PROGRAM
FOR SUSTAINABLE AGRICULTURAL DEVELOPMENT
IN CENTRAL ASIA AND THE CAUCASUS

ANNUAL REPORT
2009-2010

CGIAR

Program Facilitation Unit
Tashkent, Uzbekistan
June, 2010

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Contents

ABBREVIATIONS

ARD	Agricultural Research for Development
ARI	Advanced Research Institute
AVRDC	The World Vegetable Center
CA	Conservation Agriculture
CAC	Central Asia and the Caucasus
CACAARI	Central Asia and the Caucasus Association of Agricultural Research Institutions
CATCN-PGR	Central Asian and Trans-Caucasian Network for Plant Genetic Resources
CCER	Consortium Commissioned External Review
CGIAR	Consultative Group on International Agricultural Research
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo
CIP	International Potato Center
GFAR	Global Forum for Agricultural Research
ICARDA	International Center for Agricultural Research in the Dry Areas
ICBA	International Center for Biosaline Agriculture
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFPRI	International Food Policy Research Institute
ILRI	International Livestock Research Institute
IPM	Integrated Pest Management
IRRI	International Rice Research Institute
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
IWMI	International Water Management Institute
IWRM	Integrated Water Resources Management
MTP	Medium Term Plan
NARS	National Agricultural Research System
PFU	Program Facilitation Unit
PGR	Plant Genetic Resources
PGRFA	Plant Genetic Resources for Food and Agriculture
PSC	Program Steering Committee
RCT	Resource Conserving Technology
SVTC	State Variety Testing Commission
SWEP	System-Wide Eco-regional Program
TAC	Technical Advisory Committee
TRRC	Temperate Rice Research Consortium
UNESE	United Nations Economic Commission for Europe
USDA	United States Department of Agriculture
UNEP-GEF	United Nations Environment Program-Global Environment Facility
WUA	Water Users Association
ZEF	Center for Development Research, University of Bonn, Germany

INTRODUCTION

The *Central Asian and the Caucasus Regional Program for Sustainable Agriculture Development in Central Asia and the Caucasus* (CAC Program) of the *Consultative Group on International Agricultural Research* (CGIAR) works for improvements of food security, reduction of poverty and climate change adaptation and mitigation in the countries of

- Central Asia
  - Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan
- and the Caucasus
  - Armenia, Azerbaijan and Georgia.

Under this umbrella,

- eight CGIAR centers
  - Bioversity International
  - International Maize and Wheat Improvement Center (CIMMYT)
  - International Potato Center (CIP)
  - International Center for Agricultural Research in the Dry Areas (ICARDA)
  - International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
  - International Food Policy Research Institute (IFPRI)
  - International Livestock Research Institute (ILRI)
  - International Center for Water Management (IWMI),
- two other International Centers
  - AVRDC - the World Vegetable Center
  - International Center for Biosaline Agriculture (ICBA),
- and
  - Michigan State University (MSU)

Collaborate in a consortium that is financed as a so-called System-Wide Ecoregional Program (SWEP). This program is convened by ICARDA.

The program was established in 1998. The *Program Facilitation Unit* (PFU), a regional office that supports the CAC Program, is located in Tashkent, Uzbekistan. In 2007, a sub-regional office for the Caucasus was opened in Tbilisi, Georgia, to facilitate collaboration in the countries of the Southern Caucasus.

Since its inception, the *National Agricultural Research Systems* (NARS) and the CAC Program have established strong research collaboration that contributed to the development of agriculture and agricultural research in the region. The joint program covers a wide range of areas such as plant genetic resources, germplasm enhancement and seed production, integrated pest management, crop diversification, land and water management, livestock and fodder production, socioeconomic and policy research, human resource development and information dissemination.

The region of Central Asia and the Caucasus is huge – it covers 418 million hectares, and is thus 30% larger than India or about half the size of the USA or China[1]. It is very diverse in ecosystems, and hence, also diverse in agro-ecological production systems. Even though the countries are now, 19 years after independence from the Soviet Union, moving into different policy directions, the fundamental issues of sustainable agricultural development remain common for all countries of the region. Since the research problems are inter-related, developing solutions needs a research program that integrates genetic and natural resource management for crops and livestock with economic assessments and the necessary 'supportive' policies. These issues nowadays require a double-pronged approach – developing a regional perspective for common strategic issues in agriculture, and country-distinctive action plans for implementation at national levels.

During the last twelve years, the CAC Program has achieved considerable progress in three areas of research and development activities, namely conservation of genetic resources, germplasm enhancement and crop diversification, and efficient soil and water management, and in one more supportive area of activities, the strengthening of the NARS.

During the reporting period, between September 2009 and May 2010, work in these areas has continued and was supported by all the partners of the Program. This report highlights, in brief, major activities undertaken by the Consortium partners in the year 2009/2010.

The Eco-regional Program for CAC is organized under broad themes, with each theme sub-divided into activities, as follows, and which correspond to the outputs of the program.

1. Productivity of Agricultural Systems
    - 1.1 Germplasm Enhancement
    - 1.2 Strengthening National Seed Supply Systems
    - 1.3 Cropping Systems Management and Agricultural Diversification
    - 1.4 Livestock Production Systems and Integrated Feed/ Livestock Management
2. Natural Resource Conservation and Management
    - 2.1 Irrigation, Drainage, and Water Basin Analysis
    - 2.2 On-Farm Soil and Water Management
    - 2.3 Rangeland Rehabilitation and Management
3. Conservation and Evaluation of Genetic Resources
    - 3.1 Plant Genetic Resources
    - 3.2 Animal Genetic Resources
4. Socioeconomic and Public Policy Research
5. Strengthening the National Programs (Capacity Building)

Within the framework of these themes, specific projects are developed and implemented by the Programs Member Centers (CGIAR and ARIs) in partnership with NARS.

[1] The area of the CAC countries corresponds to 43% of the area of the USA and 44% of the area of China. The area of Kazakhstan accounts for 65% of the total area in CAC.

ACHIEVEMENTS IN 2009/2010

Plant Genetic Resources

Central Asia and the Caucasus is a region extremely rich in *plant genetic resources* (PGR). Therefore, it also has a very rich genetic diversity of crops. In all, more than 8,100 plant species are recorded in the region, of which 890 are endemic (unique to the region). The wild relatives of many crops have their evolutionary origin in this region. Hence, there are many wild relatives of today's crops. The region is the center of origin of many economically important crop species. The region is also blessed with some of the world's best collections of fruits, nuts, and melons.

After the breakdown of the Soviet Union, the links from the world-famous Vavilov Research Institute - the leading Russian institution on plant genetic resources - to its sister institutes in the Republics, which had now become independent states, were severed. Collection, conservation and documentation of plant genetic resources in the region almost came to a complete halt. Given the critical importance of conservation of plant genetic resources in the region, the CAC program partners were able to make a significant contribution to this effort since 1998. The establishment of Genebanks in all countries was supported, more than twenty collection missions were organized by and with the partners, and several thousand valuable accessions were collected. During the last year as well, the Program partners have continued their activities in this thematic area.

The meeting of National Coordinators of Central Asian and Transcaucasian Network on Plant Genetic Resources (CATCN-PGR) was organized by Bioversity International on 8-9 December, 2009, in Tashkent, Uzbekistan. The meeting was attended by National Coordinators on Plant Genetic Resources of Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, and Uzbekistan, representatives of Bioversity International and the Global Crop Diversity Trust. During the meeting, country reports on the activities of the network on PGR conservation were presented, issues related to coordination at national levels, financing, system of documentation, PGR collections in institutions, size of collections and objects of conservations, updated information on progress and development of national strategies on PGR were discussed, existing National Strategies on PGR were reviewed, the work plan for 2010-2012 was discussed and approved, and the new Chairman of the Coordination Committee of CATCN-PGR for the period 2010-2012 was appointed. During the discussion, decisions were made on achieving ratification of international treaties on PGR, providing consultative support to countries by international organizations on implementation of international treaties, increasing information exchange, improving the database and data evaluation, creating a database for assessment of climate change influence on plant genetic resources of the region, exploring possibilities for project development and elaboration of a national strategy on PGR on the basis of a regional strategy. A visit was organized to the Genome Laboratory of the Institute of Genetics and Plant Experimental Biology of Uzbekistan, where participants had the opportunity to get acquainted with the current status, work and anticipated projects of the laboratory.

The third and final phase of the project *Reviving biocultural heritage: Strengthening the socioeconomic and cultural basis of agrobiodiversity management for development in Kyrgyzstan and Tajikistan*, supported by the Christensen Fund and coordinated by Bioversity

International, was successfully concluded in 2009. During the third phase, project activities were extended to the southern Leilek region of Kyrgyzstan and the Afghan side of the Pamirs. Experiences and approaches, which project scientists acquired and developed during previous phases, were disseminated. Partners made inclusive and science-based efforts to address the community management of native fruit tree varieties by broadening earlier narrow focus on community management processes and agronomic aspects by incorporating cultural and economic dimensions. A large number of traditional recipes, culinary anecdotes and poems were collected in the Pamirs in collaboration with a lively group of enterprising women. This garnered support from the Slow Food Foundation for Biodiversity which established a *presidium for mulberry products* in December 2009.

As a whole over the time of the project implementation, key accomplishments were in such areas as:

1. Documenting and disseminating lessons and best practices.
2. Filling knowledge gaps on how to support custodians of biodiversity, with a focus on strengthening the cultural and economic foundation of agro-biodiversity management.
3. Assessing the potential to replicate best practices developed during previous project phases to new areas (Southern Kyrgyzstan and the Afghan portion of Badakshan).
4. Building the capacity of local partner institutes.

In addition, the project conducted a study on wild bee diversity in its target areas, taking into account the essential role of pollinators to agriculture and gene flow that creates new diversity, and insufficient studies in this area, particularly in Central Asia, induced to conduct researches of wild bee diversity within the project. The research grant that was part of this project enabled Bioversity to initiate collaboration with the laboratory of Prof. Laurence Packer from York University, Toronto, Canada. Lincoln Best, a PhD student, joined the project during a two month fieldtrip to collect wild bees in over 80 field sites in Kyrgyzstan and Tajikistan. While taxonomic classification at the genetic level is still underway (specimens have been shipped to laboratories worldwide), a preliminary description of the distribution of diversity and the functional characteristics of some of the bee families is available.

Occurrence of ‘colony collapse syndrome’, whereby entire honey bee colonies die off after the winter was considered as anomalous in the project area because of its geographical isolation and virtual absence of chemical agricultural inputs in the Pamirs, a bio-physical context quite different from other places where this phenomenon occurred. Introduced honey bees (*Apis mellifera*) are managed to increase crop pollination services. In the face of their decline and the challenges facing bee populations around the world, making more intentional use of native wild bee populations by increasing local population sizes through simple trap-nesting, a method introduced to the study area by the project, may provide a cheap method to strengthen the resilience of local farming systems.

With a co-funding from a Bioversity International/ UNEP-GEF project *In situ/on farm Conservation and Use of Agricultural Biodiversity (Horticultural Crops and Wild Fruit Species) in Central Asia,* has continued supporting the demonstration plots and nurseries, established during previous project phases. In Kyrgyzstan, the nurseries in Tört-Kul and Urumbash have become two of the most successful case studies within UNEP/GEF regional project. People from neighboring communities, districts and other parts of the country are

coming to the plots for planting materials and receiving advice on cultivation techniques. *Descriptor list for farmers' knowledge*, developed on the basis of previous project phases to ensure more consistent and complete data collection, is being used for focus group/community discussions and individual interviews. This year the list was used in interviews with 85 households.

The Red Listing of all 100 taxons identified for conservation has been completed in Armenia. Three of those taxons were assessed as being critically endangered, 25 endangered, 12 vulnerable, 14 near threatened, 3 data deficient and the remaining 43 were classified as of least concern. In Uzbekistan, an evaluation of plant status according to IUCN international criteria was carried out in 2009 and a Red List of species prepared. The list includes 15 vascular and grass species of CWR. Forty-eight species of woody plants and shrubs (used for medicinal, nutritional and technical purposes) are included in the Red List; 18 of them had already been evaluated according to IUCN criteria. In Armenia, the National CWR Conservation Action Plan was finalized and is now available on the web (Armenia CWR Information System; at: http://www.cwr.am). It is based on the inventory of CWRs, including 2518 taxons (this represents a large share, about 70%, of the flora of Armenia). In Armenia, a draft Species Management Plan for *Triticum araraticum*, *T. boeoticum*, *T. urartu* and *Aegilops tauschii* was developed in collaboration with partner institutions and submitted to relevant authorities for approval.

