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PROGRESS REPORT
July 2014 – June 2016

CGIAR REGIONAL PROGRAM FOR SUSTAINABLE AGRICULTURAL DEVELOPMENT IN CENTRAL ASIA AND THE CAUCASUS

About CAC Program:

The Regional Program for Sustainable Agricultural Development in Central Asia and Caucasus was initiated in 1998, and operates as a consortium of eight National Agricultural Research Organizations, eight Centers of the Consultative Group for International Agricultural Research (CGIAR consortium members) and three additional advanced research institutions (non-CGIAR consortium members). The Program assists the countries in developing the national research systems for sustainably increasing the productivity of crops and livestock through development, adoption and transfer of technologies; natural resource management, conservation strategies and socio-economic knowledge. It fosters cooperation among the countries in the Region and promotes their collaboration with the wider international community. The Program is overseen by a Steering Committee composed of National Coordinators from the eight Countries, and directors-general of the international agricultural research centers. The Program Facilitation Unit (PFU), based in Tashkent, provides policy, technical and administrative support for the implementation of the various activities and projects. It operates under the legal agreement between the Government of Uzbekistan and the International Center for Agricultural arch in the Dry Areas (ICARDA) on behalf of the consortium.

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EXECUTIVE SUMMARY

International Agricultural Research Centers and National Agricultural Research Systems established the CGIAR Regional Research Program for sustainable agricultural development in Central Asia and the Caucasus (CAC) in 1998. The Program has strengthened the Region in achieving the strategic goals of increased productivity, food and nutritional security and rural development through development and transfer of modern agricultural production technologies, while ensuring protection and sustainable use of natural resources.

The Program builds upon many years of applied research that produces results for increasing the productivity of agricultural systems through genetic resources and crop improvement, crop diversification, water management, livestock development, as well as natural resources management, underpinned by socioeconomic and public policy research. The Program comprises of eight CGIAR Centers – Bioversity International, CIMMYT, CIP, ICARDA, ICRISAT, IFPRI, ILRI, and IWMI, the National Agricultural Research Systems (NARS) of Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan, and three additional Advanced Research Institutions: WORLDVEG, – The World Vegetable Center, the International Center for Biosaline Agriculture (ICBA) and Michigan State University (MSU). ICARDA is the convening Center of the Program.

The reporting period (July 2014 – June 2016) has been fruitful in identifying improved winter wheat varieties resistant to soil salinity, frost, and heat. Varieties like 'Buniyodkor', 'Gozgon', and 'Yaksart' in Uzbekistan, and 'Chumon', 'Alex', and 'Ormon' in Tajikistan fared very well during the outbreaks of yellow rust in 2015 and 2016. New wheat varieties helped farmers not only save, but also to earn more. For instance, in Tajikistan, including the Sughd region, more than 4000 farmers benefited from cultivation and seed production of yellow rust resistant wheat varieties under a partnership grant from CRP WHEAT. ICARDA, CIMMYT, and the International Winter Wheat Improvement (IWWIP) distributed 26 International Nurseries of wheat. Similarly, ICARDA distributed 21 barley, 19 chickpea, 17 lentil, 7 fababean, and 3 grasspea Nurseries in the region. Kazakhstan-Siberian Network on Wheat Improvement (KASIB) Facilitated distribution and evaluation of more than 18000 entries in the 14th KRMTSB Nursery across 18 national breeding programs as well as 386 winter wheat lines of IWWIP across 6 locations in South-East, South, and North Kazakhstan.

A seed system analysis was conducted in the Karauzyak district of Karakalpakstan with the aim of improving agricultural seed production in Uzbekistan. The purpose was to study seed systems for cereals, legumes, vegetables, fodders and fruits in the district. Also, to understand the strengths and limitations in terms of infrastructure and availability of quality seed to the farmers, and discuss the ways to improve seed systems for various crops. Considerable progress was made to introduce and promote new varieties of mungbean in the wheat-cotton rotation in the Fergana Valley. The mungbean cultivation demonstrated how double cropping could improve water use efficiency as an effective way of converting evaporation losses from fallow land into the useful crop transpiration, which in turn resulted in the improved water use efficiency, food, and income security. A new project "Beans with Benefits", launched by WORLDVEG in spring 2015, was aimed towards the integration of improved mungbean as a catch crop (planted after winter wheat harvest) in the dryland systems of Central Asia to increase farmers' income and establish more sustainable production systems.

CIP in collaboration with the National Research Partners had advanced the research during the past three years through a project on improvement of the potato varieties as well as improving productivity in vulnerable environments of the CAC. Recent reports include evaluation of the 43 promising clones of potatoes for daylight-neutrality, stress-tolerance, higher productivity, and suitability for the second season cultivation. In a similar fashion, the cultivation of improved vegetable varieties had been addressed by the WORLDVEG-USAID project "Tajikistan Nutrition-Sensitive Vegetable Technologies". The goal was to improve the nutritional outcomes by introducing improved production methods, including greenhouses for an extended season vegetable production and containerized seedling production. Plans for a year round vegetable production and marketing are under development in Andijon, Uzbekistan. This will increase the supply of the vegetables to the households as well as markets, which would lead to dietary improvement of the local population.

Through a series of field training seminars titled "Alternative forage crops for animal feeding in winter" organized by International Center for Biosaline Agriculture (ICBA) in Karauzyak district, the farmers were familiarized with the new forage crops (16 cultivars and improved lines). A similar goal was pursued while introducing an environmentally resilient and nutritionally rich quinoa in order to improve the food and nutrition security of the low-income population living in marginal areas of Central Asia, with target countries Kyrgyzstan, Tajikistan and Uzbekistan. Extensive research by the several member centers of the Regional Program on another drought and salinity resistant plant - licorice - merits a special attention as well. The research had found that the plant helps to decrease the groundwater levels, reduce the soil salinity, and improve the fertility. The trials in the Central Kyzylkum, Uzbekistan, had shown that licorice does well in saline conditions and can be highly valued as livestock feed.

The socio-economic research on the Economics of Land Degradation had demonstrated that cultivation of the halophytic plants in the salinized areas (e.g. licorice), rotation of crops such as alfalfa, mungbean and other legume crops are effective and low-cost interventions that can be undertaken by farmers. The research found an estimated return of about USD 4 over the next 30 years for each dollar invested in land rehabilitation in addition to the major benefits for the environment. Thus, the costs of action

would amount to about USD 11 billion over the next 30 years, whereas the resulting losses may equal almost to USD 50 billion.

The conservation and development of the natural resources through sustainable agriculture have become one of the key research themes in Central Asia and the Caucasus. A project on the sustainable use of fruit tree genetic resources in Central Asia, which aims towards the improvement in the prospects for long-term food security and livelihoods for farmers in Kyrgyzstan, Tajikistan and Uzbekistan, was coordinated by Bioversity International since 2012, by generating and disseminating important knowledge for conservation of fruit and nut tree species. As a result, The Model Forest Farms were established in each of the target-study countries, in conjunction with several workshops organized during 2015 for demonstrating advanced methods of sustainable management of forest genetic resources.

The water conservation and energy resources were addressed with the introduction of drip irrigation in one of the pilot farms in the Karshi district of Kashkadarya, Uzbekistan, by using well-lifted groundwater on 5 ha area for irrigation of cotton. The engineering system of drip irrigation can alleviate many problems of traditional irrigation and increase quality performance of planting, fuel efficiency, lubricating materials, as well as mineral fertilizers. As a result, the pilot farm demonstration served as a concrete example for constantly improving yields, increasing mineral fertilizers efficiency, and reduction in irrigation water applications.

A number of field projects related to a Climate Change was also completed under the framework of the CGIAR Research Program on Dryland Systems. For example, automatic weather station was established in Khorezm, Uzbekistan to collect weather data to estimate evapotranspiration in order to schedule effective irrigation schedule for mung bean, wheat, and cotton. Compared to traditional irrigation scheduling, evapotrans-piration experiments in the Aral Sea Basin using optimum the irrigation scheduling and TDR soil-moisture measurement data demonstrated increases yield by 17% and water productivity by 37%. On the other hand, the adoption of raised-bed planting practices helped to achieve efficiency in water, time, and labor, while enhancing crop yields and minimizing soil degradation.

Actions to combat land degradation which is the key challenge in Central Asia have been supported and promoted by the three-year project to streamline the use, creation, and dissemination of knowledge on sustainable land management (SLM) in five Central Asian countries (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan). To date, the project has collected and described in standard format more than one-hundred SLM approaches and technologies that are applicable to the four main agro-ecosystems of Central Asia: rainfed and irrigated agriculture, mountains and rangelands.

CRP DRYLAND SYSTEMS IN CENTRAL ASIA

CGIAR Research Program on Integrated Agricultural Production Systems for the Poor and Vulnerable in Dry Areas

Centers: ICARDA, WORLDVEG, ICBA, Bioversity International, CIP, IWMI
National partners: USPCA, KIRP, KSRI, TSAU, KRASS, CACAARI, MAMK, TAAS, MAWR
Countries: Central Asia

Four main agro-ecosystems: rainfed and irrigated agriculture, mountains, and rangelands represent the region of Central Asia. The environmental characteristics include variable rainfall and temperature extremes, and the landscape is a mixture of mountains, deserts, and steppes. The water misuse and scarcity, the forest and land degradation, increased salinity and water table are common in the region.

The CGIAR Research Program on Dryland Systems in Central Asia is working towards enhancing food security for the rural poor and ensuring environmental sustainability in dryland agro-ecosystems while enhancing social and gender-equitable development. CRP-DS focuses on target dryland areas/systems, identified by two criteria: (i) those with the most vulnerable populations, and often associated with severe natural resource degradation, environmental variability and social marginalization, and (ii) those with the greatest potential to impact on food security in the short to medium term.

The program helps farmers learn irrigation techniques that will make the most of the region's significant saline water resources while preventing land salinization and degradation. Research in three innovation platforms in CA - Tajikistan, Kyrgyzstan, Uzbekistan - helps farmers to improve water use and manage salinity. The scientists develop crop varieties that are tolerant to drought, heat, and salinity.

Key achievements:

- Over 100 sustainable land management practices were documented in the four main agro-ecosystems in Central Asia: rainfed and irrigated agriculture, mountains, and rangelands.
- Sixteen alternative forage crops were introduced including environmentally resilient, nutritious quinoa; drought and salt-resistant licorice; and mung bean for double cropping.
- Provided robust scientific evidence that investing USD11 billion in land rehabilitation over the next 30 years will prevent losses of almost USD 50 billion.
- Provided information on technologies that added the value to the regional Climate Change Adaptation and Mitigation Program for the Aral Sea Basin (CAMP4ASB) launched by the World Bank.
- An automatic weather station in Khorezm, Uzbekistan was built. It provided data for estimating evapotrans-piration for scheduling irrigation, raising yields by 17% and water productivity by 37%.
- Also, classified smallholder livelihoods in accordance with social and ecological conditions, and assets in irrigated systems in Kyrgyzstan and Tajikistan and agro-pastoral systems in Uzbekistan.
- Identified hotspots of land degradation in Central Asia where investment of limited resources for sustainable land management would yield the most benefits.
- A Rural Women's Learning Alliance in Uzbekistan is leading local community efforts to cope with the negative effects of climate change and land degradation.
- Put in place and Innovation platform involving advanced agricultural institu-tions, national agricultural research systems (NARS), policy makers, the private sector, as well as banking services discussed improving access to credit, markets, and productive inputs, including facilitating dissemination of technical knowledge and advice for reducing post-harvest loss.
- The research evidence indicated that a systems approach to rangeland tenure and inclusive rangeland management plans adapted to local conditions are required.
- In addition, an inventory of 109 varieties of six native fruits, apple, pear, apricot, grape, peach, and pomegranate was put together. Scientists worked with local nurseries to produce planting material of the varieties best adapted to local conditions. Nurseries raised and supplied 729,000 saplings to local growers. In 2015, 290 farmers obtained saplings of the fruit trees most suitable for local conditions.
- Scientists showed that, even in the very saline, waterlogged soils widespread throughout the region, there are many salt-loving species – halophytes – and salt-tolerant non-traditional crops that produce good quality forage and food grains.
- Raised-bed and cutback furrow irrigation technologies demonstrated the enhancement of water productivity, energy use efficiency and mitigate salinization for irrigated based systems in Central Asia.
- The Water Consumer Association was established in Uzbekistan to conduct field experiments for assessing water governance on a farm level. A joint action between World Vegetable Center (WORLDVEG) and WCA developed improved varieties of mungbean under different irrigation technologies.

GENETIC RESOURCES AND CROP IMPROVEMENT

Germplasm Conservation and Enhancement in Wheat, Barley and Food Legumes

Centers: ICARDA, CIMMYT, IWWIP
National partners: KBRIGLC, UzRIPI
Funding source: ICARDA, CRP WHEAT
Project duration: On-going
Countries: CAC Region

Distribution of International Nurseries

Evaluation of improved breeding lines, identification of new improved varieties and out-scaling of selected varieties of wheat, barley, and chickpea were the major activities accomplished in 2014-2015 and 2015-2016 crop seasons. Over 2000 advanced breeding lines of wheat, barley, chickpea, lentil, fababean and grasspea were distributed to the national programs in the eight countries, following the request by the national researchers. The number of nurseries included 26 wheat, 21 barley, 19 chickpea, 17 lentil, 7 fababean and 3 grasspea. More than 160 sets of different nurseries were distributed in the region in 2014-2015 and 2015-2016 crop years.

Major Production Constraints

A spring frost occurred in the last week of March and first week of April 2015 causing wide scale damage to the winter and spring wheat, including the food legumes in Uzbekistan, Kyrgyzstan, Tajikistan, and southern Kazakhstan. Winter temperatures were historically high during 2015-2016 season resulting in early epidemic development of wheat yellow rust in February 2016 that lasted through the middle of May. The long duration of epidemics occurred due to wet and cool spring months. This required multiple sprays of fungicides on yellow rust susceptible winter wheat varieties.

New varieties

Seven winter wheat varieties were released from the germplasm provided by the IWWIP (Gizil Bugda and Fatima in Azerbaijan, Lomtagora-126 in Georgia, Azhara in Kyrgyzstan, and Shokiri, Faizbakhsh and Mohinav in Tajikistan). Similarly, nine new varieties of winter wheat were submitted to the State Variety Testing Commission (1 in Azerbaijan, 1 in Georgia, 1 in Kazakhstan, 2 in Kyrgyzstan, 2 in Tajikistan, 1 in Turkmenistan and 1 in Uzbekistan). Two new varieties of chickpea selected from germplasm from ICARDA (Garaja in Azerbaijan and Vostok in Kazakhstan)

Winter wheat resistant to yellow rust

There were severe, long epidemics of yellow rust in early months of 2016 that severely affected winter wheat production. This provided an opportunity to identify resistant varieties and select among breeding lines. Two varieties (Gozgon and Buniyodkor) showed high level of resistance to yellow rust in 2016. Three varieties (Alex, Ormon, and Chumon) were resistant to yellow rust in the Sughd region of Tajikistan under severe epidemics of yellow rust.

Photo 1. Selection of winter wheat varieties for resistance to yellow rust, Kibray, Uzbekistan, 2016

The international nurseries of winter wheat were evaluated for yellow rust resistance. More than 50 improved lines that were resistant to yellow rust were selected in 2016 for further evaluation.

Traveling seminar:

ICARDA in partnership with Kashkadarya Research Institute and Uzbek Research Institute of Plant Industry organized wheat breeders' traveling seminar from May 19-21, 2016, Which was attended by 12 young wheat breeders from Uzbekistan. The group visited the experimental wheat fields in the Kamashi, Karshi, Gallraral and Kibray, to learn about the activities and improved selected varieties.

Kazakhstan-Siberian Network on Wheat Improvement (KASIB)

Centers: CIMMYT
Donors: CRP Wheat; Kazakhstan State Budget Program BP212 'Applied Research in Agriculture'
Project period: 2015-2017
Countries: Kazakhstan

Kazakhstan-Siberian Network on Wheat Improvement (KASIB) established by CIMMYT in 2000 currently unites 21 breeding programs of Kazakhstan, Western Siberia, Ural, Altai, and Volga regions, covering the territory of more than 20 million ha of spring wheat. In Kazakhstan, in the countries of Central Asia and the Caucasus (CAC), the International Winter Wheat Improvement Program (IWWIP) is actively and effectively realized. Thanks to the IWWIP there is significant increase of the level and volume of breeding activities with the following achieved:

- The 16th KASIB nursery consisted of 51 spring bread and 25 spring durum advanced wheat varieties/lines from Kazakhstan and Russia tested in 21 Breeding Programs of the Eurasia region, analyzed, and data distributed to all KASIB Network partners. The KASIB genotypes out yielded local checks by 30-40% in the epiphytotic 2015 year because of higher resistance to leaf and stem rusts, as a result of many years of CIMMYT and KASIB partners work on wheat improvement in the high-latitude North Kazakhstan and West Siberia region.

- More than 18000 entries of 14th KRMTSB Nursery evaluated in 18 national breeding programs; 28 spring wheat lines - in the yield trial (YT) stage, and 11 advanced lines in seed multiplication stage of the breeding process. For the further wheat improvement process 117 crosses between local varieties and many genotypes from the worldwide genepool was made. 220 hybrids and 800 bread-spring wheat populations were obtained. An annual bulletin of KRMTSB and KASIB results were prepared and distributed to the cooperators.
- 386 winter wheat lines of IWWIP distributed to cooperators and evaluated at six locations in Southeast, South, and North Kazakhstan. The best lines of winter wheat in YT stage out yielded local checks by 30-50%. Two new winter-bread wheat varieties submitted in 2015.

Adoption of yellow rust resistant winter wheat varieties
Centers: ICARDA, CIMMYT, IWWIP
National partners: KBRIGLC, UzRIPI
Donors: CRP Wheat
Project period: 2013-2016
Countries: Uzbekistan and Tajikistan

Wheat production in Central Asia is seriously constrained by frequent occurrence of yellow rust fungus. Large-scale cultivation of susceptible varieties is one of the major factors contributing to continuous scourge of yellow rust in the region. There are a number of yellow rust resistant winter wheat varieties released in the region through international collaboration. However, a lack of accelerated seed multiplication plan has been a huge bottleneck in the adoption of the resistant varieties. This project funded by CRP WHEAT under partners' grant scheme aims at accelerating adoption of the yellow rust resistant winter wheat varieties in Uzbekistan and Tajikistan.

