Project 1: Conservation of Agrobiodiversity in Dry Areas

Rationale

The non-tropical dry areas contain three major centers of plant diversity, where numerous agriculturally important species originated and first domesticated. These include cereals (wheat, barley, oats and rye), food legumes (chickpea, lentil, faba bean and pea), oilseeds, vegetables, fruits and nuts, forage and pasture species, and herbs, aromatic and medicinal species. These dryland species exhibit a wide range of adaptation to prevailing abiotic and biotic stresses. The conservation of their biodiversity will serve as a valuable source of genetic material for future germplasm enhancement. However, these genetic resources are being eroded through the degradation of their natural habitats, intensification of the cultivation of arable lands, expansion of cultivation into marginal areas, and overgrazing in natural rangelands. This erosion of the biodiversity in the region is also threatening the wild relatives and landraces of agriculturally important species, as well as the associated insects (pests and predators) and micro-organisms, needed in the future as sources of resistance to biotic and abiotic stresses.

ICARDA has a global responsibility for the improvement of barley, lentil and faba bean, and responsibility within CWANA (Central and West Asia and North Africa) for the improvement of durum and bread wheat (with CIMMYT), kabuli chickpea (with ICRISAT), and forage and pasture crops. The *ex situ* collections for these species maintained by ICARDA has allowed continuous and reliable access of these genetic resources required to develop improved germplasm. The exploitation of these genetic resources through genetic improvement for the benefit of all is recognized as a key comparative advantage of ICARDA. The *in situ* conservation, through habitat management would maintain naturally occurring and evolving populations of agriculturally useful species within their natural environment. Innovative approaches are needed for *in situ* conservation.

The Fertile Crescent is the center of first domestication of small ruminants (goats and sheep) as early as 10, 000 years ago. These species have always been an important component of the production systems in the non-tropical dry areas. Over time a rich diversity of breeds has evolved. Similar to crop species, the changes in the production environment are also threatening this diversity. As such, there is a need to characterize the animal genetic resources and identify the current threats. This information is needed to devise strategies towards appropriate utilization or conservation strategies for valuable local resources.

All ICARDA mandate species are included in Annex 1 of the International Treaty for Plant Genetic Resources (ITPGR). As such, ICARDA's plant genetic resources are a global public good, made freely available upon request. ICARDA complies with the policies and guidelines of ITPGR through its use of the Standard Material Transfer Agreement.

The conservation of agrobiodiversity of barley, food and feed legumes, wheat and small ruminants in non-tropical dry areas is one of the major components of System Priority 1 established by the CGIAR Science Council. ICARDA's activities in the conservation, characterization and promotion of these species directly address the resource poor inhabiting the non-tropical dry areas. Priority 1A of the System Priorities is addressed through agrobiodiversity conservation dealing with the genetic resources of mandate crops, and also priority 1B through the *in situ* conservation of under-utilized species. The activities in animal genetic resources, characterization of animal genetic resources (AnGR) and defining pathways for their continuous utilization, directly contribute to the general goal of System Priority1C to maintain and enhance livestock diversity as the basis of further production improvements.

Major elements of the project are:

- Collection, acquisition, documentation and *ex situ* conservation of the genetic resources of ICARDA mandate crops
- Agro-morphological and molecular characterization and evaluation of *ex situ* collections for traits relevant for use in germplasm enhancement;
- Characterization of small ruminant breeds and changes in the production systems affecting genetic diversity
- Identification and use of wild relatives, landraces and other genetic stocks to broaden the genetic base of cereals and legumes;
- Compliance with the policies and guidelines of the International Treaty on Plant Genetic Resources
- Institutional strengthening and capacity building, especially for NARS.

Target ecoregions include non-tropical dry areas for barley, lentil and faba bean; and for wheat, kabuli chickpea and forage legumes in CWANA. These crop mandates essentially encompass four ecoregions:

- the lowland subtropics with cool winter with Mediterranean pattern of rainfall;
- the seasonally dry subtropics with summer rainfall;
- the subtropical and tropical highlands with (often cold) winter precipitation;
- the dry temperate areas.