More than 40 training sessions, on a variety pruning, pest management, tilling, soil conservation, fruit storage, processing, etc, formed the core of the community work carried out by project teams in both countries. Two workshops in Jalalabat (Kyrgyzstan) and Khorog (the Pamirs) marked the conclusion of the project. They brought together the farmers and scientists who had worked on project implementation with other organizations, including universities, local NGOs, and representatives of local governments.

In the projects supported by the Global Crop Diversity Trust and Bioversity International 86 accessions of sorghum were regenerated through self-pollination in 2009, which have been evaluated morphologically, biologically and economic-valuable traits and put in UzRIPI genebank for middle-term conservation, and will be transferred to Svalbard Genebank. The Global Crop Diversity Trust signed an agreement with Uzbek Research Institute of Plant Industry on funding the project *Regeneration and Safety Duplication of Priority Crop Collections for Barley, Maize and Wheat in Uzbekistan*. In the project *Regeneration of Barley and Wheat Collections in Tajikistan*, 300 accessions of barley and 500 of wheat were regenerated.

Armenia, Azerbaijan and Georgia were fully involved as member countries in the activities of the European Cooperative Programme for Plant Genetic Resources (www.ecpgr.cgiar.org) during active cooperation with Bioversity International. A number of scientists, researchers, genebank managers and documentation specialists attended network meetings and workshops.

GERMPLASM ENHANCEMENT

Wheat, Barley and Food Legumes

The winter crop season 2009-2010 was largely average for cereals and legumes productivity. In general, except for some limited areas, the CAC region received normal precipitations during the crop season. The winter temperatures were somewhat milder than normal, the spring months were normal. The mild winter conditions favored early epidemics of yellow rusts in southern Uzbekistan. Also, mild winter caused one month early invasion of wheat crop by Sunn Pest. Sudden rise in spring temperature slowed down the epidemics of yellow rust but caused heat stress, particularly for late planted wheat varieties. Cereal leaf beetle damage was noticed at much higher levels than during previous years in Uzbekistan and Tajikistan. Tajikistan wheat crop faced serious outbreaks of yellow rust and cereal leaf beetle and moderate epidemic of leaf rust and tan spot. Most of the released and candidate wheat cultivars in Tajikistan showed high level of severity of yellow rust, cereal leaf beetle and tan spot.

Evaluation of improved advanced breeding lines was a key activity accomplished in 2009-2010 crop season. Over 2,000 advanced breeding lines of wheat, barley, chickpea, lentil, faba bean and grass pea were distributed to the national programs in the CAC region. There were 14, 14, 6, 3, 5 and 20 nurseries of chickpea, lentil, faba bean, grass pea, barley, durum and wheat, respectively, distributed to the national crop improvement programs in the region. The partners in the national Crop Husbandry Institutes, Agricultural Universities and private sector in different CAC countries are collaborating with ICARDA and CIMMYT programs in the region proper evaluation of the international nurseries. The scientists from ICARDA and CIMMYT have continued helping NARS partners in selecting superior germplasm and candidate cultivars in the international and national nurseries of cereals and legumes.

Based on the recommendation of the Wheat Strategy meeting of 2009, wheat yield trials from the International Winter Wheat Improvement Program (IWWP) are being evaluated in Uzbekistan with the objective of developing CAC region targeted winter wheat yield trial within the framework of IWWIP. The trials under evaluation include CWA-WFYT (Central and West Asia Winter and Facultative Yield Trial), 10AYT-IRR (Advanced Yield Trial-Irrigated -2010), 10YT-IRR (Yield Trial-Irrigated-2010) and AYT-UZ-2010 (Advanced Yield Trial-Uzbekistan-2010). The CWA-WFYT trial with 40 entries is being evaluated at Kibray and Karshi sites under fully irrigated management in Uzbekistan. The 10AYT-IRR and 10YT-IRR trials with 75 and 100 entries, respectively, are being evaluated under irrigated conditions in Kibray, Uzbekistan. The AYT-UZ-2010 trial with 30 entries is being evaluated under irrigated management at Kibray, Karshi Namangan and Khorezm sites in Uzbekistan. Wheat breeders from Tajikistan, Kazakhstan, Uzbekistan, ICARDA-Tashkent, and two IWWIP coordinators from Turkey jointly evaluated the yield trials in Kibray and Karshi. Due to severe epidemic of stripe (yellow) rust in Karshi, there was an opportunity for the breeders to select for resistance. Around 50% of the lines in the yield trials were resistant to stripe rust. Besides stripe rust, evaluations were also made for agronomic characters, such as maturity, plant type and lodging. Approximately, 25% lines have been selected; further selection would be made for yield, grain characteristics and quality parameters after harvest. It is expected that these selected lines will be used in the CAC winter wheat yield trial in 2010-2011 crop

season. Besides these selected lines from IWWIP, national wheat improvement programs from the region will be requested to contribute best lines for inclusion in the regional yield trial. In Georgia, 18 internationally selected and adapted varieties of wheat were tested in different agro-climatic conditions. The varieties Kanzan, Ruminian and Turkish were distinguished by their productivity.

ICARDA and national partners in the CAC region are promoting autumn planting of chickpea which is becoming popular with the farmers. Traditionally, chickpea planting in the CAC region is done during spring. Cold tolerant chickpea lines distributed by ICARDA and selected by the NARS chickpea breeders are suitable for autumn planting. Autumn planting is proving a promising technology for the farmers in Kazakhstan, Uzbekistan and Tajikistan. The new cold tolerant varieties are also resistant to prevalent diseases. Autumn planted chickpea yields 50% higher than spring planted crops. The yield advantage primarily comes from utilization of winter rain for crop growth, and avoidance of terminal heat during maturity.

One variety each of winter wheat, barley and chickpea, originating from the international nurseries, were released by different national partners in CAC. These include Tale 38 wheat in Azerbaijan and Pulodi barley and Hisor-32 chickpea in Tajikistan. Pulodi is a high yielding barley variety for rainfed and irrigated areas in Tajikistan that matures earlier than the leading varieties in Tajikistan. Its yield potential is 3 to 3.5 t/ha under rainfed conditions, and 4.5 to 5 t/ha under irrigation. Pulodi is particularly liked because of its high biomass yield and its earliness. It is 8-10 days earlier than most other varieties, allowing farmers to grow two crops per year, even without irrigation. Hisor-32, a new chickpea variety has been released in Tajikistan for rainfed areas. It is suitable for both autumn and spring planting. It matures in about 115-120 and 85-90 days under autumn and spring planting, respectively. It grows 72-80 cm tall. Hisor-32 yields about 15% higher than local varieties.

Promotion of new varieties continued in 2009-2010. This included winter wheat variety Tale 38 in Azerbaijan and Dustlik in Uzbekistan. Similarly promotion of new chickpea variety in Azerbaijan and barley variety in Kazakhstan has been initiated in 2009-2010. Six tested varieties from nursery: 34IBWSN-68; 35IBWSN-144; 35IBWSN-137; KS990498-3-7-2; 14 HRWSN-49; 8EYT-SA–9 were sent in Signagi city (Bolgashvili) and Dedoplisckaro (Z.Tetvadze) for industrial testing. Adapted to the region variety of chickpea Elixir and perspective variety Aragvi were planted in 2010 for the seed production. Adapted to the exact region conditions varieties of lentil Pablo and perspective variety Cilkani were also planted. Additionally, the new varieties of wheat (1), barley (2), chickpea (2), and lentil (2) were selected from the International nurseries because of their better features in comparison to the local standard varieties and these varieties will be delivered to State Commissions on grade testing. Seed multiplication of the new varieties adapted to exact region conditions is being conducted now for achieving quick acceptance by farmers and increasing their impact.

ICARDA and national partners in Kazakhstan, Turkmenistan and Uzbekistan have started a new project entitled “Utilization of wild relatives of wheat in developing salinity tolerant winter wheat with improved quality for Central Asia” in 2010. The overall goal is to improve salinity tolerance and end-use quality of winter wheat in Central Asia by delivering elite germplasm with improved end-use quality and salinity tolerance. The specific objectives of the project are to, collect wheat progenitors (*Aegilops tauschii* and wild tetraploids) species

from saline areas of Central Asia, test the progenitors and other collections (synthetic hexaploid wheat from ICARDA, CIMMYT) for new sources for tolerance to salinity and end-use quality, produce new synthetics using progenitor species, transfer salinity tolerance and improved quality into locally adapted wheat cultivars, test advanced backcross populations in winter wheat background for their potential for yield and quality improvement in Central Asia, develop linked molecular markers to salinity tolerance and improved quality, and provide training on synthetic wheat technologies to the scientists from the Central Asia. During the project inception meeting, organized in March 28, 2010 in Tashkent, the scientist from national programs, ICARDA and Bonn University developed comprehensive plan of activities. Around 400 synthetic-derived hexaploid wheat lines are being tested on saline soils in Uzbekistan this year. The promising lines will be shared with national partners in Kazakhstan, Uzbekistan and Turkmenistan.

Four special research studies in wheat improvement for Ph.D. scholars have been started in Uzbekistan in 2010. The first study involves examination of genotype-by-environment interaction for quality parameters in winter wheat. The second year Ph.D. study is being conducted to determine effect of timely and late harvest of wheat on yield and quality traits. The third study involves identification of improved winter wheat varieties with resistance to Ug99 stem rust. The fourth study is being conducted to identify improved durum wheat varieties for irrigated and rainfed environments in Uzbekistan. A study on identifying improved wheat varieties with resistance to Ug99 stem rust and stripe rust is being conducted in the 2nd year in 2010. Another study involves identification of improved chickpea varieties suitable for autumn and spring planting.

High Latitude Wheat Improvement

CIMMYT's high latitude wheat improvement activities in Kazakhstan focused on wheat germplasm enhancement (spring wheat for high latitude and winter wheat breeding), conservation agriculture for wheat production and crop diversification and strengthening NARS capacity.

Kazakhstan-Siberian Network on Wheat Improvement - KASIB

Under Kazakhstan-Siberian Network on Wheat Improvement (KASIB) program, 14 breeding programs of Kazakhstan and Russia have exchanged nurseries of bread (KASIB-SBW) and durum (KASIB-SDW) wheat that constitute best varieties and advanced breeding lines from different breeding programs. Varieties with high yield, quality, superior agronomic traits and resistance to prevalent diseases and pests are selected from the nurseries. Eritrospermum 78, (Omsk, Russia), Lutescens 706, Lutescens 716 (Barnaul, Russia), Chelyaba yubileinaya (Chelyabinsk, Russia), Predgornaya 70 (Ust-Kamenogorsk, Kazakhstan) were identified promising varieties based on their 10-15% more yielding than the checks and resistance to leaf rust and other valuable traits. Among the durum wheat varieties, the highest yield was shown by Altyn dala, Altyn shygys (Karabalyk, Kazakhstan), Lan (Almaty, Kazakhstan), Gordeiforme 96-160-8 (Omsk, Russia), Kargala 1514/06 (Aktobe, Kazakhstan). Nearly 25%

of varieties tested in KASIB nurseries are being used by breeders for crossing in their breeding programs.

Shuttle Breeding

Under Kazakhstan and CIMMYT-Mexico Shuttle Breeding Program, the best entries of F_5-F_6 progenies are selected to make the Kazakh-Siberian Shuttle Breeding Nursery (KSBN). The new shuttle materials F_6ME6KAZ (44 entries) and F_5ME6KAZ (323 entries) were planted and evaluated in the Republican Quarantine Nursery and Karabalyk Experimental Station in Kazakhstan, and Omsk State Agrarian University (OSAU) in Russia. In order to compile the 9th KSBN the F_5-F_6 populations were selected.

In 2009, the 8th Shuttle Breeding Nursery including 113 of F_5-F_6 ME6KAZ hybrid populations were studied in 9 institutions in Kazakhstan and Russia. The adaptation of the shuttle germplasm to high latitude environment is being gradually improved. Some of the advanced shuttle lines have entered in preliminary yield trials PYT in the different breeding programs.

