakat Al-Rahmoun/Syria
04 Dalal Khoja/Syria
05 Jamal Kabas/Syria
06 Marinet Akesh/Syria
07 Mohamed Sameer Sabbagh/Syria
08 Mona Milhem/Syria
09 Mona Albash/Syria
10 Ossama Rihaoui/Syria
11 Sam Younes/Syria
12 Zouka Khayat/Syria

Seed Processing/Seed Unit, GRU (4-9 July 1999) held in Baghdad, Iraq

01 Abbas Jarrad Khashan/Iraq
02 Abdoul Aal A. Hussein Mohamed/Iraq
03 Ali Abdoul Sada Jassim/Iraq
04 Asem Ibrahim Abdallah/Iraq
05 Atika Abdel Karim Yassin/Iraq
06 Dia Karim Arghif/Iraq
07 Fattah Mohamed Salih/Iraq
08 Hamid Adeel Naib/Iraq
09 Haidar Ismail Jassim/Iraq
10 Iyad Hashim Mohamad/Iraq
11 Jaafar Mahdi Jaafar/Iraq
12 Khari Wadi Oudeh/Iraq
13 Mohamed Fteikhan Mohamed/Iraq
14 Mohamed Oumar Shihab/Iraq
15 Nidaa Mouhamed Hamoud/Iraq
16 Ousama Abdoul Kazhim Mahdi/Iraq
17 Salah Jabir Yassin/Iraq
18 Sabir Nabat Hafith/Iraq
19 Salam Shamran Kazhim/Iraq
20 Wissam Abdoul Jabbar Kassim/Iraq
21 Yaouz Thul Kifl Hussein/Iraq
22 Ziad Farih Hadadin/Iraq
23 Zuheir Hamad Abdallah/Iraq

Seed Health Testing/Seed Unit, GRU (4-9 July, 1999) held in Baghdad, Iraq

01 Adnan Khalaf Muhammed/Iraq
02 Alaa A. Mayah/Iraq
03 Ahmed A. Mustafa/Iraq
04 Dhurgam Abdul Aziz/Iraq
05 Estabraq F. Al-Sameraee/Iraq
06 Falah H. Al-Mesh-Hdani/Iraq
07 Hameda A. Al-Rubai/Iraq
08 Hameed H. Hassan/Iraq
09 Ibraheem El-Al-Jubori/Iraq
10 Maha Naif Kadhum/Iraq
11 Muhammed K. Aziz/Iraq
12 Muhammed N. Hassan/Iraq
13 Mustafa Abdul Qader/Iraq
14 Rana A. Al-Attar/Iraq
15 Sabbah M. Yousif Aboni/Iraq

16 Salem Said Saleem/Iraq
17 Tarik Muhammed Ali/Iraq
18 Wafaa H. Altai/Iraq/Iraq

Individual Non-degree
GRU

01 Meriem Laouar/Algeria	Molecular characterization of *Medicago* spp.	16 July-16 Aug
02 Moustafa Sabry El-Hakeem/ Egypt	Forage characterization and identification	09-16 Apr
03 Sulieman Oshen/Libya	Forage characterization and identification	11-15 Apr
04 Fakhri Ahmed Al-Mousa/Syria	Forage characterization and identification	14-15 Apr
05 Diab Al Mousa/Syria	Forage characterization and identification	11-15 Apr
06 Maysoun Muhammed Saleh/ Syria	Germplasm documentation and data management	31 Oct.-4 Nov
07 Ammar Kardi/Tunisia	Germplasm documentation and data management	30 May-10 June
08 Bouzbida Beshir/Tunisia	Germplasm conservation	5-20 Oct
09 Ali Faik Yildirim/Turkey	Seed health testing	10-23 July
10 Nagib Abdullah Mohamed/ Yemen	Germplasm characterization and conservation	8-20 May

Individual degree

Name/Country	**Univ.**	**Level**	**Period**
01 Siham Asaad/Syria	Aleppo Univ.	PhD	1993-2000
02 Amanuel Mahdere Zerezghi/Eritrea	Denmark Univ.	MSc	1998-1999
03 Mark van de Wouw/Netherlands	Birmingham Univ.	PhD	1998-2000

2000

Headquarters Short-term Training Courses
Sustainable Water and Soil Management and Landscape Modeling/NRMP, GRU (22 Jan.-3 Feb.) ?