Project Outputs

The project goal, purpose, outputs, output targets and associated expected outcomes and impacts are provided in the attached Project Logframe. Where an Output Target contributes to a Challenge Program or a Systemwide/Ecoregional Program, this is indicated in the Project Logframe. Below, we describe for each Output: (a) the relation to system priority goals, (b) the impact pathway, (c) the research approach to developing international public goods (IPG), and (d) the role of partner organizations.

Output 1: Crop genetic resources, including wild relatives of barley, wheat, food legumes (lentil, chickpea and faba bean) and feed legumes (vetch and grass pea) conserved *ex situ* with their genetic diversity characterized and documented and evaluated for relevant agro-morphological traits and molecular diversity

1.1 Relation to SP goals

This output contributes directly to Priority 1A specific goals 2 and 3, which call for the collection conservation, characterization and dissemination of priority crops and their wild relatives. Further, the application of the "Focused Identification of Germplasm Strategy" (FIGS) and the development of core subsets will facilitate the identification of germplasm with useful traits that will be made available to support activities associated with priorities 2A, 2B, 2C and 2D.

1.2 Description of Impact Pathways

The intended intermediate users are the CG Centers, international and NARS researchers and plant breeders. The final beneficiaries are resource-poor farm families in the non-tropical dry areas.

The increase in genetic resources acquisition, conservation, characterization, documentation and availability will allow for greater utilization for breeders, entomologists and pathologists. Increases in germplasm collections and availability of agrobiodiversity will decrease the threats of genetic erosion throughout the non-tropical dry areas and enhance the probability of finding useful genes for screening programs. The screening of materials for abiotic and biotic stresses and the use of GIS technology and FIGS will provide plant breeders with the materials to develop improved varieties for farmers, which in turn will decrease the vulnerability of farmers to the consequences of abiotic stresses, pests and diseases.

NARS partners in the CAC region will acquire enhanced capacity to collect, conserve, document and utilize their agrobiodiversity and as such, will affectively offset genetic erosion in the region.

1.3 Research Approach to Develop International Public Goods

All ICARDA mandate species are included in Annex 1 of the International Treaty for Plant Genetic Resources (ITPGR). As such, ICARDA's plant genetic resources are a global public good, made freely available upon request. ICARDA complies with the policies and guidelines of ITPGR through its use of the Standard Material Transfer Agreement. The collection of these species, comprising of a vast number of landrace materials and wild relatives, are unique to ICARDA. Their utilization would allow enhanced germplasm for special traits worldwide.

1.4 Partners' Roles

CGIAR Centers

- **CIMMYT:** An important aspect of long-term preservation of germplasm is having a duplicate set of samples stored in another site with standard controlled-environment conditions. ICARDA is collaborating with CIMMYT to duplicate its base collection of unique samples of faba bean, chickpea and wild *Cicer*, lentil and wild *Lens*, *Pisum*, *Lathyrus*, barley and wild barley, bread and durum wheat,

Aegilops, wild and primitive wheat, *Medicago*, *Trifolium* and other forages. In addition, ICARDA hosts a back-up of CIMMYT's cereals collection.

- **Bioversity International:** ICARDA participates with other CG Centers in the Systemwide Genetic Resources Programme (SGRP), coordinated by Bioversity, in both plant and animal genetic resources. ICARDA collaborates with Bioversity in two sub-regional networks on genetic resources (WANANET and CATN/PGR). ICARDA participates in developments of the SINGER project coordinated by IPGRI and contributes data to the core SINGER database. ICARDA is now involved in a number of Centre-wide collaborative initiatives in genetic resources, including risk management, safe movement of germplasm, crop registries, best-practices of germplasm conservation, etc. In addition, Bioversity participates in the CGIAR Collaborative Research Program for Sustainable Agricultural Development in Central Asia and the Caucasus, which is coordinated by ICARDA.
- **ICRISAT:** ICARDA is participating in a joint project to characterize a composite set of chickpea accessions utilizing SSR markers as part of the CP *Generation*. In addition, ICRISAT houses a safety duplicate in its long-term base collection of ICARDA's unique chickpea germplasm collection.