Biofortification enrichment of wheat grain by Zinc and Iron

To determine genotype x environment interaction for Fe and Zn, grains of 92 wheat varieties from 9th and 10th KASIB nurseries were sent to Sabanci University, Turkey, for analysis. Results showed that for Iron, the role of genotype in the overall variation was more important than the role of location. In case of Zn, the contribution of location was higher as compared to genotype effect for most of the datasets. Both for Zn and Fe, the genotype x environment interaction was significant. A study was conducted to determine diversity among spring wheat germplasm for Fe and Zn content. A historical set of 55 spring wheat cultivars developed in Siberia (Russia) and Kazakhstan from 1890s upto the present time were analyzed for Fe and Zn content. These analyses showed that there was not any considerable impact of breeding progress on the micronutrients accumulation in grains. The study of germplasm from different countries allowed to identify varieties with high micronutrient content and good adaptation to local conditions.

An evaluation of genotype x technology interaction was done to define optimal agronomy practices and screening environments for high Fe and Zn content across 4 sites in North, West, North-West, and East Kazakhstan. Zinc content in grain showed wide variation subject to locations (e.g. 14,9 mg/kg in Aktobe, West Kaz, and 58.3 mg/kg in Ust-Kamenogorsk, East Kaz). Such big differences in Zn accumulation in grains is caused by a significant variation of the microelement content in the soils. In general, additional application of Zn fertilizer increased Zn content in wheat grain. Also, it was found that Fe and Zn concentrations in grain correlated negatively with yield and positively with protein content. The soil humus content was positively correlated with the grain Fe content; a poor correlation was found between humus content and grain Zn concentration.

Winter Wheat in North Kazakhstan

The severe climate and cold winters of Northern Kazakhstan are often not favorable for winter wheat growing. However, breeding wheat varieties adapted for these conditions, in

combination with zero tillage technologies can be a good solution for wheat production and diversification in the northern parts of the country. A set of 380 winter wheat varieties and advance lines from 18 countries origin were evaluated to determine ecological adaptability under the Northern Kazakhstan conditions. The percentage of survival varied from total loss to 100% survival. The varieties from Eastern Europe (Hungary, Romania, Czech Republic, Moldova, and Bulgaria) featured the worst survival rates of 0 to 20%, while the best results were shown by varieties from Russia, Ukraine, and Kazakhstan. The varieties from Siberia (Russia) demonstrated the best frost resistance. After evaluation in these severe conditions the most resistant varieties were selected. A total of 53 varieties with good yield and frost resistance were planted in three locations: Shortandy (North), Karabalyk (North-West), and Ust-Kamenogorsk (East Kazakhstan).

On the basis of international nurseries 1st SRRSN and 2nd SRRSN a new nursery named 1st PSR has been formed. This nursery including 73 more adapted to local conditions material was sent to breeders of KASIB Network. In addition, 4th ISRTN-09, Resistance Gene, Isogenic lines of Thatcher sets were provided to breeding programs for further study and use for rust resistance breeding.

During 2008-2009 an assessment of 969 entries from KASIB Network (KASIB 8-10, varieties and advance lines of Siberian ARI, Omsk SAU, Karabalyk ARS, Fiton Breeding Company, Otar ARI) for stem rust resistance against Ug99 was made. By the results of screening 139 varieties (14%) showed good resistance to Ug99 (1R-30RMR). The disease pressure and epidemic during off season 2008-2009 was weak because of severe drought in Kenya. The control spreaders in the nurseries went up to 60-70% and in some cases slightly more. During 2009 main season the nurseries suffered by drought as well. Screening of germplasm showed that predominant pathotype in field was likely Ug99 +Sr24 (TTKST). The spreaders were based on mixture of lines with gene Sr24+Sr31 and showed susceptibility. The best resistant varieties were sent to Kenya for repeated screening. A set of 225 entries are currently under evaluation in Kenya within off season.

A number of winter and spring wheat, triticale and barley varieties was developed in Kazakhstan using germplasm of CIMMYT International Nurseries. Egemen winter wheat variety was released in South Kazakhstan since 2006, the variety of winter triticale Orda was released in 2009. The spring bread wheat variety Stepnaya 60 was developed at Aktobe Experimental Station on the basis of crosses with CIMMYT line Prinia/Druzina.

1st CAC Barley Workshop

ICARDA organized the “First CAC Barley Workshop” on 22-25 February 2010 in Tashkent Uzbekistan. The workshop was attended by 38 barley experts from different institutions including ICARDA, Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan and Russia. A number of presentations were made that highlighted different topics such as ICARDA’s Barley Strategy, status of barley in the CAC, barley improvement and production systems in the region, and industrial need of malting barley in Uzbekistan. The participants discussed at length the constraints to barley improvement and its future activities in the region. The participants also thrashed out priorities for barley improvement in the CAC, which include tolerance to abiotic (drought, salinity and frost) and biotic (diseases and insect pests) stresses, high yield potential, earliness, superior end-use quality, water use efficiency,

lodging, genetic resources, crop management, farmers' participation, regional networking and capacity building.

Yellow Rust Epidemics

There was a serious early outbreak of yellow rust in southern Uzbekistan and Tajikistan. Most of the commercial wheat varieties in Uzbekistan and Tajikistan showed high levels of severity in Uzbekistan and Tajikistan. This was second year in a row that yellow rust epidemics were recorded in southern part of Uzbekistan. The two varieties (Esaul and Zamin-1) that had been recorded resistant in 2009 showed much higher yellow rust severity in 2010. Compared to previous, a larger number of entries in international winter wheat nurseries showed susceptibility to yellow rust in Uzbekistan and Tajikistan.

Regional Awareness Meeting on Wheat Rusts

FAO organized "Regional Awareness Meeting on Wheat Rusts for the Central Asia and the Caucasus Countries" on 23-25 November, 2009 in Baku, Azerbaijan, which was participated by senior wheat breeders, pathologists, seed scientists and extension specialists from all CAC countries (except Armenia), ICARDA and FAO. The meeting drew attention at the highest levels in policy making in these countries towards the threat posed by wheat rusts, and potential threat of Ug99 stem rust. Regional and national plans were outlined and discussed among CAC participants and ICARDA and FAO experts.

Wheat rust monitoring

ICARDA, FAO and CIMMYT have stepped up their efforts on preventing the possible spread and impact of Ug99, a highly virulent strain of wheat stem rust which drastically reduces wheat yield, into Central Asia and the Caucasus. Preliminary testing has shown that although the rust is presently not detected in the region, the region is lying on its route, and it may only be a matter of time for the rust to gain foothold. This is a dramatic risk, as this disease might affect 95% of all currently planted cereal grain varieties in CAC. Annual rust surveillance for 2010 was accomplished in Azerbaijan, Uzbekistan, and Tajikistan; similar surveillance would be conducted in other countries as well.

CROP DIVERSIFICATION

Fruits

Two local varieties of fruit crops developed by farmers in Tajikistan were submitted to the State Commission on Varieties Testing. One is apricot variety Nishoni was developed by a farmer has fruits of average weight 61-65 g. It has 18-20% sugar, 22% dried substances, 10-16 t/ha yieldlong shelf life and good transportability. A grape variety Shohoni developed by a farmer has big bunch which weights 2-4 kg with size of berries of 40 mm and 40 t/ha yield.

Two hectares of wild pistachio plantation was done in a national park within *In situ Conservation of Crop Wild Relatives through Enhanced Information Management and Field Application* project. Varieties Oktyabrskiy, Zorka, Urozhainiy, and best selected forms of Albina, Orzu and Gornaya Zhemchuzhina were planned to be used as grafting material. Varieties Oktyabrskii, Zorka and Urozhaini were tested in Uzbekistan and were found to be best adapted to the local climate.

Vegetables

Two new hot pepper varieties Uchkun and Tillarang were released in Uzbekistan in 2009 and 2010, respectively. Compared to the local checks, these varieties has higher yield, resistance to diseases, larger fruit size and good taste, and are recognized by SVTC as the standard.

Major activities of the Network for Vegetable Systems Research and Development (CACVEG) included collaborative research with partner institutes in eight countries of the region in areas such as introduction of germplasm, trials of improved varieties/lines and segregating and adoption of lines, seeds multiplication, adoption of tomato grafting technology, workshops, capacity building, information exchange and collection and establishment of baseline data on vegetables.

Ninety five lines of four crops (tomato, sweet paper, eggplant and cucumber) were tested in eight countries in 2009. Promising tomato lines with higher yield than local checks were identified. These included LBR-9 and LBR-11 in Armenia, Kazakhstan and Kyrgyzstan, CLN2585D in Georgia, Kyrgyzstan and Tajikistan, and CLN2026D in Armenia and Georgia. ISPN08-1 sweet paper was released in Azerbaijan and Uzbekistan as high yielding variety with marketable fruits. Cucumber lines 09WVC C-17, 09WVC C-18 and 09WVC C-19 released for slicer; these also possess high yield and quality of fruits and resistance to diseases in Armenia, Tajikistan and Uzbekistan. 09WVC C-23 cucumber line was released for use as pickle in Armenia, Tajikistan and Uzbekistan. Eggplant line S113 was released as high yielding variety in Azerbaijan, Kazakhstan and Uzbekistan.

Additional new trials were initiated in 2009 with 102 entries of nine crops tested in five countries (Armenia, Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan). New trials initiated in CAC countries have shown good adaptation across diverse environmental conditions. The lines selected on the bases of yield and fruit quality include CLN 2070D tomato (cherry) in Kazakhstan, PBC-271 sweet paper in Georgia and Kyrgyzstan, 0636-6018-2 in Georgia,

0638-6007 in Kyrgyzstan and ISPN 06–5 in Tajikistan. ISPN 06–5 hot pepper was released in Armenia, and lines ISPN 16–1, ISPN 16–4, PP 9955–15, ISPN 16–2 and ISPN 163 were selected in Tajikistan. Eggplant lines EG063 and EG164 were released in Armenia. The new germplasm the following lines were released based on complex traits: pumpkin line 09WVC P-7 in Armenia, common bean line TOT 5976 in Kazakhstan, soybean lines AGS 441 and AGS 423 in Kyrgyzstan, and vegetable marrow lines 09WVC-S-3, 09WVC-S-2 and 09WVC-S-4.in Uzbekistan. Seeds of all these promising lines were multiplied for competitive trials in these countries.

Protected cultivation was also an important facet of the activities in the past year. AVRDC provided a new cucumber germplasm for study in greenhouse conditions in Uzbekistan. Evaluation of 6 cucumber lines was conducted in the Uzbek Research Institute of Vegetable, Melon Crops and Potato in Uzbekistan in 2009. Two cucumber lines with high yield and resistance to mildew were selected; these include C-51 (DUCh 07 TWGH-269-2) and C-55 (HCG 9 SAF 07 TWG 276-2).

Regional varietal trial initiated in 2010 included 94 lines of six crops from AVRDC tested in eight countries. These include eggplant (5 lines in four countries), sweet pepper (5 lines in three countries), cucumber (6 lines in four countries), soybean and mungbean (5 lines in two countries). New trials were also initiated in 2010 using 106 introduced lines of nine crop tested in eight countries in the region.

A joint project involving AVRDC and the Uzbek Research Institute of Plant Industry was initiated. The project titled "Complex evaluation of vegetable germplasm with unique traits, promising lines revealing and submission to the state varietal trial (2009-2011)" is being conducted in Uzbekistan under Government funding. Based on the study conducted in 2009 using AVRDC germplasm, 100 lines of ten vegetable crops and a number promising lines of various other crops were identified for further detailed evaluation.

The Government funded project "Study of the world gene fund of tomato and identification of promising lines for processing, (2009-2011)" is being implemented in Kyrgyz Agrarian University in Bishkek. Allocation of state funds for variety trials emphasizes the efficiency of the network activities facilitated by AVRDC's CAC Program.

In 2009 competitive variety trials of 38 promising lines of nine vegetable crops were conducted; these trials are being continued in eight CAC countries in 2010 as well. The selected varieties will be submitted to SVTC in near future.

Twenty three varieties of tomato, sweet and hot pepper, eggplant, vegetable soybean, mungbean, long yard bean and cabbage are under state variety trials in Armenia, Kazakhstan, Tajikistan and Uzbekistan in 2009-2010. These varieties don't have analogues in CAC countries on morphological and economic marketable traits.

Seed multiplication of promising and released varieties was undertaken for supplying high quality seeds to farmers for extensive cultivation. New varieties would give higher yields and increase diversity of the vegetable production and farmers' income in CAC countries.