Five yellow rust resistant winter wheat varieties in Uzbekistan (Yaksart, Elomon, Gozgon, Hazrati Bashir and Buniyodkor) and three yellow rust resistant winter wheat varieties (Alex, Ormon and Chumon) in Tajikistan were used in the study. In the first year 126 ha seed multiplication was planted which increased to 2,073 ha in the second year. In the third year (2014-2015) 31,048 ha (17520 ha in Uzbekistan and 13528 ha in Tajikistan) were planted which included both seed multiplication and commercial production. There were over 4000 participant farmers in 2014-2015 in the out-scaling of the yellow rust resistant varieties in Tajikistan. In Uzbekistan, 4,700 t seed was produced by KRIGBSP, which had been planted on more than 18,000 ha, by 72 farmers and seed producers for 2015-2016 crop season. Additional area was planted with the Government plan on seed multiplication and out scaling in Uzbekistan. In Tajikistan, farmers are allowed to produce their wheat seeds that can be used for further planting. To facilitate seeds processing three units of seed cleaner were procured, two in Uzbekistan and one in Tajikistan.

Photo 2. Field day organized near Khujand, Tajikistan to demonstrate the performance and seed multiplication of yellow rust resistant varieties.

A workshop was organized to assess project progress and share the findings with other wheat improvement programs in Central Asia and the Caucasus. Yellow rust resistant varieties are increasingly becoming available to the farmers to replace susceptible cultivars in each country of the region.

More than 30 winter wheat varieties (Uzbekistan-5, Tajikistan-7, Azerbaijan-5, Georgia-5, Kazakhstan-5, Kyrgyzstan-4) possessing good level of resistance less than 20% severity) have been released in recent years in the CAC region. The area of cultivation of yellow rust resistant varieties is increasing in each country. In particular, Uzbekistan has significantly progressed in increasing area (40% of total wheat area) under cultivation of yellow rust resistant varieties.

Identification of stress (frost, salinity and heat) tolerant varieties of cereals and legumes through on-farm demonstration
Centers: ICARDA, CIMMYT, IWWIP
National partners: KRICH, KBRIGLC, UzRIPI
Donors: Russian Government, CRP-DS
Project period: 2013-2016
Countries: Uzbekistan

Frost, salinity, and heat are important constraints to the winter wheat production in the Aral Sea zone of Central Asia encompassing parts of Uzbekistan, Turkmenistan and Kazakhstan. Most of the commercial varieties of the winter wheat in the region lack adequate level of tolerance to these stresses.

Around 800 improved experimental lines and released cultivars were evaluated in the Aral Sea Action Site in the Karakalpakstan and Khorezm provinces of Uzbekistan. To determine the effect of seeding depth on frost injury, 150 genotypes were planted at 2 and 4 cm depths in the second experiment.

Overall, the seeding at 4 cm depth resulted in 71% survival compared to 41% at 2 cm.

Photo 3. Differential frost survival of 150 genotypes planted at 2-cm (left) and 4-cm (right) depths.

The project activities successfully identified salinity, frost, and heat tolerant winter wheat varieties, and heat tolerant spring wheat, chickpea and mungbean varieties.

Two winter wheat varieties (Aral and Amudarya) with tolerance to medium level salinity, frost and terminal heat, and producing higher yield than the local cultivars, have been submitted to the State Variety Testing Commission in Uzbekistan. These varieties originate from IWWIP nurseries evaluated in Uzbekistan.

Planting wheat at 4 cm depth better protects winter wheat against frost damage compared to normal seeding at 2 cm depth currently is being adopted by the farmers.

Winter wheat-mung bean and winter wheat-potato annual crop rotations successfully demonstrated both in vulnerable areas (the Aral Sea Region) and in sustainable intensive systems (the Fergana Valley). Four participant farmers in the Fergana Valley of Uzbekistan were able to improve their farm income considerably from field demonstrations of winter wheat-mung bean crop rotation. This was also realized in the Aral Sea Action Site in Uzbekistan and the Sughd province of Tajikistan. Cultivation of mungbean as additional heat tolerant crop during hot summer season after wheat harvest not only increases farm productivity, but also improves soil health, family nutrition, and on-farm employment.

Capacity development:
The capacity of around 120 farmers was strengthened with information related to the options of new wheat and legumes varieties suitable to their farming system and improved production practices. Thirty-four young researchers obtained training in conducting field experiments using modern scientific methods.

Improving Seed System to Make Available Superior Quality Seed of Cereals, Legumes and Forage Crops
Centers: ICARDA, CIMMYT, ICBA, IWWIP
National partners: KRICH, KBRIGLC, UzRIPI
Donors: Russian Government and CRP-DS
Project period: 2013-2016
Countries: Tajikistan and Uzbekistan

The establishment of a seed system platform that is a goal set under the seed systems activity in central Asia that can help rural farmers to have access to quality seed of improved varieties of different crops they grow and related information on the package of production.

Seed systems analysis
In order to conceptualize the seed-system platform assistance, the seed expert from ICARDA was consulted to advice on how to proceed on this issue. The requirements to establish a functional seed system were outlined. Information was collected to understand the different agencies involved in the seed chain of different crops. The agencies involved in the seed production of major food crops in the Karauzyak district are diverse. The seed system in the Karauzyak district is well organized to meet farmers' needs; however, some strengthening through additional equipment for seeding and processing is needed. For other food crops that are minor in nature except paddy, modest infrastructures are needed for a functional seed system to make available quality seed and related information to the farmers.

Seed production
Forty farmers (39 men and 1 woman) participated in the seed production of two new varieties of wheat and one new variety of barley on 64.8 ha and 2.5 ha, respectively in Sugd, Tajikistan. The participant farmers produced 241 tons of quality seeds of the 2 new varieties of wheat and 6.7 ton of 1 new variety of barley.

The farmers were able to grow two new wheat varieties without a fungicide application, compared to the local varieties, which are always sprayed with a fungicide to control yellow rust. The activity on using quality seed of yellow rust resistant varieties without using fungicide has already seen increase in the area from 65 ha in 2014-2015 to more than 500 ha in 2015-2016.

Capacity development
Two events were organized as Farmers' Field Days to demonstrate the seed production of the new wheat and barley varieties. The capacity of more than 53 farmers, seed producers, and policy makers were strengthened through observations and distribution of information on production practices of high quality wheat, barley and chickpea seeds.

A wheat variety catalog highlighting important traits of each released variety was prepared.

Progress towards impact
The activity on using quality seeds of yellow rust resistant varieties without using fungicide has already seen increase in area from 65 ha in 2014-2015 to more than 500 ha in 2015-2016. The participant farmers have saved USD 130/ha, on fungicide by growing a yellow rust resistant varieties and not spraying the crops, coupled with higher yield of the new varieties compared to the locally grown disease susceptible varieties. These double advantages could see a fast adoption rate of new wheat varieties in the Sughd province of Tajikistan in coming years.

Promotion of high yield forage crops in short-farming rotation system under sprinkler irrigation on marginal lands
Center: ICBA
National partners: SPCA, KRRI
Donors: IDB, MARK
Project period: 2014-2016
Countries: Uzbekistan, Kazakhstan

Based on multi-years testing and breeding of pearl millet ICBA and ICRISAT germplasm the Corn Uzbek Station, Scientific Production Center for Agriculture in Tashkent region in 2015 led to the releasing of a new variety of pearl millet 'Hashaki 1'. This variety has been approved recently by the State Variety Testing Commission of Uzbekistan and released after successful evaluation in different agro-ecological zones of Uzbekistan with different soil salinity. 'Hashaki 1' yields up to 30% more crop compared to a local proso millet. In addition, it matures earlier than other tested varieties and can be used as forage for all kinds of animals.

In 2016 the new promising dual purpose, high-yielding, salt tolerant and rich in sugar stem variety of sorghum named 'Keshen' was released as a result of the selection of the high productive populations of improved lines (ICRISAT) and local varieties (Uzbekistan 18) during 2010-2015 at experimental station of the Kazakh Research Rice Institute in Kyzylorda. 'Keshen' is distinguished by its soil salinity tolerance, re-growing ability, and high sugar content in the stems, calculated before and during the plants flowering stage. It can be grown as the main crop in early spring or as the second crop in pure stands or mixed with different salt tolerant legumes after the winter wheat harvest or in rice rotation systems.

Cross-regional Partnerships for Improving Food and Nutritional Security in Marginal Environments of Central Asia
Centers: ICBA
Donors: IDB
Project period: 2015-2017
Countries: Uzbekistan, Kyrgyzstan and Tajikistan

The project is targeting crop diversification, introduction of new climate-proof, and salt tolerant crops like Quinoa (*Chenopodium quinoa* Willd.) in marginalized environments, which are influenced by multiple abiotic and biotic stresses. Seeds of five quinoa lines multiplied at ICBA compared with only 3 FAO quinoa lines, which were disseminated for field trials in Uzbekistan, Kyrgyzstan and Tajikistan. Local adaptation and yield potential quinoa cultivars were evaluated at demo field trials across 12 regional locations under different agro-ecological production landscapes. One of the key components was the seeds' multiplication due to its commercial importance. The top performing two varieties/Q5 (Uzbekistan and Kyrgyzstan) and Q2 (Tajikistan) lines of Quinoa germplasm were selected for breeding and further dissemination in Central Asia.

Photo 4. Quinoa cultivar at maturing stage (TSAU site of ICBA).

Quinoa varieties exhibited about 30% dry fodder yield and 25% seeds, which was more than local annual chenopods. A prototype of seed threshing and cleaning machine was developed and successfully tested by Tashkent Agrarian University (TAU), Uzbekistan. TAU has also took on seeds' multiplication of the five ICBA lines and produced up to 50 kg of seeds in each to be able to meet the future needs of the project.

In Kyrgyzstan, the Innovation Center of Phytotechnologies and partners from Issyk-Kul region promote quinoa cultivation and seed production. A yield visit was organized on 22 July 2016 to the farmer's field where quinoa is being grown on 0.35 ha which included 5 ICBA lines and 3 other varieties were provided by FAO. Kyrgyzstan, virtue of FAO's collaboration since 2014, is also ahead of other countries in terms of integrating quinoa into their local food system. Thus, products were developed substituting barley with 10% quinoa in the national drink (Bojo) and with 5% quinoa flour in making bread.

Tajikistan Nutrition-Sensitive Vegetable Technologies
Centers: WORLDVEG
National partner: RIHVTAAS
Donors: USAID
Project period: 2014-2017
Countries: Tajikistan

Under the U.S. Government's Feed the Future (FTF) Initiative, this project is aimed to improve nutrition outcomes by introducing improved production methods, including greenhouses for the extended season vegetable production, containerized seedling production, and introducing improved, nutritious vegetable varieties. These technologies go hand-in-hand. Greenhouses are the cornerstone of extended season production allowing for earlier and later production of vegetables in FTF's geographical focus area of Khatlon Province of Tajikistan.

In 2015, 12 small size greenhouses (2.5x8 m) were constructed on the household plots with the involvement of women in 11 districts of Khatlon Province. There were 35.000 healthy seedlings of more than 10 new varieties, and lines, and hybrids of vegetables were grown on a new

technology in pots and containers for purpose of providing households and farmers with high quality seedlings.

In 2015, a new technology was introduced for cultivation of vegetable crops in the 13 newly established greenhouses (measuring 5x20 m), promoting the harvesting of high yield tomatoes 17 kg/m2 and sweet peppers 12.9 kg/m2 in comparison with the existing backyard greenhouses.

In 2016, the project continued activities for improvement of the technologies used in the existing greenhouses and support of new farmers in greenhouse production and related technologies. A total 18 new and improved greenhouses with drip irrigation system (6x24m) were constructed in 2016. In the period of January-March, 2016 the commercial farmers cultivated 335,000 healthy vegetable seedlings, including 80,000 sweet pepper, 135,000 tomato and 120,000 cucumber.
In 2015, the project provided technical support to seedling producers by using 12 greenhouses. The provided technical support includes a new technology on the preparation of healthy organic soil substratum for the production of containerized seedlings in the greenhouses. In addition, the introduction of new vegetable varieties, lines and hybrids, including 15,790 tomato seedlings of 13 varieties, lines and hybrids; 10,605 sweet pepper seedlings of 7 varieties, lines and hybrids, and 2,897 eggplant seedlings including five WORLDVEG lines.

The project assisted 20 new FAST (Farmer Advisory Services in Tajikistan) farmer groups in the higher elevation zones of Yavan, Khuroson and Jomi districts to prepare 15,000 tomato and sweet pepper seedlings in collaboration with local seedling producers. In comparison with existing traditional vegetable seedling production, the project's support for new containerized production in greenhouses has great potential for the timely preparation of seedlings and increasingly high quality vegetable production. Local farmers ascertained that by using the new technologies the tomato seedlings were ready for planting 45-50 days after seed sowing, and sweet peppers and eggplants were ready after 55-65 days.

As a result, within the project activity in 2015 through March 2016, a total of 43 greenhouses were constructed and distributed to householders in the Khatlon province. This includes12 greenhouses (2.5x8 m), 13 greenhouses (5x20 m), and 18 new improved greenhouses with drip irrigation system (6x24m) which allowed the production of 370,000 high qualitative seedlings of vegetable crops of various varieties and hybrids of sweet pepper, tomato and cucumber.

In 2015, a wide range of training for farmers and households was conducted in 12 districts of Khatlon. A total of 849 participants (514 males (60.5%) and 335 (39.5%) females) attended.

Photo 5. New designed greenhouse with drip irrigation.

Improvement and Diversification of Vegetable Crops
Centre: WORLDVEG
National partners: SCVMIC, VSRI, LEPL, KRIPVG, KRIA, RIHVG, SIAT, IVMCP
Donor: WORLDVEG
Project period: 2014-ongoing
Countries: CAC Region

In 2014-2015 a total of 231 accessions (germplasm from WORLDVEG's gene bank and improved lines from breeding units) of nine vegetable crops were introduced into 8 countries of the CAC region, including 173 accessions of five species in 2014 and 58 accessions of nine species in 2015. All these accessions were evaluated on biological, morphological and marketability traits under different soils and climatic conditions. As a result, promising accessions and lines (early maturing, high yielding, resistant to diseases, good fruit quality, etc.) were selected in each country and seeds were multiplied for further research work. In 2016, the WORLDVEG's Regional Variety Trial is continuing in all eight countries of CAC on 69 accessions of nine vegetable crops.

Between 2014-2016, a total of 24 new varieties of 8 vegetable species are under state variety trials and 19 new varieties of 12 vegetable crops, including tomato, sweet and hot pepper, eggplant, vegetable pea, vegetable bean, vegetable marrow, custard squash, lettuce, basil, celery and mung bean have been released in the CAC countries.

Between 2015-2016, four WORLDVEG tomato accessions were studied as rootstock for three local tomato varieties (Gulkand, Ave Maria and Marvorid) in RIVMCP, Uzbekistan. As a result, 2 accessions were revealed as promising rootstock for a tolerance to soil diseases and the promoting of an increase of a tomato yield and fruit quality. Total WORLDVEG's 70 tomato accessions/lines were studied as rootstock for grafting of local variety TMK 22 for an open field, with 8 promising rootstocks revealed.

Research on grafting of one hybrid (Big Biff) onto WORLDVEG four tomato accessions were conducted in SCVMIC, Armenia. As a result, one accession was revealed as the best rootstock. Using this environment friendly biologi-

cal method will allow farmers to increase productivity and quality of the tomato production.

Photo 6. Exhibition of publications and samples of newly released vegetable varieties at the VIII Steering Committee Meeting of CACVEG, Tashkent, Uzbekistan, 10-12 November 2015

Promotional and anti-diabetic activities were conducted on introducing two new varieties into a diet: 'Fayz Baraka' and 'Mujiza' of non-traditional species *Heliantus tuberosus* L. (Jerusalem artichoke, girasol or topinambour) released in Uzbekistan. Since November 2014 topinambour was officially included in the list of crops for a consumption by the Ministry of Human Health Protection of Uzbekistan.

Demonstrational vegetable gardens (9 crops) were initiated in various soil and climatic zones of Uzbekistan, including a salted area of the Aral Sea Basin (Karauzyak), a piedmont area (Bostanlyk), a step area (Ramitan) and a valley (Fergana). A total of 185 nutritional seed kits were distributed. A total of 230 kg seeds of 4 new varieties were multiplied by householders. The activities promote home, school, and community gardening, cultivating and advocate more nutritionally effective use of vegetables.

Introduction of nutrient non-traditional vegetables such as daikon, vegetable soybean and yard-long beans was conducted to improve the diets of local population. Between 2014-2016 more than 60 new recipes of seven non-traditional crops were introduced into vegetable production and have been elaborated on and presented to various workshops and training sessions.

Between 2014-2016 five various training sessions were conducted and were dedicated to increased consumption of vegetables and nutritious/diverse diets. A total 441 people participated, including 338 female (77%) and 103 male (23%). The "Farmer's Days" sessions were conducted annually and total 800 (35% women) participated.

New varieties of Mungbean for Improved Crop Rotations
Centers: ICARDA, WORLDVEG
National partners: UzRIPI, WUA
Donor: Russian Government
Project period: 2014-2015
Country: Uzbekistan

Between 2014-2015 ICARDA/WORLDVEG activities were conducted jointly on implementation of CRP 1.1. Dryland System CGIAR Research Program on Integrated Agricultural Production Systems for the Poor and Vulnerable in Dry Areas. During the project period, the following was achieved:

- Between 2014-2015 four adaptive trials of released mungbean varieties such as Durdona, Zilola, Marjon and Turon were initiated in the Fergana Valley (Kuva district of the Fergana region and Markhamat district of the Andijan region) of Uzbekistan. Farmers welcomed new mung bean varieties in wheat-mung bean creating system. In 2016 the area under WORLDVEG new mung bean varieties were increased in Uzbekistan up to 1000 ha.
- In 2014 seeds of promising four mung bean varieties (2150 kg), vegetable soybean variety "Sulton" – 1000 kg and yard-long bean variety "Oltin Soch" variety – 10 kg were multiplied for distribution to farmers.
- In 2015 four mungbean seed production farms were created in Kuva district of Fergana region of Uzbekistan to produce elite seeds on the area 8 ha and in 2016 the area for mungbean elite seed production in five farms was increased up to 28 ha which will allowed them to have qualitative mung bean seeds for further sowing of around four thousand hectares.
- A total of three training sessions within CRP 1.1. Dryland System were successfully conducted. A total of 56 trainees participated, including 20 (36 %) women and 36 men (64%).