Challenge Programs:

CP Generation: ICARDA is participating in Subprogram 1, which aims to explore the genetic diversity of the global germplasm collections of the CGIAR research centers. ICARDA was responsible for creating the composite collections for barley, lentil and faba bean. ICARDA also is collaborating with ICRISAT on the composite collection of chickpea.

Other International Partners:

Global Crop Diversity Trust: collaboration in developing a global strategy for the *ex situ* conservation of barley, and in developing a regional plant genetic resources strategy for CAC anticipated to be completed by the end of 2007. Thereafter ICARDA will provide follow-up and support activities. ICARDA is currently coordinating two projects funded by GCDT, one to create an inventory of *ex-situ* collections in CAC countries and the other to facilitate the development of national information networks in which cross-institutional linkages are strengthened to ensure information about ex-situ accessions flow to and from a centralized data hub. Thereafter, ICARDA will continue to technically backstop these information networks to ensure their long-term sustainability. ICARDA recently hosted the global crop strategy meeting for chickpea, lentil, faba bean and grasspea and will soon host the crop strategy meeting for barley.

Australia

- **Australian Winter Cereals Collection, Tamworth:** This institution is a co-architect in the project entitled *Development and conservation of plant genetic resources in the Central Asian Republics*. Scientists from AWCC participate in collection missions, training and evaluation activities associated with the project. Additionally AWCC plays a key role in the research of the project *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*.
- **Australian Temperate Field Crops Collection, Horsham (ATFCC):** This institution is a co-partner in the project entitled *Development and conservation of plant genetic resources in the Central Asian Republics*. Scientists from ATFCC participate in collection missions, training and evaluation activities associated with the project.
- **Centre for Legumes in Mediterranean Agriculture (CLIMA).** CLIMA has also played a key role in the PGR-CAC project. CLIMA has been a key partner in a series of collaborative projects involving the Vavilov Institute in which pulse legume accessions have been evaluated and regenerated at ICARDA.
- **Department of Primary Industries (DPI), Horsham, Victoria:** ICARDA is collaborating with DPI to create a global portal of passport and evaluation data of its genetic resources holdings in the International Chickpea Information System (ICIS), International Faba Bean Information System (IFIS), and International Lentil Information System (ILIS) data bases.
- **Southern Cross University (SCU), Grain Food CRC:** Collaboration in a study of the genetic manipulation of flavor in grain legumes. This project funds a Ph.D. student registered at SCU.

Austria: Landwirtschafflich-Chemische Budesversuchsanstalt (BAVL). The National Genebank of Austria houses a safety duplicate collection of 1588 accessions of ICARDA's faba bean germplasm collection.

France: Institut National de la Recherche Agronomique (INRA) – Dijon. ICARDA is collaborating with INRA - Dijon on the establishment of a composite collection and subsequent genotyping of faba bean genetic resources as part of the Generation Challenge Program.

Germany: University of Kiel. ICARDA is in collaboration in the molecular genotyping of a composite collection of lentil germplasm as part of the generation Challenge Program, utilizing SSR (simple sequence repeat) markers developed at the University of Kiel as part of a joint Ph.D. project with ICARDA.

Russia: The N.I. Vavilov Research Institute for Plant Industry (VIR). ICARDA collaborates with VIR for genetic resources exchange, collection missions and genetic resources evaluation and documentation. VIR scientists play a key role in the joint project with the Australian Winter Cereals Collection listed above. They have worked on capturing collection site data, field evaluation of germplasm identified by the project and the molecular characterization of material.

Spain: University of Cordoba, Instituto de Agricultura Sostenible. ICARDA is collaborating with the University of Cordoba to establish a composite collection and genotyping of faba bean genetic resources as part of the Generation Challenge program.

Switzerland: Station Fédérale de Recherches Agronomiques de Changins (RAC), Nyon. RAC houses a safety duplicate collection ICARDA's unique accessions including Lathyrus and Vicia accessions.