In 2010, AVRDC-CAC has undertaken a project titled "Development and Delivery of Ecologically-Based IPM Packages for Field and Vegetable Crop Systems in Central Asia"

(IPM Tomato Package). Under this project four tomato lines resistant to diseases have been introduced from AVRDC to Kyrgyzstan, Tajikistan and Uzbekistan.

In 2010, 16 tomato lines have been introduced from AVRDC to Tashkent State Agrarian University of Uzbekistan and grafting of high-yielding scions on disease-resistant tomato rootstock has been conducted to control diseases. Use of this environment friendly biological method will allow farmers to increase productivity and quality of tomato in greenhouses and in open fields.

Potato

Characterizing tuber bulking in advanced CIP clones for enhanced potato breeding capacity under long day conditions of Central Asia

Two experiments to characterize tuber bulking were set up in the dual cropping system of the temperate lowlands of Uzbekistan. Results can be utilized in the lowland cropping system of the whole Central Asia region. The objective of the experiments was to investigate the tuber bulking behavior of CIP's germplasm materials so as to classify them in specific maturity groups according to their reaction under different growing seasons characterized by diverse photoperiod and temperature regimes. Considering a growing cycle of 80 days, which is too short for the currently tested CIP clones under the long day conditions of Central Asia, the majority of the germplasm showed a tuber bulking behavior approaching the intermediate maturity group when potato is grown during the first growing season of the lowlands (March till June). This was more evident for clones 397077.16, 720150 and 388615.22 which had high marketable yield per plot (3.04 to 3.51 kg/m^2) and per plant (0.53 to 0.58 kg) when harvested 100 days after plantin (DAP). On the other hand, during the second growing season in the lowlands (mid-July to October) it emerged that if there is demand to produce more marketable tubers, harvest at 130 days is recommended for clones 720150, 720087, 720141, 397029.21, 397073.16, 390478.9, 392797.22, 388615.22, 397099.4 and 397099.6, while harvest should be carried out at 110 DAP for 720139, 397054.3 and 720087. UNICA (392797.22) was more suitable to planting in the second growing season because of its long dormancy.

CIP clones under variety release process

Three new CIP clones, 388611.22, 388615.22 and 392797.22, have been selected for variety release in Uzbekistan and delivered to the local State Committee for Variety Testing. Other selected CIP clones 390478.9, 397073.16 and 397077.16, identified with the Uzbek names of *Pskem*, *Hosildor* and *Sarnav* have been admitted to the second year of tests. In Kazakhstan, candidate CIP clone 392780.1 has been selected with the name *Ushkonyr*. In Tajikistan, CIP clones 720189 and 392797.22 have been selected and together with 397077.16 (candidate var. name *Faizabad*) are passing though the release process.

BMZ-GTZ project "Enhanced food and income security in SWCA through potato varieties with improved tolerance to abiotic stress" (2008-2010).

The drought tolerance trial included 12 CIP clones compared with Sante, a Dutch variety. CIP clone 397054.3 was characterized by the largest plant canopy and the lowest significant

values for wilting and senescence at 70 DAP, as well as the lowest harvest index (0.63%). The same clone produced the lowest number of tubers/plant (4.9) under severe water stress, followed by 388615.22 and 391180.6 (5.6). The highest yield in all the treatments (30.0, 24.5 and 15.7 t/ha, respectively), was obtained by 397077.16. Yield maintenance under water-limited conditions was the highest for CIP clone 720189 (97.3%), followed by 388615.22 (89.4), 392780.1 (86.5%) and 397077.16 (81.7%), meaning that reduced water levels did not affect their tuber yield excessively. No significant interaction between irrigation regimes was found for total and marketable yield, and tuber weight per plant. Influence of drought was observed on deformed tubers under, values ranging from 22.4% of clone 388615.22 to the 2.3% for 397077.16. The clones were assessed for drought and salinity tolerance under in-vitro conditions.

Strategy for improving farmer-based seed potato systems developed and validated for Tajikistan and Uzbekistan

One of the main challenges CIP in Central Asia is to assist local NARS in diffusing improved potato varieties and technologies that would allow enhancing quality of farmers' saved seed. The potato crop shows potential for increase in Uzbekistan and Tajikistan provided that some tools are supplied to improve variety diffusion through enhanced seed production systems. Testing of TPS as an alternative seed potato technology in the highlands of Central Asia over years has shown potential of adaption to conditions of resources-poor smallholders, where access to farmers' fields is difficult, and price of conventional seed is unaffordable. However, it is still a relative novel concept, which is not yet widely accepted by the agricultural community except in Tajikistan. The strategy for variety diffusion should make full use of other technologies (i.e. aeroponics) as well. Collaborative activities to develop the informal seed system by means of TPS have been implemented in Tajikistan with German Agro-Action in Zarafshan valley and with Global Partners and the Institute of Horticulture and Vegetables in Rasht valley. In Uzbekistan, collaboration continues with the Biotech Dept. of the National University. In 2009, more than 500 kg of disease-free minitubers have been produced in the two 500 m^2 screenhouses installed by CIP.

Potato virus distribution in different agro-ecological conditions of Uzbekistan

Farmers in Uzbekistan usually select small-sized potatoes for propagation from the stock of potatoes stored in their cellars or cut large tubers seed that cause a perpetuation of virus diseases in their fields. Because of these continuous practices and the use of imported seed from Europe that became common in the last twenty years, CIP wanted to investigate the potato virus distribution in the country as well as the presence of Phytoplasma-like diseases. To better know precedent situation, a survey by local specialists engaged by CIP-Tashkent was carried out in the regions of Tashkent and Samarkand, the major potato producing areas of Uzbekistan. Results from the DAS-ELISA test on potato leaves taken from 30 fields revealed that fields in Samarkand region appeared more infected by potato virus diseases than those in Tashkent region. Samples analyzed by radioactive NASH technique at CIP-HQ and based on spotted membranes sent by CIP-Tashkent gave 3 positive results to PSTVd (Potato Spindle Tuber Viroid) in Tashkent and 8 in Samarkand regions. Some samples sent to a referenced laboratory in United Kingdom to perform PCR technique so as to determine the presence of phytoplasmas, gave negative results in all cases. Furthermore, no PMTV (Potato Mop Top Virus) was detected in the spotted membranes through NCM-ELISA. The following solutions would improve the situation: introducing farmer-participatory approaches to bring

awareness about virus diseases and the value of selecting virus-free potato tubers for new plantings; and capacity building to update background knowledge of local specialists.

Halophytic plants

Native wild halophytes and conventional and non-conventional sorghum and pearl millet varieties, technical and fodder crops

The main focus of ICBA activities in 2009-2010 was to introduce and evaluate native wild halophytes and conventional and non-conventional sorghum and pearl millet varieties, and technical and fodder crops for their ability to grow and produce economic yields under saline environments. Special attention was paid to the development and adoption of innovative management options in order to increase productivity and income generation on salt-affected, marginal lands.

Among the sorghum varieties/improved lines from ICBA germplasm, Speed Feed, Sugar Graze, Super Dan, Pioneer 858, SP 40516, SP 47105, SP 39105 and SP 39269 showed good adaptability to the high salinity in irrigated lands and on degraded desert salt affected rangelands in Uzbekistan and North Tajikistan.

The seven pearl millet cultivars received from the ICBA and ICRISAT and planted in the Kyzylkum desert, Uzbekistan, produced between 38 and 96 t ha^{-1} of green biomass, of which the cultivars Raj 171 (90.0 t ha^{-1}), IP 19586 (91.6 t ha^{-1}), and IP 22269 (96.7 t ha^{-1}) performed best. If these cultivars are grown near the watering points in the vicinity of the herds (size of 2000 units) on 10 hectare area, the survival ratio could easily be doubled from 2 kg to 4 kg day^{-1} per animal during the severe winter season.

For last two years, there is a high demand among farmers to get good quality seeds of salt tolerant alfalfa. Therefore, trials for seed multiplication established in 2007 on Galaba farmer, Syrdarya province; Kyzylkesek site, Navoi region and at the Yangiobod site in Tajikistan were monitored. In 2009, 200 kg of elite seeds were produced and disseminated through 'a farmer to farmer' program in Uzbekistan and north Tajikistan. Three salt tolerant alfalfa varieties (Eureka and Sceptre from ICBA and Kyzylkesekskaya), showing high adaptation to the extremely saline environments of the cotton/wheat systems of all four countries, are going to be submitted to the State Variety Testing Commission.

Salt tolerant varieties of *Helianthus tuberosus*

In 2009, ICBA in partnership with NARS initiated the evaluation of salt tolerant local varieties of topinambur – Haet Baraka and Novinka, which showed good performance and accumulation of green biomass under highly saline environments in Takhtakupur, Karakalpakstan (at the Aral Sea area). Investigation on salt tolerance and impact of irrigation with marginal quality water on the growth and tubercle yields and quality of topinambur varieties have also been started at the Kyzylkesek site, Uzbekistan. These salt tolerant varieties are economically useful for feeding livestock and as a source for renewable energy production. This activity will continue in 2010 by financial support from State Committee for Science and Technology of the Government of Uzbekistan within framework of the ICBA-NARS Project "Integrated approaches for sustainable use of marginal lands in Priaralie and

Kyzylkum Desert through the introduction of biosaline technologies and promoting renewable energy production".

Experiments of last years on the establishment of irrigated halophytic rangelands (in pure stands or intercropped with different salt tolerant crops) at the Kyzylkesek site by using underground artesian water showed that increased fodder availability near the desert settlements would improve survival of the livestock, consequently the income of agropastoralists. Summer cypress (*Kochia scoparia*), highly tolerant to drought and salt stresses, was planted in the Kyzylkum desert in Uzbekistan. Planted in spring 2008, the green biomass of *Kochia scoparia* was 14.0 t ha^{-1}, while *Climacoptera lanata* yielded 7.0 t ha^{-1}, and hoary orache (*Atriplex nitens*) yielded 27.0 t ha^{-1} green biomass. The study results are also presented in ICBA publications.

Sweet-stem sorghum (*Sorghum bicolor*)

In 2009, two demonstration trials within the framework of the collaborative ICARDA/ICBA/ICRISAT project was established and 28 varieties of sugar sorghum, 16 of which were received from ICRISAT (India), were evaluated for suitability to be produced on saline soils in the Kegeyli rayon of Karakalpakstan and at the Zangyota site, Corn Center, Tashkent province. The top grain yields were achieved with Uzbekistan (8, 9 to 10.6 t/ha) and SP-47513 (8.7 t/ha). Varieties S-35, E-36-1, ICSV-707 produced the average grain yield of 7.66 t/ha. The highest sugar content of 10 to 15 % was observed in SP 47513 (15.2%), Sorgo Oranjevoe (12.6%), ICSV 112, ICSV-707 and SP-47529 (about 11%), E -36-1 and S-35 (10%). The highest yield of fresh biomass that produced about 68% of juice and almost 8.5 t ha^{-1} total sugar was obtained for Uzbekistan-18 variety, followed by Karakalpakskiy (6.5 t ha^{-1} total sugar) and Orangevoe 160 (4.1 t ha^{-1} total sugar) as local varieties and Sugar Graze, ICSV 745, ICSV 112 among tested improved lines from ICBA that could successfully used for the ethanol production.

Agro-silvipastoral model for improvement productivity of marginal salt affected lands

An agro-silvicultural model of trees intercropped with complementary crops, especially deep-rooted, early-maturing and frost tolerant legumes and graminous crops continued to be evaluated on marginal lands under arid climate in Uzbekistan (Central Kyzylkum) and northern Tajikistan (Yangiobod Farm). Herbaceous fodder crops planted within the inter-spaces of salt-tolerant trees/shrubs plantations improve productivity of saline prone soils, solve the animal feed gaps in the lands degraded both by overgrazing and salinity, and increase the profits for farmers. Wild halophytes planted in widely spaced patterns allow for easy mechanical cultivation and harvesting of forage grass and legumes.

The findings on utilization of drainage mineralized water on establishment of wild multipurpose wild and fruit tress were initiated early at the Yangiobod farm (north Tajikistan). Limited irrigation with low quality water was required during the initial stage of growth before sole reliance on available drainage water (higher salinity; EC 2.5 -8.3 dS m^{-1}) resource become possible. The level of water table varied 1.5-3.0 m below field level. Soil salinity at root zone was about 45 dS/m. The fast growing and high rate of survival were noted for local poplar species (about 91.3%) apricot (*Armeniaca vulgaris*) as 75.2 % and *Dyospyros virginiana* of about 54.8 %, when cultivated in mixed stands with various salt tolerant crops. Species of Elaeagnus angustifolia having an exceptional ion-translocation

bioremediation mechanism might be referred to as aggressive colonizers since they tend to invade natural habitats and push out less salt tolerant species.