01 Mariana Mostafa Yazbek/Lebanon
02 Mohamad Hussein Ali Monzer/Lebanon
03 Rabei Adel Kabalan/Lebanon
04 Adel Sulimaan Al-Shoubaki/Jordan
05 Mahmoud Khaleel Al-Akhras/Jordan

06 Haitham Hasan Hasasneh/Palestine
07 Salah Jamal Al-Lahham/Palestine
08 Fouad Fares Sweedan/Syria
09 Waad Youssef Ibrahim/Syria

Ecogeographic and Botanical Survey/GRU, IPGRI (6-17 February, 2000)

01 Abdul Latief Ali Al-Ghzawi/Jordan
02 Ibrahim M. Rawashdeh/Jordan
03 Elias A. Rmeily/Lebanon
04 Mariana Yazbek/Lebanon
05 Mohamed Hussein Monzer/Lebanon
06 Ashraf M.M. Sawafta/Palestine
07 Nawwaf A.M. Atawneh/Palestine
08 Fadel Suliman Al-Kaiem/Syria
09 Kamil Abdalla Chanan/Syria

Utilization of Wild Species of Cereal Improvement/GRU (30 Apr. to 11 May, 2000)

01 Mogdad Darwish Al-Aji/Syria
02 Nidal Obid Jairouddia/Syria
03 Sami Ali Alghazali/Syria

Conservation and Utilization of Plant Genetic Resources/GRU (30 April-13 May, 2000) Jointly organized between ICARDA/University of Birmingham

01 Evaldina Fernandes/Angola
02 Costantino Bonomi/Italy
03 Geoffrey Kananji/Malawi
04 Yacoob Mungroo/Mauritania
05 Anna Reed/UK
06 Lara Hughes/UK
07 Samantha Gale/UK
08 Kiran Andrea Whire/St. Vincent
09 Fakhri Al-Mousa/Syria
10 Fawzi El Ghaith/Syria
11 Majeed Aboud/Syria

Genetic Resources Documentation and Data Management/GRU (14-18 May, 2000)

01 Amjad Bader/Syria
02 Imad Bilal/Syria
03 Manhal Rajab/Syria
04 Taghred Wahbe/Syria

Non-headquarters Short-term Training Courses
Range Land and Grazing Management GRU/ICARDA and ACSAD (18-27 April, 2000)

01 Mouafak Mohamed/Syria
02 Abed Al- Latif Ali/Syria
03 Naheda Abu- Hamdan/Syria
04 Mahmoud Al-Turshan/Palestine
05 Salah Al- Laham/Palestine

Plant Taxonomy in the Arid Ecosystem Zones GRU/ICARDA and ACSAD (7-18 May, 2000)

01 Ehab Ahmed/Syria
02 Marawan Al-Safadi/Syria
03 Ghaida Mir Ali/Syria
04 Wafaa Rida/Syria
05 Mohamed Ali Ali/Syria
06 Nawwaf A.M. Atawneh/Palestine

Individual Non-degree

01 Saida Nebeche Khaldoun/Algeria	Seed health testing	1-11 Aug.
02 Azizpour Ghisar/Iran	Seed health testing	23 June-17 July
03 Hassan Khanzadeh/Iran	Seed health testing	23 June-17 July
04 Mariana Mostafa Yazbek/Lebanon	Review of existing data on biodiversity	15-23 Jan.
05 Mohamad Hussein Ali Monzer/ Lebanon	Review of existing data on biodiversity	15-23 Jan.
06 Hussein Ali Al-Qasem/Jordan	Seed health testing	15-27 July
07 Yahya Khalil Shakhatreh/Jordan	Germplasm characterization	20-26 May
08 Ensherah M. Nazzer Ahmar/Syria	Data processing for germplasm catalogs	29 Jan.-10 Feb
09 Maysoun Muhammad Saleh/Syria	Data processing for germplasm Catalogs	29 Jan - 10 Feb
10 Mohamed Adanan Nehlawi/Syria	Seed health testing	15-27 July
11 Mohamed Hosam Safeie/Syria	Seed health testing	15-27 July

ICARDA/IPGRI

01 Mohamed Abdollah Ghaleb/Yemen	Genetic resources documentation	23-28 Sept.

Individual degree

Name/Country	Univ.	Level	Period
01 Siham Asaad/Syria	Aleppo Univ.	PhD	1993-2000
02 Mark van de Wouw/Netherlands	Birmingham Univ.	PhD	1998-2000
03 Maha Syouf/Jordan	Jordan Univ.	MSc.	2000-2001

2001

Headquarters Short-term Training Courses
Use of Geographic Information System (GIS) Remote Sensing for Agrobiodiversity Assessment (28 Jan. to 08 Feb., 2001)/NRMP, GRU, IPGRI

