ICARDA International Center for Agricultural Research in the Dry Areas

CGIAR in Uzbekistan

Ties that Bind

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Headquarters
International Center for Agricultural Research in the Dry Areas (ICARDA)
PO Box 5466, Aleppo, Syria
Tel: (+963) (21) 2213433, 2213477, 2225112, 2225012
Fax: (+963) (21) 2213490, 2225105, 5744622
E-mail: icarda@cgiar.org
Website: www.icarda.org

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ACRONYMS

ADB	Asian Development Bank
ARIGLCI	Andijan research Institute of Grain and Legume Crops under Irrigation
AVRDC	World Vegetable Centre (Asian Vegetable Research and Development Centre)
BISA	Basin Irrigation System Administration
BMZ	The Federal Ministry for Economic Cooperation and Development (Germany)
CA	Conservation Agriculture
CAC	Central Asia and the Caucasus
CAPRI	The CGIAR System wide Program on Collective Action and Property Rights (CAPRi) is one of several intercenter initiatives of the CGIAR.
CATCN-PRG	Central Asian and Transcaucasia Network on Plant Genetic Resources
CGIAR	Consultative Group on International Agricultural Research
CIMMYT	International Maize and Wheat Improvement Centre
CIP	International Potato Centre
CRP	Collaborative Research Program
CRSP	Cooperative Research Support Programme
CWR	Crop Wild Relatives
FAO	Food and Agriculture Organization of United Nations
FAO-TCP	FAO-Turkey Cooperation Program
GBURIGLCI	Galla-Aral Branch of Uzbek Research Institute of Grain and Legume Crops under Irrigation
GEF	Global Environment Facility
GTZ	Agency for International Cooperation (Germany)
ICARDA	International Centre for Agricultural Research in Dry Areas
ICBA	International Centre for Biosaline Agriculture
ICRISAT	International Crops Research Institute for Semi-Arid Tropics
IDB	Islamic Development Bank
IFPRI	International Food Policy Research Institute
ILRI	International Livestock Research Institute
IWMI	International Water Management Institute

IWRM	Integrated Water Resources Management
IWRM-FV	The Integrated Water Resources Management in the Fergana Valley
IWWIP	International Winter Wheat Improvement Program
KRIGBSP	Kashkadarya Research Institute of Grain Breeding and Seed Production
LTVR	Lowlands sub-Tropic Virus Resistant
MAWR	Ministry of Agriculture and Water Resources
MSU	Michigan State University
NARS	National Agricultural Research System
NGO	Non-Government Organizations
NUU	National University of Uzbekistan
PFU	Program Facilitation Unit
SANIIRI	Central Asian Scientific Research Institute of Irrigation
SDC	Swiss Agency for Development and Cooperation
SIC-ICWC	Scientific Information Centre of Interstate Commission for Water Coordination in Central Asia
SNC-UZB	Second National Communication of the Republic of Uzbekistan under the UN Framework Convention on Climate Change
SVTC	State Variety Testing Commission
TPS	True Potato Seed
TSAU	Tashkent State Agrarian University
UCD	University of California-Davis
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UPOV	The International Union for the Protection of New Varieties of Plants
USAID	United States Agency for International Development
UzRIPI	Uzbek Research Institute for Plant Industry
UzRIVMCP	Uzbek Research Institute of Vegetables, Melon Crops and Potato
UzSPCA	Uzbek Scientific Production Centre for Agriculture
WPL-PL	Water Productivity Improvement at Plot Level
WUA	Water Users Association
WUG	Water Users Group

FOREWORD

The CGIAR Eco-Regional Collaborative Research Program for Sustainable Agricultural Development in Central Asia and the Caucasus has been actively present in the Region since 1998. It currently involves eight Centers - CIMMYT, CIP, ICARDA, ICRISAT, IFPRI, ILRI, Bioversity International, IWMI, and three other advanced research institutions - AVRDC, ICBA and MSU. The Program has supported and promoted research collaboration among the eight National Agricultural Research Systems of Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan.

The policy makers, who recognized the value of the collaborative research, met with the Centers and donor representatives in June 2001 in *Issyk-Kul*, Kyrgyzstan to adopt the Issyk-Kul Declaration which called upon key partners to play a proactive role in building the agricultural research system in the region

The goal of the Program is to achieve increased productivity through generation and transfer sustainable agricultural production technologies, while ensuring protection of natural resources.

There have been extensive consultations between CG Centers and the NARS to identify and prioritize thematic research areas. With the seed money provided by the CGIAR and additional funds raised by the participating centers, the program has made considerable impact in the Region. Particularly in Uzbekistan, key achievements were made in genetic resource conservation, germplasm enhancement and crop diversification, efficient soil and water management, socio-economic research and capacity building.

The CGIAR recently launched its new strategic framework with global Research Programs defining its agenda in the key thematic areas. The CGIAR Research Program 1.1 “Dryland Systems” already identified five pilot sites in the CAC Region, and two of them will be located in Uzbekistan. I am convinced that this new major initiative will further strengthen our fruitful collaboration in the future.

We are grateful to the Government of Uzbekistan for hosting the Centers and their staff through the Regional Office of ICARDA for CAC. Without the generous support of the host country, it would have been impossible to successfully implement the collaborative activities in the Region.
This brochure highlights the various activities undertaken by the Program together with our partners in Uzbekistan during the last 13 years.

Dr. Mahmoud Solh,
Chair of the CGIAR Collaborative Research Program for Central Asia and Caucasus, DG - ICARDA

Agrarian science of Uzbekistan has participated in a Collaborative Program on Sustainable Agricultural Development in Central Asia and the Caucasus (CAC) since September 1998. Under the auspices of Steering Committee Program, scientists of Uzbekistan are able to meet each year with their colleagues from Central Asia and the Caucasus to exchange the results of scientific activities and experience, summarize results of joint reach and develop future plans.

At present time, CAC region scientists, in collaboration with eight International Centers of Consultative Group and three leading institutes - participate in this Collaborative Program.

A wide range of the most important research activities were carried out based on priority directions of agricultural research and gave positive results. New technologies have been developed and adopted, new varieties of wheat, chickpea, lentil, groundnut, potato, vegetable and other crops have been released.

This publication illustrates the results of collaborative efforts of Uzbek agricultural scientists with scientists from International Centers for the last 13 years. I have no doubt that our collaboration in future will only get strengthened.

Taking this opportunity, I would like to congratulate all the scientists involved in the Collaborative Program, readers of the given publication and all Uzbek people with the 20th anniversary of the independence of Uzbekistan and wish happiness, prosperity and every success in our activities for the sake of our people.

Dr. Sherali Nurmatov,
Deputy Minister of Agriculture and Water Resources,
Director General of Uzbek Scientific Production Center for Agriculture

STRENGTHENING OF THE UZBEKISTAN - CGIAR PARTNERSHIP

A well-established partnership between the Centers and NARS in the framework of the Regional Program has been a key factor for the Program's success achieved in a very short time. Uzbekistan plays a very significant role in the partnership, given the history of agricultural research. Several research and educational institutions based in Tashkent served as regional hubs for all Central Asia during the Soviet period of history. The CGIAR Program Facilitation Unit (PFU) has been located in Tashkent since 1998 under the hosting arrangement between ICARDA and the Government of Uzbekistan. The Unit employs experienced and qualified international and national staff, many of which are citizens of Uzbekistan. The PFU has provided valuable connections and effective communications among stakeholders and beneficiaries. It is responsible for facilitating the work of the Centers and research partners in the region to ensure effective delivery of the Program outcomes.

Dr. Mahmoud Solh, CGIAR CAC Program Chair, Director General, ICARDA (left) and Mr. Elyor Ganiev, Minister of Foreign Affairs of Uzbekistan (right)

Today, the Program and its members have established strong partnerships with all key national research institutions in Uzbekistan, which have been at the forefront of the on-going agricultural reforms taking place in Uzbekistan during the last decade. The major partner of the Centers in Uzbekistan is the Ministry of Agriculture and Water Resources, the Uzbek Scientific Production Center for Agriculture (UzSPCA) under the Ministry of Agriculture and Water Resources, with Dr. Sherali Nurmatov, Deputy Minister of Agriculture and Water Resources, Director General, UzSPCA, as the CGIAR National Coordinator. A number of important research projects were completed by the Centers with the support of UzSPCA and other partners in Uzbekistan.

The outcomes and results of those projects have contributed to the overall goal of strengthening national food security and increasing the productivity of agricultural systems. Therefore, there is no doubt that sustaining effective

partnerships with NARS in Uzbekistan will continue making valuable inputs to the development of the national economy as a whole, and of agricultural sector in particular.

The results of joint collaboration in the area of enhancing the wheat production system in Uzbekistan was presented to His Excellency Mr. Islam Karimov, President of the Republic of Uzbekistan, during his working visit to Kashkadarya Research Institute of Grain Breeding and Seed Production in June 2011. Being a part of UzSPCA, this Institute has been of a major focus for joint activities in Uzbekistan in introducing modern technologies and innovations in effective breeding of grain crops for the benefit of local farmers and rural population.

Many students graduate from Uzbekistan's colleges and universities every year. This young, educated and dynamic generation provides a great potential to contribute to agricultural research for development in Uzbekistan, in the region and internationally. One of the key challenges in making impact is efficient delivery of the knowledge and technologies generated by research to the farmers' fields. The Program collaborates with national policy makers and others stakeholders in their efforts to build a strong extension service reaching farmers in future.

This publication highlights the achievements of a joint collaborative research program for sustainable agriculture between CGIAR and Uzbekistan during the past ten years.

AGRICULTURAL RESEARCH COLLABORATION IN UZBEKISTAN

1. PRODUCTIVITY OF AGRICULTURAL SYSTEMS

1.1. GERMPLASM ENHANCEMENT

Wheat, Barley and Food Legumes

One of the primary tasks of the CGIAR in the Region has been crop improvement. This is done through introducing advanced germplasm materials and conducting collaborative research activities with national partners in Uzbekistan in the area of germplasm enhancement. Collaboration with ICARDA and CIMMYT in crop improvement includes:

- introduction of improved germplasm of bread wheat
- testing and selection of new varieties jointly with Uzbek scientists
- seed multiplication of improved varieties
- training of young scientists
- development of research infra-structure.

Similar collaborative activities are carried out between Uzbekistan and ICARDA in other crops including durum wheat, barley, chickpea, lentil, faba bean and grass pea. These collaborative activities in crop improvement in Uzbekistan are undertaken primarily in partnership with the research institutes of Uzbek Scientific Production Center for Agriculture (Kashkadarya Research Institute of Grain Breeding and Seed Production, Uzbek Research Institute of Plant Industry, Andijan Research Institute and its Galla-Aral Branch) and Tashkent State Agrarian University.

Kashakadarya, Uzbekistan: Wheat breeders discussing crop improvement activities.

Through these international efforts, more than 2000 improved crop germplasm accessions have been provided to Uzbekistan every year, which are initially tested in plant quarantine facilities and later distributed to extensive field testing by different research institutions.

(Kashkadarya Research Institute of Grain Breeding and Seed Production, Uzbek Research Institute of Plant Industry, Andijan Research Institute and its Galla-Aral Branch)

This collaboration involving Uzbek Scientific Production Center for Agriculture, ICARDA and CIMMYT has resulted in identification of new varieties of winter wheat. Under such collaboration, Galla-Aral Branch of Andijan Research Institute released a salt tolerant wheat variety “Dustlik” in 2005 which is grown mainly on saline soils of Syr Darya region. “Dustlik” is also moderately resistant to yellow rust and performs well under heat stress.