United Kingdom: University of Birmingham. ICARDA is collaborating with the University of Birmingham in *in situ* conservation with an ICARDA research associate completing his Ph.D. program in taxonomic identification of the *Viciaceae.*

United States of America:

- **University of California, Davis***.* ICARDA is collaborating on a study to understand the evolution and domestication of cultivated and wild lentil, peas, and chickpea being conducted at University of California, Davis.
- **USDA/ARS Western Regional Plant Introduction Station, Pullman, Washington**. Under a cooperative agreement entitled "Conservation and collection of plant genetic resources in Central Asia and the Caucasus", USDA is participating in a series of joint plant collection missions and storage facility capacity developments in the CAC region.

<u>Output 2</u>: Small ruminant genetic diversity is characterized and pathways for utilization and conservation identified

2.1 Relation to SP goals

The specific goal 1 of System Priority 1C aiming at molecular and phenotypic characterization of indigenous livestock including an analysis of relatedness is addressed by the documentation of phenotypic characterization of small ruminant breeds in Central Asia including the description of performance traits and production systems. Also the development of a methodology for phenotypic and molecular characterization using the example of Syrian goat population directly addresses this specific goal. Comprehensive information on breeds is a prerequisite on decisions of what to conserve and or the development of options for further development of the breeds.

The development of a methodology for documenting market and consumer trends affecting AnGR diversity contributes to Specific goal 3 that assesses in situ and ex situ conservation options. The methodology contributes to assessment of threats and therefore needs for conservation. It thereby supports the development of in situ conservation options. It also contributes to Specific Goal 3 aiming at the establishment of policies conducive to the appropriate exchange, use, development and conservation of livestock diversity. In situ conservation of AnGR through improvements in the current utilization of AnGR is addressed through the activities in project 6.

2.2 Description of Impact Pathways

The characterization of the genetic diversity of small ruminants and identification of the main drivers of change has implications in the conservation and utilization of genetic resources for the benefit of farmers. Towards this end, Output 2 involves the development and application of a method to quickly identify traits that are valuable for emerging market opportunities while also assessing with precision the degree of threats to endangered genetic groups. The information generated will provide entry points for activities under Project 6 to respond farmers' claims for lack of access to improved animals and also for the valuation of undervalued breeds and production systems. This method, which will be used and improved in partnership with ILRI, will be transferred to NARS.

The Center's role will be that of a provider of research methodologies. In interaction with ILRI and with global agencies such as FAO, it is also expected that will influence the policy environment.

Implementation of work will take place in representative countries in the dry areas where a large diversity is available.

2.3 Research Approach to Develop International Public Goods

The phenotypic characterization of small ruminants is an important contribution to the global documentation of AnGR. Developing the capacity of the biotechnology unit at ICARDA in molecular characterization of small ruminants aims at supporting and enhancing national research capacities. Determining molecular genetic diversity of AnGR is an important step towards the global understanding of existing diversity in sheep and goats. Molecular characterization of the CWANA sheep and goat breeds through national research centers will add to the existing analyses in Africa and Asia and is an important step towards a global understanding of genetic diversity of small ruminants. Phenotypic and molecular characterization of Syrian goats is used as an example to develop a model for comprehensive characterization of small ruminant genetic resources in the CWANA region. ICARDA emphasizes the need for characterization methods with a production systems perspective that could be used in different scenarios in the dry areas where local AnGR are undervalued or threatened.

2.4 Partners' Roles

ICARDA in collaboration with partners coordinates the research implementation and contributes to consolidated analysis of information. ICARDA and partners provide training to NARS and other collaborators to upgrade relevant skills.

NARS take part in the planning and evaluation of research, collecting and assessing data in defined country research sites. NARS institutions involved include:

Central and West Asia and North Africa

- Tunisian Agricultural Research Institute (INRAT)
- Tunisian Agricultural University (INAT)
- Ministry of Agriculture and Agrarian Reforms, Research and Extension Directorate, Syria
- Main NARS from Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan, Azerbaijan, Georgia and Armenia

Latin America:

- National Institute of Agricultural Technology, INTA-Argentina,
- National Agricultural Research Enterprise, EMBRAPA-Brazil, through two research centers
- National Agricultural Research Institute INIA-Venezuela,
- National Agricultural and Forestry Research Institute, INIFAP-Mexico
- Autonomous University of San Luis Potosí, Mexico
- Secretary of Agriculture of San Luis Potosí State, Mexico
- Tropical Center for Agricultural Research, Santa Cruz, Bolivia

International partners jointly develop the research methodologies with ICARDA. They include the International Livestock Research Institute (ILRI), FAO, and the University of Natural Resources and Applied Life Sciences, Vienna, Austria.