01 Hassan Faroq Mustafa Al-Omari/Jordan
02 Safa Salti Mazahreh/Jordan
03 Mohamed Hussein Monzer/Lebanon
04 Tamim El-Takch/Lebanon
05 Safinaz Bader/Palestine
06 Salah Jamal Al-Lahham/Palestine
07 Abedlrahman Al-Zouhby/Syria
08 Waad Ibrahim/Syria

Molecular Characterization for Biodiversity Studies/GRU (March 11 – 22, 2001)

01 Mohamed Hamdy Emam Amar/Egypt
02 Hussein Mohamed Migdadi/Jordan
03 Rony Faraj El-Khoury/Lebanon
04 Jihad Rostom Noun/Lebanon
05 Buthaina Abd-alah Mizyed/Palestine
06 Amer Basem Ibrahim Basha/Syria
07 Bahij Mohamed El-Mustapha/Syria
08 Nedal Obid Jiroudieh/Syria
09 Robin Ibrahim Yousef/Syria

Non-headquarters Training Courses
Collecting and Utilizing of Local Plant Genetic Resources/GRU (20-27 March, 2001) held in Dhamar, Yemen

01 Abdullah Hussein Al Najjar/Yemen
02 Abdel Habib Mahyub Ali Al Kuds/Yemen
03 Ahmad Ali Shamsan Al Dahmash/Yemen
04 Kaed Ben Askar Al Wade/Yemen
05 Mouhamad Mukbel Mare'e/Yemen
06 Mouhammad Mouhammad Zaki Doss/Yemen

07 Mouhammad Hasan Omar/Yemen
08 Munsif Saeed Khan/Yemen
09 Nadia Kasem Abdel Rabb/Yemen
10 Najib Ali Saeed Al Saghir/Yemen
11 Najib Abdallh Mouhammad/Yemen
12 Rajab Mahfuz Sharfa/Yemen
13 Saleh Omar Ahmad Bahhah/Yemen

In-Situ Conservation and Field Gene Bank Management/GRU/IPGRI/ACSAD (1-12 April, 2001) held in Damascus, Syria
01 Musallum Walid Iyad/Jordan
02 Abdul Wahab Mush Al-Halaika/Palestine
03 Fakher Mossttafa Abed/Palestine
04 Mariana Mostafa Yazbek/Lebanon
05 Ali Mohamad Chehadeh/Lebanon
06 Fakhri Ahmad Al-Mousa/Syria
07 Wafa Ali Reda/Syria

Individual Non-degree

01 Kamal Menasria/Algeria	Rangeland genetic resources collection and management	06-20 May
02 Suliman El-Mehdi Abulkher/Libya	Rangeland genetic recourses collection and management	03-17 May
03 Hamed Karem Hamed/Libya	Seed health testing	19 Aug.-1 Sept.
04 Basem Hasan Al-Samman/Syria	Identification of wild food and Pasture legumes	05-17 May
05 Basima Barhoum/Syria	Seed health testing (field inspection)	13-24 May
06 Abedallah Youssef Al-Youssef/ Syria	Identification of wild food and Pasture legumes	06-17 May
07 Marinet Elias Akesh/Syria	Seed health testing	12-30 Aug
08 Mona Ahmad Nazir Al-Bash/Syria	Seed health testing	12-30 Aug
09 Mohammad Adwan Nehlawi/Syria	Seed health testing (field inspection)	12-24 May
10 Nashat Atalla Abo Tafesh/Syria	Identification of wild food and pasture legumes	05-17 May
11 Samir Baha El-Dein Mahfoud/ Syria	Seed health testing (field inspection)	12-24 May

Individual degree

Name/Country	Univ.	Level	Period
01 Maha Syouf/Jordan	Jordan Univ.	PhD.	2000-2001

2002

Headquarters Short-term Training Courses

Conservation and Utilization of Plant Genetic Resources/GRU (4-18 May, 2002) Jointly organized between ICARDA/University of Birmingham

01 Abdul Samad Montaz/Pakistan
02 Cristina Mariana Sousa Correia/Portugal
03 Sonia Ricardo Dias/Portugal
04 Maria Johanns Scholten/Netherlands
05 Sammar Ismaiel Hassan/Syria
06 Penny Ann Richardson/UK
07 Daniel Haydn Wrnech/UK
08 Carol Lynette Clethero/New Zealand
09 Rmona Marie Bradley/UK