Area planted under “Dustlik” is increasing every year and expected to reach more than 50,000 hectares in 2011-2012. In 2010 Kashkadarya Research Institute of Grain Breeding and Seed Production and ICARDA submitted three wheat varieties (“Hazrati Bashir”, “Elomon” and “Gozgon”) to the State Variety Testing Commission. These varieties developed by International Winter Wheat Improvement Program (IWWIP), a joint program involving CIMMYT, ICARDA and Ministry of Agriculture of the Government of Turkey, were tested in Uzbekistan for three years for their performance. These three early maturing wheat varieties are resistant to yellow rust and possess high yield potential and superior agronomic traits. These varieties are expected to replace several yellow rust susceptible varieties currently being grown in Uzbekistan, and thus help to reduce economic losses for the farmers. Moreover, two varieties of triticale (“Norman” and “Farhad”) were released in Uzbekistan in collaboration with CIMMYT and ICARDA.

In partnership Cereals and legumes

In partnership with ICARDA, two varieties of chickpea (“Djahangir” and “Zumrad”) and two varieties of lentil (“Dormon” and “Oltin Don”) were released in Uzbekistan in 2008. Another chickpea variety “Malhotra” is in the final stage of release in Uzbekistan. The partners in Uzbekistan and ICARDA are working together on seed multiplication and promotion of these varieties of food legumes.

In 2010, IWWIP, ICARDA and CIMMYT initiated a field testing of winter/ facultative wheat germplasm in Uzbekistan as a sub-regional activity on identification of varieties adapted to the specific environmental conditions in CAC region. This partnership program is being implemented jointly with the Uzbek Scientific Production Center at Kashkadarya Research Institute of Grain Breeding and Seed Production and Uzbek Research Institute of Plant Industry. Under this collaboration, multi-location agro-ecological trials were conducted in 2010 at four sites (Karshi, Kibray, Namangan and Khorezm). Beginning from 2011, this national agro-ecological trial is being conducted in five locations (Karshi, Galla-Aral, Kibray, Namangan and Khorezm). Additionally, 195 segregating populations of winter wheat were evaluated in 2011 to select and develop varieties which could be more adapted to the CAC region.

In 2010, a BMZ/GTZ funded project was launched aimed at developing salt tolerant winter wheat varieties with good crop capacity and improved quality in Uzbekistan, Kazakhstan and Turkmenistan. This three-year project is being implemented in Kashkadarya and Khorezm regions of Uzbekistan. The overall goal of the project is to improve salinity tolerance and end-use quality of wheat in Central Asia by delivering elite germplasm with improved features. These will accelerate the delivery of new wheat cultivars for farmers' use. Salinity tolerant winter wheat germplasm will be developed by ICARDA and tested in Uzbekistan to identify new varieties. Around 800 winter/facultative germplasm have been tested in Uzbekistan in 2011 and many superior genotypes have been selected for further evaluation to identify salt-tolerant wheat varieties.

Cereal varieties released in Uzbekistan

#	Crop	Variety name	Involved CG Center	Released year	Institute-originator	Traits
1	Wheat	Dustlik	ICARDA, CIMMYT	2005	Gallaaral Branch of ARIGLCI	salt tolerant; moderately resistant to yellow rust; performs well under heat stress
2	Chickpea	Djahangir	ICARDA	2008	GBURIGLCI	high yielding; disease resistant
3	Chickpea	Zumrad	ICARDA	2008	GBURIGLCI	high yielding; disease resistant
4	Lentil	Darmon	ICARDA	2008	ARIGLCI	high yielding; disease resistance; large seed size
5	Lentil	Oltin Don	ICARDA	2008	ARIGLCI	high yielding; disease resistance; large seed size
6	Triticale	Norman	CIMMYT	2008	UzRIPI	high yielding; forage use
7	Triticale	Farhad	CIMMYT	2008	UzRIPI	high yielding; forage use

Cereal varieties released in Uzbekistan						
#	**Crop**	**Variety name**	**Involved CG Center**	**Released year**	**Institute-originator**	**Traits**
1	Chickpea	Malhotra	ICARDA	2011	ARIGLCI	high yielding; large seed size
2	Wheat	Hazrati Bashir	ICARDA, CIMMYT	2012	KRIGBSP	early maturing, resistant to yellow rust, high yielding
3	Wheat	Elomon	ICARDA, CIMMYT	2012	KRIGBSP	early maturing, resistant to yellow rust, high yielding
4	Wheat	Gozgon	ICARDA	2012	KRIGBSP	early maturing, resistant to yellow rust, high yielding

Forage Crops

Through an ADB-supported project “Enabling Communities in the Aral Sea Basin to Combat Land and Water Resource Degradation through the Creation of Bright Spots” (2005-2008), IWMI, ICBA and ICARDA jointly set up on-farm trials aimed at evaluation of populations and improved lines of sorghum and pearl millet, which were provided by ICRISAT›s genebank. The evaluation was conducted to check ability to tolerate saline/sodic conditions, as well as to identify high-productivity varieties for fodder, grain and green manure production. This partnership program was implemented jointly with the Uzbek Scientific Production Center for Agriculture at Uzbek Research Institute of Plant Industry, national Corn Station and Institute of Karakul Sheep Breeding and Desert Ecology. Multi-location trials were established under different agro-climatic zones in Uzbekistan that significantly differed in soil salinity level. As a result of the project, germplasm of 42 populations and improved breeding lines varieties of pearl millet (*Pennisetum glaucum*) and 14 varieties of sorghum (*Sorghum bicolor*) were

Using hay mulching for effective soil and water management

evaluated using 15 agro-biological parameters. Furthermore, it was found that pearl millet and sorghum could become a possible and economically interesting alternative for reclamation of underutilized marginal drylands, reducing the summer fallow practices by increasing the land use ratio that will improve biodiversity and generate alternative flexible options for improved livelihoods of poor farmers.

In 2010 - based on previous 2006-2009 field testing of pearl millet conducted by Uzbek Corn Station in collaboration with ICBA and ICRISAT - a new, promising, dual-purpose variety of pearl millet named “Hashaki 1” was released. This was a result of breeding a highly productive, open pollinated population called “HHVBC tall” (ICRISAT) with local varieties. “Hashaki 1” salt tolerant pearl millet variety is currently under state varietal trials in SVTC in Uzbekistan. In 2011 “Hashaki 1” was planted on large area and could be mostly used as green forage in early spring and in summer for all kinds of animals.

In 2011, a three-year IDB-funded project was initiated by ICBA in close collaboration with ICRISAT, ICARDA and the NARS in Uzbekistan, Kazakhstan and Tajikistan on developing salt tolerant sorghum and pearl millet varieties with good forage and grain yield. This three-year project is being implemented in sites near Tashkent, Syr Darya, Navoi and Khorezm regions in Uzbekistan. The overall goal is to improve salinity tolerance of high-yielding sorghum and pearl millet lines, as well as cultivars resistant to abiotic stress (heat, drought and salinity) in Central Asia by delivering valuable germplasm with appropriate biological and agronomic features. These will accelerate the delivery of new sorghum and pearl millet cultivars for farmers and agro-pastoralists.

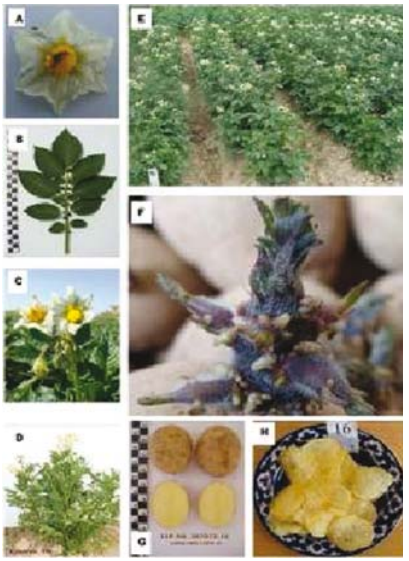
Potato

Different types of potato germplasm have been distributed to Uzbekistan by the International Potato Center- (CIP) since opening the office in Tashkent. These include 75 advanced clones, selected for resistance to viruses, abiotic stress and marketability; 14 tuber families combining adaptation properties to long day conditions and virus resistance; and 21 TPS families.

CIP advanced clones have been distributed at two stages:

- in 2005 – 34 clones belonging to the Lowlands sub-Tropics Virus Resistant (LTVR) population, combining virus resistance, heat tolerance and market characteristics;
- in 2008 – 41 advanced clones with traits of resistance to abiotic stress.

Among the LTVR clones, 20 were retained after preliminary field observations in 2006, which include six potato clones submitted by local NARS to SVTC



CIP-bred clone CIP No. 397073.16 – SERKHOSIL

A: Flower; B: Leaf; C: Inflorescence; D: Habit; E: Plant canopy (60 days after planting); F: Sprout;
G: Tuber; H: Cooking performance

in 2009 as candidate varieties for release. One of these clones was released by the SVTC in November 2010, while two other varieties are still under release process.

True Potato Seed (TPS) introduced by CIP have shown extremely vigorous growing habit and resistance to diseases and abiotic stress in Uzbekistan. It has to be noted that all the tested TPS families had dry matter content higher than 21%.

CIP is leading a BMZ-funded project started in 2008 and aiming at the development of potato varieties resistant to abiotic stress (drought, heat and salinity). This project is done in collaboration with the Institute of Vegetables, Melon and Potato, the Department of Bio-organic Chemistry of the National University and the Soil Agrochemistry Institute, all based in Tashkent region.

In the heat tolerance field trial carried out in Tashkent from July to October, 2010, the average marketable yield of the tested CIP-bred clones was of 29.6 t/ha, with values ranging between 19.6 t/ha and 40.8 t/ha. In the drought tolerance trial, five clones were the best performing due to high drought tolerance index (DTI), low drought susceptibility index (DSI), and high yield maintenance under severe water stress conditions.

Salinity tolerance was also studied under in-vitro conditions at the Department of Bio-organic Chemistry of the National University, in order to find suitable screening methods to quickly test important amounts of germplasm materials. At the highest salinity level of 1.5% NaCl, a wide range of clones showed tolerance and 100% viability, meaning that they were able to regenerate once placed in a normal Murashige & Skoog medium.

Released potato varieties in Uzbekistan						
#	**Crop**	**Variety name**	**Involved CG Center**	**Released year**	**Institute-originator**	**Traits**
1	Potato	Serkhosil	CIP	2010	UzRIVMCP; NUU	virus resistant; heat tolerant; high yielding; high dry matter content (>21%); mid-late.
Potato varieties under release in Uzbekistan						
1	Potato	Sarnav	CIP	2011-2012	UzRIVMCP; NUU	tolerant to heat, drought and salinity; mid-late; virus resistant; high yielding; high dry matter content (>21%); appealing tubers with yellow flesh.
2	Potato	Pskem	CIP	2011-2012	UzRIVMCP; NUU	drought and heat tolerant; virus resistant; high yielding; mid-early

Vegetable Crops

In 2005, AVRDC – the World Vegetable Centre – established collaboration with the Uzbek Research Institute of Plant Industry (UzRIPI) and Mamun Academy (Khorezm region), which has mainly focused on ecological evaluation of introduced AVRDC vegetable germplasm. In the following years, the Uzbek Research Institute of Vegetables, Melon Crops and Potato (UzRIVMCP) and the Tashkent State Agrarian University (TSAU) joined this collaboration. These research institutes and the university participate in the implementation of the AVRDC global project “CAC Regional Varietal Trial”.

The project activities have supported selection of a new source for further breeding work, developing new varieties of vegetable crops and increasing the seeds of new varieties for their dissemination for wide cultivation.

In total, about 700 accessions of 15 vegetable species have been introduced from AVRDC to Uzbekistan. The evaluation of agronomic performance and characterization of morphological traits of the introduced germplasm were undertaken by the partner institutions.

As a result of this research, a number of promising accessions (early maturing, high-yielding, diseases resistant, fruit quality, etc.) were selected from each crop and seeds of promising varieties were multiplied. Protected cultivation is an important aspect of the activities conducted by the World Vegetable Centre in Uzbekistan. In order to improve disease-resistance of the Uzbek cucumber cultivars, a number of crossings with the germplasm introduced by AVRDC has been conducted and six lines were provided for study in greenhouse conditions in the UzRIVMCP. The research allowed selecting the best mildew-resistant cucumber lines with high yielding properties.