The optimal integrated agroforestry –farming system comprising 12-15% of tree cover, 58% of alfalfa and 27-30% of annual forage crops provide satisfactory drainage – control of saline environments preventing accumulation at the root zone area. It was found that the irrigation scheduling (rate and regime) should be critical point to the success of agroforestry.

Mapping of halophytic vegetation and domestication of economic valuable halophytes

In this mapping it was found that the soil salinity types, moisture and sodium ion content were the major factors responsible in the cover vegetation changes. Vegetation richness, botanic species diversity and plant biomass were well integrated with soil salinity calculated for sodium ion accumulation. A significant drop in soil salinity and the concentration of different ions was detected in winter-spring seasons, which was attributed to the diluting effect of snow and rain water. Research is continued and a scientific-based concept for the domestication of aboriginal tree/shrubs and perennial halophytes into a biosaline agriculture system for Central Asian will be developed.

Leaf carbon stable isotope (^{13}C) analysis and water use efficiency of different ecological groups of plants, including perennial legumes, are being studied to determine the relationship of soil salinity with vegetation biomass. Field investigation on this aspect in collaboration between ICBA (International Center for Biosaline Agriculture), University of Yamanashi, Japan, and the Plant Physiology Institute of the Academy of Sciences of the Russian Federation have been continued.

Field Expedition work has been organized 28 October- 08 November 2010 with support of ICBA on mobilization of phytogenetique resources of halophytes of Golodnaya Steppe (Syrdarya and Dzizak regions), Kyzylkum Desert, Aygakitma and Karakata salt depression. Scientists from Kyoto University, Japan, Tehran University and Plant Physiology Institute of Academy of Sciences of Russian Federation have been participated. Seeds for more than 150 species of wild halophytes and 28 species of salt tolerant conventional crops have been collected. Presently, the description of species and seed quality control is conducted at the Gulistan State University.

INTEGRATED PEST MANAGEMENT

Integrated Pest Management (IPM), Cooperation Research Support Program (CRSP) project has begun in October 2005 and covered three countries in Central Asia region: Kyrgyzstan, Tajikistan and Uzbekistan. This regional program was led by Michigan State University (MSU) in collaboration with University of California-Davis (UC-Davis), International Center for Agricultural Research in Dry Areas (ICARDA) and a number of governmental, non-governmental organizations (NGOs) and local universities in the region. The project focused on three components.

1) Collaborative research program to enhance efficiency and product lines of biolaboratories;

2) Collaborative research program to enhance biological control of pests through Landscape ecology, habitat management;

3) Strengthening of outreach and educational programs in ecologically based IPM.

During 2009-2010 year under the project component 1, collaborative research on enhancing efficiency and product lines of biolaboratories has been focusing on development conditions for rearing of predatory mites and their application on vegetable fields to control of crop sucking pests. This research program has tested colonization and acclimatization of predatory mite *Amblyseius* sp on bran mites, spider mites and other prey and non-prey diets in biolaboratories in Uzbekistan and Kyrgyzstan. The results have revealed that predatory mites can be potential biological agents against spider mite, *Tetranycus urticae* in vegetable fields and greenhouses and whitefly *Trialeurodes vaporariorum* in tomato greenhouses. New methodologies for maintaining and rearing predatory mite cultures during winter time on prey food and non-prey artificial diets have been developed. In addition, predator-prey ratios have been determined. *A.mackenziei* has been found to be effective in controlling *Thrips tabaci* in onion crop in Uzbekistan and Kyrgyzstan.

The project component 2 has conducted collaborative research on landscape ecology and biological control in Tajikistan and Kyrgyzstan. In collaboration with NARS, a database on native flowering plants has been developed. Available plant seeds were collected for field testing. Sixty native and locally adapted plant species were evaluated for their attractiveness to natural enemies of pests. Out of 12 native plants species that were the most attractive to natural enemies, 8 plants have shown potential for their use in agricultural landscapes for enhancing biological control, and are currently being tested in farmers' fields consisting of maize, cotton, wheat and vegetable crops. To disseminate the concept of landscape ecology in the region, research results have been presented in more than 10 workshops and various papers published including a TV documentary. For this work implementing period of time the project has built an excellent research team of partners in Central Asia among National Agricultural Research Systems (NARS) to promote landscape ecology/biocontrol approaches in the region. A total of 130 wheat entries were screened for cereal leaf beetle, and some lines have shown resistance to cereal leaf beetles, a serious pest of wheat in the region.

The other studies on biological control have been conducted for this report time. For control of bollworm *Heliothis armigera* on tomato crops in different Central Asia regions various pheromone traps have been tested. For control of thrips and whiteflies the blue and yellow sticky traps have been used. The results have shown that these methods are very effective and ecologically safety ways to suppress significant numbers of crop pests.

NATURAL RESOURCE MANAGEMENT

In December 2009, ICARDA together with NARS partners from Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan initiated a multi-disciplinary project entitled: "Impact of Climate Change on rural livelihood in Central Asia". The project has three subcomponents: a biophysical assessment component, a GIS/downscaling of climate change component, and the socio-economic assessment of rural livelihood as affected by climate change.

In order to access the biophysical impact of climate change on wheat production and productivity, ICARDA scientists in collaboration with NARS partners selected 20 strategic wheat production sites within different agro-ecological zones in the four countries, which fully represent the major wheat production zones of Central Asia. Historic production data from these sites are used for a site/region-specific calibration of the crop-simulation model CropSyst. For site selection and data collection the members of the project team visited national research institutes to familiarize with their scientific and experimental work and to provide consultation on the CropSyst model application. In the framework of the project a training course on "Crop Simulation Modeling using CropSyst" was held in Tashkent, 7-11 December, 2009, which was attended by 13 participants from nine regional science institutions. Data collection in combination with the acquisition of necessary meteorological data will be completed by July 2010. Modeling the impact of climate change will be done by using regionally downscaled global circulation model results. First results are expected by the end of 2010.

The Sustainable Land Management Research Project

Land degradation is particular acute and widespread in the Central Asian countries Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan and Turkmenistan, and is evidenced in rising groundwater tables, increasing land salinization, erosion and loss of soil fertility. This is particularly precarious in the context of global warming and climate change, which affects the Central Asian region above average along with more frequently occurring seasonal droughts. Research efforts in the frame of the Central Asian Countries' Initiative for Land Management (CACILM) have been made to develop sustainable land management options as strategic platform to combat land degradation, and increase the livelihoods of the poor farming population.

The Sustainable Land Management Research (SLMR) project, financially supported by the Global Environmental Facility (GEF), is part of the framework of the Central Asian Countries' Initiative for Land Management (CACILM), a 10-year program where all 5 Central Asian countries with the support of several international donors engage in combating land degradation and improve rural livelihoods in the region.

The SLMR project with its focus on research for development was commissioned in five Central Asian countries from July 2007 to August 2009 not only to promote sustainable land management research, but also to contribute to restoration, maintenance and enhancement of the productive functions of land to improved the economic and social well-being of the population while preserving the environmental functions of these areas.

Covering rainfed and irrigated agriculture, mountain areas and rangeland/pastures, 12 research sites were selected where sustainable land management options were tested in close collaboration with the national research institutions of the five Central Asian republics.

Laser-assisted land leveling, irrigation with plastic chutes and conjunctive use of drainage and irrigation water were tested and showed to increase water productivity by 15-25% in Kyrgyzstan, Turkmenistan and Uzbekistan. Raised-bed seeding improved seed germination rates, halved (wheat and rice) seeding rates, reduced water use by 10%, and allowed for diversifying the cropping geometry in Kazakhstan, Kyrgyzstan and Uzbekistan. Intercropping of cotton with legumes, maize with legumes, or sainfoin with barley proved highly profitable

for farmers in Kyrgyzstan, Tajikistan and Uzbekistan. Also planting into standing stubble, or applying mulch were tested, and especially in the mountainous regions of Kyrgyzstan and Tajikistan, residues on sloped land and terraces successfully reduced erosion and increased soil moisture content in the topsoil. Rangeland productivity and fodder availability could be increased by planting suitable salt-tolerant fodder crops such as alfalfa, Sudan grass, triticale and sorghum, and licorice. Saxaul and other halophyte species were found to be highly suitable for diversifying the rangeland plant population and increase the pasture quality for the livestock herds. Different sources of income generation for the livestock farmers in the region could be encouraged. Using GIS-based similarity analyses environments similar to the SLMR project sites could be identified for potentially outscaling of the developed technologies.

The results have thus abundantly demonstrated that adoption of improved technologies of soil and water management could enhance productivity, resulting in higher rural incomes and household food security, and contribute to the conservation of natural resources and the sustainability of agricultural production in the region.

However, the adaptation of sustainable land management practices and modifying conventional crop production technologies has to be considered an innovation process by itself. This requires not only a shift in the local research paradigms but also demands the support of extension-type structures for awareness creation among the population and trainings for the successful implementation of improved land management practices with benefits for people and nature alike.

Drylands Management in Central Kazakhstan. Validation and Demonstration of New Technologies for Restoration of Degraded Lands and Forage Crop Production

The main objective of the Project component implemented by CIMMYT is to show different methods of grassland establishment by sowing perennial and annual crops with low costs resulting in sustainable and profitable production, to convert the abandoned dry lands of Central Kazakhstan into pastures to contribute to carbon sequestration. Based on the results obtained the following conclusions were made:

- The best method of abandoned land restoration is chemical fallow followed by direct sowing of perennial forages. This method controlled weeds best.
- Perennial forages and their mixtures which produce the highest yield in dry conditions of Central Kazakhstan were identified.
- Replacement of natural hayfields with sown cereal forages has doubled the productivity, whereas establishment of legumes and legume and cereal mixtures increased the hay yield four-fold. In the dry steppe of Kazakhstan, sowing legume and cereal mixtures can be widely adopted technology for pasture establishment and a good option related to the climate warming.
- Sowing annual forages instead of fallow allows obtaining additional produce such as green forage, hay and grain. This conclusion is also new; at present the most widely used method to turn abandoned lands to forage production is fallowing.
- A ‘green conveyor’ concept was developed for the region which envisages production of annual forages as well as perennial ones. This approach shall greatly prolong the period of forage availability and enhance the range of forages.

Conservation Agriculture for irrigated cropping system of South Kazakhstan

Since 2002 CIMMYT agronomy activities in South Kazakhstan have been focusing mainly on furrow irrigation and raised bed wheat planting showing high efficiency for seed multiplication and wheat production in comparison with traditional way. Last year, CIMMYT started combining of raised bed planting and furrow irrigation with zero tillage, i.e. direct seeding on permanent beds. The first results demonstrated advantages of this technology, including tillage cost reduction, better residue management, weed control, improved irrigation conditions, reduced seed rate, economic efficiency of the crops production. If the distance between beds is acceptable for other crops in the rotation, use of permanent beds can significantly reduce the time between harvesting the previous crop and sowing the next one (obtaining two crops in one year is the most important objective and challenge for the region).

Conservation Agriculture for rainfed cropping system of North and Central Kazakhstan

In the beginning of 2000 CIMMYT, NARS and MoA (Ministry of Agriculture) initiated large-scale Conservation Agriculture activities in the rainfed area of North and Central Kazakhstan. Due to these activities the area of CA has been increased from virtually none to hundreds thousands hectares. According to the official assessments the cumulative area under CA was estimated within the range of: 500,000 – 600,000 ha in 2007, and 1,300,000 ha in 2008. The idea of CA became a state policy in agriculture in Kazakhstan. In 2009 Kazakhstan was included in the list of 10 countries having the largest areas under CA in the world. Presently CIMMYT activities on CA for rainfed cropping system are focused on weed control, crop rotation/diversification, and fertilization strategies.

Study of no-till efficiency in grain production in the agricultural landscapes of Central Kazakhstan at "Vlad" Farm.