"Beans with Benefits": Integrating improved mungbean as a catch crop into the dryland systems of South and Central Asia for increased smallholder farmer income and more sustainable production systems
Center: WORLDVEG
National partners: UzRIPI,
Donors: BMZ-GIZ
Project period: 2015-2018
Countries: Taiwan, Pakistan and Uzbekistan

The aim of the project is to improve farmers' income and increase the sustainability of dryland production systems in South and Central Asia, conducting of trials and adoption of improved farmer-preferred mung bean lines with increased resistance to viruses and bruchid pests. As well as a resilience to environmental stresses, mung bean production technologies for strengthening increased soil fertility and crop production; establishment of a mung bean learning alliance in each target country, training of NARS, building of farmers' capacity in soil improvement and using mung bean as a catch crop.

In 2015, a total of 295 mungbean accessions received from WORLDVEG were studied, including 47 accessions during the spring term of sowing, and 247 accessions during the summer term of sowing. Promising accessions were revealed.

In 2016, the best 25 accessions were evaluated in three zones of Uzbekistan in Karakalpakstan, Tashkent and Fergana regions. In addition, 63 new mungbean accessions were studied.

Potato Production Support and Research to Improve Food Security in Tajikistan
Centers: CIP
National partners: RIHVTAAS, IBPPG Donors: USAID
Project period: 2014-2016
Countries: Tajikistan

Potatoes, an important staple in Tajikistan, are a good source of vitamin C and potassium, but they are relatively low in iron and zinc. To this end, CIP conducts trials and studies on how to increase the amount of iron and zinc in the potato's tuber through breeding of fortified potato varieties. The introductions of three stress-resistant, high-yielding genotypes are to be compared with locally used commercial varieties on 77 demonstration plots in seven districts of Khatlon province.

The average yield of three CIP genotypes (CIP 720189, CIP 392797.22, CIP 392780.1,) was 35 tons/ha for the first growing season and 25 tons/ha for the second growing season. While the average yield of the local varieties was 25 and 15 tons/ha respectively under the same conditions.

Farmers in Khatlon have poor access to quality seeds for the second growing season. In connection, CIP has developed and introduced a method of artificially breaking dormancy of tubers. The method allows farmers to use part of the potato harvest from the first growing season as seeds (by not difficult artificial treatment) of freshly harvested tubers.

Farmers are oriented on the production of early potato for fresh market. Early potato production technology allows them to produce an early harvest 35 to 37 t/ha of CIP genotypes in mid-May while in standard culture harvested at the beginning of June. Introduction of early potato production under the plastic film led to an additional income calculated at 15,000 somoni/ha.

Thirty-one on-farm training seminars on early potato production technology, artificially breaking dormancy, potato cultivation, and harvest to improve local farmer-based seed production were conducted in the framework of the project. In total, 720 smallholder farmers were trained.

In 2015 a range of training sessions for farmers and households were conducted by WORLDVEG in 12 districts of Khatlon region. A total of 849 participants 514 males (60.5%) and 335 (39.5%) females attended.

Improved potato varieties and water management technologies to enhance water use efficiency, resilience, cost-effectiveness, and productivity of smallholder farms in Central Asia
Centers: CIP and IWMI
National partner: IVMCP
Donors: GIZ
Project period: 2014-2015
Countries: Uzbekistan

During the project period, several research studies were conducted on the evaluation of 36 CIP-bred clones and 18 CIP-bred TS families. Of 36 advanced clones evaluated, 27 showed tolerance to drought with high productivity under long-day conditions in the highlands of Uzbekistan (Pskem); 15 of them showed superior performance in comparison with the controls; 8 clones showed tolerance to drought with high productivity under long-day conditions in the lowland of Uzbekistan (Tashkent), showing superior performance to the controls. Cumulative analysis across locations and years identified 5 clones tolerant to drought with high productivity under both highland and lowland climate conditions, and these have since been recommended for registration at the national level.

Photo 7. Cooking quality test of CIP-bred potato clones at IVMCP, Uzbekistan, October 12, 2015.

According to the results of cooking quality tests, 2 clones were found with best cooking quality characteristics, including the taste and the texture when grown in both lowland and highland conditions: CIP 392797.22 and CIP 397073.16. CIP 392797.22 stands out with high productivity and the best quality for both climate zones of Uzbekistan. The project therefore recommended this clone for registration in the national list. Its resistance to viruses is a plus, since this characteristic can contribute to farmers' ability to produce and maintain disease-free seeds upon which potato productivity crop depends.

Additionally, IWMI organized the field trials in Andijan and Fergana provinces of Uzbekistan. The experiments were entirely carried out under farming conditions and took place in two farms: 'Sarkor', located in Fergana and 'Baht Taronasi', which is located in Andijan. Results indicated that, when the water deficit was high the yields were very low. However, moderate deficit irrigation did deliver decent yields compared to conventional full watering.

Similar results were obtained when the researchers looked into the economic costs. Gross margins were usually higher under a conventional and moderate deficit irrigation, rather than under extreme treatments. The researchers also noted that under extreme water deficit treatments, farmers could still make more money growing potatoes than other conventional crops like cotton.

Conservation for diversified and sustainable use of fruit tree genetic resources in Central Asia
Centers: Bioversity International
National partners: KNAU, RIHVTAAS, RSPCOGF
Donor: LIST
Project period: 2012-2016
Countries: Kyrgyzstan, Tajikistan and Uzbekistan

The project is aimed to advance the conservation of genetic resources of the three fruit and nut tree species – apple, apricot, and walnut. This project combines technology and variable approaches in order to avoid the loss of the valuable resources including the genetic adaptations that maybe unique to this areas and to explore the potential. Also, by using combination of technology and approaches to understand patterns of phenotypic variability in nutrition and its associated genetic diversity, as well as to identify locations where valuable genetic resources are grown, to evaluate threats and recommended approaches and guidelines for their conservation.

630 nut and fruit samples and 1,950 leaf samples of walnut, apple, and apricot trees were collected from the wild and home garden populations in the different regions of Kyrgyzstan, Tajikistan, and Uzbekistan. Genetic diversity analyses were completed for all walnut and apple tree samples.

Photo 8. Sampling in walnut populations in Tajikistan.

The Young Researchers from the Kyrgyz National Agrarian University, Tajik Institute of Horticulture including the Vegetable Growing and Uzbek Scientific and Production Center of Ornamental Gardening and Forestry who were trained on use of the molecular markers in the analysis of fruit trees diversity in the Research Centers in Tashkent, Uzbekistan and in Luxembourg.

Model Forest Farm initiative was launched in Karalma Forestry Enterprise in Kyrgyzstan (KAMFF) and the Sijjak Forestry Enterprise in Uzbekistan. This component of the project identifies and demonstrates sustainable management approaches of the fruit and nut tree resources, while improving livelihoods of local people. Establishing similar Model Forest Farm in Tajikistan will take place in the second phase of the project.

The semi-structured and structured interviews and focus group discussions were conducted in Karalma Forestry Enterprise, Kyrgyzstan for the qualitative studies in order to provide empirical evidences on the relationship between gender norms, agency, and innovations in the natural resources management. This study identifies gender-based constraints that need to be overcome in the different contexts to achieve lasting and equitable improvements in the natural resources management.

Improving the availability and use of diverse seed and other planting materials to reduce vulnerability and improve food security for small holders in vulnerable ecosystems
Centers: Bioversity International
National partners: UzRIHVW, TSAU, IVMCP, UzSPCA, FUU
Donor: SDC
Project period: 2013-2016
Country: Uzbekistan

The project was aimed to improve the production of the seed and planting materials of vegetable and fruit crops in Uzbekistan, increasing the knowledge and skills of farmers, strengthening collaboration between government organizations and farmers, developing recommendations on improving legislative basis related to protection of rights of farmers' seed-producers and nursery keepers. Achieved results are as follows:

- Four project site regions were identified, where quality seed and planting materials are produced. These regions are: the Northern region covering Karakalpakstan and Khorezm province; Sothern region covering Surkhandarya province; the Fergana Valley region covering Namangan and Fergana provinces and Central region covering Samarkand and Tashkent provinces.
- Focused six fruit and vegetable crops, including apple, apricot, grapevine, pomegranate, onion, and carrot.
- Expedition surveys to project sites were conducted and key farmers producing quality planting materials and seeds were identified.
- Training workshops and round table discussions were organized with farmers of all project sites dedicated to propagation, certification, quality of seed/planting materials, role of women in agricultural production, local assortment of fruit and vegetable crops, creation and maintenance of the portfolio of varieties in project sites.
- Developed and published brochures including instructions and recommendations for production of quality planting materials of fruit crops, and on quality seed production of vegetable crops in Uzbek and Russian languages. Including booklets about varieties,

diseases, production of vegetables and seeds of onion and carrot, and cultivation of planting materials of apple, apricot, grapevine and pomegranate.
- Alternative ways were developed and recommended for acceleration of promotion of local varieties through studies on demonstration plots according to the methodologies of State Committee for testing of the varieties.
- Impact analysis of the project was conducted on the level of diversity, production volume of seeds/planting materials.
- The farmers were provided with tools, stock, and materials for works in the orchard, vineyard, nursery, and seed producing plots and seed banks.

Photo 9. Fair of planting materials of fruit crops and grapevine, organized in Fergana valley.

- Exhibitions of the agricultural crops/products were organized with the samples of the best local varieties of carrot and onion, planting materials of apple, apricot, grapevine, and pomegranate.
- A workshop on legislation of the Republic of Uzbekistan related to the seed systems development in the country was organized at the national level. During the workshop, the recommendations for improving National legislation were agreed upon. The analysis of legislation was conducted related to production of seeds and planting materials of vegetable and fruit crops.

CROP DIVERSIFICATION

Conservation Agriculture Adoption and Crop Diversification in Kazakhstan
Centers: CIMMYT
Donors: Kazakhstan State Budget Program BP212 'Applied Research in Agriculture'
Project period: 2015-2017
Countries: Kazakhstan

With the joint efforts of Kazakhstan scientists, farmers, and government, including the international cooperation with FAO, ICARDA, World Bank, the areas under no-till have been increasing from virtually none in 2000 to 2.15 mln ha in 2015.
In 2015 crop season no-till in Kazakhstan was practiced on at least of 2.15 mln ha. With this Kazakhstan is in the list of top 10 countries with the largest areas under no-tillage in the world. In South-East Kazakhstan, one of the main winter wheat growing regions, CA area in 2015 in comparison with 2014 had increased by 10%. The total size of the cropping area under CA reached up to 150,000 ha. The winter wheat yield gain in favor of CA technology had averaged 1.1 t/ha in irrigated and 0.2 t/ha in rain fed conditions.

One hundred ninety nine genotypes of maize and sorghum originating from different countries were evaluated in main agricultural regions of Kazakhstan (Southeast, North, and West).The best 50 productive maize and sorghum varieties and lines were selected, and appropriate agro-technologies were developed for an on-farm production of these crops.

Ten maize and six sorghum genotypes suitable for high latitude area of Kazakhstan (North, West) were identified and seeds produced. This is of high importance in terms of poor farmers' ability to obtain the seeds for a next crop season as well as to increase farmers' independence from the high-priced seed providers.

A collection of around 200 samples of maize and sorghum were characterized, and documented.

Building capacity of men and women farmers and other stakeholders in cultivation and post-harvest practices
Centre: ICARDA
National partner: KRIF
Donor: Russian Government
Project period: 2015-2016
Countries: Uzbekistan

The research was aimed to increase the crop production under conservation agriculture (CA) related studies as well as to increase the land use efficiency while improving the seed production of forage cereals and legumes from salt-affected land through adoption of improved cultivars under no-till technology, including grain and hay storage under farms' conditions at the Aral Sea Basin. In addition, this research evaluated the potential for increases in cereal-legume productivity and the elevated feed unit per hectare in forage crop rotation under CA. in addition, to assess economic implications of introduced interventions in the target area.

The results presented in this activity with the different forage crops cultivation and their seed production indicate that tillage reduction for the surface irrigated production systems reverberate in the same positive way in terms of production profitability and sustainability of the total crop production as well as to improve the soil's fertility.

Photo 10: Forage crops demonstration site at Karakul settlement.

New crop rotations with forage crops are recommended to livestock farms in order to fill forage gaps during the winter period. Double-cropped no-till mung bean after winter the wheat harvest increased land use efficiency and provided a 20% yield advantage after the no-till wheat, which shows a very significant difference.

A Karakul Seed Producers Network (KSPN) was established in order to improve seed production of the forage crops for salt-drought affected areas of Karakalpakstan, through implementation of no-till practice. The network already started to produce seeds of the forage crops since 2015. The seed of forage crops was multiplied and distributed to the neighboring farmers around the project demo sites. Up to June 30 2016, the total volume of the seeds produced is 10,941 kg.

Two training courses were conducted to raise awareness among the farmers on post-harvest technologies. The farmers were taught how to avoid on-farm losses during the storage, which is very important in Karakalpakstan especially with the forage crops in private sector. There were some years when grain prices had increased by 20-30%. As a result, the farmers kept grain and hay for more than six months waiting for a sale opportunity or even a rise in prices in the local markets. The further research is needed in order to get more information on postharvest technology and profit from this technology.

In total, 339 participants (274 males and 65 females) attended nine training courses and field days, including policy makers, specialists from district agricultural department, researchers, farmers, and households.

A single variant of a no-till drill was produced in a workshop located in Nukus, Karakalpakstan. The new no-till drill is a direct result of the "CGIAR Collaborative Research & Capacity Building Program for the Development of Sustainable and Resilient Agricultural Production Systems in Central Asia under the Conditions of Changing Climate" project, funded by the Government of Russia. Given that purchasing of ready no-till drills from abroad may be costly option, with not all farmers being able to afford such expensive equipment. This option is not only an effective economic solution, but also is a great prospect to speed up the adoption of conservational agricultural practices in the region.

Strategic Practical Options for Integrating Crop-Livestock Practices under Conservation Agriculture in Tajikistan
Centre: ICARDA
National partners: TRIF, RISS, RIV, TAAS Donor: IFAD
Project period: 2013-2016
Countries: Tajikistan

The concept of sowing crops without tilling the soil is a relatively recent practice for Tajikistan. Therefore, the development of a conservation agriculture (CA) system in this region remains a true challenge, particularly across Fergana and Gissar valleys where an integrated crop-livestock production system predominates. Farmers' awareness was the major constraint to adoption of CA. The project demonstrated that the predicted peak level of adoption will not exceed 60% in Tajikistan and 21 years will be required to reach such level.

Research activities were conducted in Tajikistan and were able to promote awareness of CA systems, and in particular the development of zero-till (ZT) seeding systems. Availability of suitable ZT seed drills for research and demonstration purposes was made available through the project. These being amongst the first specialized CA equipment to ever be used in Tajikistan.

In the irrigated areas of Tajikistan, land remains idle for more than three months after the cereal harvest. Double cropping was made possible with no-till seeders in Tajikistan with direct seeded mung bean after wheat. Because of this intensification, total cost decreased by 10.2 % and the net return was increased by 17.2 %.

Annual forage legumes and cereals are often cultivated under rain fed conditions in dry areas. However, their potential production has not been tested under CA. In rain fed cereal-legume based systems of Gissar Valley, no-till proved to be more profitable, resource saving as well as energy saving when forages are introduced in the rotation with cereals. Except for triticale, forage pea, vetch and their combination yielded much better under no till; forage pea yield increased by 53% under no till.

Alley cropping using shrubby forage species like mulberry is a suitable technology under rain-fed conditions of Tajikistan where soil erosion represents a big threat to crop production; it provides additional feed biomass in areas where winter is very harsh for livestock productivity and even survival. Potential area for adoption is around 0.5 million ha where soil erosion is a threat.

WATER MANAGEMENT

Introduction of Optimum Irrigation Scheduling in Uzbekistan (mungbean-wheat trials)
Centre: ICARDA
National partner: KRASS
Donor: Russian Government
Project period: 2015-2016
Countries: Uzbekistan

First year trial with introducing mung bean in wheat crop rotation showed positive impact of the technology in terms of additional source of income to farmers with soil nutrient enhancement potential. Optimum irrigation scheduling increased not only yield and water productivity but also ensured getting additional income to the farmers at the project site:

- Automatic weather station was successfully established in Khorezm, Uzbekistan, allowing to collect weather data to estimate evapotranspiration in order to schedule effective irrigation for different crops, including mung bean, wheat, cotton, and so forth.
- Compared to traditional irrigation scheduling, evapotranspiration experiments in the Aral Sea Basin using optimum irrigation scheduling based on the TDR soil-moisture data demon-strated increases in yields by 17% and water productivity by 37%.
- At the same time, the adoption of the raised-bed planting technology helped to save water, time and labor costs, while enhancing crop yields and minimizing soil degradation.

Photo 11. Applying new soil-measurement technologies in Khorezm, Uzbekistan.