Output 3: Institutional strengthening and capacity building

3.1 Relation to SP goals

This output contributes directly to Priority 1A specific goals 2 and 3, which call for the collection conservation, characterization and dissemination of priority crops and their wild relatives through capacity building. It also directly supports Priority 5A, specific goal 2. This output helps to provide NARS with the physical infrastructure and the human capacity will necessary for NARS to implement policies that will conform with and sustain the principals of the International Treaty on PGRFA. Further more, of capacity building of this nature has a positive impact on policy development as policy makers become more aware of the importance of PGRFA.

3.2 Description of Impact Pathways

NARS partners in the non-tropical dry areas will acquire enhanced capacity to collect, conserve, document and utilize their agrobiodiversity and as such, will affectively offset genetic erosion. ICARDA provides technical backstopping and training to NARS partners in gene bank construction, management of genetic resources and data base development. Trainings of NARS scientists are provided both in country and at ICARDA headquarters. Technical backstopping is carried out regularly upon the request of the countries.

3.3 Research Approach to Develop International Public Goods

The institutional strengthening and capacity building aspect of this MTP is the knowledge generation and sharing amongst all stakeholders interested in conservation of genetic resources. As such, the methodologies resulting from these activities and provided to NARS partners benefit all.

3.4 Partners' Roles

NARS Partners

Central Asia and the Caucasus (CAC):

Collaboration with NARS partners in plant genetic resources collection and characterization and in germplasm enhancement and screening will continue in 2008 - 2010. A major focus is capacity development so that national programs will have the ability to collect, conserve, document, evaluate and utilize the regions rich agro-biodiversity. Specific NARS partners include:

- Armenian Botanic Institute
- Research Institute of Genetic Resources, Azerbaijan
- Georgian Research Institute for Crop Husbandry
- Ministry of Agriculture of Kazakhstan
- Research Institute of Crop Husbandry and Plant Industry, Kyrgyz Republic
- Tajik Agricultural Academy of Sciences
- Turkmen Research Institute of Cereals and Legumes
- Uzbek Research Institute of Plant Industry

Morocco: Institut National de la Recherche Agronomique (INRA). ICARDA collaborates with INRA on joint collection missions in Morocco and training on both gene bank management and molecular genotyping.

NARS partners of Iraq, Qatar, Syria, Pakistan, Kazakhstan, Egypt, Morocco, Algeria, Yemen, Turkey, Ethiopia and Eritrea

ICARDA conducts formal training courses towards maintenance of gene banks and conservation of genetic resources.

Project 1	**Conservation of Agrobiodiversity in Dry Areas**
Goal	Sustainable conservation of agrobiodiversity to increase agricultural production in the dry areas
Purpose	Improved livelihoods of resource poor farmers from the conservation, improvement and sustainable use of agrobiodiversity of plants and animals and the adoption of improved varieties and associated technologies.