In 2009 the main attention was paid to crop rotation and fertilization aspects of CA introduction. Fallow-wheat still remains the most common cropping program in Central and North Kazakhstan. But it is becoming more and more obviously that summer fallow can be replaced by many crops including grain legumes, oil crops and forages. The studies carried on at "Vlad" Farm, Central Kazakhstan, demonstrated that the replacement of the fallow by grain legumes allows to use arable lands more rationally. In particular, this new field structure gives an opportunity to cultivate grain legumes and other crops without any reductions of wheat growing areas. The data obtained showed that the spring wheat yield in these crops rotations is higher as compared with "fallow-wheat" system. Generally, the crop rotations as compared to fallow-wheat monoculture have many advantages: increased crop production from total area, more efficient soil conservation and soil fertility management, crop diversification associated with more sustainable farming, and more efficient weed and pest management. Experiments on fertilizers efficiency in CA fields were conducted in the different landscapes of Central Kazakhstan. The highest yield increase was obtained in case of joint application of nitrogen and phosphorous fertilizers in the rate $P_{20} + N_{20}$.

CIMMYT and Karabalyk Experimental Station joint research on CA and crop diversification in North-West Kazakhstan

In 2009 the joint activities were corresponded actually the continuation of the on-going research on no-till technologies for wheat production and crop diversification in the region. The main conclusions are:

- With the laps of time of the no-till adoption the wheat and other crops yields have been increasing in comparison with conventional practice;
- No-till has appeared more efficient as compared to conventional tillage both without fertilizers and with nitrogen fertilizer;
- Crop rotation is an important factor of the wheat yield increase, diversified crop production in the region, efficient weed and pest control, increased crop production from total area;

Almost all tested wheat varieties responded positively on no-till technology.

The Integrated water resources management in Fergana Valley (IWRM-FV) project

The Integrated water resources management in Fergana Valley (IWRM-FV) project, funded by the SDC (the Swiss Agency for Development and Cooperation), was established in September 2001 and will run until December 2010 when it would have completed IV consecutive phases. The project focuses on improving the effectiveness of water resources management through the introduction of integrated water resources management (IWRM) principles in the Fergana Valley which is shared by the Kyrgyz Republic, Tajikistan and Uzbekistan. The issues addressed by the project, among others includes possibilities for water saving, improvements in water productivity, reorganization of water administrations, promotion and institutional building of water users' associations (WUA's), establishment of a unified management for three pilot canals and development of transparent, fair and efficient water distribution mechanisms among users.

Based on the successful experiences gained during previous phases, in 2008 the project moved to Phase IV. The proposal for Project Phase IV was approved by the Interstate Commission for Water Coordination (ICWC) in Central Asia. The implementation of the project is entrusted to an association of two organizations - the International Water Management Institute (IWMI) and the Scientific Information Centre (SIC) of ICWC.

Main achievements of "IWRM-FV" (Phase IV) project during the reporting period (from January 1 – December 31, 2009):

Following the IWRM concept, the SIC ICWC – IWMI Consortium has developed guidelines and then evaluated them in the pilot zones within three Central Asian countries with a total area of over 120,000 ha, that include the command zones of Aravan-Akbura canal (AAC) in Kyrgyzstan, Khodjabakirgan canal (KBC) in Tajikistan and Southern Fergana canal (SFC) in Uzbekistan. In 2009, the IWRM concept was further disseminated for two trans-boundary

small river (TSR) basins, Khodjabakirgan and Shahimardan, and to the Akbura river basin in Kyrgyzstan. The refinements introduced in institutional structures were as follows:

1. Transition to hydrographic management, covering all water hierarchy levels from canal management organizations through to WUAs, water users groups to the end user was carried out.

2. An appropriate system has been developed and the principle of public participation in water management at all water hierarchy levels has been widely introduced.

3. A management system based on the accounting and interaction of all available water resources (surface water, groundwater, and collector-drainage water), which provides at least the organizational losses, has been developed and introduced.

4. National policies and the legal framework for dissemination of the IWRM approaches are in place.

5. Capacity Building and dissemination strategies were developed, implemented and the impact monitored through M&E protocol.

Water productivity improvement at plot level project

Water productivity improvement at plot level project (WPI-PL) funded by the SDC has the objective of enhancing water productivity, crop yield and improve yield stability at the plot level through improved on-farm management and on-plot water management, thereby avoiding negative impacts on the environment such as water logging and salinization. The project activities are implemented in three countries of Fergana Valley: Kyrgyzstan, Uzbekistan and Tajikistan. During the 2009 the following achievements were made:

1. National partners have been selected in compliance with the criteria identified during the project formulation workshop held on 18-20 September 2008 and stakeholders' workshop on planning actions held on 19 November 2008.
2. The national partners and the regional group jointly approved districts, WUAs and demonstration fields. The total number of demonstration fields is 26 with the following breakdown by countries: Kyrgyzstan – 6, Tajikistan – 5 and Uzbekistan – 15.
3. The partners assessed compliance of certain farmers' needs with those identified previously and prepared the list of technologies that are already available for dissemination and those that need to be developed further and adapted to the local conditions.
4. The national teams of Kyrgyzstan, Tajikistan and Uzbekistan identified the list of technologies for dissemination (17 out of 19); 2 technologies need to be developed further through adaptive research. A survey among farmers was undertaken to identify the technologies.
5. Trainers have been selected; strategy and approaches for farmer and disseminator training have been identified in all the republics.
6. The established partnerships between innovation cycle participants, which formed the basis of the project, have confirmed the appropriateness of the chosen strategy.

Sustainable management of groundwater in arid and saline environments - a comparative analysis of Tunisia and Central Asia project Phase II was funded by OFID from 1 January 2008 – 30 June 2009.

The objective of the studies for the Phase II of the project was to understand the socio-ecology (social, economic and agricultural contexts) of groundwater use and link to management, development and governance scenarios based on the integration of models and components developed in Phase I.

The studies undertaken were divided into three main components:

Component I: The socio-ecological surveys of ground water use for irrigation under different policy environments existing in Central Asian countries;

Component II: Modelling ground water use for irrigation for representative aquifers of Fergana Valley with a focus on quality and interaction of surface and subsurface waters;

Component III: Evaluation of ground and surface water resources available for irrigation within Fergana Valley.

Under Component I, the socio-ecologic survey of ground water use for irrigation was carried out in northern Tajikistan. Farmers from Rasulov district of Sogd province, Tajikistan who have access to ground water were identified as the target group. The survey was conducted in 16 of 28 villages of the district with a total of 192. The survey results indicated that: 1) The majority of water users prefer to use gravity flow and abstracted groundwater as compared to water pumped from the Syrdarya River; 2) access to groundwater during the last years is significantly worsened due to the shortage and the cut of power supply, lack of maintenance and need for rehabilitations of wells; 3) District Water Management Organizations responsible for maintenance and operation of wells do not have enough funds and spare parts to maintain the operation of these wells. The survey found that water users share the operation and maintenance cost of wells, clearly indicating that some farmers are willing to make short term investment in groundwater development. The survey highlighted factors contributing to a reduction of the groundwater abstraction which where in order of importance as follows: interruptions in power supply; poor governance of operation and maintenance of wells; low income of farmers. The following recommendations were made based on the survey conducted to promote groundwater irrigation in the Sogd province of Tajikistan: 1) The state could consider subsidizing the power supply for groundwater abstraction; 2) The state could create credit lines for rehabilitation of existing and the construction of new wells for irrigation purposes; 3) steps to be made to reduce the cost of installation of wells, these include access to local markets for cheap pumps from China and India, and the use of PVC piping; 4) the existing wells can be transferred to the WUA. The WUAs have to sign agreements with the branches of the water management organizations responsible for “pump” irrigation for maintenance and operation of the wells. At the same time, WUAs will have agreements with water users for water delivery with an indication of a volume and a schedule of the groundwater delivery. Under Component II, modelling ground water use for irrigation for Sokd aquifer using Visual MODFLOW has continued. During the first phase of the project the geo-filtration model of Sokd aquifer was developed using Visual MODFLOW. Predictions were made for three alternative scenarios including: (1) the current scenario with

under development of ground water for irrigation; (2) the scenario of intensive ground water use for irrigation and; (3) the scenario of surface flow banking in subsurface aquifers in winter and intensive ground water abstraction in summer. The modelling studies indicate that poor conventional irrigation practices are the main factors leaching dissolved salts from the aeration zone to the groundwater and contributing to increasing water salinity. This issue exists especially in the tail parts of the Sokd River basin. The results of the modelling indicated that increasing groundwater extraction from 116 million m^3 per year (Mm^3/yr) to 729 Mm^3/yr under conventional irrigation practices may further degrade the quality of groundwater spread in the first and second layers. Hence there is a need to assess the impacts of water saving technologies in the prevention groundwater salinity. Further, optimization of location and number of new wells can be applied to maintain water quality in the Sokh River basin.

Under Component III different strategies to improve water management in Fergana Valley were compared. Water deficits in the region will continue to grow due to increasing water demands, competition between hydropower generation and agriculture, and climate change. Conjunctive use of ground and canal water for irrigation in Fergana valley is one of the alternatives to cover the water deficit in Syrdarya River basin. This technology is to be compared with other alternatives to support the feasibility and economic viability of this approach.

Alternative technologies were grouped into the three different strategies:

Strategy 1: Sub-irrigation and satisfying the water needs of crops from shallow water tables

Strategy 2: Lowering the groundwater at the depth ("critical" depth) and eliminating evaporation from the water table.

Strategy 3: Conjunctive use of canal and groundwater for irrigation in zones with favourable hydrogeology conditions.

The study indicated that adoption of the Strategy 1 will shift the non-process water depletions associated with evaporation to productive use. This strategy can significantly intensify agriculture in the Fergana Valley. Scale of adoption of the strategy is dependent on State agricultural policy. The free choice of farmers to select their cropping pattern and having access to free open markets for agricultural crops is a precondition for the wide adoption of water saving agronomy practices. The process fraction of depleted water will increase from 0.39 to 0.47 and the process fraction of available water from 0.35 to 0.40. However, the regional water saving potential of this strategy for downstream uses is low. Under this strategy water service charges have to be implemented on an area-base, since 'free' water available for crops from shallow water table can cover up to 60-90% of crop needs. Adoption of volumetric water charges will not bring significant water saving but may reduce the expected income of Water User Organizations (WUAs).

Strategy 2 allows for the reduction in the current non-process water depletions from the soil and the water table. Adoption of water saving technologies along with the agronomy practices becomes important to maintain the water table at critical depths. This strategy can provide water savings through a reduction in evaporation and the winter drainage flow. Total water saving under the strategy 2 including improved agronomy practices comes to 600-1000 Mm^3

per year, which can be utilized by downstream users. The process fraction of depleted water will increase from 0.39 to 0.50 and the process fraction of the available water from 0.35 to 0.38. The Fergana Valley represents the region with high upstream – downstream impact. Therefore, the maintenance of the water table at a 'critical level' will depend on the efficiency of the rehabilitation and the maintenance of irrigation and drainage infrastructure. Under this scenario volumetric water pricing can be applied to stimulate water saving since crop water needs will be satisfied mainly from the canal system.

Strategy 3 allows for the management of all components of non-process depletions, including evaporation and flow to sinks. The strategy brings local and regional benefits since wide exploitation of groundwater will permit saving summer river flow for the needs of downstream users. Groundwater abstraction for irrigation will free the capacities for accumulation of winter flow of the small rivers of Fergana Valley and Naryn River. The water utilizable in the downstream will increase by 3700 Mm^3, which means that committed needs of the downstream users will be met in most years. This water saving can be achieved by excluding the flows to the sink, reducing evaporation losses and the river flow pollution. Under this strategy the process fraction of depleted water will increase from 0.39 to 0.70. Water productivity will increase almost twice for orchards and vines and by 50% for vegetables and wheat.

LIVESTOCK AND FEED PRODUCTION

Project on "Community Action in Integrated and Market Oriented Feed-Livestock Production in Central and South Asia", funded by IFAD

Socioeconomics

Activities on value addition and local processing of goat fibers by women in research sites in Tajikistan were completed successfully. Market for Mohair of different colours and production of its processing was studied. Yarns from Takli village, Tajikistan, conquered good reputation in Wisconsin, USA, and are receiving good orders from customers there. The women involved in these activities were provided with spinning machine tools manufactured in New Zealand.

Range and forage productivity

New forage crop species were introduced in irrigated lands of Northern Tajikistan and Kyrgyzstan to improve the availability of forages for livestock production. Pearl millet crop can be looked at as another crop to diversify the crop base on a farm in Northern Tajikistan and Kyrgyzstan. Although their profit is not dramatically different from other agricultural crops, their drought tolerance, and the fact they are feed crop rather than a food crop, can help buffer a farmer's economic risk from variability in weather or commodity crop prices.