Individual Non-degree

Genetic Resources Unit

01. Hussein Ali Al-Qassem/Jordan	Seed health testing	14-26 Sept
02. Ziad Wasfi Naser/Jordan	Seed health testing	14-26 Sept
03. Ekhlas Hussein Alwan/Iraq	Germplasm documentation and data management	12-26 Apr
04. Huda Jassim Hanin/Iraq	Germplasm collection and documentation and seed bank management	3-17 May
05. Mohammed Nafi Hassan Al-Ani/Iraq	Seed health testing and field inspection (Fungi)	17-30 May
06. Rana Aqeel Abd-Al-Razal Al-Attar/Iraq	Seed health testing and field inspection (Bacteria)	17-30 May
07. Widad Hamdan Dauod/Iraq	Germplasm collection and field tour	3-17 May
08. Sana'a Abdulwahab Al-Shik/Iraq	Genetic resources activities	13-19 Oct
09. Sahira Abdulrahman Abdulwahab/Iraq	Genetic resources activities	13-19 Oct
10. Ibrahim Ahmed Haddad/Iraq	Genetic resources activities	13-19 Oct
11. Adil Mohammad Said Omar/Iraq	Genetic resources activities	13-19 Oct
12. Hussein Alawi Thanoon/Iraq	Genetic resources activities	13-19 Oct

13. Mohammad Naem Abu-Saultan/Palestine	Germplasm documentation and data management	30 June-11 July
14. Omar Abd Al Aziz Al Omar/Syria	Seed health testing	15-26 Sept
15. Mohamed Said Sheikh Ali/Syria	Seed health testing	15-26 Sept

GRU 2003

Headquarters Short-term Training Courses

Application of molecular tools for biodiversity studies/GRU (23 Feb. to 6 March, 2003) Sponsored by ICARDA/GEF-UNDP

01. Ramla Yakhou Dalila/Algeria
02. Sobhia Mohamed Saifan/Jordan
03. Ali Mohamed Chehade/Lebanon
04. Dima Mohamed Jaber Halawani/Palestine
05. Khaled Salem Sawalha/Palestine
06. Abid Farid/Pakistan
07. Tamara Tazhibayeva/Kazakhstan
08. Fadel Soliman Al Kaiem/Syria
09. Hesham Al-Atwani/Syria
10. Saher Juma Al-Bakeer/Syria

Seed Bank Management/GRU (22-26 June, 2003) Sponsored by ICARDA/ GEF-UNDP

01.Sleiman Badih Skaf/Lebanon
02. Ibrahim Mohammed Rawashdeh/Jordan
03. Hassan Tahami Ouabbou/Morocco
04. Fawzi Elias Al-Ghaith/Syria

Non-headquarters Short-term Training Courses

Rangeland and Livestock Management/GRU (2-6 March, 2003) held in Amman, Jordan Sponsored by GEF-UNDP

01. Asem Abdalfatah Al-Rousan/Jordan
02. Awad Khalef Al-Ka'abneh/Jordan
03. Ra'ad Jeries Al-Zayadeen/Jordan
04. Sami Ali Obaid/Jordan
05. Faten Fouad Raad/Lebanon
06. Salam Mohamed Usamah Bsat/Lebanon
07. Salah Jamal Al-Lahham/Palestine
08. Abdalla Yussef Mozher/Syria
09. Kamil Abdullah Shanan/Syria

Individual Non-degree

01. Adel Esmail Kaloosh/Syria	Seed health testing	21 Sep.-2 Oct.
02. Mohamed Othman Saad/Syria	Seed health testing	21 Sep.-2 Oct
03. Mnawar Talal Al Tammo/Syria	Forage species identification	20-24 Apr
04. Ghada Khalil Ahmad/Syria	Forage Species identification	20-24 Apr
05. Sidi Ould Taled Moctar/ Mauritania	Seed health testing	7-16 Dec

Individual degree

Name/Country	**Univ.**	**Level**	**Period**
01. Ali Shehadeh/Syria	Birmingham Univ.	PhD	Sept. 03

APPENDIX 17E.

Reports, posters, workshop papers generated by the GEF-UNDP Dryland Agrobiodiversity Project