- Prior to this demonstration, experiment comprehensive investigation on efficiency of conventional irrigation scheduling against widely used ET-based irrigation scheduling in Khorezm region had been limited. This experiment while demonstrating the efficacy of ET-based irrigation scheduling services provides crop coefficients for mung bean and winter wheat grown in predominant HMZs.
- First year trial with introducing mung bean in wheat crop rotation showed positive impact of the technology in terms of additional source of income to farmers with soil nutrient enhancement potential. Optimum irrigation scheduling applied for mung bean and wheat increased not only yield and water productivity but also ensured getting additional income to the farmers at the project site.
- Revenue values were calculated on the base of input data incurred in optimum and traditional irrigations revealed that optimum irrigation produced maximum USD 4007 revenue while that was USD 3423 i.e. less by 17 %, which additionally proves higher economic benefit to farmers from introducing new advanced irrigation technology.
- Yields of wheat entries ranged from 4.4 to 6.6 t/ha with its maximum observed for Elomon entry under Optimum irrigation and wheat-fallow rotation. Minimum yields were observed for Tanya variety under Farming practices and Wheat-fallow rotation. However, Yaksart variety provided better performance, regardless of irrigation regime or cropping pattern. The variety was valued for its lower height, longer spike length compared to conventional irrigation trials. It was noticed that late irrigation affected the crops in flat plots, causing more lodging whereas the raised bed plots were more tolerant to late irrigation and wind.
- Capacity building for farmers, using the field trials was conducted in the experimental site in Urgench District (for 30 farmers). Experimental design and Raised bed furrow irrigation was presented to stakeholders during the Conservation Agriculture workshop in Karauzyak.
- Twenty-nine participants including local crop farmers, representatives of agricultural sector attended the field day in June 2016. The event demonstrated the performance of winter wheat varieties on raised bed under furrow irrigation; crop rotation effect on yield under optimal and conventional irrigation; and learned farmers' opinions on winter wheat performance.

Yield Gap Analysis of Wheat Production in Central Asia
Centre: ICARDA
National partners: CRI, GRIC, SRILP, RIF, TAAS
Donor: Russian Government
Project period: 2016
Countries: Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan

In 2013, Central Asia region had about 16 million ha sown to wheat (FAOSTAT 2013). However, productivity of wheat in general is low and as around 1.0 t/ha in the rain fed areas and 4.0 t/ha in the irrigated areas on the average. Wheat production in the region increased from 18 Mt in 2000 to 26 Mt in 2010, which is a quite high increase based on improved management practices combined with the use of improved varieties and irrigation. Water scarcity, irrigation induced salinity, increasing land degradation and climate variability causing extreme events of heat, drought, and frost pose significant threats in achieving improved wheat productivity in the region. Thus, there is a need for the use of the improved production practices together with the improved cultivars to ad-

dress these challenges and meet the increasing demand for food.

As a result, there is a gap between the potential yield and the actual yield of wheat production in Central Asia. Therefore, an attempt has been made to estimate yield gap in wheat production and find out reasons for such a gap.

Eighteen sites were considered in this study. These reflected all the major agro-ecological zones of Central Asia suitable for wheat cultivation; rain fed (spring) wheat production predominating in the north of Kazakhstan and irrigated cropping in the more arid south of Central Asia.

CropSyst model tools showed higher efficiency as a tool to simulate crop yields for both research station to identify the reasons for such a gap and to estimate yield gap by applying different management practices. Main interventions (early sowing, pre-sowing irrigation (50 mm) and optimum Nitrogen Management) were applied in rain fed Kazakhstan and Tajikistan. These sites might increase farmer's yields from 42 to 200% while the increase of experimental station yields over farmers' field yields ranged from 16 to 110%.

In irrigated sites of Central Asia, the main interventions (salinity management, optimum irrigation, and optimum Nitrogen Management) were applied which might increase farmers' yields from 36 to 182% while the increase of experimental station yields over farmers' field yields ranging from 5 to 47%.

Thus in the main rain fed and irrigated areas in Central Asia, there is sufficient gap that can be possible bridged by improved irrigation, nitrogen and salinity management in the future. Preliminary research indicated that (early sowing, pre-sowing irrigation (50 mm) and optimum Nitrogen Management) applied on rain fed sites and optimum irrigation in combination with optimum Nitrogen Management for irrigated sites could significantly reduce this yield gap.

Because water deficit issues already exist in the region, a targeted crop breeding towards draught and temperature tolerance in combination with the improved agronomic management (shifting the planting dates) may be able to tackle the issue. The current situation of the excessive irrigation and subsequent secondary soil salinization are a constant threat to agricultural demands for improved irrigation and drainage management. Therefore, further research should address these issues in order to improve irrigation management under high salinity conditions. These might include a residue retention, crop rotation with alfalfa, and development of optimum leaching rates, including optimum Nitrogen and Phosphorous management, and last but not least a crop rotation and improved varieties.

Determining optimum water and nutrient leaching requirements for the saline areas of Khorezm, Uzbekistan (Salinity Project)
Centre: ICARDA
National partners: KRASS
Donor: Russian Government
Project period: 2015-2016
Countries: Uzbekistan

Irrational water use and mismanagement are at the root of several environmental problems in the Aral Sea Basin, including the secondary salinization. Pre-season leaching (February-March) is common practice amongst the farmers to manage soil salinity challenges. For example, farmers in the Khorezm region tend to apply up to 600 mm of leaching volume to prevent accumulation of salts in the root zone. However, an excessive leaching volume causes the water table to rise at 1-1.5 m depth, which is a dangerous depth. These shallow groundwater levels cause secondary soil salinization by capillary rise into the rooting zone, which nullifies pre-season leaching efforts, entails yield losses, and seriously threatens economic growth and development.

Research results using HYDRUS-1D and CropSyst models demonstrated possibilities to determine the optimum leaching and irrigation volumes for the most common crop pattern (cotton and wheat) in the Aral Sea Basin, in consideration with the salt dynamics in the crop-rooting zone. The model HYDRUS-1D simulated and estimated water and salt balances under the shallow groundwater table and salinity as well as soil salinity. This study assessed optimum irrigation and leaching practices through water and salt balance of the irrigated fields under cotton and winter wheat, estimated capillary rise and salinity intrusion from groundwater during vegetation and leaching seasons. Maximum cotton and wheat yields were obtained under leaching rate of 150-200 mm and irrigation rate at 320 mm and 240 mm respectively. Higher irrigation rates increased soil salinity level at root zone and did not have any positive impacts on crop yields. Based on these results, decisions could be made on how to increase the farmers' income and improve the water productivity.

Utilization of low quality water for halophytic forage and renewable energy production
Centers: ICBA
National partners: USU, NUU, UzRIKSHDE
Donors: USAID
Project period: 2012-2015
Countries: Uzbekistan

Two field research/demonstration sites in Central Kyzylkum and Khorezm, Uzbekistan, were monitored and evaluated through field and laboratory chemical analysis of water, soil, and aboveground biomass. Assessment of halophyte biomass of 20 species had discovered that they are rich in protein, lipid, minerals, and hydrocarbon contents with forage potential for livestock feeding systems.

It was revealed that some halophytes contained very high concentrations of mineral compounds (about 40-50 % of

DM) in a contrast to conventional grasses (5-10 % of DM). It confirms that significant amount of various type of salt from soils/water, which were accumulated in the plant tissues could be remove.

The protein content was significant at up to 17.6% and with up to 24.6% of soluble carbohydrates. Sheep, goats, can graze Atriplex, Climacoptera, Kochia, several Salsola and other species and horses during the entire period of plant growth, particularly autumn-winter after mineral salts are leached from plant tissues. Since it could improve range restoration of salty/loamy sand and alkaline soil, atriplex in pure stands or mixed with the other salt tolerant fodder shrubs and grass, it was recommended for improving and creating long-term autumn-winter pastures.

Sustainable Management of Water Resources in Rural Areas in Uzbekistan
Centers: IWMI jointly with GIZ
National partners: MAWR
Donors: European Union
Project period: 2016-2019
Countries: Uzbekistan

The main goal of the 'Sustainable management of water resources in rural areas in Uzbekistan' project is to contribute to sustainable and inclusive growth in the rural sector of Uzbekistan in the context of a changing climate and bring together three interconnected components. The specific objective is to improve the water supply and the efficiency of water resource management at national, basin and farm level.

The expected overall result of Component 1 is the creation of a national policy framework for water governance and integrated water resources management. Legal, institutional, organizational, and financial frameworks of water resources management are enhanced and aligned with international standards.

As the main partner of GIZ in implementation of Component 1, IWMI plays an important role in contribution to the creation of the national policy framework for the water governance and integrated water resources management principles of implementation from farm up to basin level.

Achieved outcomes up today:
- Created database of water related programs for improved coordination and efficiency water programs;
- Inventory list of the on-going projects pilot/demo sites and their short descriptions provided;
- Provided selection mapping of the pilot river basins from 6 pilot regions: Andijan, Fergana, Namangan, Syrdarya, Kashkadarya, and Surkhandarya including pilot farms;
- Compiled list of legislation documents related to water management;
- Prepared review of the implementation of water saving technologies in agriculture of the Republic of Uzbekistan.

Salinity Management in Central Asia under IWMI's Uptake Strategy
Centres: IWMI
National partners: GSU, NUU
Donor: CGIAR Research Program WLE
Period: 2013-2015
Country: Uzbekistan

Salinity Management in Central Asia (Licorice) project is part of the ongoing IWMI uptake activities. In this specific context, the main goal of the "uptake" endeavors is to raise awareness about the long-term benefits of IWMI's licorice initiative. IWMI-Central Asia office coordinates this research project with the support of local partners - the Gulistan State University and the National University of Uzbekistan.

IWMI's research with national and regional partners in Uzbekistan has demonstrated that licorice cultivation is an effective livelihood option in dry land and degraded areas with the high levels of soil salinity. IWMI has collaborated with local universities and government agencies to identify abandoned and highly saline lands that can be allocated for licorice cultivation. The study identified that over 700,000 ha of low productive land in Uzbekistan is suitable for such purposes. If large-scale licorice cultivation can be initiated, in its turn the large areas of dry land and degraded soil can be restored into a fertile and productive condition.

Photo 12. Policy dialogue on "Improving soil and land degradation through licorice cultivation in Uzbekistan", 18 December, 2015.

In order to inform the IWMI's research findings regarding salinity management measures to policy makers and donor agencies working in Uzbekistan, a Policy Dialogue Workshop on "Improving Soil Salinity through Licorice Cultivation in Uzbekistan" took place on December 18, 2015 at the Tashkent Institute of Irrigation and Melioration (TIIM), Tashkent, Uzbekistan. The workshop was aimed at fostering dialogue between researchers and policy makers by promoting cooperation among different stakeholders from different disciplines with practitioners working in the field of salinity management, facilitating the exchange of knowledge and bridging the science/policy gap.

Impact of Water Users Associations on Water and Land Productivity, Equity and Food Security in Tajikistan
Centres: IWMI
National partner: ALRIT
Donor: USAID Feed the Future Program
Period: 2014-2018
Country: Tajikistan

The IWMI has been commissioned to design and conduct an impact evaluation of the water users associations (WUAs) that were established between 2010 and 2014, and supported under USAID's Feed the Future Program (FTF).

Achieved outcomes:
In total, 1920 households were surveyed; they are located in 160 villages belonging to the 80 *Jamoats*. The results of this evaluation will provide:

- information to strengthen the functioning and resilience of WUAs;
- evidence pertaining to impacts on crop choices and cotton production;
- identify opportunities to improve food security on household plots (i.e. kitchen gardens and presidential plots).

This information will assist USAID, the Government of Tajikistan and other donors in Central Asia in formulating more improved institutions for water management, strategizing water sector investment portfolios, and improving land and water productivity.

Valuation of Ecosystem Services for Improving Agricultural Water Management in Kazakhstan
Center: ICARDA
National Partner: CAREC
Donor: CRP-WLE
Project period: 2014-2015
Country: Kazakhstan

Flood irrigation of cotton is predominantly practiced in Kazakhstan. This practice is unsustainable due to the seasonal unavailability in water supply and depletion of river discharges that were historically important in maintaining water levels downstream in nearby wetlands and the Aral Sea.

Farmer surveys were used along with Resource Investment Optimization System (RIOS), Soil, Water Assessment Tool (SWAT) modeling to evaluate alternative irrigation practices, and cropping systems that can conserve water while maintaining farmer incomes.

Simulations showed significant reductions in irrigation water demands in the alternative scenario relative to the baseline scenario. Under the baseline scenario, flood-irrigation of cotton the annual irrigation demand was simulated 928 MCM/year. Irrigated demand decreased by 38% to 573 MCM/yr. when 40,439 ha of flood irrigated cotton was converted to drip irrigated cotton, sprinkler irrigated alfalfa, and drip irrigated grapes. This represents a savings of 355 MCM/year in water extracted from irrigation canals and groundwater wells.

The water conserved would then be available for other downstream uses, including recharge of wetlands and replenishment of the Aral Sea. Survey results indicated that 60% of the farmers are willing to change from flood-irrigated cotton to alternative irrigation methods and cropping systems.

Modeling results indicated the greatest water savings arise when flood irrigated cotton is converted to drip irrigated orchards. Gender study highlighted the access to water and markets as key factors influencing livelihoods. In villages which had easier access to markets but not the greatest access to water, women sold fruits and vegetables grown in their backyards to earn a living whereas in upstream villages, where access to water is easy, but no markets exist, women use fruits and vegetables only for the household consumption.

Improved Water-use Efficiency through Innovative Technologies in Irrigation and Farming
Centre: ICARDA
National partners: SIC-ICWC, KRASS
Donor: Russian Government
Project period: 2014-ongoing
Country: Uzbekistan

ICARDA scientists have conducted a research study in irrigated farmlands of the Fergana Valley and Khorezm region implementing ET-based irrigation scheduling decision-support tool.

Results from this study show that there can be a 32-35% saving of water without loss in yield when irrigation is applied using the ET-based scheduling method.

The pilot plots are representative of 35% of irrigated area in the Fergana Valley (241,407 ha) and 35% in the Khorezm area (79,566 ha). If this methodology is widely adopted by the WUAs of both locations, large amounts of water can be saved which can be diverted for supporting downstream ecosystem services, expanding irrigated agriculture, industrial, and municipal purposes.

In order to ensure success of the research beyond the project lifecycle, farmers from participating WUAs, local water management authorities, national partners, as well as Scientific Academia were involved, consulting and training at every step of the research.

A Russian version of a reference ET calculator was developed; several handbooks were published and distributed during the Farmer Field Days on how to calculate ET-based water application requirements for different crops and varieties.

Use of Non-Conventional Agricultural Water Resources to Strengthen Water and Food Security in Transboundary Watersheds of the Amu Darya River Basin (UNCAWR)
Centers: ICBA
National partners: NTSAU, UzRIKSHDE, SSU, IDFF, TAAS
Donors: PEER-USAID
Project period: 2015-2016
Countries: Uzbekistan, Turkmenistan and Tajikistan

The main aim of this project is to improve regional water and food security in the arid regions of Central Asia by securing better livelihoods, income for rural remote communities through mobilization of non-conventional resources in the Amu Darya River Basin

UNCAWR project worked with farmers (their families and local communities) closely by supporting them with seeds (germplasm), handout materials, technical advice, and provided them with small devices/equipment for field monitoring of soil and water quality. A field-tested toolkit for rapid small ruminants' value chain assessment was developed. One of the gaps in forage options for saline lands in the Delta of Amudarya River Basin, which was addressed through local initiatives that included women learning alliances. Solutions included the growing of winter feed for livestock keepers, using halophytes and non-conventional crops. A network of forage seed growers was established and options for double cropping (suitable crops and their seeds such as quinoa, sorghum, pearl millet, mung bean, sudan grass, forage pea, sunflower, caw pea, sesame) and rice crop rotation systems were introduced. Two field-training seminars for women leaders, farmers and agro-pastoralists, were conducted in Shortanbay (Karakalpakstan) and in the middle stream of Amu Darya River (Bukhara oasis). The main activities were related to the adoption of non-traditional crops as the second crops in the wheat farming rotation that were organized with support of local administrative governments, universities, local non-governmental organization, private seed production growers and agro-pastoralists.

Towards a sustainable food production on marginal saline lands in Aral and Caspian seas basins
Center: ICBA, ECFS
National partners: ASRF, SRI, PPI, NUU, NTSAU, IB, NAA, ICP, ASK
Donors: IDB
Project period: 2013-2015
Countries: Uzbekistan, Kyrgyzstan and Azerbaijan

The main goal: Improving agricultural production under saline conditions with minimal trade-offs within the Aral and Caspian Sea Basins through applying an agro-pastoral and irrigated mixed farming systems approach.

Research was conducted in the drylands regions of the Aral Sea Basin (in upper steam Kyrgyzstan and downstream Uzbekistan) and Caspian Sea Basin (in the saline prone Shirvan plain of Kur-Araz lowlands in Azerbaijan), where irrigated agriculture has a long history of soil and water salinization concerns. The project also had also benefits from close collaboration with the Eurasian Center for Food Security that gave access to the databases and human resources of the institutions and working groups in Central Asian and Caucasus countries. This integrated approach enabled us to examine alternative ecosystems conservation and food-security management schemes through development of institutional and policy instruments in order to take advantage of international expertise on the use of marginal water and plant resources (halophytic and salt tolerant crops) in saline inland and coastal ecosystems and test model enhancements developed by this project in a global context.

Managing irrigation-drainage systems to sustainably enhance productivity in Fergana Valley, Central Asia
Centers: ICARDA
National partners: KRASS, SIC-ICWC
Funding source: CRP WLE
Project duration: 2014-2016
Countries: Uzbekistan

Rapid expansion of irrigated lands during 1960-1980 in Uzbekistan was followed by installation of drainage systems in response to water logging and salinity problems. Currently, artificially drained areas in Uzbekistan cover about 2.9 Mha, of which 19% (about 13% of country's irrigated land) constitutes subsurface drainage systems. Depending on hydrological and economic conditions, the depth of subsurface drainage installation is usually 0.3-1.0 m deeper from the depth of the active groundwater level (GWL) and space between two laterals is not less than 50 m. Most of these drainage systems were typically designed to discharge water continuously, without regard to the environmental consequences. Therefore, there is a need for a new approach to subsurface drainage that applies management to these drainage systems to reduce their downstream environmental impacts while maintaining agricultural production. Controlled drainage may be an option with an existing drainage system that contributes to reduced drainage flow and lower irrigation requirements.

The objective was to study how the fluctuations in groundwater levels in the soil profile will affect the soil's moisture and soil salinity, groundwater salinity, and crop water uptake, and how much surface water can be saved by controlling the drainage outflows without having adverse impact on yield. Project established controlled drainage experiments at the field level in the Fergana valley. The experiments were conducted with the assistance of SIC-ICWC at a farm where a tile drainage system existed, but was not operational. The KRASS assisted in the data analysis and modeling the shallow groundwater situation by the use of groundwater model. A detailed technical report leading to ISI journal papers (two) on best surface water-groundwater strategies in large irrigation and drainage systems of central Asia was produced.