Competitive trials are being conducted in research institutes on promising lines of tomato, cucumber, pepper, eggplant, cabbage, squash and other crops. Altogether, 10 new varieties of vegetable crops have been developed in collaboration with institutes and released by SVTC of Uzbekistan between 2007 and 2011.

Released vegetable varieties in Uzbekistan

#	Crop	Variety name	Involved CG Center	Re-leased year	Institute-originator	Traits
1	Vegetable soybean	Ilkhom	AVRDC	2007	UzRIPI	early maturing, high yielding, high protein and oil content, performs well as repeated crops
2	Vegetable soybean	Universal	AVRDC	2008	UzRIPI	early maturing, high yielding, high protein and oil content, performs well as repeated crops
3	Mungbean	Zilola	AVRDC	2008	UzRIPI	early maturing, high yielding, upright stem (not lodging) , performs well under heat stress and as repeated crops

Released vegetable varieties in Uzbekistan						
#	**Crop**	**Variety name**	**Involved CG Center**	**Re-leased year**	**Institute-originator**	**Traits**
4	Mungbean	Marjon	AVRDC	2008	UzRIPI	early maturing, high yielding with qualitative grain, upright stem (not lodging), performs well under heat stress and as repeated crops
5	Hot pepper	Uchkun	AVRDC	2009	UzRIPI	Mid-maturing, high yielding with a big fruit size and a high chemical composition.
6	Hot pepper	Tillarang	AVRDC	2010	UzRIPI	Mid-maturing, high yielding with a big fruit size and a high nutrient content
7	Vegetable soybean	Sulton	AVRDC	2011	UzRIPI	Mid-maturing, high yielding, high protein and oil content, performs well as repeated crops
8	Mungbean	Durdona	AVRDC	2011	UzRIPI	Ultra-early maturing, high yielding, upright stem (not lodging) , performs well under heat stress and as repeated crops
9	Yard long bean	Oltin soch	AVRDC	2011	UzRIPI	early maturing, high yielding, performs well as repeated crops
10	Leafy cabbage	Shark guzali	AVRDC	2011	TSAU	early maturing, high yielding with a high nutrient content, performs well as year-round cultivated crop in an open and protected areas

Vegetable varieties under release in Uzbekistan						
#	**Crop**	**Variety name**	**Involved CG Center**	**Ex-pected year of re-lease**	**Institute-originator**	**Traits**
1	Mungbean	Turon	AVRDC	2011	UzRIPI	early maturing, high yielding with qualitative grain, upright stem (not lodging), performs well under heat stress and as repeated crops
2	Leafy cabbage	Shifobakhsh	AVRDC	2011	TSAU	TSAU early maturing, high yielding with a high nutrient content, performs 3well as year-round cultivated crop in an open and protected areas
3	Vegetable soybean	“Ilgor”	AVRDC	2012	UzRIPI	Mid-maturing, high yielding, high protein and oil content, performs well as repeated crops
4	Sweet pepper	“Sabo”	AVRDC	2012	UzRIPI	Early-maturing, high yielding, a high nutrient content
5	Hot pepper	“Sayid”	AVRDC	2013	UzRIVMCP	Mid-maturing, high yielding, a high nutrient content
6	Eggplant	“Feruz”	AVRDC	2013	UzRIVMCP	Mid-maturing, high yielding, a high nutrient content

1.2 STRENGTHENING NATIONAL SEED SUPPLY SYSTEM

There is a mix of public sector and domestic private seed companies, cooperatives, and farmers involved in seed production and supply in Uzbekistan. Although the state policy and regulatory framework tend to support the role of the private seed sector, a more strategic approach is still required for addressing existing capacity building and quality improvement challenges in this sector.

The report on "*The status of varietal development and seed sector activities in Uzbekistan*" was prepared by ICARDA and submitted to FAO in March 2006. It was published in (English, Russian and Uzbek) for the benefit of wider audience (www.icarda.cgiar.org/cac) and comprises of:

- current situation pertaining to the varietal development
- variety testing and registration system
- seed production
- seed quality control
- seed quarantine system
- seed marketing
- information on seed training courses.

More specifically, different seed potato production systems were thoroughly studied by CIP with the objective of formulating appropriate strategies for further improvement. It was found that the formal potato seed sector is based on the principle of centrally planned management where the Ministry of Agriculture and Water Resources grants production licenses to 36 seed production farms. These farms belong to "Uzkartoshkanavuruglari" LLC - where imported seed of elite and class-A category potato from Holland and Germany are multiplied for one or two generations. This system does not work well because: i) it is too centralized; ii) research farms are not situated in disease-free areas; iii) research infrastructure is localized only in the lowlands which is a highly unsuitable environment for potato. The intentions of the policy makers to establish favorable legislation for the development of private seed enterprises may bring about a change. A business plan was already prepared with this intention and would represent a first attempt to reform the seed potato system that would also need more consideration in terms of seed quality control.

The informal potato seed system, which supplies most of the seed in the country, is rarely carried out by specialized seed growers because most of them are dual producers, producing seed and ware potato at the same time. The seed flow is from farmer to farmer or local traders to farmers. The quality control is the critical point in the system being only based on a simple sorting of seeds after harvest or storage. Seed price is largely based on the principle of offer and demand. CIP has focused its work on

the informal seed system, which is indeed the largest supplier of seed to smallholders.

The lack of appropriate extension system available at the national level has been a major constraint. Due to limited budget resources, CIP focused its efforts on the development of local initiatives, mainly in the areas of Gilane and Kitab (Kashkadarya province), and Pskem (Bostalnik district). Particularly in Gilane, at the altitude of 2800 m above sea level, a group of farmers supervised by CIP received a number of candidate varieties for multiplication and diffusion following the positive and negative selection. In contrast, in Kitab and Pskem, work mainly concentrated on the multiplication of seedling tubers issued from TPS materials produced in nurseries by a women-group.

Pskem, Bostalnik district, Uzbekistan. Harvest of seedling tubers from True Potato Seeds (TPS) families

The research work was conducted at the National University of Uzbekistan (NUU),where CIP has improved its research facilities. CIP facilities comprise of a laboratory for tissue culture for the production of 100,000 in-vitro plantlets per year. They also include three x 600 m2 aphid-proof greenhouses, equipped with drip irrigation system. This research resulted in the determination of a calendar of operations that can be of great use in the case of large-scale seed production activities. Moreover, as a result of experiments, the appropriate media for the production of mini tubers under greenhouse conditions was identified as a mixture of subsoil, organic manure, sand and rice husks. With the introduction of crop rotation inside the greenhouse, it was possible to avoid expensive operations like soil sterilization that always represents one of the bottlenecks in the mini-tuber production stage.

Seed multiplication of new vegetable crops varieties released in collaboration with AVRDC was conducted jointly with the Uzbek Research Institute of Plant Industry. It aimed at supplying farmers with elite seeds for wide cultivation. Seeds of these varieties were multiplied also in private farms in Kibray district - “Yangiobod Khusanov Durbek”, “Ziyaviddinov Risqali” and “Istiqlol” - in collaboration with Farmers’ Association of Uzbekistan. Seed

multiplication of released new leafy cabbage variety “Shark guzali” was conducted in the experimental fields of Tashkent State Agrarian University. These new, released varieties - including non-traditional vegetable species - allow for higher yields, diversified vegetable production, improved nutritional value and increased farmers’ income in Uzbekistan.

ICBA, in collaboration with Uzbek Institute of Karakul Sheep Breeding and Desert Ecology, initiated different seed multiplication and seed technologies production systems of native forage halophytes. These systems aim at formulating appropriate strategies for further distribution among interested agro-pastoralists and herders. This work has been ongoing since 2008.

1.3 CROP DIVERSIFICATION

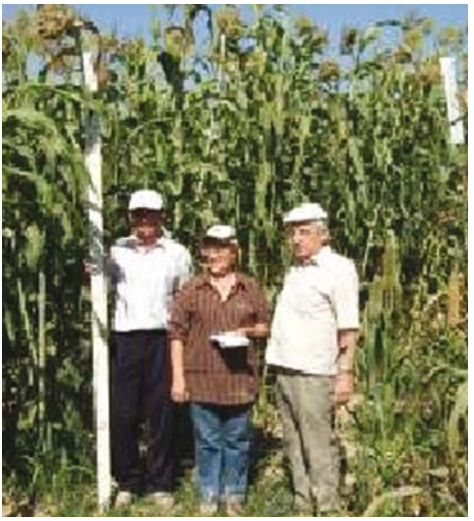
Introduction of alternative crops is essential for ensuring diversification of agriculture. In this context, several alternative crops have been tested and identified in Uzbekistan by CGIAR centers in collaboration with NARS partners.

Dual-purpose crops

Dual-purpose pearl millet (*Pennisetum glaucum*) and sorghum (*Sorghum bicolor*) are two nutritional and highly productive, early spring and summer crops. They were introduced and evaluated to fill existing gaps in grain and forage production in different eco-agro-climatic zones of Uzbekistan. Although sorghum is presently a less important crop by area, and pearl millet is new to many countries of the region, the high-yielding genotypes of these crops are among the top plant materials in terms of salinity tolerance. They will allow sustaining economic yields at high salinity levels, where the production of other crops becomes uneconomical.

Dual-purpose (grain and fodder) nutritious cereals (sorghum and pear millet) with limited irrigation were taken up as second crops after early legumes, winter wheat and barley. Introduced pearl millet germplasm from ICBA and ICRISAT are more water-use efficient, highly tolerant to salt and drought, and do not require preparatory fine leaching work before planting. Pearl millet could become a possible and economically interesting alternative for reclamation of underutilized marginal drylands. It could also reduce the summer fallow practices by increasing the land-use ratio. This will improve biodiversity and generate alternative flexible options for improved livelihoods of poor farmers.

Introduced sorghum varieties and/or improved lines from ICBA and ICRISAT germplasm had significantly higher growth rates, plant height, yield of fresh and dry biomass and seed production during the vegetative stage than those of locally planted varieties. Among the 42 populations and improved



Sorghum, a nutritional and highly-productive dual-purpose crop

breeding lines of pearl millet that have been tested so far, 8-12 genotypes showed tolerance to abiotic stress (salinity, heat and drought) with high-yielding (both forage and seed production) ability, thus being suitable for spring planting as the main crop in non-saline and moderately saline areas in Uzbekistan. Improved early-maturing populations were found well adapted as a second planting crop after barley and wheat harvest under moderately saline (Tashkent and Syr Darya regions, Uzbekistan), and highly saline conditions (Karakalpakstan, Uzbekistan and Dashauz region, Turkmenistan).

The majority of identified varieties have high plant density that makes them useful for cultivation in early spring-summer as animal forage. Densely covering the salt-affected lands, they contribute to the soil improvement and moisture holding that should be taken into consideration when determining crop rotations. Especially promising, is planting of pearl millet in early spring (February-March) as it would ensure high fodder yield on the saline/ degraded sandy desert rangelands. The seven pearl millet cultivars received from the ICBA and ICRISAT and planted in the Kyzylkum desert, Uzbekistan, produced 38-96 t/ha-1 of green biomass. 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 ration could easily be doubled from 2 kg to 4 kg/ day-1 per animal during the severe winter season.

Salt tolerant crops

Two salt tolerant varieties of alfalfa (Medicago sativa), Eureka and Skeptre, introduced by ICBA were found to outperform the local variety Khivinskii (used in Karakalpakstan), while the Kyzylkesekskaya variety (Central Kyzylkum) showed almost similar salt tolerance, green biomass and grain yield comparing to the new introduced alfalfa cultivars. In all countries of the region, the introduced salt-tolerant alfalfa germplasm showed rapid germination, high seed production and excellent regenerative capacity.