Regional component

- Amri A. et al. 2001. Agro-morphological characters, farmer selection and maintenance. IPGRI training guide for *in situ* conservation on-farm. pp: 49-70.
- Amri A. et al. 2001. Crop population genetics and breeding (mating systems). IPGRI training guide for *in situ* conservation on-farm. pp: 49-70.
- Amri A. et al. 2001. Enhancing the benefits from farmers from local crop diversity. IPGRI training guide for *in situ* conservation on-farm. pp: 49-70.
- Amri A., L. Ouammou and F. Nassif. 2002. Barley food recipes in Morocco. Proceedings of the ICARDA workshop on Barley for food. Tunis 14-17 Janaury 2002.
- Amri A., M Ajlouni, W. Khoury, Y. Sbeih and A. Khnifis. 2002 strategy for conservation of dryland agrobiodiversity. 2002. Proceedings of IPGRI global *in situ* workshop held in Morocco on 21-24 January 2002.
- Amri A., F. Nassif, A. Birouk and M. Saddiki. Conservation of agrobiodiversity through participatory plant breeding. Proceedings of IPGRI global *in situ* workshop held in Morocco on 21-24 January 2002.
- Amri A. and M. Ajlouni. 2002. The importance of *in situ* conservation of agrobiodiversity in sustaining the use of natural resources. 2002. Proceedings of the Second Jordanian Environment Workshop. Zarqa University, Jordan.
- Valkoun J., A. Amri, J. Konopka and A. Shehadeh. 2001. Characterization of wild *Triticum* using GIS technology. Proceedings of the 3rd International Triticea conference, Cordoba, Spain.
- Amri A. and W. Khoury. 2002. Potential role of local agrobiodiversity in enhancing the livelihoods of local communities. Proceedings of ESCWA/World Bank

Posters/leaflets

- Amri A., J. Valkoun and A. Shehadeh. 2000. Community-based *in-situ* conservation of dryland agrobiodiversity . Presented at EPCOT Center, Florida, USA.
- Amri A., J. Valkoun and A. Shehadeh. 2000. Community-driven *in-situ* conservation of dryland agrobiodiversity . Genetic resources Unit-ICARDA.
- Project leaflets in Arabic and English

Newsletter and Website

- Eleven issues of Dryland Agrobio. Project Newsletter. Available on ICARDA website.
- Project webpage developed within ICARDA website.

Other reports and products

- Annual Project Reports for 2000 and 2001
- Project Implementation Reports for 2000, 2001, 2002, 2003
- Monthly reports since July 1999 till December 2003
- Mid-term evaluation report 2002
- 19 international experts reports
- Regional documentary film
- socioeconomic, feeding calendars and flocks mobility, and GIS databases
- Eco-geographic/botanic database

Summary of reports and publication by National Components

Jordan Component

- Annual Project Reports for 2000 and 2001
- Project Implementation Reports for 2000, 2001, 2002, 2003
- Monthly reports since July 1999 till December 2003
- 12 papers in the proceedings of national and international conferences
- 8 reports and studies (socioeconomic survey, survey of local knowledge associated with agrobiodiversity, feeding calendar and flocks mobility, review of existing biodiversity policy and legislation, characterization of almond species in Jordan, biodiversity in Islam);
- Teachers methodological guide
- 4 posters, 2 CD screen savers, two leaflets on the project, 2 issues of the newsletter
- 13 MSc Thesis

Lebanon Component

- Annual Project Reports for 2000 and 2001
- Project Implementation Reports for 2000, 2001, 2002, 2003
- Monthly reports since July 1999 till December 2003
- 3 papers in the proceedings of national and international conferences
- 18 reports and studies (socioeconomic survey, survey of local knowledge associated with agrobiodiversity, status of agrobiodiversity and genetic resources, feeding calendar and flocks mobility, review of existing biodiversity policy and legislation, water harvesting, honey production, and studies of medicinal plants);

- Teachers methodological guide, status of education in Beqa'a
- 3 posters, 3 project sites leaflets, 3 issues of newsletter, a website
- 2 TV spots, one CD-ROM on medicinal plants

Palestinian Authority Component
- Annual Project Reports for 2000 and 2001
- Project Implementation Reports for 2000, 2001, 2002, 2003
- Monthly reports since July 1999 till December 2003
- 2 papers in the proceedings of national and international conferences
- 9 reports and studies (socioeconomic survey, survey of local knowledge associated with agrobiodiversity, feeding calendar and flocks mobility, review of existing biodiversity policy and legislation, policy and legislation options, ...);
- Teachers methodological guide
- 4 posters, four leaflets on the project,
- 2 documentary films and 10 TV spots

Syria Component
- Annual Project Reports for 2000 and 2001
- Project Implementation Reports for 2000, 2001, 2002, 2003
- Monthly reports since July 1999 till December 2003
- 2 papers in the proceedings of national and international conferences
- 24 reports and studies (socioeconomic survey, survey of local knowledge associated with agrobiodiversity, feeding calendar and flocks mobility, review of existing biodiversity policy and legislation, landraces of figs, landraces of olives, landraces of grapes, water harvesting);
- Teachers methodological guide and biodiversity education guide
- 2 posters, two leaflets on the project, two leaflets on project sites,
- 1 documentary film

ICARDA-30/250/Nov. 2004