Results showed that around 20 to 45 % of surface water supplies can be reduced by fluctuating the groundwater levels between 1-2 m below the soil surface. The best leaching strategy is to open the drainage valves during the

irrigation system and lower the groundwater levels below 2 m soil depth. This will reduce the salinity by 20 to 25 % as compared to other practices. We produced two research papers, annual reports, conducted workshop, conducted 'Farmers Field Days" and flyers on the importance of a controlled drainage concept. The farmers were convinced along with the authorities (even we witness) that some farmers started controlling the drainage outflows by blocking the drains. We trained the national partners and they are now able to use the model for simulating future scenarios.

Evaluating the effect of conjunctive use of canal and drainage waters, different cropping patterns, and improved irrigation practices on control of salinity and waterlogging
Centers: ICARDA
National partners: KRASS, SIC-ICWC
Funding source: Russian Government
Project duration: 2014-2016
Countries: Uzbekistan

An extensive irrigation network exists in irrigated areas of Uzbekistan to convey freshwater mainly from the Syrdarya and Amudarya rivers to farmers' fields. Losses from unlined irrigation conveyance infrastructure and over irrigation during field application led to shallow groundwater levels in the region. These shallow groundwater levels are threatening the menace of waterlogging and soil salinity. To control waterlogging and salinity, an extensive network of mainly open surface drains exists in the region. It has been observed during the last decades that the tendency of dry years is increasing in Uzbekistan.

Moreover, farmers are not getting adequate canal water supplies, especially located at tail end of the irrigation network. To combat water scarcity, farmers apply conjunctive use of canal and drainage water to achieve their yield targets. However, continuous use of canal water and drainage water can build soil salinity in the root zone, degrade the fertile agriculture lands and eventually reduce the crop yields. The hydrological models exist to simulate scenarios for proper management of canal water and drainage water in a more sustainable way. Moreover, crop pattern and improved irrigation practices can reduce the adverse impacts of soil salinity.

Several models for simulating soil moisture and soil salinity in vadose zone exists. These models can simulate the impact of conjunctive use of canal water and groundwater, cropping strategies and irrigation practices on soil salinity and root water uptake and eventually crop production.

We conducted field experiments having the ability to use canal and drainage water together. Data regarding soil moisture, soil salinity, soil texture, soil organic matter, hydraulic conductivity, pF curves, irrigation depths, irrigation water salinity, groundwater depth and salinity, crop height and rooting depth, yield, fertilizer, pesticides and other inputs etc. was collected at high spatial and temporal resolutions.

These data sets were used to calibrate and validate the HYDRUS model to simulate scenarios for conjunctive water management for a long run. Results showed that conjunctive use of canal and drainage water of salinity 4 ds/m can be used without affecting the crops yield. However, it needs the best water management strategy. The leaching amounts should be 20 % from the normal practice during cropping season to avoid the adverse impact. A crop rotation having no fallow land would reduce the salinity levels. Two students got their M.S. degree under this project.

SOCIO-ECONOMIC RESEARCH

Economics of Land Degradation in Uzbekistan
Center: ICARDA
Donor: ZEF
Project period: 2013-2014
Countries: Uzbekistan

The Economics of Land Degradation initiative indicated that cultivation of halophytic plants in salinized areas (e.g. licorice), rotation of crops such as alfalfa, mung bean and other legume crops is an effective and low cost intervention that can be undertaken by farmers.
The research found an estimated return of about USD (four) for each dollar invested in land rehabilitation, including major benefits to the environment. Thus, the costs of action would be around USD 11 billion over the next 30 years, whereas, if this is not the case, the resulting losses may equal to almost USD 50 billion.

The final project publication summarizes the findings and contains technical and policy recommendations for implementing ELD targeted interventions (making active use of GIS mapping and modelling, and contains a section on ground trothing of ELD assessment in Uzbekistan).

An Assessment of the Economics of Land Degradation for Improved Land Management in Central Asia
Center: ICARDA
National partners: FRIK, KRISSA, AUCA, KNAU, TAAS, NPAUET, RIAE
Donor: BMZ
Project period: 2014-2016
Countries: Central Asia

Project outputs:
- The project conducted economic valuation of losses (damages) from land degradation and their major ecosystem services, caused by human's activities;
- In Central Asia, the initiative used the altitudinal approach. Between five countries, the areas of the land use on the certain height were distributed. Areas were distributed as follows: Kyrgyzstan – high land pastures, Tajikistan – foothills and low mountains, Kazakhstan – Forestry and non-rain fed agriculture, Turkmenistan – low land pastures, Uzbekistan – Irrigated agriculture;
- National case studies will help to validate economic effectiveness and provide options for practices/ methods of sustainable use of land resources, based

on applicability and feasibility;
- The project publications are expected to increase awareness of decision makers and capacity of local specialists on the use of the analysis and economic valuation of an ecosystem during decision-making process.

Impact:
The project outputs will serves to transform global understanding of the economic value of productive land based on both market and non-market values, and to improve stakeholder awareness for socio-economic arguments to improve sustainable land management, prevent the loss of natural capital, and preserve ecosystem services, as well as to combat climate change, address food, energy, and water security.

Photo 13. Gullies from water and wind erosion in mountainous areas of Tashkent province

Enhancing WUA role in water allocation and management via institutional interventions
Center: IWMI
National partners: SBWMAT, SSBWMAU
Donor: CRP-DS
Project Period: 2014-2015
Countries: Uzbekistan

Research in the Fergana Valley focused on in-depth analysis of water governance situations at Water User Association (WUA) level in Tajikistan and Uzbekistan. This research identified the major factors and determinants that impede collective action within the WUA in order to improve operation and maintenance of on-farm irrigation and drainage systems. The research was based on qualitative as well as quantitative data collection and analysis. Data was collected in both 2014 and 2015 in partnership with the World Bank, University of Bern and Leibniz Institute of Agricultural Development in Transition Economies (IAMO), Halle, Germany. The research findings were presented at the International Forum titled: "Agriculture and climate change in transition economies". Session B1: Climate change, water resources and agricultural development in Central Asia on June 16-19, 2015 at Leibniz Institute of Agricultural Development in Transition Economies (IAMO), Halle, Germany (Anarbekov and Mukhamedova, 2015).

Research findings contributed to the discussion of the Policy workshop of the InDeCa project of the Volkswagen Foundation program: "Between Europe and the Orient - A Focus on Research and Higher Education for Central Asia and the Caucasus". In addition, researchers actively participated in the consultation workshop organized by World Bank Office in Tashkent on a recent assessment of the quality of irrigation water management in Uzbekistan held on December 09, 2015.

Improved irrigation system (growing wheat-mungbean)
Centre: IWMI jointly with AVRDC
National partners: SSBWMAU, WCAFPU
Donor: CRP-DS
Project period: 2014-2015
Countries: Uzbekistan

The following experiments were conducted within the research project in K. Umarov Water Consumer Association, Tashlak District of Fergana Province in Oct 2014. Three types of the winter-wheat varieties were cultivated in Gulamjon Mashrab Ugli farmer's 1.3 ha of land. These three types are: a) winter variety Nota from Russia; b) new variety 'Elomon'; c) new variety 'Hisorak'. Three types of winter-wheat experiments have been conducted with application of three types of irrigation technologies: farmer practice (control); cut back furrow irrigation and alternate furrow irrigation. In both experiments, cut back furrow irrigation produced better results as compared to other irrigation technologies.

The farmers were interested in taking part in the trails since they would receive new varieties of winter wheat as well as mung-bean crops. They also learned new irrigation techniques, which had a better chance for increased yields.

The outcome of the activities was that farmers started cultivating mung-bean after harvesting winter wheat. With the mung-bean as second crop, it generates a higher income and helps to increase land productivity, soil fertility, and efficient water application. More than 15 farmers, including one female, committed to apply mung-bean after winter wheat in the wider area for the next years cultivations.

LIVESTOCK

Increasing livestock productivity to improve availability of animal proteins to the households and increased revenues and wellbeing of livestock keepers
Centre: ICARDA
National partners: UzRIKSHDE, STLRI, SSU, NTSAU
Donor: Russian Government
Project period: 2013-2016
Countries: Tajikistan, Uzbekistan

In early 2015, ICARDA and the Karauzyak district authorities agreed to support the establishment of an elite Karakul flock of livestock cooperative '40 Let Karakalpakstana' that had 0.5 million hectares of desert rangelands, including 800 ha of rainfed and arable areas for forage crops

cultivation. The Elite flock of Karakul Sheep was established by cross-mating 10 heads of pedigree Karakul Sur rams with 317 heads of Karakalpak breed of Karakul Sur. As a result, in spring 2016 lambing season, a total number of 164 heads of elite and first class Karakul Sur lambs were selected for breeding.

Photo 14. Training on "Improved technologies of dairy processing", May 2016.

A "Toolkit for a rapid assessment of small ruminant value chains (RVCA) in Central Asia" was developed and used to assess livestock value chains at target project sites in Tajikistan and Uzbekistan.

The RVCA toolkit was used to conduct two assessments of a small ruminant value chains for dairy and meat in Sughd province of Tajikistan (arid mountain) and in Karauzyak district (desert rangelands) of Karakalpakstan in 2015. These regions were selected as small ruminants playing a key role in income generation (over 80%) in the households of rural communities. The study showed that the small ruminant value chains were not well developed yet in both target sites as livestock market infrastructure, storage and cooling facilities, certification services, and logistics are still in early development stages. Such information is very useful for potential future value-chain interventions to assist in targeting project interventions where they are needed the most.

In Northern Tajikistan, value chain assessment for small ruminant commodities resulted in capacity building interventions, whereby the project team introduced a manual milk fat separator to reduce labor and improve time efficiency in making butter. The skim milk, which is a by-product of the butter, can be used to make fat free cheese, further increasing benefit, and incomes.

The project team seasonally collected field data on animal blood metabolites, on pastoral animal grazing pathways by using GPS collars, and on rangeland vegetation that will help to create a comprehensive picture of the current interplay between the rangelands and livestock, as well as how institutional arrangements and pastoral tenure can be altered to improve this. When linked with larger scale geographic datasets such information can provide broader policy information.

In total 12 capacity-development activities were held and attended by 238 people (124 men and 114 women).

Increasing livestock productivity by increasing winter feed production from arable land and hayfields
Centers: ICBA, ICARDA
National partners: NTSAU, UzRIKSHDE, SSU
Donors: CRP Dryland Systems
Project period: 2015-2016
Countries: Uzbekistan

Taking place in the Aral Sea Basin, several demo trials were established within the project period in Shirkat farm in "Koybak" local farmer household in Karabuga, both sites are located in Karauzyak district, Karakalpakstan. These sites are the most representative of agro-pastoral zones of a much larger Amudarya River watershed at the transition zone between irrigated agriculture and Kyzylkum sandy desert. The project was aimed at studying effective management of marginal (low quality) lands and water, production of non-conventional crops (NCC) as forage for livestock and other alternative use.

The list of such crops include: sorghum (3 varieties), pearl millet (2), triticale (2), perennial sorghum, sesame (1), fodder beet maize (2), forage and vegetable legumes (6), topinambur (2), indigofera (1), atriplex (3), kochia (2), clover, onobryhis, alfalfa – as high potential sources for forage production. All of these crops can be planted on field saline abandoned margins - category of marginal lands located in the field margins of the main fields dedicated to planting traditional crops (cotton-wheat-rice).

Photo 15. Field seminar with women farmers at Karabuga farm in Karakalpakstan, June 2015.

A series of field training seminars titled "Alternative forage crops for animal feeding in winter on household farms" were organized on several field mission expeditions. Seminars covered different aspects of alternative forage crops for animal feeding in winter, as well as a popular master cooking class on preparation of food recipes from non-traditional nutritious crops were inspiring for about 45 women farmers who decided to create a Rural Women Learning Alliance for diversifying household incomes through cultivation of non-traditional crops.

GEOINFORMATICS

Mapping cropping systems in the Fergana Valley, Uzbekistan
Center: ICARDA
Partners: CARII and Uni. of Urzberug
Donor: Russian Government
Project period: 2015-2016
Countries: Uzbekistan

The overall purpose of this research is to quantify crop systems and production pattern in the Fergana Valley (FA). This study has employed a time series of satellite earth observation from different sources (RapidEye/ BlackBridge, Landsat5/7/8, MODIS) to assess crop system variables especially land use patterns, crop types, and crop rotation at the per-field level from 2004-2015 (which is mainly oriented toward data availability).

Annual maps of crop types, pattern, and rotation, at the field level will enable to back trace past and recent crop production patterns, crop intensity, and help indicating and explaining potential land degradation and thus supporting spatial planning. The project focusses on two major crop types in FA, cotton and winter wheat. The following research questions are the basis of this research activity:

1. What are the spatial and temporal pattern of crop cultivation in FA?
2. What are the spatial and temporal pattern of crop productivity in FA?
3. Which factors drive the observed spatial pattern and temporal changes in crop cultivation and crop productivity?

Remote sensing had allowed assessing of agricultural land use pattern and production dynamics at the per-field level, which is a critical contribution to agricultural management in the Fergana Valley. Results are presented in a standardized map layout, tables, and online-dedicated portal.

- Crop maps were created for each survey year from 2014 to 2015. Based on confusion matrices, the classification accuracy of these maps ranged from 0.78–0.85%. Cotton, winter wheat, and rice crops are clearly distinguished from other crops as indicated by their high-level accuracies.
- Crop acreages and the spatial distribution of the three main crops showed that the dominant crop in the study site was cotton (39 % – 43 % of all fields), followed by winter wheat (26 % – 36 % of all fields). Both crops were cultivated all over the landscape, albeit cotton tended to be more concentrated in the central parts of the study area. Rice fields only covered minor parts of the landscape (2 % – 6 % of all fields) and were almost exclusively cultivated in the central part.
- Results also show that there is a strong indication that there was heterogeneity in crop yields even within small distances. The most prominent factors affecting production was the spatial and temporal diversity of the crop patterns, i.e. locations with a higher diversity tended to have higher yields. Furthermore, fields were located in areas with a small share of agricultural tended to be less productive.
- The crop pattern, i.e. the presence or absence of multi-annual crop rotations, and the spatial diversity of crops had the most persistent effects on crop yields across years. Areas with a lower diversity or abundance of crop rotation tended to have lower crop yields, with differences of partly more than one t/ha yield.
- Further analysis need to be undertaken to explain the observed yield pattern, and to understand the linkages between water availability, market trends, distances to markets and processing units (wheat mills or cotton producing factories), and the inclusion of ground water data (depth and salinity).

A dedicated geo web portal has been established for data and product visualization. These assessments can be found at http://geoagro.icarda.org/ca/

KNOWLEDGE MANAGEMENT IN CACILM PHASE II

Center: ICARDA
National partners: KRISSA, SRILP, KRII, KNAU, TAAS, RIF, RISSA, TSWMSPDI
Donors: IFAD
Project period: 2013-2016
Countries: Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan

In its effort to consolidate existing (including indigenous) knowledge and practices on sustainable land management (SLM) were used by local agricultural producers, as well as to promote their out scaling, Knowledge of Management in CACILM II project has compiled and systematized more than 90 practices. These practices are applicable to four main agro-ecosystems of the region: rain fed, irrigated, mountains and rangelands, four of selected SLMs were tested at demonstration sites in each of the five countries: Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan.

Similarity maps for five countries have been generated. National teams for analysis of suitability mapping in Central Asia have used digitized maps (soil erosion, natural grassland, land use, landscape, soil types and vegetation). Suitability maps help identify target areas to disseminate SLM packages in the four agro-ecosystems.

At the project's inception workshop, held in Bishkek, Kyrgyzstan in 2013, national partners and organizations had identified the need to assess the impact of CC on agriculture. To address identified gaps, the project conducted training on available downscaled models to Central Asian regions. The training "Downscaling climate change scenarios: impact on agriculture and adaptation strategies

through SLM in CA" was organized in June 16-20, 2014 in Tashkent.

Country teams applied their new skills to locate and extract future climate data in collaboration with organizations, which collect climate observations, bias correction tools were run over obtained data., In addition to available data from previous projects, some country teams collected historical data from meteorological stations near the demonstration sites.

In order to disseminate the project knowledge to a wider audience, an online Knowledge Platform www.cacilm.org was launched. The project actively used social media, reaching out to tens of thousands of users on Facebook and YouTube. More than 10 (of over 40) videos were produced by the project were aired on Kazakhstan, Tajikistan and Uzbekistan TV channels.

The project organized more than 25 "Field Days", drawing over 800 attendees, 15 workshops with nearly 1,000 participants, and 5 regional trainings for 80 staff from partner institutions.

In addition, over 50 publications have been prepared in English, Russian, Kyrgyz, Tajik and Uzbek languages, including policy briefs, infographics, SLM technologies, brochures and textbooks for students and children.

Project outputs:

- ICARDA is working on paper "Exploring agricultural innovation systems in post-Soviet Central Asia" including RAS analysis which is prepared by Shinan Kassam for further publication in ISI journal;
- Two policy briefs were prepared on agricultural innovation systems in post-Soviet Central Asia and land reform in Uzbekistan;
- Focus Group Discussions were conducted at each project site to verify the uptake of the suggested SLM interventions;
- Cost-benefit analysis of selected SLM packages was conducted based on data collected at pilot sites. The results will support presentation of the proposed technologies to stakeholders;
- Literature review on land tenure was conducted in Uzbekistan, Kazakhstan, Tajikistan and Kyrgyzstan to identify gaps and barriers to a broad uptake of SLM technologies;
- Policy workshops were held to discuss implications of the land reforms in Tajikistan and Kyrgyzstan. These forums were used to elaborate project recommendations for dissemination of SLM interventions.

Impact:
The project worked to establish linkages between knowledge generating research community, a wide range of stakeholders and potential users of the SLM innovations. It also helped to develop better communication tools (e.g. policy briefs, research paper) to channel the knowledge addressing the challenging issues of land degradation, low agricultural productivity, irrigation water deficit, etc. among the various stakeholders.