Topinambur at flowering stage

These two varieties were also superior to local verities by length of generative sprouts, number of flowering buds, size and number of pods and seeds per a pod, which, in combination, demonstrate higher seed productivity of introduced germplasm.

During recent years, there has been an increasing demand among farmers for good quality seeds of salt tolerant alfalfa. For this purpose, seed multiplication trials of alfalfa were established at the Kyzylkesek site (Uzbekistan). In 2008 and 2010, an amount of 300 kg of alfalfa was produced and distributed among interested farmers, both in Uzbekistan and Tajikistan.

Research between 2008 and 2011 also demonstrated that when alley-cropped barley, triticale and alfalfa are taken together, they yield 20% higher green biomass than barley alone grown under the traditional barley-fallow system. Growing salt-tolerant, high-yielding legumes in combination with cereals, alternated by strips of aboriginal halophytes was found to have great potential for producing more of the highly nutritional fodder (both fresh and as hay). Planting these two valuable forage crops is encouraged to take place along the saline water bodies, like artificial ponds and freely flowing artesian wells. Even during the remediation period, they have potential to generate income for farmers since their biomass can be used as high quality forage additive for livestock. Their root material is well-known to have very high marketability in many industries, especially pharmaceutics.

Crops for soil remediation

The potential impact of Licorice (*Glycyrrhiza glabra*) for remediation of different categories of saline soils was demonstrated by IWMI, ICBA and ICARDA in collaboration with Gulistan State University. It was done within the *Bright Spots* collaborative project implemented in 2005-2008. Later on, ICBA - in cooperation with Gulistan State University at the Nowbahor Farm, Syr Darya region - demonstrated agricultural management of salt-affected soils through introduction of consequent series of phytoremediation technology. This technology envisages 4-5 years of cultivation of licorice and 1-2 years of planting of facultative salt tolerant crops rather than switching to cotton-wheat rotation. Licorice cultivation was the optimal option in

the current policy, economic and social environment. A farmer learning alliance was established under the *Bright Spots* project and a total of 100 ha of licorice was established on abandoned saline lands. This approach to out-scaling innovations may be an appropriate mechanism that could be promoted by the government in Uzbekistan and in other Central Asian countries.

Renewable energy crops

In 2009 and 2010 ICBA, in partnership with NARS, initiated the evaluation of alternative energy and salt tolerant crops, which for the last decades has been underutilized and neglected.

Topinambur at flowering stage

Two local varieties of topinambour (*Helianthus tuberosus*) – Fayaz Baraka and Novinka – showed good performance and accumulation of green biomass under moderately saline environments in Takhtakupur, Karakalpakstan and at the Kyzylkesek site (Central Kyzylkum). These salt tolerant varieties are economically useful for feeding livestock and they are a source for renewable energy production.

These evaluated varieties were more water-use efficient, highly tolerant to salt and did not require preparatory fine leaching work before planting. They showed high plant density (67,000-89,000 individuals/ha), which makes them useful for cultivation in industrial fields in early spring-summer as green forage for any kind of animals. Yields of fresh biomass on sandy saline soils varied from 58.2 to 87.9 t/ha, when yield of tuber was 35.6-42.0 t/ha. Tuber yield was more sensitive to water and soil salinity than aboveground green biomass. The light, saline, sandy soils of the Kyzylkum desert are much more favorable for the creation of industrial fields of topinambur.

Sweet-stem sorghum is a source of renewable energy that can be converted into bio-ethanol. Renewables are currently not used in Central Asia, but Uzbekistan has demonstrated interest in establishing plantations on marginal lands where food crops cannot be grown due to the high soil-salinity. In 2008-2010, two demonstration trials - within the framework of

the collaborative ICARDA/ICBA/ICRISAT and Program Facilitation Unit (PFU) project- were established. Also, 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 and at the Zangi-ota site, Corn Center, Tashkent province.

In 2011 ICBA has established collaboration with Kitakiyushu University, Japan and National University of Uzbekistan. They joined efforts to conduct a lab-scale anaerobic degradation of three wild halophytes (*Kalidium capsicum, Salicornia europaea* and *Climacoptera lanata*) from highly saline biotopes of Kyzylkum desert, compared with conventional glycophyte *Panicum coloratum*. The research unveiled the potential of non-palatable biomass of desert, wild-growing halophytes to become a valuable source of renewable energy production in Central Asian countries.

1.4 LIVESTOCK PRODUCTION SYSTEMS AND INTEGRATED FEED/ LIVESTOCK MANAGEMENT

Like the entire Central Asian region, livestock production in Uzbekistan faces a number of challenges. Despite the government support for this sector with special focus on boosting cattle production, natural resource constraints still exist. Bottlenecks mainly include limited rangeland and forage cropland areas, which are being further exacerbated by the decreasing average rainfall and increasing summer temperatures recorded for the recent years.

These factors have adverse effects on Uzbekistan, as well as on other Central Asian states. Increasing demand for meat, fueled by the population growth and increasing urban incomes, indicates that it is necessary to consider more resource-saving feed-livestock production systems. This is essential to maintain the current level of production and ensure sustainable increases in productivity in the sector. The formerly very productive livestock system has deteriorated and livelihoods of the people have dramatically declined as a result of intensive use and climate change impact.

In Uzbekistan, desert natural pastures valuable for livestock development occupy an area equal to 17.5 million hectares; only 485.1 thousand hectares of this are presently under irrigated agriculture. Saline pastures cover about 2 million hectares. The main vegetation distributed here are halophytes, which can be used as important source of feed, fodder, technical plants, medicinal plants, etc. These valuable genetic resources might play a very important role for soil desalinization, water table control, and valorization of non-conventional water resources, landscaping purpose and sand-dune fixation. The creation of high productive arid livestock fodder farming systems will result in sustainable functioning of ecosystems, safety of natural habitat and increase of the income levels of rural communities.

Afforestation to improve rangelands

Afforestation has been an effective approach for rehabilitating saline landscapes. This provides farmers with valuable products from marginal degraded land; utilizes the otherwise-unproductive land; and lowers elevated groundwater table (GWT). Afforestation - as an option to mitigate land degradation affected by various degree of salinity, waterlogging and overgrazing - requires a strong and comprehensive evaluation of appropriate native and non-conventional multipurpose tree species (MPTS).

These species should be intercropped with valuable crops to increase land productivity, control the elevated groundwater table (GWT) via bio-drainage and improve livestock arid fodder production.

An agro-silvicultural model of trees intercropped with complementary crops, especially deep-rooted, early-maturing and frost tolerant legumes and gramineous crops was conducted by ICBA in collaboration with Institute of Karakul Sheep Breeding and Desert Ecology and Gulistan State University.

This model was applied on marginal lands under arid climate in Uzbekistan (Central Kyzylkum) and Syr Darya region. Herbaceous fodder crops planted within the inter-spaces of salt-tolerant trees/shrubs plantations have many advantages. They improve productivity of saline-prone soils, solve the animal feed gaps in the lands degraded by overgrazing and salinity, and increase the profits for farmers. Wild halophytes planted in widely-spaced patterns allows for easy mechanical cultivation and harvesting of forage grass and legumes. Findings from the screening of 12 multipurpose tree species showed high survival rate, quick relative growth rate, high adaptive features and utility value of firewood and/or foliage. The most promising species were *Haloxylon aphyllum, Populus euphratica, P. nigra var. pyramidalis, Elaeagnus angustifolia, Robinia pseudoacacia, Tamarix hispida, T. androsowii, Salix babylonica, Acacia ampliceps and the shrubs Atriplex canescens, A. nitens, A. undulata, Hippophae rhamnoides* and *Ribes niger*, including stands of native rangeland halophytes grown alone, or mixed with various traditional salt tolerant fodder crops.

Utilization of marginal low quality water to improve the livestock feeding system and diversify the income of rural communities

Experiments on utilization of mineralized drainage water on the establishment of multipurpose, wild and fruit trees were initiated at the Kyzylkesek site. Many of the artesian waters wells, with high temperatures, could be used for the development of arid fodder production, recreation, vegetable production, and other purposes. Tree/shrub plantations were deeply planted (sticks tap into the water table) through transplanting seedlings in early February. A limited irrigation with low quality water was

required during the initial stage of growth before full reliance on available drainage water (higher salinity; Ec 2.5 -8.3 dS m-1) resource become possible. The level of water table varied between 1.5-3.0m below field level.

Soil salinity at root zone was about 45 dS/m. High, and fast growing rates of survival were noted for local popular species (about 91.3%) of apricot (*Armeniaca vulgaris*) – 75.2%, and persimmon (*Dyospyros virginiana*) – 54.8%, when cultivated in mixed stands with various salt tolerant crops. Species of oleaster (*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 - provides satisfactory drainage control in saline environments, preventing strong accumulation of salts at the root zone area. It was found that the irrigation scheduling (rate and regime) is critical to the success of agroforestry.

Utilization of mineralized underground water is the key advantage for the domestication of economiy-valuable native trees, shrubs and halophytes forage. It increases the productivity of saline prone sandy desert rangelands, provides seed multiplication and helps establishment of tree plantations and shelterbelts. These outcomes promote bio-drainage, increase organic matter, and bi-products such as wood, fruit and fodder for animals. Demonstration fields were established in 2009-2011 in Akaltyn (Syr Darya region), Kyzylkesek (Madanyat Farm, Navoi region) and Papanaya (Nurata district).

They aim to evaluate the performance of dual-purpose crops (flax, sesame, pearl millet, sorghum, amaranthus, saflor, indigofera, chickpea and others) in pure stands or mixed with multi-purpose trees and shrubs. This acts as an ecosystem-based adaptation to climate change and helps to generate additional income for small local communities in these regions.
For all the aforementioned reasons, the alternative agricultural production systems have a great potential to assist in utilizing the marginal resources, including low quality water for irrigation. These systems also provide economic returns and environmental benefits to the farmers and agro-pastoralists on marginal lands. With proper screening and evaluation, non-conventional salt tolerant crops can become an integral component in local crop-livestock feeding and farming production systems, where water and/ or soil salinity occurs. Cultivation of valuable cereals in pure stands or mixed intercropping system seems to be a promising option for a more flexible diversification of the existing cotton-wheat through intercropping system.

1.5 INTEGRATED PEST MANAGEMENT

Since the first years of independence, the Government of Uzbekistan has introduced and promoted complex reforms in agricultural sector. Although these reforms have unquestionable positive impacts on farmers, there is still an obvious need for technical assistance and institutional support. Crop diversification to restore sustainability which has been severely damaged by the large-scale monoculture approach maintained during the Soviet era- is also needed. To assist Uzbekistan in drafting an effective policy that would address the above-mentioned farmers' needs, it is necessary to introduce an organized and technically-competent agricultural research and extension system. Today, banning the use of highly toxic pesticides is a general trend in all Central Asia and the Caucasus. It makes the Integrated Pest Management (IPM) approaches which provide alternative pest control methods for farmers, an essential component. In this context, ecologically-based IPM in Uzbekistan play an important role in reducing losses due to pests, minimizing reliance on chemical pest control, and, thereby fostering the long-term sustainability of agro-ecosystems.

Introducing Integrated Pest Management (IPM) approach

Phase II of the Central Asia IPM project - funded and led by USAID Cooperative Research Support Program and guided by Michigan State University and University of California-Davis in collaboration with ICARDA - was implemented by a number of governmental and local universities in the region. The IPM Phase I began in October 2005 and covered three countries in the region: Kyrgyzstan, Tajikistan, and Uzbekistan. The project focused on three components that were identified through a regional stakeholders' forum held in Uzbekistan in May 2005. These components are as follows:

- Collaborative research program to enhance the efficiency and product lines of bio-laboratories
- Collaborative research program to enhance biological control of pests through landscape ecology/habitat management
- Strengthening of outreach and educational programs in ecologically-based IPM.