The research on forage crop management practices such as alfalfa fertilization, maize seeding rates was initiated in Akdala, Kazakhstan and in Dusti, Tajikistan, in order to improve forage production and reduce the cost of cultivation. It should be mentioned that there was

considerable variation between farmers. The results of cost benefit analysis showed that there is significant effect nitrogen fertilization in alfalfa first harvest year.

An experiment was conducted in Tajikistan and Kyrgyzstan where two sites were selected per country to examine the influence of geo-morphological landscape patterns on vegetation characteristics across central Asia in the context of environmental and management factors to improve the understanding of plant community dynamics. From the results, it can be inferred that site, season and aspects have significant impact on the specie composition, cover, and biomass production (PO.001).

Low-quality cereal crop residues, especially rice straw, are important feed resources in the smallholder crop-livestock systems. A feeding experiment was conducted in Kyrgyzstan (January-February) and Tajikistan, Khujand (April-May) over a period of two months to compare the feeding of chopped and unchopped types of coarse fodder. The experiment showed that the quantity of residues after feeding was reduced through chopping with the exception of sainfoin hay which was consumed equally well in both forms

Improvement of livestock productivity

Vaccines and veterinary medicines against widespread diseases were provided to farmers. Additional feeding was organized in the improved farms and an optimal ratio of available forage was proposed. Simplified systems of the individual estimation (grading) of goats and flock circulation were developed and introduced among farmers in Khujand, Tajikistan. Testing of impact of early weaning on performance of lambs and on milk production of ewes is finished. Early weaned lambs were fattened in the Nagul system with strategic supplementation and compared with lambs raised in the traditional system. Training of farmers on the technology of the early lambing was held on the sums of carried out studies. Product diversification options in sheep production were developed in Shymkent site and include Brynza (a brined white sheep's-milk cheese) preparation technology; Kurut (hard dried balls of fermented milk or milk curds) and dried fruits preparation technology; Chechil (dried ‘brynza’ (low-fat) cheese) preparation technology; homemade sausage preparation technology. Training of farmers was conducted on milk processing and preparation of homemade sausages.

SOCIOECONOMIC AND POLICY RESEARCH

A joint project between IFPRI, ICARDA and the national programs of the five Central Asian countries on “Economic Analysis of Sustainable Land Management Options in Central Asia” was completed in 2009. The project assessed the economic feasibility and profitability of land management options in major agro-ecological and socioeconomic contexts of Central Asia.

The project made the following conclusions:

Giver that the social profitability is likely greater than private profitability for most of the SLM technologies considered, there is a strong economic case for promoting such technologies where they are privately profitable, and even in some cases where they are not privately profitable but are socially profitable. Conservation tillage has been adopted in large

areas of northern Kazakhstan and in some irrigated cotton-wheat areas, but adoption is still much less than the potential. Many farmers may still be unaware of this technology and its potential impacts, or may fear the risk of lower returns. Addressing this will require continued and increased investment in on farm research trials and demonstrations, and synthesis of the information collected to better characterize the contexts in which minimum tillage is most likely to be profitable. A similar conclusion applies for other commonly used though not fully adopted land management practices such as fertilizer and manure.

For some technologies, other constraints besides lack of awareness of the technology or lack of knowledge about its likely impacts in particular contexts are also relevant. This includes lack of availability of raised bed planters, lack of local availability and high costs of transporting materials such as phosphogypsum, availability of seedlings of trees to plant in rangeland areas, and policy and institutional constraints that inhibit use of more water efficient crops or grazing in remote areas. Such constraints also may exist for options that are socially profitable but not privately profitable, although they are less immediately binding in this case. For example, water efficient technologies may not be adopted as long as the price for water use is very low. In such cases, the first priority is to identify whether the option is indeed socially profitable, and if so, to assess alternative means to promote adoption of the option, such as use of increased charges for water, subsidies for adoption of more efficient measures, or regulatory requirements to use such measures. Such an assessment should consider the informational and other capacity limitations of the government to implement alternative approaches, as well as the potential efficiency, distributional and environmental impacts.

For options that are neither privately or socially profitable, there is no case to support them on economic efficiency grounds. Fertilizer use in some contexts may be an example. In such circumstances, the best policy (from an economic efficiency and environmental standpoint) is not to promote such technologies, including reducing subsidies for their use.

Considering the large variations in private and social profitability of land and water management technologies across the diverse contexts of Central Asia, it may be that a given technology is privately and socially profitable in some contexts but unprofitable in other contexts. Hence, the appropriate response will be context dependent. "One size fits all" approaches to technology dissemination and promotion should be avoided. Rather, an adequate understanding of the likely costs and benefits of technologies in local contexts, informed by applied research as well as farmers' own knowledge about what works where, is needed to guide the development, dissemination and promotion of sustainable land and water management technologies.

Based on these conclusions, the project made several recommendations for CACILM – Central Asian Countries Initiative for Land Management.

In December 2009, ICARDA together with NARS partners launched a new multi-disciplinary project titled "Impact of Climate Change on rural livelihood in Central Asia". The aim of the project is to assess the impact of climate change on wheat production and productivity and thus the vulnerability of some major agro-ecosystems and the people living therein. The project has three subcomponents: biophysical assessment, GIS addressing the regional downscaling of global circulations models that predict the impact of climate change, and the socio-economic assessment of rural livelihood as affected by climate change.

The study will be carried out in a joint effort of scientists from the four countries (Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan) and ICARDA on the basis of integration of research work done previously at ICARDA with that in regional/country programs.

Under the economic component, currently surveys have been launched in the project countries to gather data on the farmers' production practices and their perceptions of climate change and their adaptation behavior.

In the frame of the Bioversity International project *Reviving biocultural heritage: Strengthening the socioeconomic and cultural basis of agrobiodiversity management for development in Kyrgyzstan and Tajikistan* research activity on *Linking fruit diversity to markets through culture* was initiated in collaboration with and co-funding from the Swiss College of Agriculture (SHL), the Mountain Societies Development and Support Programme (MSDSP) of the Aga Khan Foundation and the Jalalabat RAS. The main question addressed during this study is how the value of local fruit tree diversity could be enhanced through market commercialization, but in a way that strengthens local culture and agriculture of Kyrgyzstan and the Tajik Pamirs. A questionnaire for understanding the market chain of local *agrobiodiversity products* and assessing the potential for their commercialization was developed by Twenty interested farmers (10 in each country) from various communities were trained in administering the questionnaires and asked to conduct interviews in their villages with an assistance of project scientists. 147 questionnaires were gathered in this manner. The collected information was translated and is currently being cleaned and analyzed; preliminary research findings based on the workshops and field visits are discussed and presented at the international conference in Switzerland. Among concrete outcome of the work on linking markets, culture, and local agrobiodiversity has been the establishment of the Slow Food *presidium for mulberry products* in December 2009.

Within Bioversity International/UNEP-GEF project *In situ/on farm Conservation and Use of Agricultural Biodiversity (Horticultural Crops and Wild Fruit Species) in Central Asi*a in Kazakhstan proposals on amendments and additions to existing national laws "Land Code" (2003), "About peasant (farmer) farms" (1998) are prepared and focused on assignment of the land use rights along with selling or donation of farm's property to purchaser of the property and broadening rights and responsibilities of the head and members of the farmer's household. New regulations on providing subsidies for establishment of new orchards and their management are adopted by the Government of Kazakhstan. In Kyrgyzstan national project team is developing proposals on amendments in national laws on "About local self-government and administration" and "About farms" aimed on increasing responsibility of local authorities for violation of farmers' rights. Proposed amendments will be targeted on encouraging farmers to establish associations and protection of their rights, providing support to farmers dealing with fruit crops. In Turkmenistan concept laws "National legislative mechanisms to support farmers and local communities in conservation *in situ* of local fruit crops diversity" is drafted by the national project team. In Tajikistan proposals on amendments to the national law "About farms" are prepared and submitted to the Low Chamber of the Parliament of Tajikistan. The national project team is participating in the development of national law "About breeding achievements" which are aimed on supporting farmers and scientists in their work on sustainable agriculture development and protection of their rights on genetic resources. In Uzbekistan national partners are developing national law "About Conservation of Genetic Resources of Crops and their Wild Relatives" which will

include issues on sustainable management of fruit crops genetic resources along of germplasm of other crops.

Analysis of existing national legislation on Farmers' Rights is completed in all five countries following the guidelines/ recommendations provided by Bioversity International and national consultants presented their reports on the analysis outputs at the Regional Workshop on Farmers' Rights (21-24 April, 2009, Tashkent, Uzbekistan) organized with participation of Bioversity's expert on Legal Aspects. The Regional Workshop on "Access and Benefit Sharing (ABS)" (23-25 March, 2010, Tashkent, Uzbekistan) overviewed status of work on development of proposals in countries for improving national legislation for supporting in situ and on farm conservation and farmer's rights, access and sharing benefits, produced within the project.

CAPACITY BUILDING

The Program has been actively working on capacity building of NARS, students, farmers and national staff since its establishment in the region. Several trainings, workshops and filed days were organized during the reporting period. ICARDA-CAC organized training courses in wheat genetics and breeding in 2010 where more than 25 young researchers from Uzbekistan participated. ICARDA-CAC also organized a wheat breeders' travelling seminar in on 14-15 May 2010 in which wheat breeders from different institutes in Uzbekistan, Tajikistan and Kazakhstan and experts from IWWIP turkey participated. The researchers got an opportunity to learn from the experienced wheat breeders during these events. Several wheat pathologists and breeders from the CAC region participated in the 4th Regional Yellow Rust Conference in Antalya on 9-12 October 2009. Wheat researchers from the region shared their research findings with others and learned from the experiences shared by wheat pathologists and breeders from other region. ICARDA organized several training courses in its Headquarter in Syria which trained several young researchers from the CAC region. The International Winter Wheat Program has organized a 4-month (April – July 2010) training course in wheat improvement in Turkey where three young wheat breeders from Central Asia are participating.

In Kazakhstan 2 Farmers' Associations growing fruit crops were established in Bayseit village of Enbekshikazah district and in village Karatalsk of Eskeldin district in Almaty region. In Tajikistan two Farmers' Association growing fruit crops is established in Istravshan District, Sughd Province and Rasht District in Central Tajikistan. Arrangements are made to establish Farmers' Association in Gorno-Badakhan Autonomous Province and in Khotlon Province. In Uzbekistan, local representatives of national Farmers' Association are participating in the project activities implementation in the project sites and discussions and meetings of the project team with farmers.

During 2009 a number of Kazakhstan agricultural scientists and specialists, CIMMYT-Kazakhstan staff members visited leading world research and educational centers and organizations for technical backstopping of their respective research programs as well as to participate in various meetings, workshops, symposiums, and training programs abroad. In 2009 more than 20 people visited CIMMYT-Kazakhstan offices in Astana and Almaty within the framework of international cooperation programs and projects (visiting scientists and

specialists from CIMMYT, FAO, Washington State University, Australia, USA, Italy, Russia, Central Asia and Caucasus countries, etc.).

Farmers' Field Days were conducted by AVRDC-CAC office in eight countries of Central Asia and the Caucasus, including Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan in 2009 to demonstrate promising and released varieties of vegetable crops and strengthening collaboration with farmers on introduction into vegetable production of achievements and increasing of seed multiplication. More than 250 people participated of these field days. Among participants were representatives from state parliament, ministers, scientists, farmers, processing firms' representatives and businessmen. These events had a wide evaluation by governmental channels of radio and TV, journals and magazines.

During two last years, AVRDC-CAC office has been paying more attention to vegetables nutritional value for a diet diversification and human health, especially of non-traditional crops (vegetable soybean, leafy cabbage, daikon and etc.) and a number recipes were elaborated and disseminated. In 2010 new initiative was organized by AVRDC on establishment of school garden in two schools in Tashkent region with the purpose of teaching pupils to nutrient and value of vegetable crops and introduction into a school food of nutrient vegetables to improve a diet.

Two field days to discuss the benefits of oversowing and application of nitrogen were planned by ICARDA livestock project for participating households and pilot farms in Kemin and Chuy district in April and June 2009: (1) "Rational use of communal pastures in the Northern part of Kyrgyzstan" with 42 participants including members of Akbeket community, pilot farmers and neighbor farmers. Second field day on theme "New technological options to improve hay field productivity and to increase farmers' income" was conducted on 2 June 2009. More than 60 people took part at the field day. Another field day course was organized from 24-25 July 2009 in Dushanbe to discuss double cropping system in the project demonstration site. In first day, principal investigator on forage production made presentations on the base of obtained results of double cropping system. The second day of the training course was devoted to practical courses in mung bean crop management. A total of 52 participants attended.