CACAARI

Integration of Foresight academy in CAC
Source: CACAARI

In November 2014, CACAARI with support of GFAR organized a workshop on introduction to foresight concept, and building a critical mass in foresight in the CAC region, during the CAC Regional Conference on RAS in Bishkek, Kyrgyzstan. The objectives of the workshop were to engage participants in a foresight exercise about the futures of food, agriculture, and rural development in the CAC region, as well as initiating a process for building foresight capacity in the region. The event would help build up a critical mass with which CACAARI can work in order to promote and implement the concept of the foresight academy.

The continuation of this process took place on GCARD3 Global event (5-8 April 2016, Johannesburg, South Africa). Theme 5 of GCARD3 was "Ensuring better rural futures" which mainly focused on the practical use of foresight. There were two groups (farmer organizations and regional, including AARINENA, CACAARI and FARA) in order to come up with a clear title, goals, objectives, milestones, identifying partners, and the required resources for the future agricultural developments in agri-food systems.

It was accepted and recommended to start the joint work on foresight and its integration within the regions. The process will act collectively in the upcoming 3 years to GCARD4 on establishing foresight platforms that will bring together farmers (via farmer organizations in all regions, including CAC) with research and innovation actors from around the world to develop and select preferred future scenarios.

Extension and Rural Advisory Services (RAS) in CAC: The outcomes of the integration

CACAARI announced 2014 as an extension of RAS year, which provided the background for developing CAC-FRAS, which served as a network, a platform for extension agents, and advisory service providers to further improvement in the current process Nationally. Therefore, CACAARI jointly with GFAR, GFRAS and MEAS organized a needs assessment studies in CAC countries together with national meetings on discussing status, strengths and weaknesses of the rural advisory services system. The policy makers, government officials, and all correspondent stakeholders of RAS attended the national meeting. As a second step in this process, a regional conference was organized based on the outputs of the national assessment studies and recommendations to the governments of the countries were made.
The Presidential Decree governed by made Clause 32 of Article 109 of the constitution, in order to improve the material and technical base of scientific research institutions in the system of the Ministry of Agriculture of the Azerbaijan Republic and the decision of the Cabinet of Ministers of Azerbaijan Republic #109 dated on 17 April 2015 was to be renamed.

Agricultural Research Center of Azerbaijan was renamed as the Center of Agrarian Sciences, Information and Advice of the Ministry of Agriculture. The main trigger for such a move was the regional event and its outcomes serving as a background for the goal of integrating and emphasizing the importance of Advisory Services in the CAC region.

PUBLICATIONS

ISI Listed Journal Articles:

1. Akramkhanov, A., D. J. Brus, D. J. J. Walvoort. 2014. **Geostatistical monitoring of soil salinity in Uzbekistan by repeated EM surveys.** Geoderma. 213:600-607.
2. Belan I., Rosseeva L., Rosseev V., Badaeva E., Zelenskiy Y., Blokhina N., Shepelev S., Pershina L. 2015. **Study of adaptive and agronomic characters in lines of common wheat Omskaya 37 carrying 1RS.1BL and 7DL-7Ai translocations.** Russian Journal of Genetics. Applied Research. 5:41-47.
3. Bobojonov I., Aw-Hassan A. 2014. **Impacts of climate change on farm income security in Central Asia: An integrated modeling approach.** Agriculture, Ecosystems and Environment. 188:245–255.
4. Burlakoti R.R., Shrestha S.M., Sharma R.C. 2014. **Effect of natural seed-borne inoculum of Bipolaris sorokiniana on the seedling emergence and vigour, and early establishment of foliar blight in spring wheat.** Archives of Phytopathology and Plant Protection. 47:812-820. DOI: 10.1080/03235408.2013.823272
5. Closset M., Boubaker D., Aw-Hassan A. 2014. **Measuring the economic impact of climate change on agriculture: a Ricardian analysis of farmlands in Tajikistan.** Climate and Development. 7(5): 454-468. DOI: 10.1080/17565529.2014.989189
6. Egamberdieva D., Shurigin V., Gopalakrishnan S., Sharma R. 2014. **Growth and symbiotic performance of chickpea (Cicer arietinum) cultivars under saline soil conditions.** J. Biol. Chem. Res. 31:333-341.
7. Gowda P.H., Howell T.A., Baumhardt R.L., Porter D.O., Marek T.H., Nangia V. 2016. **A user-friendly interactive tool for estimating reference ET using ASCE-EWRI standardized Penman-Monteith equation.** Appl Eng Agric. 32: 383-390. DOI 10.13031/aea.32.11673
8. Karabayev M., Morgounov A., Braun H.J., Wall P., Sayre K., Zelenskiy Yu., Zhapayev R., Akhmetova A., Dvurechenskii V., Iskandarova K., Friedrich T., Fileccia T., Guadagni M. 2014. **Effective approaches to wheat improvement in Kazakhstan: Breeding and Conservation Agriculture.** Journal of Agricultural Science and Technology. 4:761-765.
9. Karimov A., Simunek J., Hanjra M., Avliyakulov, M., Forkutsa, I. 2014. **Effects of the shallow water table on water use of winter wheat and ecosystem health: implications for unlocking the potential of groundwater in the Fergana Valley (Central Asia).** Agricultural Water Management. 131:57-69.
10. Khazratkulova S., Sharma R.C., Amanov A., Ziyadullaev Z., Amanov O., Alikulov S., Ziyaev Z., Muzafarova D. 2015. **Genotype × environment interaction and stability of grain yield and selected quality traits in winter wheat in Central Asia.** Turkish Journal of Agriculture and Forestry. 39:920-929. DOI:10.3906/tar-1501-24
11. Löw, F., Waldner, F., Navratil, P., Latchininsky, A., Bolkart, M., Colditz, R. and Biradar, C., 2016. **Timely monitoring of Asian Migratory Locust habitats in the Amudarya delta, Uzbekistan using time series of satellite remote sensing vegetation index.** Journal of Environmental Management.
12. Mirzabaev A., Ahmed M., Werner J., Pender J., Louhaichi M. 2016. **Rangelands of Central Asia: challenges and opportunities.** Journal of Arid Land. 8:93-108. doi: 10.1007/s40333-015-0057-5.
13. Mueller J. P., Kosimov M.A., Kosimov F.F., Brent L., Nishanov N., Rischkowsky B. 2016. **Do Texas Angora bucks improve mohair weight and quality traits of Tajik Angora goats?** Small Ruminant Research. 134:74-78.
14. Mukhamedova N., Wegerich K. 2014. **Integration of villages into WUAs-the rising challenge for local water management in Uzbekistan.** International Journal of Water Governance. 2:153-170.
15. Mukhtarov F., Fox S., Mukhamedova N., Wegerich K. 2015. **Interactive institutional design and contextual relevance: water user groups in Turkey, Azerbaijan and Uzbekistan.** Environmental Science and Policy. 53:206-214.
16. Nurbekov A., Akramkhanov A., Kassam A., Sydyk D., Ziyadullaev Z., Lamers J.P.A. 2016. **Conservation Agriculture for combating land degradation in Central Asia: a synthesis.** AIMS Agriculture and Food. 1:144-156. DOI: 10.3934/agrfood.2016.2.144
17. Nuriyeva S., Akparov Z., Hajiyev E., Abbasov M., Sharma R.C. 2016. **Evaluation of wheat genetic resources of Azerbaijan on normal and saline fields.** Turkish Journal of Agriculture and Forestry. 40:186-193. DOI:10.3906/tar-1502-84
18. Oyiga B.C., Sharma R.C., Shen J., Baum M., Ogbonnaya F.O., Leon J., Ballvora A. 2016. **Identification and characterization of salt tolerance using a multivariable screening approach of wheat germplasm.** Journal of Agronomy and Crop Science. Published online 6 July 2016,DOI:10.1111/jac.12178
19. Pak M., Wegerich K., Kazbekov J. 2014. **Re-examining conflict and cooperation in Central Asia: a case study from the Isfara River, Ferghana Valley.** International Journal of Water Resources Development. 30:230-245.
20. Platonov A., Wegerich K., Kazbekov J., Kabilov F.. 2014. **Beyond the state order?: second crop production in the Ferghana Valley, Uzbekistan.** International Journal of Water Governance. 2:83-104.
21. Reddy M., Jumaboev K., Bobojonov I., Carli C., Eshmuratov D. 2016. **Yield and Water Use Efficiency of Potato Varieties under Different Soil-Moisture Stress Conditions in Fergana Valley of Central Asia.** Agroecology and Sustainable Food Systems. 40:407-431. http://dx.doi.org/10.1080/21683565.2016.1141145
22. Sarkar B., Sarkar A., Sharma R.C., Verma R.P.S., Sharma I. 2014. **Genetic diversity in barley (Hordeum vulgare) for traits associated with feed and forage purposes.** Indian Journal of Agricultural Sciences. 84:650-655.
23. Sarkar B., Sharma R.C., Verma R.P.S., Sarkar A., Sharma I. 2014. **Identifying superior feed barley genotypes using**

GGE biplot for diverse environments in India. Indian J. Genetics Plant Breeding. 74:26-33.
24. Sharma R.C., Morgounov A., Akin B., Bespalova L., Lang L., Litvinenko M., Mustatea P., Ozturk I., Postolatiy A., Rajaram S., Braun H. J. 2014. **Winter wheat East European Regional Yield Trial: Identification of superior genotypes and characterization of environments.** Crop Science. 54:2469-2480. doi:10.2135/cropsci2014.01.0028
25. Sharma, R.K., Osmanzai M., Singh R.P., Braun H.J., Sharma, R.C. 2014. **Identification of high yielding wheat genotypes through evaluation of international nurseries.** Cereal Research Communications 42:303-313. doi10.1556/CRC.2013.0060
26. Sharma, R.C., Nazari K., Amanov A., Ziyaev Z., Jalilov A.U. 2016. **Reduction of winter wheat yield losses caused by stripe rust through fungicide management.** J. Phytopathology. 164:671-677. http://onlinelibrary.wiley.com/doi/10.1111/jph.12490/epdf
27. Sharma, S., E. Duveiller, C.B. Karki, D.B. Thapa, R.C. Sharma, and A,K, Joshi. 2015. Wheat stripe rust virulence and varietal resistance in the foot hill Himalayas in Nepal. J. Agric. Sci, Technol. B 5:477-485.
28. Sharma-Poudyal, D., Sharma R.C., Duveiller E. 2016. **Control of Helminthosporium leaf blight of spring wheat using seed treatments and single foliar spray in Indo-Gangetic Plains of Nepal.** Crop Protection. 16:161-166. http://dx.doi.org/10.1016/j.cropro.2016.06.017
29. Soliev I., Wegerich K., Kazbekov J. 2015. **The costs of benefit sharing: historical and institutional analysis of shared water development in the Ferghana Valley, the Syr Darya Basin**. Water. 7:2728-2752.
30. Wegerich Kai. 2015. **Shifting to hydrological/hydrographic boundaries: a comparative assessment of national policy implementation in the Zerafshan and Ferghana Valleys**. International Journal of Water Resources Development. 31(1):88-105.
31. Zhapayev R., Iskandarova K., Toederich K., Paramonova I., Al-Dakheel A., Ismail S., Pinnamanent S., Omarova A., Nekrasova N., Balpanov D., Ten O., Ramanculov E., Zelenskiy Y., Akhmetova A., Karabayev M. 2015. **Sweet sorghum genotypes testing in the high latitude rainfed steppes of the North Kazakhstan.** Journal of Environmental Science and Engineering. 4:25-30.

Journal Articles:

32. Akhmetova A., Karatayeva R., Suleimenov R., Zelenskiy Y., Morgounov A., Zhapayev R., Karabayev M.. 2015. **Testing of durum wheat varieties and lines for resistance to leaf rust in the conditions of Northern Kazakhstan (Akmola province).** Modern Mycology in Russia. Moscow, Russia, p.143-146.
33. Anarbekov Oyture. 2015. **Comparative assessment of WUAs Governance role on efficient use of water resources in Fergana Valley**. url: mel.cgiar.org
34. Asoev N.A., Ibragimov N.I., Nurbekov A.I., Yatimov B.N., Khomatov A. 2015. **Winter wheat productivity under different tillage methods.** Journal of Tajik Academy of Science.
35. Clifton K., Louhaichi M. 2015. **Land tenure, climate change and livestock mobility in central and southern Asian grasslands.** In: P.K Ghosh, S.K. Mhanta, J.B. Singh, P.S. Pathak. Grasslands: A Global Resource Perspective. New Delhi, India: International Grasslands Congress. p. 347-362.
36. Gafurov Z. 2015. **Mapping low productive irrigation soils of Republic of Karakalpakistan using images.** In: Karimov A. (ed.). Reclamation of salt-affected land and licorice. (In Russian). Publisher: University. P. 187-196.
37. Gafurov Z., Kattakulov F., Eshmuratov D.. 2016. **Water surface dynamical change analysis of Sudochi Lake in Aral Sea area using Remote Sensing Information, Journal of Irrigation and Melioration.** Tashkent Institute of Irrigation and Melioration. №02(4). ISSN 2181-8584.
38. Gultyaeva E., Shaydayuk E., Kosman E., Goncharov N., Akhmetova A.. 2015. **Virulence of Pucciniatriticina Eriks on tetraploid wheat species.** Modern Mycology in Russia. Published by the National Academy of Mycology (editors: Y.Dyakov, Y.Sergeyev). Moscow, Russia. v. 5, p. 124-128.
39. Holmatov B., Lautze J., Kazbekov J.. 2015. **Tributary-level transboundary water law in the Syr Darya: overlooked stories of practical water cooperation.** International Environmental Agreements: Politics, Law and Economics. doi: 10.1007/s10784-015-9308-3
40. Holmatov B., Lautze, J. 2016. **Thinking inside the Basin: Scale in Transboundary Water Management.** Natural Resources Forum. doi: 10.1111/1477-8947.12099
41. Karimov A., Smakhtin V., Mavlonov A., Borisov V., Gracheva I., Miryusupov F., Akhmedov A., Anzelm K., Yakubov S., Karimov A.A.. 2015. **Managed aquifer recharge: potential component of water management in the Syrdarya River Basin**. Journal of Hydrologic Engineering Special Issue: 8th International Symposium on Managed Aquifer Recharge. 20(3):1-12.
42. Karimov B., Mavlyanova R. 2016. **Grafting method for improving of yield and quality of tomato.** Journal Agriculture of Uzbekistan. #4, p. 12-13 (in Uzbek).
43. Kazbekov Jusipbek, Wegerich Kai, Yakubov Murat, Musayev Sardorbek, Akramova, Indira.. 2015. **Project owners – overlooked factors of uncertainty in the example of a water infrastructure improvement project?** Environmental Science and Policy.
44. Keatinge J.D.H., Wang J.F., Dinssa F.F., Ebert A.W., Hughes Jd'A, Stoilova T., Nenguwo N., Dhillon N.P.S., Easdown W.J., Mavlyanova R., Tenkouano A., Afari-Sefa V., Yang RY, Srinivasan R., Holmer RJ, Luther G., Ho FI, Shahabuddin A., Schreinemachers P., Iramu E., Tikai P., Dakuidreketi-Hickes A., Ravishankar M. 2015. **Indigenous Vegetables**

Worldwide: their Importance and Future Development. Acta Hort. v. 1102, p. 1-20. (in English).
45. Kuzieva D. 2015. **Mungbean rejuvenate a soil and it is the most consumer product.** J. Farmer. v. 1, p. 43-45. (in Uzbek).
46. Martirosyan G.S., Balayan R. S. 2015. **The results of cucumber variety "Gayane " grafting on different pumpkin rootstocks.** Journal "Agricultural Messenger", №3, Tashkent, Uzbekistan.
47. Martirosyan G.S., Zurabyan V.E., Tadevosyan L.M. 2015. **The efficiency of ussage of pesticide Rampart on development, yield and disease resistance of vegetable and melon crops**. Journal "Agroscience". Yerevan, Armenia. №1-2, p 10-13.
48. Mavlyanova R. 2014. **Agroecology is actual direction of ecological extension.** Ecological Messenger. 11. p.14. (In Russian).
49. Mavlyanova R. 2014. **Legume crops potential in a modern agricultural production.** J. "Farmer", № 7. Uzbekistan. p. 31-33. (In Uzbek).
50. Mavlyanova R. 2015. **Improved vegetable varieties for Central Asia and the Caucasus developed from WORLDVEG – The World Vegetable Center germplasm.** Ekin. Crop Breed and Gen. (1-2): p. 100-104. (in English).
51. Mavlyanova R., Zuev V. 2015. **Soybean varieties' potential.** Farmer. v. 3, p. 32-33. (in Uzbek).
52. Mirzabaev A., Goedecke J., Dubovyk O., Djanibekov U., Le Q. B., Aw-Hassan A. 2015. **Economics of Land Degradation in Central Asia.** Policy Brief No.19, ZEF Center for Development Research University of Bonn
53. Mochalova, Elizaveta, Anarbekov Oyture, Kahhorov U.. 2014. **Institutions as key drivers of collective action in WUAs [Water User Associations] of Uzbekistan.** 8p.
54. Oyiga B.C., Sharma R.C., Shen J., Baum M., Ogbonnaya F.O., Leon J., Ballvora A.. 2016. **Identification and characterization of salt tolerance using a multivariable screening approach of wheat germplasm.** In Press, J. Agron. Crop Sci.
55. Platonov A., Karimov A., Prathapar S. 2015. **Using satellite images for multi-annual soil salinity mapping in the irrigated areas of the Syrdarya province,Uzbekistan.** Submitted to Journal of Arid Land Studies
56. Sarikyan K.M. 2015. **Phytopathological evaluation of *Capsicum annuum* L. species (sweet pepper and chilli) germplasm from the genefund of the World Vegetable Center under conditions of Ararat Valley, Armenia.** Journal "Vegetables of Russia", Moscow, Russia, №1 (26), p. 52-57.
57. Stepanova N. 2015. **Vegetables of Uzbekistan - Eat with pleasure!** Mir Novostey (InfoNews). 14 (1112): 20-21. (in Russian).
58. Toirov M., Marasulova D. 2015. **Wide world for the Meeting.** J. Uzbekiston Kishlok hujaligi. 12: 11. (in Uzbek).
59. Urolova D. 2015. **Healthy cooking for a people.** J. Farmer. 3: 62-64. (in Uzbek).
60. Vardanyan N. S. 2015. **Selection of sweet pepper accessions (*Capsicum annuum L.*) on productivity and fruit quality/ Journal "Agroscience", Yerevan, Armenia**. № 5-6, p. 209-212.