For the past five years, this regional project has helped to promote ecologically-based IPM approaches, practices and education targeting a range of stakeholders in Central Asia, including government institutions, universities, NGOs and farmers. Using participatory approaches, the project activities have been implemented through a team of three research associates from Central Asia based in Tajikistan, Kyrgyzstan and Uzbekistan.

The research associates work in cooperation with the ICARDA Regional program and U.S.-based project team members at MSU and UCD.

Breeding predatory mites for effective pest control

A joint research program on enhancing efficiency and product lines of bio-laboratories was set to focus on predatory mites. It tests colonization and acclimatization of predatory mite *Amblyseius sp* on bran mites, spider mites and other prey species in bio-laboratories in Uzbekistan. The results have revealed that predatory mites can be potential biological agents against pests including spider mite, (*Tetranychus urticae*), thrips (*Thrips tabaci*) and whitefly (*Trialeurodes vaporariorum*) in cotton, tomato and onion fields. New methodologies for maintaining and rearing predatory mite stock cultures during winter time have been developed. Predator-prey ratios have also been determined. The species *A. mckenziei* has been found to be effective in controlling *Thrips tabaci* in onion crop in Uzbekistan.

Explaining predatory mites breeding methods

In collaboration with NARS, a database on native flowering plants has been developed. Available plant seeds were collected for field testing, and sixty native and locally adapted plant species were evaluated for their attractiveness to natural enemies of pests. Out of 12 native plant species that were the most attractive to natural enemies, eight species have shown potential for their use in agricultural landscapes. These species have the potential for enhancing biological control; they 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 diversified ways including more than 10 workshops, various papers published, and a televised documentary. The project has built an excellent research team of partners in Central Asia among NARS to promote landscape ecology/bio-control approaches in the region.
A total of 130 wheat entries were screened in Uzbekistan for 34 cereal leaf beetle resistance, and some lines have shown resistance to cereal leaf beetles - a serious pest of wheat in the region.

2. NATURAL RESOURCE CONSERVATION AND MANAGEMENT

Natural Resource Conservation and Management refers to the conservation and management of natural resources such as soil, land, water, fauna and flora with a particular focus on the impact of this management on the quality of life of both present and future generations. Natural resource conservation and management is closely interrelated with the concept of sustainable development, a scientific principle that forms a basis for sustainable global land-management and ecological governance to conserve and preserve natural resources. Natural resource conservation and management specifically focuses on a scientific and technical understanding of ecosystems and their resources, as well as the life-supporting capacity of those resources.

To address some of these challenges, the CGIAR Regional Program in partnership with the national partners in all countries of the CAC Region, works on various soil and water management-related research. The activities address major on-farm soil and water management constraints with a view to increasing agricultural production through better soil fertility, enhanced nutrient use efficiency and improved water productivity. Results have amply demonstrated that adoption of improved technologies of water and soil 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.

2.1 IRRIGATION, DRAINAGE, AND WATER BASIN ANALYSIS

Water is a crucial but increasingly scarce resource in Central Asia. Scarcity implies growing competition between the needs of communities, industries, power production and agricultural use.

Within Central Asia, the Fergana Valley occupies a special place. With approximately 11 million people and shared by the Kyrgyzstan, Tajikistan and Uzbekistan, the Valley is the most populous area in the region. It is approximately 300 km long and up to 70 km wide, and its total area measures around 22,000 km2. The Valley has some of the most fertile soils of Central Asia and, given the importance of agriculture, natural resources such as land and water have historically been amongst the most disputed factors in this region.

Today, irrigated agriculture is estimated to consume around 92% of total water in the Valley. However, water-use efficiency is low, since more than 50% of water diverted for irrigation is wasted due to technical and

institutional issues. Irrigation infrastructure is in dire need of repairs, and inefficient managerial arrangements result in unreliable, inadequate and inequitable water distribution as well as excessive water-use. The fundamental problem is clearly not water scarcity but mismanagement. With the privatization of agriculture and the liberalization of agricultural markets – fully achieved in Kyrgyzstan, partly in Tajikistan and tentatively in Uzbekistan – there is an urgent need to reorganize water management. In particular, management systems have to change from a top-down supply-oriented approach to a participatory and demand-driven approach. This is necessary in order to provide thousands of farms with irrigation water in an adequate, transparent and equitable manner.

To assist Uzbekistan in addressing the above-mentioned challenges, IWMI, a key participating Centre of the Regional Program in CAC, has been implementing a number of technical projects in the area of effective water management practices.

Integrated Water Resources Management (IWRM) in Fergana Valley

The Integrated Water Resources Management in the Fergana Valley (IWRM-Fergana) project is financed by the Swiss Agency for Development and Cooperation (SDC) and has been implemented by IWMI in partnership with the Scientific-Information Center of the Interstate Commission for Water Coordination of Central Asia (SIC-ICWC) since 2001. The main goal of the project is to contribute to more secure livelihoods, increased environmental sustainability and greater social harmony, through the improved effectiveness of water resources management in the Fergana Valley.
The project is aimed at improving the effectiveness of water resources management through the introduction of principles of IWRM in the Fergana Valley. Issues addressed by the project include. inter alia, possibilities for:

- water saving
- improvement of water productivity
- reorganization of water administration
- promotion and institutional build-up of Water Users' Associations (WUAs)
- establishment of unified management for three pilot canals
- development of transparent, fair and efficient water distribution mechanisms among users.

A Water Users Association is a self-managing group of farmers working together to operate and maintain their irrigation and drainage network, to ensure fair and equitable water distribution, and to increase crop yields. Since 2007, the project has focused on transboundary small rivers to extend the principles of IWRM along selected small rivers, which have linkages to pilot canals. The establishment of Water Users' Association:

- encourages greater participation of farmers in management decisions
- ensures greater water use efficiency through increased productivity per water unit
- ensures greater participation of farmers in the operation and maintenance of irrigation systems.

What was done?
- More than 700 members of the local water management system, WUA specialists, farmer groups and other stakeholders were trained and equipped with appropriate skills and sufficient capacity to take over the management and governance of newly introduced, participatory, bottom-up institutions.
- Creation of 30 hydrographic WUAs (covering more than 37,000 hectares (ha) with a population of 300,000) and 300 Water User Groups (WUGs) on tertiary canals, 20% of whom are members of WUA councils.
- Creation of a System-wide Management Organization (SMO).
- Creation of a Union of System-wide Water Users (UWU) based on WUAs and other water users/interest groups.
- Creation of System-wide Water Committee (SWC) – a joint user and state body to oversee water management at each riparian side and cooperate in transboundary water management with the other riparian side.

Results from the IWRM-Fergana project:
- Consensus is reached between locally elected governing bodies on the riparian sides through informal dialogue and information exchange.
- Trust and confidence in governing bodies of co-riparian sides.
- Joint understanding and management of water resources during the water scarce period (April-May) when water is mostly needed.
- Introduction of an early warning system and emergency calls during mudflows and floods.
- Joint maintenance (sharing of labor force and machinery, and joint leaning of transboundary canals).
- Joint discussion of water demands, water use plans and other key activities of joint interest.

Improving water productivity

Water Productivity Improvement at Plot Level is another IWMI project in Uzbekistan. This project aims at enhancing water productivity at plot level by disseminating knowledge on irrigated agricultural production practices (agro-technical and hydro-technical practices) to farmers. This activity is typically undertaken by agricultural extension specialists in other countries. Today, since a formal form of agricultural extension does not exist in the Central Asian countries, a new organizational structure called *Innovation Cycle* that consists of researchers, training centers, disseminators and

Water accounting in place

farmers was proposed and accepted. *Innovation Cycle* is effectiveness in disseminating knowledge on improving water productivity. To test the effectiveness of this structure, 25 demonstration plots were selected in the countries of Kyrgyzstan (five plots), Tajikistan (five plots) and Uzbekistan (15 plots).

Out of a total of 19 technologies that were proposed for improving water productivity, 11 technologies were accepted and implemented by farmers. Analysis of data, on water productivity from demo plots and from farmer interviews, indicated that the farmers are very happy with the information they received. In addition, water productivity of the demo plots increased by an average of 30%, with a 10-15% saving in water use. Project specialists have conducted a number of trainings. A total of 72 training programs increased the knowledge of almost 1,500 farmers. In addition, more than 50 different publications in the form of brochures and newspaper articles were prepared and disseminated to farmers in demo plots, around the demo plots, and in other project areas.

With a view to improving equity in water distribution within WUAs, this Project has started working on equipping selected WUAs with flow measurement structures and gates. Seventeen WUAs in three countries have been equipped with water-measuring devices (665 units) and gates (617 units). Eight WUAs are 100% equipped with flow measurement structures, which is the main requirement for the introduction of volumetric payment for water. Introduction of volumetric water charges is expected to encourage farmers to use water rationally by using water-saving technologies at field level. Equitable distribution of water within WUAs will eliminate conflicts over water use among farmers and between WUAs and farmers.

This project is implemented in collaboration with regional partner such as SIC-ICWC, and several national institutions and organizations and NGOs in the countries of Kyrgyzstan, Tajikistan, and Uzbekistan. The project is funded by SDC (Swiss Agency for Development and Cooperation).

The stress on water resources in Central Asia is increasing due to growing population pressure, demand for food and energy, and competition between

different water users. Water resources management is further complicated by climate change and regional environmental issues. The Syr Darya River Basin is an example of where all of these problems come together and keep growing. The establishment of new independent states since the beginning of the 1990s changed existing water allocation frameworks in the basin. It also increased competition between the upstream hydropower systems and downstream agriculture. The shift to maximizing hydropower generation in the upstream - Toktogul Reservoir on the Naryn River - caused water shortages during the summer and excessive flows of 2-3 km^3 during the winter, annually, in the lower reaches of Uzbekistan and Kazakhstan. This has induced water losses to the saline Arnasai depression, which, at present, has a water surface area of over 3,000 km^2 and a volume of over 40 km^3.

Effective use of ground water

Through its Ground Water Project, IWMI proposed a strategy to alleviate the above problems in the short-term, and to improve water security in the long-term. The strategy is based on conjunctive surface water and groundwater use, with "*groundwater banking*" and recovery for irrigation in the Fergana Valley - being the key to the impasse of basin water management problems. Supported by the (OPEC) Fund for International Development (OFID), IWMI conducted innovative and influential research on groundwater banking and recovery in the region and suggested that there was a high potential for groundwater irrigation and recharge in the Valley. The research also indicated the need for developing proper groundwater extraction technologies that were economically viable for small farmers in the larger Central Asia region. Currently, the project is doing on-farm testing and demonstration of groundwater extraction and irrigation technologies for different groups of farmers in Central Asia.

The project benefits small farms in areas experiencing water shortages in the Fergana Valley and Syr Darya Province; Syr Darya-Sokh Basin Irrigation System Administration (BISA); NARS and national water policymakers.

In areas where managed aquifer recharge was undertaken through the use of drainage basins, research found at least two relatively low-cost technologies of groundwater recovery which could be adopted by the small farmers of Central Asia. These are boreholes equipped with low-yielding pumps at 2-3 liters per second and shallow wells that were 20-40 m deep. Field demonstration studies at a pilot orchard farm showed that the farmer did not have any water shortage due to access to groundwater through the borehole equipped with the low-yielding pump. The cost of the indicated technologies is 10-20 times less when compared to the 60-100 m deep wells which are widely used in the region. This technology is a practical solution for small farms of the Fergana Valley who are facing irrigation

water shortages. In 2010, over 20 farmers followed this exercise of digging wells and installing low-yielding pumps. This simple groundwater extraction technology has become popular among farmers growing orchard crops, vegetables and melons in the Fergana Valley.

Strong partnerships with local institutions such as the Hydrogeology and Engineering Geology Institute, Sokh-Syr Darya BISA and the Hydrometeorological Service of Uzbekistan were developed during the implementation of this project.