Besides, in Kazakhstan products of 12 local varieties of apple and pear were demonstrated at the Famers' Fair in Talgar village, Almaty Province organized for participants of the principal workshop of farmers on January 30, 2009. In Tajikistan the national project team jointly with the Ministry of Agriculture of Tajikistan, National farmers Association, Tajik Agrarian University and Tajik Research Institute of Fruit and Vegetable Crops organized Farmers Fair of fruit Crops saplings in Khudjand, Sughd Province (February 28, 2009), Dushanbe (March 2, 2009) and Bohtar district, Khotlon Province (June 7, 2009) where 80 farmers from different parts of the country were able to exchange planting material of 50 local varieties and forms of fruit crops.

Farmer Field Day "Rational Use of Lands in Agrarian Sector and Ways of Improvement of its biological and soil productivity", 18 June, 2009, Gulistan State University, Uzbekistan.

A Farmers' Filed Day was conducted by ICBA on 19th August, 2009 in Asht district, northern Tajikistan, where achievements and future plans for up-scaling of biosaline agroforestry production on marginal farmer abandoned lands were analyzed.

Within the framework of the ICARDA's multi-disciplinary project "Impact of Climate Change on rural livelihood in Central Asia", a training course on crop-soil simulation using CropSyst model with participation of NARS partners involved in the project, from 4 CA countries (Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan) was conducted in Tashkent on 7-11 December 2009. In total, 13 scientists attended the training, including 2 from ICARDA-CAC.

Mr. Batyrbek Tajamatov postgraduate student from partner Kyrgyz Agrarian University trained on individual training on "Breeding and Seed Production" conducted by AVRDC-CAC office in Tashkent in 13-18 July, 2009. This training already has been allowed him to conduct series crossing of tomato varieties in summer 2009 to receive hybrids for further research work.

To allowance of a necessity of English language knowledge AVRDC-CAC office has been arranged the pecuniary aid to ten young specialists working on vegetable research to study on English courses (in eight home countries) from December 2009.

One young scientist from Uzbekistan was trained at Julius Kuhn Institute, Rostock, Germany, in screening of potato genotypes for drought tolerance, during 2-11 June. Other two scientists, from Tajikistan and Uzbekistan, received training in potato hybridization at the Central Potato Research Institute, Shimla, India, during 1-15 July. Capacity building activities continued with the local NGO "Tukhmiparvar", in Tajikistan. NGO's staff received training in potato selection and multiplication under disease-free conditions. In Uzbekistan, capacity building focused on a feasibility study for the establishment of a private seed potato enterprise. In Georgia, an agreement was signed between CIP and Agro-Cartu, a private seed potato enterprise for assistance in potato micropropagation and further disease-free seed multiplication under screenhouse and field conditions.

Biophysical sub-component of the project "Impact of Climate Change on rural livelihood in Central Asia" entitled "Assess the vulnerability of selected agro-ecosystems in Central Asia to threats resulting from climate change – production and productivity of winter-wheat" was introduced on the Final Sustainable Land Management Research Project workshop (4-5 August 2009, Tashkent). The stakeholders in Central Asia were informed about the study objectives, anticipated outcomes and planned activities.

The "Review and Planning Meeting in Vegetable Variety Selection and Adoption in Central Asia and the Caucasus" held in 7 – 9 December 2009 in Tashkent, Uzbekistan. Over 42 participants from Central Asia and the Caucasus, including Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan, AVRDC-The World Vegetable Center and PFU-CAC participated on this workshop. The status, achieved results, current constrains and perspectives of regional varietal trials in CAC region and ways for further collaboration were discussed during this meeting.

The Third Steering Committee Meeting on Central Asia and the Caucasus Vegetable Research and Development Network held in Tashkent, Uzbekistan in 10 – 11 December 2009.

Total 30 participants, including the national coordinators on R&D and specialists of eight CAC countries (Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan), AVRDC – The World Vegetable Center and PFU – CAC participated on this meeting. Collaborative discussion was focused on existing activity, a status and problems and to find ways of the further strengthening of capacity of NARS and vegetable R&D and developing appropriate policy options that are critical for crop diversification, micronutrient security, off-season production, distribution channels, post-harvest technologies and market economy in CAC region. It was resolved to pay an emphasis on strengthening of collaboration with other international networks.

The Final Regional Workshop for the IFAD funded Project "Community Action in Integrated and Market Oriented Feed-Livestock Production in Central and South Asia", which will be held in Chimkent, Kazakhstan, 10-11 December 2009. The final regional workshop on was highlighted and reviewed the most important technical results generated in the project. In this Final Regional Workshop thirty one specialists from IFAD, ICARDA, and NARS partners participated.

Bioversity International carried out various training sessions at regional and national levels for policy makers, researchers and conservation officers, extension workers, educators and local communities. Six Regional Training Workshops on Capacity Building, on Farmers Rights and on DIVA-GIS Application for Management of Plant Genetic Resources, on Harvesting, Drying and Processing of Apricot Fruits, on Walnut Distribution and Diversity Level Assessment and on Application of Molecular Markers in Diversity Assessment of Plant Genetic Resources were organized in 2009. And three Regional Training Workshops on Linking Information from Focus Group Discussion, Household Surveys, and Farm and Forest Assessment, on Access and Benefit Sharing and on Capacity Building were organized from January to April, 2010. During these training workshops 12 farmers from Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan gained knowledge and improved skills in assessment of diversity level of target fruit crops, establishment of orchards of target fruits, agronomy practices, processing technologies, conducting household survey and market research, development of public awareness materials. In Kazakhstan 63 farmers improved their skills in establishment of nurseries for multiplication of planting material of fruit crops, mother orchards for rootstocks, agronomy practices, correct packaging and storage of rootstock material, technology of fruit crops cultivation, pruning and cutting fruit trees and grapevine for increase of their productivity, pre-sowing preparation of seeds of fruit crops, duration of seed stratification for stone fruit crops at training workshops, organized in Saryagash District of South-Kazakhstan Province (March 17-18, 2009) and Merke District of Jambyl Province (18-20 March 2009). In Turkmenistan three training workshops were organized for 29 farmers on selection of sites for establishment of orchards, fruit trees pruning and cutting technologies and establishment of nurseries in Ahal Province (15-24 February, 2009), Dashgovuz Province (22-27 March 2009) and Mary Province (4-7 March 2009). In Tajikistan 45 farmers were trained on drying and processing technologies of apricot fruits at the national training workshop organized on May 22, 2009 in Khuroson District, Khotlon Province.

ICBA Workshop 30 May, 2009 on "Marginal Quality Water Utilization in Agriculture with Special Reference to Central Asia" organized in collaboration with Islamic Development Bank and Ministry of Agriculture of Turkmenistan, Ashgabat, Turkmenistan

A total 7 students participated in the IFAD-livestock project conducted by ICARDA for the period 2007-2009. One PhD thesis on Awassi sheep that had been started before the initiation of project was completed and successfully defended in 2008 (Title of the thesis: "The effectiveness of the crossing of local coarse wool ewes with the rams of the Awassi breed and the characteristic of their crossbreeds" by Abdymajitov Nurzhan Keneshevich).

The project component on IPM outreach and education focused on both academic and non-academic stakeholders through student field schools (SFS) and farmers field schools (FFS) in collaboration with NGOs government institutes and local universities in Tajikistan and Kyrgyzstan. To enhance university education, an inventory of IPM educational programs in Central Asian Universities was conducted. These IPM programs were used to design course programs for SFS and also for publishing new IPM materials (books, booklets, extension bulletins, etc.).

Two postgraduate students are continuing research on tomato and broccoli in Armenia and three postgraduate students and one postdoc are continuing research on AVRDC' germplasm, including vegetable soybean, hot pepper, long yard bean and leafy cabbage in Uzbekistan. Approval of their thesis titles by Scientific Councils in countries emphasizes the efficiency of the research facilitated by AVRDC's CAC Program.

Five Regional and National Training Centers, serving as Centers of Excellence to provide training to instructors and facilitators are established in each country of the region and Regional Training Center on Socio-Economic Aspects at the Kazakh Research Institute of Economy, Agro-Industrial Complex and Rural Area Development; Regional Training Center on Walnut at the Kyrgyz Research Institute of Forestry; Regional Training Center on Apricot at Sughd Branch of Tajik Research Institute of Fruit and Vegetable Crops, Regional Training Center on Pomegranate at Turkmenistan Experimental Station of Plant Genetic Resources in Garrygala; Regional Training Center on Molecular Markers at Uzbek Institute of Genetics and Experimental Biology of Plants are fully equipped and functional. Eight National Training Centers on Priority Fruit and Nut Bearing Crops are established in all five countries of Central Asia to provide trainings to national researchers and farmers.

During 2009-2010 there was third regional forum in Kyrgyzstan held where over 50 stakeholders attended by Bioversity International. The project team published more than 10 articles and extension bulletins, and gave more than 6 presentations at regional, national and international scientific meetings, workshops and forums. Through various training programs, 50 farmers were trained in IPM through farmer field schools in Tajikistan, Kyrgyzstan and Uzbekistan. In Addition, 6 students (50% women) were trained in IPM through a first ever student field school established by the project in collaboration with a local university.

ICARDA organized a training course "Integrated Pest Management – Safe Use of Pesticides" from 7 to 12 June 2010 in Tashkent, Uzbekistan, which had 14 participants from the CAC region. The training was provided by the subject matter specialists from Crop Life International and ICARDA. This training course provided an opportunity to the participants to learn from the experts the principles and practices of IPM and safe use of pesticides.

AWARDS AND RECOGNITIONS

During the Technical Cooperation among Developing Countries (TCDC) Session of the International Conference on Horticulture (ICH-2009) in Bangalore, India in November 09-12, 2009, Dr. Ravza Mavlyanova (AVRDC-CAC) was selected as the member of the Executive Council of the International Network on Vegetables (VEGINET).

INFORMATION DISSEMINATION

Much attention was paid to the dissemination of research findings. Information dissemination was conducted during a year through Farmers' Days, exhibitions, presentation, interviews, news letters and posters, leaflets and data base. A number of publications were published in 2009 (see the section on publications below).

Three promising varieties (mungbean variety Durdona, vegetable soybean Parvoz and long yard bean Oltin soch) were selected by the State Scientific Comity to present on the State Innovation Ideas Fair in EXPOCENTER of Uzbekistan in April 2009.

New for Central Asia a tomato grafting methodology was presented on EXPOCENTER of Uzbekistan in March 1-3, 2010.

Recipes on non-traditional crops were elaborated by AVRDC-CAC office with partners in 2009, including vegetable soybean -5, pack-choi – 20 and daikon – 16 recipes for popularization and healthy diet for further publications and distributions among a population).

4 volumes of "Agromeridian" journal were issued in 2009. The hard copies (1000) were distributed among the farmers, higher agriculture establishment teachers, the project agents, MOA representatives and other agriculture specialists for advertising and reading in different oblasts and cities of Kazakhstan. The final research and financial report on the "Agromeridian" journal publishing was prepared and submitted to the MOA-World Bank Project authorities. The brief version of the journal was maintained on the pages of the website (www.agromeridian.kz).

Proceedings of the International Consultation on Conservation Agriculture held in Astana-Shortandy on July 8-10, 2009, namely "*No-Till with Soil Cover & Crop Rotation: A Basis for Policy Support to Conservation Agriculture for Sustainable Production Intensification"* of 350 pages with edition of 500 copies were published in June towards the conference.

A number of publications were published jointly with AVRDC partners in 2009-2010, including articles, number booklets and posters on AVRDC activities in CAC, "Vegetable soybean Parvoz", "Mung bean Durdona", "Leafy cabbage", "Daikon" and "Dishes from non-traditional crops" in order to distribute achieved results.

The annual KASIB and KSBN data bulletin (169 pages) was published and distributed to KASIB Network members. At present all members of KASIB network have provided the grain harvested in 2009 from 10th KASIB for quality analysis of grain, along with yields and other data obtained during the current year research.

Series of publications of Sustainable Agricultural Development in Central Asia and the Caucasus were published and are available at www.icarda.org/cac.

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