Proceedings:

61. Akhmetova A., Zhang P., Singh D., Wellings C.R., Bariana H.S., Park R.F., Hoxha S., Bersimbay R., Morgounov A.. 2015. **Rust resistance in Kazakhstan and Siberia spring wheats: genotype prediction as a basis for effective resistance breeding.** Proceedings of the BGRI Technical Workshop, 17-20 September, 2015, Sydney, Australia, p.15.
62. Akhmetova A., Karatayeva R., Shtephan G., Kaskarbayev Z.. 2015. **Field screening for resistance to leaf rust pathotypes in the germplasm bank of spring wheat in Kazakhstan.** Proceedings of the 14th International Cereal Rusts and Powdery Mildews Conference, 5-8 July 2015, Copenhagen, Denmark, p.151-152.
63. Akhmetova A., Zelenskiy Y., Karabayev M., Morgounov A.. 2015. **Yield potential and rust resistance of the KASIB (Kazakhstan-Siberia Network on Wheat Improvement) nurseries.** Proceedings of the KASIB Workshop, 4-6 August, 2014, Novosibirsk, Russia. Published by Siberian ARI on Crop Production and Breeding, 2015, Novosibirsk, Russia p.3-8.
64. Akhmetova A., Zelenskiy Y., Karabayev M., Zhapayev R., Shreyder E., Shamanin V., Esimbekova M., Morgounov A.. **Identification of leaf and stem rust resistant germplasm from Kazakhstan-Siberia spring wheat network.** Proceedings of the 14th International Cereal Rusts and Powdery Mildews Conference, 5-8 July 2015, Copenhagen, Denmark, p.143-144.
65. Anarbekov O., Wichelns D., Akramov I. 2016. **Assessing the Financial and Economic Viability of Water User Associations and Canal Management Organizations in Ferghana Valley countries of Central Asia.** Inter-Conference Symposium Agricultural Transitions along the Silk Road Restructuring, Resources and Trade in the Central Asia Region. 4 - 6 April 2016 Almaty, Kazakhstan
66. Anarbekov Oyture, Mukhamedova, Nozila. 2015. **Water Users' Associations in Central Asia: Opportunities and challenges for development**. IAMO (Leibniz Institute of Agricultural Development in Transition Economies) 2015 Annual Forum: Agriculture and climate change in transition economies. Dates: 17. – 19. June 2015 | Halle (Saale), Germany. URL:http://projects.iamo.de/fileadmin/veranstaltungen/iamo_forum/2015/Presentations/IAMO_Forum_2015_B1_3_Mukhamedova.pdf
67. Anarbekov Oyture. 2015. **IWMI's experience and activities in institutional aspects of water management in Uzbekistan.** Presentation has been done in the Policy workshop of the InDeCa project of the VolksWagen Foundation program: "Between Europe and the Orient - A Focus on Research and Higher Education in/on Central Asia and the Caucasus", May 19, Tashkent, Uzbekistan

68. Avetisova G.Ye., Melkonyan L.H., Sarikyan K.M. et al. 2015. **"Ekobiofeed + universal biological preparation".** Proceedings of III International Scientific Conference on Young Researchers "Dialogues on Sciences" Yerevan, Armenia, p. 6-7.
69. Bishimbayeva N., K.Baymagambetova, R.Urazaliev, V.Chudinov, G.Sereda, O.Gass, L.Bekenova, A.Amirova, M.Karabayev, I.Rakhimbayev. **Creation of soft spring wheat precocious forms by use of biotechnology methods.** Proceedings of the 2nd International Congress "Global Climate Changes and Biodiversity", 11-12 November, 2015, Almaty, Kazakhstan, p.36-40.
70. Bobokalonov F., Ch. Andre, S. Legay, R. Azimov, J. Loo, H. Gaisberger, N. Kamolov, S. Aaliev, E. Kaparova, N. Mukhsimov, E. Butkov.**Preliminary assessment of genetic diversity of apricot populations in three Central Asian countries.** Proceedings on International Scientific – Practical Conference "Methods of increasing the yield of apricot orchards and modern ways of processing its fruits", 9-10 July 2016, Bobojon Gafurov, Tajikistan, p. 141-147.
71. Gultyaeva E., A.Akhmetova, E.Shaydayuk, I.Kazartcev, M.Aristova. **Comparison of *Pucciniatriticina*Eriks isolates from the Northwest of Russia and Northern Kazakhstan for virulence based on phenotype and SSR-markers analyses.** Proceedings of the 14th International Cereal Rusts and Powdery Mildews Conference, 5-8 July 2015, Copenhagen, Denmark, p.84-85.
72. Gultyaeva E., E.Shaydayuk, E.Kosman, A.Akhmetova, N.Goncharov. **Virulence of *Pucciniatriticina*Eriks on *Tritcum* and *Aegilops* species.** Proceedings of the 14th International Cereal Rusts and Powdery Mildews Conference, 5-8 July 2015, Copenhagen, Denmark, p.82-83.
73. Jantasov S. K., Nusupova A. O. 2014. **Regional trial of tomato accessions from the World Vegetable Center for the protected ground.** Collection of scientific papers " Scientific support of the potato, vegetable and melon growing.- Kaynar, Kazakhstan. p. 178-181.
74. Jumaboev, K., Anarbekov O., Reddy J.M., Eshmuratov D. 2015. **Improving Water Productivity On-Farm level through establishing Irrigation Extension Services in Ferghana Valley of Central Asia.** Discussion Paper Series on Institutional Development for Common Pool Resources Management in Central Asia. Discussion Paper 6/2015, p.9-14.
75. Karabayev M., A. Morgounov, R.Urazaliev, Y.Zelenskiy, A.Akhmetova,R.Zhapayev,M.Berdagulov,V.Chudinov, G.Sereda, L.Bekenova, V.Tzygankov, M.Esimbekova,K.Aitymbetova, A.Alshoraz, N.Yushenko, V.Shamanin, V.Ganeyev, K.Iskandarova, H.-J.Braun. **Mobilization of wheat genetic resources, breeding and Conservation Agriculture for food security and climate change mitigation in Kazakhstan.** Proceedings of the 2nd International Congress "Global Climate Change and Biodiversity", 11-12 November, 2015, Almaty, Kazakhstan, p.4-7.
76. Karabayev M., A.Morgounov, Y.Zelenskiy, A.Akhmetova, V.Shamanin, M.Berdagulov, V.Chudinov, G.Sereda, L.Bekenova, V.Tzygankov, V.Ganeyev, R.Zhapayev, R.Urazaliev, H.-J.Braun. **Wheat improvement in Kazakhstan and Siberia through effectively organized breeding process.** Proceedings of the 9th International Wheat Conference, 20-25 September 2015, Sydney, Australia, p.63.
77. Karabayev M., P.Wall, K.Sayre, R.Zhapayev, A.Akhmetova, Y.Zelenskiy, T.Fileccia, T.Friedrich, M.Guadagni, A.Morgounov, H.-J.Braun. **Adoption, advancement and impact of conservation agriculture in Kazakhstan.** Proceedings of the 9th International Wheat Conference, 20-25 September, 2015, Sydney, Australia, p.57.
78. Karimov B, Lyan E, Mavlyanova R. 2015. **Selection of promising rootstocks for grafting greenhouse tomato varieties for growing in greenhouses of Uzbekistan.** Proceedings of the International Conference "The role of the seed breeding in ensuring of a food security." Dushanbe, Tajikistan. p. 84-88. (in Russian).
79. Karimov B., Lyan E. and Mavlyanova R. 2016. **Complex study of accessions and revealing of promising tomato rootstock for greenhouses.** Proceedings of the Conference "The role of science and perspectives for vegetable, melon and potato production in Uzbekistan. Tashkent, Uzbekistan, p.39-42. (in Russian).
80. Karimov B., Mavlyanova R., Asadov Sh. **Promising accessions revealing for tomato grafting.** Proceedings of the International Conference "Genetic resources of agricultural crops: status and perspectives of use". 18 August 2014. UzRIPI, Tashkent, Uzbekistan. p. 258-261 (in Russian).
81. Kim V. 2015. **Vegetable soybean cultivation in Uzbekistan.** Proceedings of the International Conference "The role of the seed breeding in ensuring of a food security." Dushanbe, Tajikistan. p. 147-149. (in Russian).
82. Kiselyova N. A., Lukyanec V. N., Baytoreeva A. N., Jakataeva E. R. 2015. **New varieties of underutilized and non-traditional vegetable crops.** Collection of International Conference: "Scientific support of the potato, vegetable and melon growing of Kazakhstan", Almaty, Kazakhstan. p. 218-221.
83. Koishybayev M., A.Akhmetova. **The features of wheat rust development and the resistance of local cultivars in Kazakhstan.** Proceedings of the BGRI Technical Workshop, 17-20 September, 2015, Sydney, Australia, p. 20.
84. Koishybayev M., V.Chudinov, A.Akhmetova. **The wheat breeding for resistance to diseases with airborne infection in the northern Kazakhstan.** Proceedings of the 9th International Wheat Conference, 20-25 September, 2015, Sydney, Australia, p.128.
85. Li E.V., Shuyskaya E.V. & Toderich K.N. 2015. **Salinity impact on seed germination of *Haloxylon aphyllum* (Minkw.) Iljin grown under different desert environments.** In the Book: Proceedings of the scientific-production conference " Anatomy of Plants and conservation of genetique plants resources" , "Mounis Design Group' Publisher,Tashkent, Uzbekistan. pp. :132-136.
86. Martirosyan G., G.Sargsyan. 2014. **Results of studing initial material for pepper breeding.** Proceedings of the Eurasian Symposium on Vegetables and Greens, Acta Hort., ISHS, №1033, p. 47-52.
87. Martirosyan G.S., Sargsyan G.J. 2015. **Study and evaluation of the samples for allocating the tomato valuable initial material for breeding.** Bulletin of National Agrarian University of Armenia, №2, p 20-25

88. Mavlyanova R. 2014. **Vegetable Research in Central Asia and the Caucasus to Enhance Nutritional Security and Livelihoods.** Acta Horticulture.№1033. Proceedings of the Eurasian Symposium on Vegetables and Greens. Sarkisyan G. (ed). p. 39-45 (in English).
89. Mavlyanova R. 2014. **WORLDVEG-The World Vegetable Center germplasm using for new vegetable varieties breeding in Central Asia and the Caucasus.** Proceedings of the International Conference "Genetic resources of agricultural crops: status and perspectives of use". 18 August 2014. UzRIPI, Tashkent, Uzbekistan. p. 224-229 (in Russian).
90. Mavlyanova R. 2015. **Diversification and seed production development in Central Asia and the Caucasus.** Proceedings of the International Conference "The role of the seed breeding in ensuring of a food security." Dushanbe, Tajikistan. p. 120-124. (in Russian).
91. Mavlyanova R. Adilov M. 2014. **Non-traditional vegetable crops in Uzbekistan.** Proceedings of the Conference "Present status and potential for a development of breeding and seed production". 18 December 2014. TSAU, Tashkent, Uzbekistan. p.155-157. (In Russian).
92. Mavlyanova R. **Strategic approaches for research and development of vegetable production in Central Asia and the Caucasus.** Thesis of the 29th International Horticultural Congress, 17-23 August 2014. Brisbane, Australia (in English).
93. Mukhamedova, Nozilakhon; Wegerich, Kai.. 2014. **Land reforms and feminization of agricultural labor in Sughd province, Tajikistan.** Colombo, Sri Lanka: International Water Management Institute (IWMI); 37p. (IWMI Research Report 157)
94. Mukhamedova, Nozilakhon; Wegerich, Kai.. 2014. **The rising challenge of water resources management at the urban fringes - evidence from Ferghana district of Uzbekistan** [Abstract only]. ; pp.88
95. Nangia, V. 2014. **Valuation of ecosystem services for improved agricultural water management in Kazakhstan**. Int'l conf. Sustainability in the Water-Energy-Food Nexus, May 19-20, Bonn. Germany.
96. Nangia, V. 2014. **Valuation of ecosystem services for improving agricultural water management in Kazakhstan**. Workshop to establish guidelines for using SWAT to assess ecosystem services, October 15-17, International Livestock Research Institute (ILRI), Addis Ababa Campus, Ethiopia.
97. Nangia, V. 2015. **Agricultural water management and ecosystem services in the Aral-Syrdarya Watershed – Searching for novel ways to share water and improve ecosystem services in Kazakhstan.** International workshop on climate change and integrated dryland agricultural ecosystems, Nov 19-22, Beijing, China.
98. Nangia, V. 2016. **Managing scarce water resources in irrigated agri-food systems of Central Asia.** August 30-September 2, Annual Meeting of Japanese Society of Irrigation, Drainage and Rural Engineering (JSIDRE), Sendai City, Japan.
99. Nangia, V. 2016. **Managing scarce water resources in irrigated agri-food systems of Central Asia.** ASA-CSSA-SSSA annual international meeting, November 6-9, Phoenix, AZ, USA.
100. Nangia, V. 2016. **Weather station network-based irrigation advisory system to improve on-farm water productivity.** Conf. Water and rural development: integrated water resources management-2030 sustainable development agenda, October 5-7, Tunis, Tunisia.
101. Nangia, V., S. Charre, A. Inozemtseva, S. Raghavan, and D. Mulla. 2015. **Agricultural water management and ecosystem services in the Aral-Syrdarya watershed, Kazakhstan – Searching for novel ways to share water and improve ecosystem services in Kazakhstan**. 8th Ecosystem Services Partnership (ESP) Conf., November 9-13, Stellenbosch, South Africa.
102. Nangia, V., S. Zhakenova, D. Mulla, and S. Raghavan. 2016. **Valuation of ecosystems services to improve agricultural water management**. Conf. Water and rural development: integrated water resources management-2030 sustainable development agenda, October 5-7, Tunis, Tunisia.
103. Nurbekov A., A. Kassam, A.Mirzabaev, J. Turok, D. Sydyk and Z. Ziyadullaev. **Possible role for Conservation Agriculture in climate change adaptation and mitigation in Central Asia:** A preliminary review. "Agriculture and climate change in transition economies". 17-19 June 2015. Halle (Saale), Germany. http://projects.iamo.de/forum/2015/abstracts-and-presentations.html
104. Nurbekov A., A.Kassam, A.Musaev, D.Sydyk, Z.Ziyadullaev, and H.Muminjanov. **No-till winter wheat cultivation in the irrigated conditions Central Asia and the Caucasus.** International Conference on Conservation Agriculture and Land Use 31.05-02.06 2016. Budapest, Hungary.
105. Nurbekov A., A.Kassam, A.Musaev, D.Sydyk, Z.Ziyadullaev, D.Feindel, H.Muminjanov and J.Turok. **Effect of tillage methods on productivity of winter wheat in the irrigated conditions Central Asia and the Caucasus.** 18th International Soil Conservation Organization Conference May 31 – June 5, 2015 El Paso, Texas, USA. http://iscoabstract.weebly.com
106. Nurbekov A., T.Bukhoriev, A.Kholmatov, H.Cicek, H.B.Salem, and A.Kassam. **Legume-cereal mixtures under no-till and conventional tillage agriculture in Tajikistan.** International Conference on Conservation Agriculture and Land Use 31.05-02.06 2016. Budapest, Hungary.
107. Nurbekov A., Ziyadullayev Z., Sydyk D., Asoev N., Yatimov B., Kholmatov A. **Effect of tillage methods on productivity of double cropped mungbean in the irrigated conditions of Central Asia.** International Conference on Pulses, Marrakesh, Morocco, 18-20 April, 2016. pp 137.
108. Nurbekov Aziz, Tanzila Ergasheva, Dhehibi Boubaker, Harun Cicek and Hichem Ben Salem. 2015. **Attitudes to-**

wards conservation agriculture practices in Tajikistan. The role of agriculture in food security conference. 12 September 2015. Dushanbe, Tajikistan. Pp. 292. ISBN 978-99975-48-73.
109. Sargsyan G.J.. I.V. Vardanian, Z.E. Harutunyan. 2014. **Usage of Callus Culture in Selection of Pepper and Tomato**. Proceedings of the Eurasian Symposium on Vegetables and Greens, Acta Hort., ISHS, №31033, p. 77-84.
110. Shamanin V., A.Morgounov, I.Likhenko, I.Potockaya, A.Chursin. **Spring bread wheat breeding strategy for West Siberia under negative effects of climate change.** Proceedings of the 2nd International Congress "Global Climate Changes and Biodiversity", 11-12 November, 2015, Almaty, Kazakhstan, p.278-279.
111. Toderich K.N., Ismail Shoaib, Rabimov A.R. Mukimov T.Kh. , Khujanazarov T.M., Shuyskaya E.V., Babokulov N.A., Khamraeva H. & Bekchanov B.B. 2015. **Biosaline low cost techniques to improve productivity of degraded rangelands and livestock feeding system under ongoing climate changes environments.** Proceedings of the International Conference dedicated to 85 anniversary of the Institute of Karakul Sheep Breeding and Desert Ecology., 13-15 August, 2015, Samarkand,Uzbekistan, "Zarafshon' Publisher: pp. 287-293
112. Turdieva M.K., A.K. Kayimov, K.I. Baymetov. **Local diversity of fruit, nut crops and grapevine as a basis for development of organic horticulture in Uzbekistan.** Proceedings of International Scientific-Practical Conference "Advantages of fruit and vegetable products of Uzbekistan", 12 July 2016, Tashkent, Uzbekistan.
113. Vardanyan N. S. 2015. **Comparative assessment of sweet pepper varieties (Capsicum annuum L.)**. *Bulletin of State Agrarian University of Armenia, Vol. 21*. p. 25-30.
114. Z.Gafurov, A.Karimov 2014. **Evapotranspiration and Land use and Land cover change analysis in Karshi steppe, Uzbekistan for water requirement analysis.** 2nd International Conference on Arid Lands Studies 2014. Abstract book, Samarkand, Uzbekistan
115. Zelenskiy Y., A.Akhmetova, A.Morgounov, V.Shamanin, M.Berdagulov, V.Chudinov, G.Sereda, L.Bekenova, V.Tzygankov, V.Ganeyev, R.Zhapayev, R.Urazaliev, M.Karabayev. **Kazakhstan-Siberian network and shuttle breeding programs for high latitude wheat improvement.** Proceedings of the 2nd International Congress "Global Climate Change and Biodiversity", 11-12 November, 2015, Almaty, Kazakhstan, p.247-248.
116. Zhapayev R., OmarovaA., Nikishkov A., Yushenko D., Iskandarova K., Paramonova I., Nekrasova N., Toderich K., Akhmetova A., Zelenskiy Y., Karabayev M. **Sorghum yield potential assessment in different agro-ecological zones of Kazakhstan (for feed and biofuel).** Proceedings of the 2nd International Congress "Global Climate Change and Biodiversity", 11-12 November, 2015, Almaty, Kazakhstan, p.217-218.