Trans-boundary water management

The Trans-boundary Water Management in Central Asia Project, was initiated in 2009 and funded by GIZ with the objective of assisting local water management administrations in selected trans-boundary rivers to gain the necessary knowledge and capabilities for IWRM. The project was implemented in five countries in Central Asia including Uzbekistan, Tajikistan, Kyrgyzstan, Kazakhstan and Turkmenistan. The project consists of the following components:

a. creation of land-use/land-cover maps for selected sites using bimonthly Moderate Resolution Imaging Spectro-radiometer (MODIS) satellite images
b. delineation of watersheds of selected rivers from high spatial resolution (30 m) to create a Digital Elevation Model (DEM)
c. delineation of irrigated areas of selected canals or basins in 2009 from Landsat 5/7 satellite images
d. assistance in training local specialists in creating thematic geographic information system (GIS) layers and the practical use of satellite images.

Several workshops with local partners (Zerdolvodkhoz in Uzbekistan, Oblvodkhoz in Tajikistan, Aralo-Syr Darinskaya Inspektsia in Kazakhstan, and Batken Rayvodkhoz in Kyrgyzstan) have been convened as part of an information exchange strategy and 34 representatives of different irrigation systems were trained in GIS and database management. It is expected that the trained local specialists will create and update GIS layers and databases that would lead to better decision-making and efficient water usage in the sector.

In addition to the above-mentioned project activities, IWMI has triggered and supported a number of wider trans-boundary initiatives in Central Asia. In particular, IWMI is:

- co-founder of the Amu Darya Basin Network (linking researchers, implementers and policymakers)
- co-organizer of the advanced North Atlantic Treaty Organization (NATO) research workshop, "*From Joint Scientific Research to Sustainable*

Regional Cooperation on Water" focusing on the Amu Darya River

- member of the Erasmus Mundus Central Asia Project, which is the establishment of a sustainable/operational network for academic exchange between Central Asia and European countries.

2.2 CONSERVATION AGRICULTURE

Conservation agriculture (CA, or Zero Tillage) refers to practices which alter soil composition, structure composition, structure and natural biodiversity as little as possible o reduce degradation (e.g. salinization, soil erosion and compaction). CA provides important benefits for the environment and economic benefits for the farmer. Farmers living in Karakalpakstan have two goals in mind: to produce a reliable harvest from their heat and salt affected fields and to do this economically by conserving water and nutrients.

Being defined as a concept for resource-saving agricultural crop production, CA strives to achieve acceptable profits, high and sustained production levels while concurrently conserving the environment. CA is based on enhancing natural biological processes above and below the ground. Interventions such as mechanical soil tillage are reduced to an absolute minimum, and the use of external inputs such as agrochemicals, nutrients of mineral or organic origin are applied at an optimum level and in a way and quantity that does not interfere with, or disrupt the biological processes.

Alternative agricultural production methods

A three-year project on "*Sustainable agricultural practices in the drought affected region of Karakalpakstan*" - supported by FAO through technical cooperation facility project in Uzbekistan - was implemented by the Ministry of Agriculture and Water Resources (MAWR) of Uzbekistan 2004 - 2007. The overall objective of the project is to demonstrate alternative, profitable and more sustainable forms of agricultural production methods such as appropriate water and soil conservation practices and CA for small individual farmers in Karakalpakstan.

Winter wheat growing on cotton field

The project was executed by the Ministry of Agriculture and Water Resources of Uzbekistan, with on-site technical guidance

and support provided by ICARDA and competent national and regional institutes and agencies. The contract included assistance in the formation and strengthening of a water user association, improved on-farm water management, conservation agriculture and integrated crop management.

During the implementation of the project, an experiment was conducted to identify yield of potential wheat production on no-tillage system. The objectives of this experiment were to see if high yields can be produced by no-till wheat and to see if it is an economical alternative compared to conventionally planted wheat.

Mulching is one of the simplest and most beneficial practices. Mulch is simply a protective layer of material that is spread on top of the soil. Mulches can either be organic, such as manure, grass clippings, straw, bark chips, and similar materials, or inorganic, such as stones, brick chips, and plastic. Both organic and inorganic mulches have numerous benefits. Influence of crop residue on soil humidity and density in the upper layer of the ground were studied.

Zero tillage

Recent introduction of innovative approaches such as the zero tillage system, herbicides and residue management offers an opportunity to increase double cropping. Fuel for producing agricultural products has become expensive. By using no-tillage, multi-cropping technique, two crops can be planted with the same fuel required for one conventional crop. Fuel for harvest, processing and transportation would be higher than in single crop production owing to increased production and the extra harvest. Therefore, when choosing the crop to grow, it is necessary to consider the economics of the entire rotation instead of a single crop in isolation. Also, it is important to be aware of any potential insect or disease problems that could affect crops later in the rotation. Covering crops in the rotation may also have an impact on diseases and pests, whether positive or negative.

Proper seedbed preparation and the selection of seeding rate are important management considerations for successful production of wheat and other agricultural crops in Karakalpakstan. Bed planting of wheat can be applied to improve the percentage of germination of seed in the field conditions. Also, seed rate can be reduced - and during the vegetation period of wheat field can be cultivated once with fertilizer application. Lodging control of irrigated wheat can be achieved through bed planting practices.

Laser-assisted, precision land-leveling saves irrigation water, nutrients and agrochemicals. It also enhances environmental quality and crop yields. In spite of the known benefits of precision land-leveling, Karakalpak farmers

are unable to take full advantage of it due to high soil salinization. They have to rely on traditional methods of land-leveling which are labour-intensive and crude, and do not achieve a high level of smoothness of land surface. Laser land-leveling technique is well known for achieving higher level of accuracy in land-leveling.

New machinery for sustainable agricultural practices was provided by the project to the farms which are located in the project demonstration pilot site. During the implementation of the project three no-till planters were brought from Brazil.

A successful spray application does not depend only on a good sprayer or correct use of the chemicals but also on factors to be determined in the field under specialized orientation. Among these factors, some concepts should be part of a criterion of evaluation so that positive results may be attained within the pest control program.

A manual on conservation agriculture in Uzbekistan was prepared. This manual brings together a collection of concepts, experiences and practical suggestions that can be of immediate use for identifying problems and formulating, executive and evaluative actions to benefit and improve the productivity and conservation of soil and water resources. Conservation agriculture is a very important land use option that should be further studied and promoted for the benefit of the farmers in Uzbekistan.

2.3 RANGELAND REHABILITATION AND MANAGEMENT

Several filed surveys conducted by ICBA, in collaboration with international experts from Russia, Iran and Turkmenistan in 2009 and 2010, showed that the flora of halophytes of Uzbekistan includes indigenous, highly valuable genetic diversity, only little known or unknown for agricultural use. Among them there are 38 species of forage value, 25 species of trees and shrubs useful as food, fuel, wood, bio-drainage and landscaping value, 15 medicinal species and 8 dying plants. An innovative program on the domestication and utilization of some of the identified wild germplasm with suitable modern agro-technologies was conducted on experimental fields in the Central Kyzylkum Desert and in Syr Darya region.

In 2008-2010, seed collection for ex-situ and in-situ conservation of 68 drought and salt tolerant fodder, medicinal, technical and dying plants has been conducted in the transect between Aratau and Nuratau mountain ranges, including Aydarkul-Arnasay Lake system. Majority among them represents a unique source of valuable germplasm of drought and salt tolerant, multi-pastoral fodder species, medicinal, aromatic and technical wild underutilized species, which would be multiplied and introduced into

agro-pastoral system under climate changing conditions and in ecologically-friendly way. This in-situ collection includes endemic species, which face the highest risk of extinction due to climate change and anthropogenic pressure. Incorporation of these medicinal and fodder species into a bio-saline farming system represents the only source of income for many poor rural families, who depend on crop-livestock production system practiced on marginal low fertile lands. Due to their ability to be propagated vegetatively and by seeds, these plants, are the target fodder species for:

- rehabilitation of degraded pastures
- sand-fixing
- water-table and soil erosion control
- haymaking and silage
- better stock feeds (feed blocks) for animals in the late-autumn winter.

Efficient use of native halophytes should become an alternative low cost option in the rehabilitation of wetlands and abandoned salinized rangelands, which would be utilized by farmers themselves and will add to their household income.

3. CONSERVATION AND EVALUATION OF GENETIC RESOURCES

The CAC Region is a large geographic area rich in agricultural biodiversity, which is very important to its agriculture today. This region is the center of diversity and origin of crops species that are of global importance. Among those crop gene pools that are originated or diversified here are:

- cereals (wheat, barley, and rye)
- food legumes (lentils, chickpea, faba bean, and pea)
- forage legumes (*Trigonella, Trifolium, Onobrychis, Vicia,* and *Lathyrus*)
- vegetables (cabbage, onion, garlic, melons, carrot, radish, and spinach)
- fruit trees (almond, apricot, apple, pear, pistachio, cherry, plum, walnut, pomegranate, quince, hazelnut, azarole, cornelian cherry, Russian olive, grape, fig, chestnut and mulberry)
- fiber and oil crops (safflower, flax, cotton, and sesame)
- medicinal and aromatic plants (e.g. Mandragora, Achillea, Glycyrrhiza, Valeriana, and Ferula).

Conservation and evaluation of genetic resources is an area of considerable importance in Uzbekistan since it represents the West Middle Asian Center of origin and diversity for many of the globally important agricultural crops.

3.1 PLANT GENETIC RESOURCES (PGR)

Agricultural biodiversity is essential for sustainable development of agricultural sector in the economy of Uzbekistan, including its social, economic and cultural aspects. Main functional areas of agricultural biodiversity, such as food production, landscape and ecosystem protection make the conservation of plant genetic resources a mission of great socio-economic and ecological importance. Consequently, plant genetic resources have a great biological potential for increasing livelihood and well-being of vulnerable groups of population. They have practical value for breeders in developing better, more adaptive and more productive crops, by using wild relatives or landraces to find genes that are responsible for important traits.

Horticultural crops gene pool conservation

Uzbekistan, along with the other four Central Asian countries works to identify options for conserving horticultural crops and their wild relatives. This is done through a regional UNEP-GEF/Bioversity International project on "*In Situ/On-Farm Conservation of Agricultural Biodiversity (Horticultural Crops and Wild Fruit Species) in Central Asia*". The overall goal of this five-year project is to provide farmers, institutes and local communities with the knowledge, methodologies and policies to enable in-situ/on farm conservation of globally significant horticultural crops and wild fruit species in Central Asia.

The project focuses on traditional local varieties of fruit crops maintained by farmers and their wild relatives growing in forests, and on enhancement of farmers' and community's capacities to conserve in-situ horticulture diversity. Conservation of these resources will allow farmers to increase the crop capacity of their farms and improve living standards in the rural areas.

The project component in Uzbekistan has focused on conservation of eight most important fruit crops, including apple, pear, apricot, grape, walnut, almond, pistachio and pomegranate. Project objectives are being implemented through assistance to farmers and tenants. This is achieved by encouraging cultivation of orchards, cultivation of planting materials of local varieties for local markets, and preservation of wild plantations of fruit crops with the greatest varietal diversity. The project activities cover the entire territory of Uzbekistan and are being implemented in collaboration with different national research institutes of agricultural profile representing five specified groups.

Within the framework of the project, all farmers holding nurseries were provided with grafting materials including 22 varieties and forms of apple, 25 of apricot, eight of pear, 22 of grape, 14 of pomegranate, four of almond and four of walnut. During expedition surveys 22 demonstration plots -

with a total area of 13.9 hectares with local varieties and forms of fruit crops and their wild fruit species - were established on existing orchards in farm households and forest lands and16 key nurseries with a total area of 0.24 hectares were selected. The Regional Training Centre on molecular markers was established on the base of the Institute of Genetics and Plant Experimental Biology in 2007. Moreover, the National Training Centre on stone fruits, pomegranate, subtropical crops and grapes was established at the Uzbek Scientific Research Institute of Horticulture, Viticulture and Winemaking named after R. Schroeder and National Training Centre on nut crops at the Scientific Production Center on Decorative Horticulture and Forestry in 2007.