Output Targets		Intended Users	Outcomes	Impact
Output 1: Genetic resources, including wild relatives of barley, wheat, food legumes (lentil, chickpea and faba bean) and feed legumes (vetch and grasspea) conserved *ex situ* with their genetic diversity characterized and documented and evaluated for evaluated for relevant agro-morphological traits and molecular diversity		**Global crop improvement and genetic resource conservation programs**	**Assured availability of landraces, wild relatives and genetic stocks**	**Reduced genetic erosion in the non tropical dry areas and available sources of biotic and biotic resistance**
2008	1500 accessions of wild relatives, landraces and advanced lines of wheat, barley, lentil and chickpea characterized for reactions to major diseases and insects and important agro-morphological traits	ICARDA and NARS plant breeders	Disease and insect resistance incorporated into breeding material	Genetic vulnerability and risk from pests and diseases reduced in the farmers' fields
	Collection mission in Central Asia and Caucasus region for wheat, barley and cool season food and feed legumes	Breeders, plant scientists – regional and international	Increased representation of agro-biodiversity from CAC countries available for screening and research programs	Greater probability of finding useful genes in screening programs
	Sub-sets of chickpea accessions identified for drought tolerance using GIS	ICARDA and NARS plant breeders	New drought tolerant genetic materials identified and included into ICARDA and NARS screening and breeding programs	Stable performance of cultivars in the farmers' fields and reduced risk for drought affected farmers
2009	Application of FIGS (Focused Identification of Germplasm Strategy) for bread wheat and chickpea genetic resources developed and available on internet	Breeders, plant scientists – regional and international	Increased efficiency of germplasm screening and utilization	Resource-poor farmers less vulnerable to abiotic and biotic stresses
	Herbarium established, document and database available on internet involving 10,000 entries	CG Centers, international and NARS researchers	Increased accuracy of taxonomic identification in *ex situ* germplasm collections and in species diversity surveys of agrobiodiversity conserved *in situ* in original ecosystems	NARS capacity in taxonomic knowledge enhanced
	1500 accessions of wild relatives or landraces of wheat, barley, lentil, chickpea and faba bean characterized for reactions to major diseases and insects in 2008 verified	ICARDA and NARS plant breeders	Disease and insect resistance incorporated into breeding material	Genetic vulnerability and risk from pests and diseases reduced in the farmers' fields

Output Targets		Intended Users	Outcomes	Impact
2010	1000 additional accessions of wild relatives and landraces of wheat, barley, faba bean, lentil and chickpea characterized for major diseases and insects and important agro-morphological traits	NARS plant breeders and farming communities	Assessed wild relatives and landraces of wheat, barley, faba bean, lentil and chickpea characterized for important agro-morphological traits	Genetic vulnerability and risk from pests and diseases reduced in the farmers' fields
	Reference collections of 300 accessions established for barley, chickpea *(with ICRISAT)*, wheat (*with CIMMYT*), lentil and faba bean and evaluated for drought related traits	ICARDA breeders and biotechnologists, advanced research institutes and NARS	Reference collections available for allele mining for barley, chickpea (with ICRISAT), wheat (with CIMMYT), lentil and faba bean	Greater probability of finding useful alleles in genebank germplasm
Output 2: Small ruminant genetic diversity characterized and pathways for utilization and conservation identified		Government and international conservation programs and NARS	Conservation and management plans for threatened genetic resources are available	Genetic threats to genetic diversity is reduced
2008	Book on characterization of small ruminant breeds in Central Asia and the Caucasus	National government, extension services and NGOs, scientists in advanced research institutes, and NARS information systems (DAGRIS)	Current knowledge on animal genetic resources (AnGR) in the region is documented	Gaps in knowledge can be targeted by NARS and governmental programs, threats to AnGR are identified and conservation strategies can be developed
2009	Publication on effects of market and consumer trends in the diversity of sheep breeds in Tunisia	National government, researchers in advanced research institutes and NARS	Methodology for documenting market and consumer trends affecting AnGR diversity is developed; direct effects are identified	Knowledge on impact of market and consumer trends allows to predicts trends and to develop effective utilization or conservation strategies
2010	Molecular and phenotypic characterization of the goats of Syria	Researchers in advanced research institutes and NARS	Methodology for comprehensive characterization with a systems perspective is developed	Supports understanding of genetic diversity in a wider sense
Output 3: Institutional strengthening and capacity building				
2008	Technical backstopping and capacity building of NARS plant genetic resources	National programs	Enhanced capacity of national programs to collect, conserve and document and utilize their agro-biodiversity	Ability to counter genetic erosion and utilize plant genetic resources enhanced
2009	Increased NARS plant genetic resources capacity in CAC countries through assistance in strategy development, PGR *ex situ* conservation activities, including documentation, fund raising and training	National programs of Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan	Enhanced capacity of national programs to collect, conserve and document and utilize their agro-biodiversity	Genetic erosion in the CAC region countered Greater access to unique genetic resources for national programs and global community
2010	Training courses in genebank management, molecular characterization and documentation.	National programs	Enhanced capacity of national programs to conserve, characterize and document their agro-biodiversity	Ability to counter genetic erosion and utilize plant genetic resources enhanced