Regeneration of cereal crops

Bioversity International, supports the Global Crop Diversity Trust in the implementation of "*Regeneration of Sorghum Collection*" (April 2008 - March 2011) and "*Regeneration and Safety Duplication of Priority Crop Collections for Barley, Maize and Wheat*" (February 2010 – March 2011) projects on the base of Uzbekistan Research Institute of Plant Industry. Up to now, 257 accessions of wheat, 157 accessions of barley, 102 accessions of maize and 257 accessions of sorghum have been regenerated by self-pollination method. Methodical instructions of VIR (N.I.Vavilov All-Russian Research Institute of Plant Industry) and list of crop descriptors, developed by Bioversity International, were used for regeneration, evaluation and documentation of regenerated accessions. The accessions were characterized and documented on morphological, biological and economy-valuable traits in field and laboratory conditions. Obtained data will be provided to the Trust, made available in Regional CAC-DB (Central Asian and Caucasus Database) System and published in the Institute's web-site (www.uzripi.org) in 2011. Accessions of regenerated seeds will be transferred for safety duplication to VIR, ICARDA and CIMMYT gene banks. These projects provide an opportunity to preserve valuable plant collections for future generations.

Conservation of crop wild relatives

In 2004–2009, Bioversity International implemented a global project on "*In-situ Conservation of Crop Wild Relatives through Enhanced Information Management and Field Application*", funded by UNEP-GEF. The main objective of the project was to enhance conservation of crop wild relatives (CWR) in Armenia, Bolivia, Madagascar, Sri Lanka and Uzbekistan, and to improve use of information tools to support their conservation and sustainable use.

In the scope of the project, a draft National Strategy and Plan for CWR conservation in Uzbekistan was prepared and a management plan for wild almond was developed and delivered to authorities of Ugam-Chatkal National Park and Chatkal Biospheric Reserve for implementation. Additionally, a

national information system - covering maps with pinpointed pilot plots, taxonomy data, information about threats, phenology of studied species, biological description of plants adaptability of the studied species was prepared and 15 vascular and grass species of CWR were included in Red List.

Genetic erosion assessment

During 2005-2006, Bioversity International implemented a project entitled "*Genetic Erosion Assessment of Traditional Vegetable Crops in Fergana Valley, Uzbekistan*". This project aimed at evaluation of traditional vegetable crops genetic erosion, identification of factors causing the erosion, and development of recommendations on conservation of traditional vegetable crops. The project helped to assess the status of vegetable production and vegetable genetic resources availability in Fergana valley. Survey mission to the main areas of vegetable production was conducted and the degree of traditional vegetable crops' genetic erosion in different agro-ecological zones of Fergana valley was identified through farmers' inquiries and genetic erosion indicators. Action plan and recommendations on conservation of local traditional vegetable crops in Fergana valley were developed, and the ex-situ collection of Uzbek Research Institute of Plant Industry was enriched with accessions of local varieties and forms of vegetable crops.

4. SOCIOECONOMIC AND PUBLIC POLICY RESEARCH

The transition from centrally planned Soviet systems towards independent and market-oriented economies, started after the gaining independence in the early 1990's.. This process has been very challenging in all CAC countries, including Uzbekistan. The policy principle of gradual liberalization and strong social support conducted by Uzbekistan helped to avoid a massive reduction in the agricultural output, which was actually the case in many other countries in transition between 1991 and 1999. Starting from 2000, an increased pace of agrarian reforms in Uzbekistan allowed restructuring of the agricultural sector. Former bigger shirkat cooperatives (kolkhozes) were dismantled into numerous small private farms, which provided huge opportunities and presented a new set of important challenges to overcome. These reforms enabled Uzbekistan to move from dependency on food imports to food self-sufficiency.

Socio-economic, policy and institutional studies are at the core of the efforts needed for increasing agricultural production, improving rural livelihoods, and boosting incomes of the local farmers. In this regard, Uzbekistan also faced a paradigm shift in terms of socioeconomic and policy research.

Although the CAC countries inherited strong capacities for biophysical research from the former system, most of the socioeconomic and policy sciences that existed before became irrelevant under the new realities of market economy. For this reason, adapting old socioeconomic and policy research capabilities in the region and developing new, became a "challenge within a challenge".

Strengthening socio-economic research capacities

To accompany NARS partners in their effort to further develop agricultural economic research in Uzbekistan, the Regional Program has included or initiated appropriate social and economic studies, as well as capacity building for socioeconomic research in virtually all its projects. This strategy was very important in terms of directly tailoring the innovations developed by biophysical research to the users. The economic studies allowed evaluating the rates of return and potential impact of the promising technologies developed within the projects. For example, in Tashkent province of Uzbekistan, the socioeconomic research conducted by ICARDA showed that replacing fallow in winter wheat cultivation with mungbean as a double crop, increased farmers' income by 6.4 times (ADB-funded project on Soil and Water Management). In Syr Darya province, planting licorice in abandoned and highly degraded lands not only helped to ameliorate the soil quality, but was also economically profitable (IWMI-ICARDA-ICBA project on *Bright Spots*, funded by ADB). In addition, this could allow, with economies of scale, for contributing to the development of confectionary production and pharmaceutical sector in the country.

The "*Papanaya-project*" on dual purpose crops showed that villagers in rural areas invest substantial amounts of money into higher education of their children to give better chances to those, who will not inherit the farm, to enable them to make their living in urban areas. This change from agriculture to industry and service is a normal process in countries that can afford it. Ensuring food security while staying in the village also needs proper education, e.g. in conservation agriculture, irrigation, fruit and vegetable production, pollination, rangeland ecology etc. Relevant fields of education include agriculture, soil and water management, forestry, and so skills relevant for value chains on agricultural products and marketing new products. If climate change leads to lower yields, the income from the crop should be increased to avoid income losses for those with less profitable fields.

The members of the CGIAR-CAC Regional Program believe that policy reforms are essential for further enhancing growth in the agricultural sector, many of them related to natural resources use and management. As a result, efforts will be continued and expanded on this line of joint research in future.

4.1 POLICY ADVICE

Introducing effective policy advice based on knowledge generated through collaborative research and aimed at enhancing agricultural productivity, is one of the work components of the CGIAR Centers in Uzbekistan. There were a number of various activities conducted by the Centers in collaboration with NARS partners aiming at building their capacities in policy design and implementation during recent years.

Improving seed policy

A National Seed Policy Forum was held in, 2006 in Tashkent. More than 52 specialists from FAO, ICARDA, Ministry of Agriculture and Water Resources, Ministry of Finance, Ministry of Economy, Uzdonmakhsulot State Company, Uzbek Scientific Production Center for Agriculture, State Seed Quality Control and Certification Center, State Variety Testing Commission, AVRDC, CIP, and research institutions have participated in this forum.

The National Seed Policy Forum analyzed the important correlations between the seed supply systems, legal aspects and other services of the seed production in Uzbekistan. Alternative strategies for policy makers that can be adopted according to the prevailing conditions in the country have also been discussed and proposed. This process of diversification seems likely to continue in Uzbekistan, and thus, requires more sound and responsive policy options, which reflect the interests of different stakeholders. Although the Government has introduced seed sector regulations, there is still lack of documented national seed policy pronouncements. The forum has emphasized this need in a clear, stable and consistent seed policy which would define the functions and linkages among the institutions involved in the seed sector and the mechanisms for coordinating the activities and monitoring the progress of the national seed industry.

Taking into account the importance of enhancing the regulatory framework of the varietal development and seed sectors, a newly amended draft seed policy, including the final drafts of Composition, Terms of Reference and Operational Modalities of the Proposed National Seed Board of the Republic of Uzbekistan were developed and officially submitted to the Ministry of Agriculture and Water Resources in 2007.

Facilitating favorable policies in biodiversity conservation

To support the mission of plant genetic resources conservation in the country, Bioversity International, jointly with IFPRI and CAPRI, implemented the "*Strengthening community institutions to support the conservation and use of plant genetic resources in Uzbekistan* and *Turkmenistan*" project

during the period between 2002 and 2005. Within the project mission on effecting plant genetic resources conservation and use in Uzbekistan, issues on changing the system of land utilization and rural organizations were investigated. The project helped to increase the portfolio of biological assets available to rural households in Uzbekistan by securing crop genetic resource base and increasing the participation of local institutions in PGR management. Socio-economic data on fruit crops conservation and use at households, village and district levels were collected and project results were presented at the CAPRI/Bioversity International Workshop, held in October 2003 and a subsequent FAO Workshop in 2004.

In 2009 and 2010, strategies were developed for the conservation of plant genetic resources of salt tolerant crops and wild halophytes in food and agriculture for arid and semi-arid zones of Uzbekistan. National consultation workshop was conducted in 2008 to identify the specialized working group on bio-saline agriculture production together with national stakeholders. The documentation of ex-situ and in-situ collections of plant genetic resources of salt tolerant crops and halophytes is being continued at the base of Gulistan State University and Karakul Sheep Breeding and Desert Ecology in Samarkand.

Within the project "In-Situ/On-Farm Conservation of Agricultural Biodiversity (Horticultural Crops and Wild Fruit Species) in Central Asia", full analysis of the existing national legislation on conservation of wild fruit species in protected areas and other forest lands was completed in Uzbekistan in 2008. The output of the analysis was presented at the Regional Workshop on Policy Issues organized by the project in November 2008, in Tashkent. According to the action plan on development of policy proposals agreed at the Workshop, national partners have made their proposals on strengthening conservation and protection of biodiversity, including wild fruit species.

These proposals have been made available for "Concept of Forestry Development in Uzbekistan for the period till 2030" and the national Forest Code. National partners made good progress in development and submission of policy and legislative proposals according to the action plan. Tools and guidelines for benefit sharing were reviewed and discussed by national partners at Regional Workshop on Access and Benefit Sharing (in March, 2010, Tashkent). The National Farmers' Association was established by the President's Decree in 2005, and its local representatives actively participate in the project field activities.

Shaping water management policy

On 26 December 2009, the Oliy Majlis (Parliament of the Republic of Uzbekistan) reconsidered and enacted the Water and Water Use Law. Because of a series of meetings and negotiations initiated by a national

support and coordination group, the approaches of the IWMI project are reflected within that law. The Law acknowledged the principles of IWRM. At present, by order of the government, eight positions of sub-legislative acts were prepared by the project committee and are currently under consideration of the Ministry for Agriculture and Water Resources. For information is available on the following link
http://www.multitran.ru/c/m.exe?a=110&t=4566921_2_1&sc=0

4.2 Climate Change

Climate change poses a major threat to the agricultural sector of Uzbekistan, which is highly affected by increasing temperatures and reduced days with snow cover (SNC-UZB, 2009). Agricultural production in Uzbekistan mainly relies on irrigated fields. The major water resources, Amu Darya, Syr Darya and Zerafshan, receive most of their waters from neighboring countries. Managing reduced water resources in times of higher demand will be a major challenge for the agricultural sector. In Uzbekistan, agriculture employs 44% of labor force and contributes around 28% to the country's GDP. Arable land per capita is lower than on global average and will further shrink in view of the rapidly growing population and increasing salinity and land degradation.
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WBGU (2007) and Stern-Report (2006) both regard Central Asia as an area with one of the highest risks of conflicts worldwide in the course of climate change. In 2009 the Second National Communication of the Republic of Uzbekistan under the United Nations Framework Convention on Climate Change (SNC-UZB, 2009) was published. This profound and comprehensive document of the Uzbek government addresses vulnerability, adaptation and mitigation issues and is a main basis for setting the strategy of CGIAR research in Uzbekistan.

According to Robinson and Engel (2008) in Uzbekistan, the duration of frost free period will increase by 8-15 days by 2030. It is estimated that the prolongation of the vegetation period might improve yield of maize, rice and cotton by about 10%. On the other hand, the increase of days with extreme temperatures may negatively affect these crops. Cotton production might decrease by 9-15% in the Bukhara, Kashkadarya, Surhandarya and Tashkent regions unless irrigation water is highly increased. Specifically, rice production is at risk as it needs 20-38°C for proper vegetation and growth.

If farmers plant rice before May 15, its germination is very slow due to cold temperature effect. If they plant in July 1 or after that, germination percentage decreases due to very high temperature. At present there is a small window of opportunity: rice planted between May 25 and June 10 can escape from both, low and high temperatures. But the predicted regional increase of temperature by 3-4°C is a high challenge for research and

breeding (Devkota, 2010). Early springs and late autumns are favorable for potatoes, melons and tomatoes, but these crops will be adversely affected by extreme temperatures in mid-summer. Temperatures above 40°C are unfavorable for melon and watermelon production and may decrease crop yields significantly (Robinson and Engel, 2008). SNC-UZB forecasts yield losses for cotton, winter wheat, alfalfa, rice and vegetables. Grapes can totally fail if temperature is too high in early stages, as already now reported by very experienced farmers in Nurata region. An increase in days above 35°C may cause significant decreases in tomato yields in some regions according to Robinson and Engel (2008). Crop diversification towards more drought and heat tolerant crops might be a strategy to prevent income losses (Christmann et al., 2009).

Livestock production highly depends on vegetation of rangelands and on alfalfa production, but alfalfa requires huge amounts of water for a forage crop. Pastures are already highly degraded – ranging from 24.5% in Samarkand region up to 43.8% in Navoi region (Yusupov, 2009) – and will further deteriorate by climate change. The use of fodder halophytes might be an alternative, but this requires more research (Christmann and Aw-Hassan, 2011). The increase of temperature will have a negative impact on the reproductive capacities of Karakul Sheep (SNC-UZB, 2009). Changing climatic conditions will also expand the area of plant diseases, weeds and pests (SNC-UZB, 2009).

Climate change adaptation strategies

In 2009, ICARDA in partnership with scientists from the national agricultural research system launched a new multi-disciplinary project on the "*Adaptation to Climate Change in Central Asia and People's Republic of China*". The overall objective of the project is to increase knowledge in the field of climate change and drought management, especially on how different ecosystems can adapt to climate variability and extreme climate events. Knowledge helps to achieve sustainable, equitable, and productive use and conservation of natural resources including water, soils and biodiversity within an ecosystem approach, in the context of challenges of climate change. The specific objectives of the research project are:

- analyze the current status of selected agro-ecosystems, their ecological significance and threats posed by human-induced non-climatic factors such as land degradation and inefficient water use
- develop climate change scenarios for the selected agro-ecosystems
- assess the vulnerability of the selected agro-ecosystems to threat resulting from climate change, particularly drought, on the basis of the developed climate change scenarios and to develop scenarios for socio-economic impacts on poverty and food security in the countries in the study area

- develop options and strategies to adapt to climate change so as build climate resilience in development planning in the target countries
- strengthen the capacity to conduct socioeconomic and policy research related to sustainable land management in the region.

In 2010, ICARDA in cooperation with ICBA started the project "*Strategic dual purpose crops and mobilization of underutilized plants as part of a climate change adaptation strategy. Case study in semi-desert, foothill rangelands near Papanaya settlement, Nurata district*", which is funded by the German Ministry for the Environment, Nature Protection and Nuclear Safety, within the International Climate Change Initiative. The project includes methods for rain harvesting, subsurface irrigation for fruit trees, forage shrubs, the development of local climate change adaptation strategies and development of small value chains on dual purpose crops and dye plants. Livelihoods in this region currently depend mainly on production of grapes and livestock (based partly on rangelands and partly on alfalfa). Pastoralists already face forage problems due to rangeland degradation. Also, according to SNC-UZB (2009) alfalfa production may have significant losses in the course of climate change. Therefore forage production has to be diversified and increased.

The Nurata region also suffers from environmental degradation due to overgrazing on foothills, which are also bare of trees. Mudflows, specifically after hail in spring, cause high damages and might increase in the course of climate change. Crop diversification, value chains and increase of forage production are of high importance to sustain agricultural production, food security and income level of local communities. Integrated local climate change adaptation strategies - which include identification of necessary skills to adapt to climate change and favorable areas for collective action on improving local environment and preventing hazards - shall increase resilience of the rural population.

Enjoying "dual purpose" crop dinner

4.3 CAPACITY BUILDING

CGIAR places a special emphasis on building the research capacities of NARS partners in CAC region, including in Uzbekistan. As an integral part of almost each activity and project conducted by CGIAR Centers in Uzbekistan, capacity building is aimed at creating new, and strengthening existing potential of research institutions to ensure their abilities and efficacy in facing the research challenges in reforming the agricultural sector.

Equipment supply

Upon requests received from Uzbek PGR scientists, the Ministry of Agriculture and Water Management of Uzbekistan, USDA, international centers ICARDA and IPGRI had jointly agreed to upgrade the storage facility at the Uzbek Research Institute of Plant Industry (UzRIPI) and turn it into a medium-term storage facility. This will help to conserve quality seeds for 10-15 years. On 19 September, 2002, the newly renovated gene bank facility was formally opened at the UzRIPI by Deputy Minister of Agriculture and Water Management and Director General of UzSPCA Dr. Sherali Nurmatov. ICARDA has provided eight deep freezers for conservation of seeds to the Gene Bank.

Enjoying "dual purpose" crop dinner

Later, under the Project on "*Improving the facilities of Gene Banks in the CAC Region*" (2005-2006), funded by Global Crop Diversity Trust, the following equipment was provided to the Uzbek Gene Bank:

- seed moisture meter (Lab oven) – 1 unit
- plastic seed containers – 18,500 pieces
- Standby Generator – 1 unit
- One PC to each the Uzbek Rice Research Institute, the Cotton Breeding Institute, the Galaaral Branch of Andijan Institute of Grain and Legumes crops under irrigation
- Digital Camera and Power Point Projector to the Uzbek Research Institute of Plant Industry.

The equipment needs have been identified for various components of the Seed Program. Based on those needs, different suppliers were requested to provide their offers to deliver the equipment for the project. Seed Conditioning Plant was installed in Uzbek Research Institute of Plant Industry. Currently, this machine is working well and the farmers neighboring the Institute are processing their wheat seeds for planting. The laboratory equipment for seed testing have been installed in Uzbek State Seed Quality Control and Certification Center and Gallaaral Branch of Research Institute of Cereals and Legume Crops under Irrigated Conditions and are being used to comply with ISTA procedures in near future.

Modern scientific equipment have been provided to 2 research institutes of Uzbekistan participating in the BMZ/GTZ funded project has a component focusing on strengthening research capacities by providing scientific equipment to the national laboratories.

Training young generation of professionals and researchers

With the support from CGIAR centers, more than 90 scientists and young researchers from various research institutions, as well as more than 100 farmers from different regions of Uzbekistan participated in trainings, workshops, conferences and other activities organized at several occasions, both locally and internationally.

The ICARDA initiated BMZ/GTZ funded project has a component focusing on capacity development in wheat improvement through advanced university degrees and short-term specialized trainings for local specialists. Under this project, a young scholar from Uzbekistan is now pursuing an M.Sc. degree in wheat biotechnology at Bonn University in Germany. Moreover, with the support from CG centers, three young researchers from Uzbekistan have been awarded a highly competitive IFAR research grant to conduct innovative research.

In 2007, within the project activities of Bioversity International, the Regional Training Centre on molecular marker was established on the base of the Institute of Genetics and Plant Experimental Biology. In the same year, two National Training Centers were organized - National Training Centre on stone, pome, subtropical crops and grapes at the Uzbek Scientific Research Institute of Horticulture, Viticulture and Winemaking named after R. Schroeder and National Training Centre on nut crops at the Republican Scientific Production Center on Decorative Horticulture and Forestry.

The collaborative capacity building program included research to improve pest management through enhancing capacities of existing bio-laboratories and through a better understanding of landscape ecology and habitat

management. IPM outreach and educational activities have been initiated through Farmer and Student Field Schools in cooperation with NARSs, NGOs and universities. The project component on IPM outreach and education focused on both academic and nonacademic stakeholders through student field schools (SFS) and farmers field schools (FFS) in collaboration with NGOs, government institutes and local universities in Uzbekistan. 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.).

Enhancing IT skills of national staff

A training course on "Crop Simulation Modeling using CropSyst" as a part of the Climate Change project was organized in December 2009. It was attended by 13 participants from nine institutions, namely ICARDA-CAC, Kazakh Institute of Soil Science and Agro-chemistry, Kyrgyz Biotechnology Institute, Tajik Research Institute of Soil Sciences, Central Asian Research Institute of Irrigation (SANIIRI), Uzbek State Uzgipromeliovodkhoz Institute (UZGIP), Research Hydro-meteorological Institute (NIGMI), ICBA and ZEF-UNESCO project. The Scientists of the Central Asian scientific research institutes show lively interest in using the CropSyst model in their national research. This is because they have been familiarized with CropSyst model, and involved in the data collection in the framework of the project. However, taking into account the model complexity, most scientists expressed the wish to have Russian graphical user interface (GUI). At their request the multi-lingual version of the model's GUI has been developed, translated into Russian and Uzbek and successfully tested on the job.

PUBLICATIONS

A number of publications, including magazines, brochures, leaflets, and books have been produced within the framework of the CGIAR Central Asia and the Caucasus Program. Most of those publications refer to specific research project activities, as well as their results and outcomes. Below is a short list of such publications, some of which can be found on the website of the Program at www.icarda.cgiar.org/cac, and others can be available upon request to PFU (please email to pfu-tashkent@cgiar.org):

Periodicals:

- CAC News quarterly newsletter – highlights all activities implemented by CG Centers in the Central Asia and the Caucasus region
- The Russian version of the IPGRI Newsletter – produced by IPGRI-CWANA three times per year
- The Bulletin on Wheat Seed Production – CIMMYT
- The Russian version of Newsletter of Regional Wheat Network – CIMMYT

Books:

- "On-Farm Soil and Water Management in Central Asia" – ICARDA
- "Rangeland of Arid and Semi-Arid Zones in Uzbekistan" (426 pages) – CIRAD-ICARDA
- "Descriptors for Pistachio" (the Russian version) – IPGRI.

Brochures:

- "CGIAR Collaborative Research Program for Sustainable Agricultural Development in Central Asia and Caucasus" – CGIAR-CAC PFU
- "ICARDA in Central Asia and Caucasus" – ICARDA
- "Guide to Wheat Diseases and Pests" – CIMMYT
- "Wheat Grain Quality in Central Asia" – CIMMYT
- "Forest Genetic Resources: IPGRI's Strategic Action Plan" – IPGRI
- "How to Establish a Water Users Association?" – IWMI
- "Social Mobilization and International Development Approach and Strategy" – IWMI
- "Demonstration of Effective Irrigation and Land Management for Increasing Water and Land Productivity" – IWMI
- "Manual on Conservation Agriculture Practices in Uzbekistan" – ICARDA
- "The best local varieties of grape and technologies of their cultivation in Uzbekistan" – Bioversity International
- "Technology of cultivation and multiplication of local varieties and forms and apple and pear in Uzbekistan"- Bioversity International
- "Growing potatoes from True Potato Seed (TPS)" – CIP
- "An improved method to produce rooted seedlings and grow potatoes from True Potato Seed (TPS)" – CIP
- "Potato post-harvest and store management" – CIP
- "Positive and negative selection" – CIP.