Working Papers:

117. J. Mohan Reddy, Kakhramon Jumaboev, Ihtiyor Bobojonov, Carlo Carli and DavronEshmuratov. 2016. **Yield and Water Use Efficiency of Potato Varieties under Different Soil-Moisture Stress Conditions in Fergana Valley of Central Asia.** Agroecology and Sustainable Food Systems.
118. Louhaichi, M. 2015. **Methodology for Assessing Rangeland Vegetation in the Action Sites (Karakalpakstan & Tajikistan).** ICARDA: Amman, Jordan
119. Louhaichi, M. 2015. **Using GPS collars at the Karakalpakstan site.** Presentation of Work. ICARDA: Amman, Jordan.
120. Nurbekov Aziz, Amir Kassam, Dossymbek Sydyk, Zokhidjon Ziyadullaev, Seymur Safarli, Hafiz Muminjanov, David Feindel and Jozef Turok. **Practice of Conservation Agriculture in the irrigated areas in Azerbaijan, Kazakhstan and Uzbekistan.** pp. 86
121. Nurbekov Aziz, Asad Musaev, Dossymbek Sydyk, Zokhidjon Ziyadullaev and Jozef Turok. 2015. **Conservation Agriculture in Irrigated Areas of Azerbaijan, Kazakhstan and Uzbekistan.** ISBN: 92-9127-476-3. Tashkent, Uzbekistan. Pp46. https://cloud.mail.ru/public/EsAA/JRdA5LuGN

Books:

122. Aden Aw-Hassan. Vitalii Korol, Nariman Nashinov, Utkur Djanibekov, Olena Dubovyk, and Alisher Mirzabaev. 2016. **Economics of Land Degradation and Improvement in Uzbekistan.** Chapter 21
123. Alisher Mizabaev, Jamn Goedecke, Olena Dubovyk, Utkur Djanibekov, Quang Bao Le and AdenAw-Hassan. **Economics of Land Degradation in Central Asia.** Chapter 10
124. Asatov Sh., Zuev V.I., Mavlyanova R.F.. 2014. **Chinese leafy cabbage and its cultivation technology principal elements.** Tashkent, Uzbekistan. 104 p. (In Russian).
125. Esmira Alirzayeva, Valida Ali-zade, Tamilla Shirvani and Kristina Toderich. 2016. **Evaluation of Wild Halophytes of Aralo-Caspian Flora Towards Soil Restoration and Food Security Improvement.** Münir Öztürk, Muhammad Ashraf Ahmet Aksoy, M.S. A. Ahmad Khalid Rehman Hakeem (Editors). Plants, Pollutants and Remediation.,Springer Publisher: 63:99
126. Kristina Toderich, Timur Khujanazarov, Shoaib Ismail , Elena Shuyskaya & Toshpulot Rajabov. 2015. **Improving the productive use of marginal lands in mixed farming and pastoral systems as a part of climate change adaptation strategy.** Proceedings of the 5th Kubuqi International Desert Forum. Kubuki-China: 169-192.
127. Mavlyanova R. 2014. **Impact of national and international programs and projects in mitigating food and nutritional insecurity in Central Asia and the Caucasus.** In: "The Basics of Human Civilization - Food, Agriculture and

Humanity, Vol. II: FOOD. P. Nath (edit). New India Publishing Agency. p. 529-544 (in English).
128. Zuev V, Mavlyanova R, Dusmuratova S, Buriev H. 2015. **Vegetables are a food and a medicine.** Tashkent, Uzbekistan. 178 p. (in Russian).
129. Kabulova F.D., M.K. Turdieva. 2014. **Sea buckthorn of Zarafshan: theory, practice and perspectives.** Bioversity International, Rome, Italy, 111 p. (in Russian)
130. Arzumanov V.A., E.A. Butkov, M.K. Turdieva, K.I. Baymetov, A.A. Yushev. 2015. **Plant resources of fruit and nut crops of Central Asia and their role in formation of local varieties.** Bioversity International, Rome, Italy, 106 p. (in Russian)

Brochures:

131. Amanov A., Baymetov K., Mavlyanova R. et all. 2016. **Cataloque of fruit, grape, vegetable and melon crops.** UzRIPI, Tashkent., Uzbekistan. 36 p. (in Uzbek, Russian and English).
132. Amanov A., Baymetov K., Mavlyanova R., et al. 2014. **The Catalogue of new and promising varieties of agricultural crops**. UzRIPI, Tashkent, Uzbekistan. 20 p. (In Russian).
133. Aytbayev T. E., Amirov B. M., Janabaev T. T. 2014. **Varieties and hybrids of potatoes and melons selected in the Kazak Research Institute of Potato and Vegetable Growing, committed to the use in the Republic of Kazakhstan**. Catalogue.- Almaty, Kazakhstan. p. 160.
134. Aytbayev T. E., Amirov B. M., Janabaev T. T. 2016. **Varieties and hybrids of potatoes and melons of selection of the Kazak Research Institute of Potato and Vegetable Growing, committed to the use in the Republic of Kazakhstan.** Catalogue. Almaty, Kazakhstan. 181 p.
135. Aytbayev T. E., Krasavina V. K., Krasavin V. F., Ergabilova G. T. 2014. **Catalogue of varieties of potato and vegetables suitable for processing.** Almaty, Kazakhstan. 51 p.
136. Khakimov R.A., Mavlyanova R.F., Ermolova E.V. 2016. **Vegetable, melon crops and potato Catalogue.** RIVMCP, Tashkent., Uzbekistan. 35 p. (in Russian and English).
137. Mavlyanova R, Mecozi M (eds.). 2015. **Catalogue of released and promising vegetable varieties in Central Asia and the Caucasus.** WORLDVEG - The World Vegetable Center, Tashkent, Uzbekistan. 25 p. (In English and Russian).
138. Mavlyanova R. F., Yang R-Y., Khusamitdinov R. R., Nesterenko V. P. and Umarov A. Kh. 2016. **Central Asian and the Caucasusian recipes with new vegetables.** R. Mavlyanova and Ray-Yu Yang (eds.). Publishing Agency "Navruz", Tashkent, Uzbekistan, 67 p. (in English, Uzbek and Russian).
139. Mavlyanova R., Mecozzi M., Begmuratov A. (eds.). 2014. **WORLDVEG's Partnership for Vegetable Systems Research and Development in Central Asia and the Caucasus.** Tashkent, Uzbekistan. 52 p. (in English and Russian).
140. Varieties and hybrids of vegetable crops. 2014-2015. Catalogue. Scientific Center of vegetable and Industrial crops, Erevan, Armenia. 33 p.

Patents

141. Karabayev M., A.Amirova, N.Bishimbayeva, I.Rakhimbayev. **The method of obtaining of wheat embriogenic callus tissue capable to long-term plant regeneration.** PATENT of the Republic of Kazakhstan #29149, 17.11.2014.
142. Mavlyanova R., Amanova M., Rustamov A. **"Girasol fresh for a food".** STATE STANDARD of the Republik of Uzbekistan, №2905, 05.01.2015.
143. Salikhov S.A., Mavlyanova R.F. **"Girasol tubers processing method"**. PATENT of the Republik of Uzbekistan, №IAP 05091, 2015.
144. Tautenov I., Umirzakov S., Massino I., K.Toderich, Zhapayev R., S.Bekzhanov. **New Sorghum Variety "Keshen".** PATENT of the Republic of Kazakhstan #575, 20.10.2015.
145. Zhapayev R., I.Tautenov, S.Umirzakov, I.Massino, K.Toderich, S.Bekzhanov. **New Sorghum Variety "Keshen".** PATENT of the Republic of Kazakhstan #575, 20.10.2015.
146. WORLDVEG Certificates for new vegetable varieties for 2014-2016:
a. Tomato - Alsu; Sweet pepper - Shodlik, Loshtak, Nabat and Krasnoe chudo;
b. Hot pepper - Artsiv, Dari-murch, Said and Mumtoz; Eggplant - Kuvonch and Tukhfa;
c. Vegetable pea - Sladkiy bob; Vegetable bean - Mravalmartsvala; Vegetable marrow - Unumdor and Gayrat; Custard squash - Meduza;
d. Lettuce - Polezniy; Basil - Balgyn; Celery - Poleznaya zelen; Mungbean - Bereketli.

Extension and training materials

147. Gafurova L, Khamidova Kh, Amanov A, Mavlyanova R, at all. 2016. **Ecologically friendly technologies for cash crops cultivation in soil and climatic conditions of Bukhara region.** Guide for farmers Bukhara, Uzbekistan, 38 p. (in Uzbek).
148. Gafurova L, Khamidova Kh, Amanov A, Mavlyanova R, Sharipov O, Tillakhodjaeva N, Avtonomov V, Asadov A, Akhmedov Sh, Makhkamova D, Begmatov Sh. 2015. **Agrobiologic methods for soil improvement in Bukhara region. Guide for farmers.** 24 p. (in Uzbek).

149. Mavlyanova R. 2015. **Cultivation technology of mungbean in Fergana valley conditions**. Booklet. WORLDVEG/ICARDA/UzRIPI/WUA. (in Uzbek).
150. Mavlyanova R. 2015. **Cultivation technology of vegetable crops.** Booklet. WORLDVEG and UzRIVMC&P, Tashkent, Uzbekistan. (in Uzbek).
151. Mavlyanova R. 2015. **Ecologically friendly IPM methods for vegetable crops.** Booklet. WORLDVEG/RIVMCP. (in Uzbek).
152. Saidov N. 2015. **Integrated Pest Management (IPM) for greenhouse vegetables.** Brochure. (in Tajik).
153. Saidov N. 2015. **Methods of composting and Soil solarization.** Leaflet. (in Tajik).
154. Saidov N. 2015. **Natural means of plant protection for control of pest in vegetable crops.** Brochure. USAID-WORLDVEG, Dushanbe, Tajikistan. 27 p. (in Tajik).
155. Saidov N., Mavlyanova R., Ergashev M.Ch. 2016. **Vegetable cultivation technology in greenhouses.** Dushanbe, Tajikistan, 30 p. (in Tajik).
156. Toderich K, Mavlyanova R. 2015. **Diversification for a food security and a livelihood improving of a population in Aral Sea Basin.** Brochure. ICBA, WORLDVEG, ICARDA, NSU. Nukus, Uzbekistan. 18 p. (in Karakalpak).

Monographs

157. Boboev Hasan, Yoshiro Higano, Toderich Kristina. **Conservation Agriculture Technologies and Policies in Uzbekistan.** New Frontiers in Regional Science: Asian Perspectives (monograph (book) proposal submitted to Springer Series, May 2016)
158. Butnik A.A., Toderich K.N., Matyunina T.E., Japakova U.N. & Yusupova D.M. 2016. **Manual on fruit morphology and biology of seed germination of desert plants of Central Asia.** Vladimir .Pechenitsin, Shaoib Ismail and Josef Turok Eds. Bilik Print' Publisher., Tashkent, Uzbekistan 316pp. (in Russian with English summary)
159. Toderich K.N., Bobokulov N.A., Rabbimov A.R., Shuiskya E.V., Mukimov T.KH., Popova V.V. & Khakimov U.N. 2015. **K*ochia prostrata* (l.) Schrad – a valuable forage plant for improving the productivity of arid and semi-arid degraded rangelands in Central Asia** (in Russian with English summary), Shoaib Ismail Eds. "Fan va Tekhnologiya" Publisher, Tashkent. Uzbekistan, 156pp.

Blogs

160. Nangia, V. 2016. **Evapotranspiration-based irrigation scheduling: A promising tool for Uzbek farmers**. (English:http://www.cac-program.org/news/detail/499; Russian: http://www.cac-program.org/ru/news/detail/500)
161. Nangia, V., P. H. Gowda, T. Yuldashev, S. Mukhamedjanov, and A. Mukhamedjanov. 2014. **Optimizing use of water for crop production using evapotranspiration-based irrigation scheduling in the Fergana Valley**. CGIAR Research Program on Dryland Systems. (http://cac-program.org/files/b99ffb2d611550c1373cbf96f3c661c6.pdf)
162. Kiktenko, L., B. Dessalegn, S. Charre, and V. Nangia. 2015. **Markets offer women opportunities to capitalize on ecosystem services – a case study from South Kazakhstan**. (https://wle.cgiar.org/markets-offer-women-opportunities-capitalize-ecosystem-services)
163. Nangia, V. 2015. **Seeking novel ways to share water and improve ecosystem services in Kazakhstan**. CGIAR Research Program on Water, Land and Ecosystems (http://wle.cgiar.org/blog/2015/06/07/seeking-for-novel-ways-to-share-water-and-improve-ecosystem-services-in-kazakhstan/)

ACRONYMS

ADB	Asian Development Bank
ALRIT	Agency of Land Reclamation and Irrigation of Tajikistan
AS	Academy of Sciences
ASK	Academy of Sciences of Kyrgyzstan
ASRF	Academy of Sciences of Russian Federation
AUCA	American University of Central Asia Kyrgyzstan
BISA	Basin Irrigation System Administration
BMZ	Federal Ministry for Economic Cooperation and Development
CAC	Central Asia and the Caucasus
CACAARI	Central Asia and the Caucasus Association of Agricultural Research Institutions
CACSARC-kg	Central Asia Crafts Support Association's Resource Center in Kyrgyzstan
CACVEG	Regional Network for Vegetable Systems Research & Development
CAREC	The Regional Environmental Centre for Central Asia
CGIAR	Consultative Group on International Agricultural Research
CIMMYT	International Maize and Wheat Improvement Centre
CIP	International Potato Centre
CMO	Canal Management Organization - in charge of day-to-day canal management
CRI	Cotton Research Institute
CRP-DS	CRP-Dryland Systems
CRP-WLE	CRP-Water, Land, and Ecosystems
CWC	Canal Water Committees – the governing body for CMO
FRIK	Forest Research Institute Kazakhstan
FUU	The Farmers' Union of Uzbekistan
GIS	Geographic Information System
GIZ	Die Deutsche Gesellschaft für Internationale Zusammenarbeit
GRIC	Gallaral Branch of Research Institute of Cereals, Uzbekistan
GSU	Gulistan State University
GW CA	Groundwater Central Asia project
IB	Institute of Botany
IBPPG	Institute of Botany, Plant Physiology and Genetics under the Academy of Sciences, Tajikistan
ICARDA	International Center for Agricultural Research in the Dry Areas
ICBA	International Centre for Biosaline Agriculture
ICP	Innovation Center of Phytotechnology
ICRISAT	International Crops Research Institute for Semi-Arid Tropics
IDB	Islamic Development Bank
IDFF	Institute of Desert, Flora and Fauna
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
ILRI	International Livestock Research Institute
IVMCP	Research Institute of Plant Industry and Research Institute of Vegetable, Melon Crops and Potato, Uzbekistan

IWMI	International Water Management Institute
IWRM	Integrated Water Resources Management
IWRM-FV	Integrated Water Resources Management-Fergana Valley Project
IWWIP	International Winter Wheat Improvement Program
KBRIGLC	Kashkadarya Branch of Research Institute for Grain and Leguminous Crops
KIRP	Kazakh Institute of Rice Production in Kyzylorda
KNAU	Kyrgyz National Agrarian University named after K.I. Skryabin
KRASS	Khorezm Rural Advisory Support Service
KRIA	Kyrgyz Research Institute of Agriculture
KRICH	Karkalpakstan Research Institute of Crop Husbandry
KRIF	Karakalpak Research Institute of Farming
KRII	Kyrgyz Research Institute of Irrigation
KRIPVG	Kazakh Research Institute of Potato and Vegetable Growing
KRISSA	Kazakh Research Institute of Soil Science and Agrochemistry named after U.U.Uspanov
KRRI	Kazakh Research Rice Institute, Kazakhstan
KSRI	Kazakh Soil Research Institute
LEPL	LEPL Scientific-Research Centre of Agriculture Georgia
LIST	Luxembourg Institute of Science and Technology
MAMK	Ministry of Agriculture and Melioration of Kyrgyzstan
MARK	Ministry of Agriculture of the Republic of Kazakhstan
MAWR	Ministry of Agriculture and Water Resources, Uzbekistan
NAA	National Academy of Azerbaijan
NCSG	National Coordination and Support Group
NGO	Non Governmental Organization
NPAUET	National Public Association «Union of Economists of Turkmenistan»
NTSAU	Nukus branch of Tashkent State Agrarian University, Karakalpakstan
NUU	National University of Uzbekistan
PFU	Program Facilitation Unit
PPI	Plant Physiology Institute
RESP-2	Rural Enterprise Support Project - Phase II (funded by World Bank)
RIAE	Research Institute for Agricultural Economics Uzbekistan
RIE	Research Institute Economics, Tajikistan
RIF	Research Institute of Farming, Kyrgyzstan
RIF	Research Institute of Farming, Tajikistan
RIHVG	Research Institute of Horticulture and Vegetable Growing, Tajikistan
RIHVTAAS	Research Institute of Horticulture and the Vegetable of Tajik Academy of Agricultural Sciences
RISS	Research Institute of Soil Science, Tajikistan
RISSA	Research Institute of Soil Science & Agrochemistry (Uzbekistan)
RIV	Research Institute of Vegetables, Tajikistan
RSPCOGF	Republican Scientific and Production Centre of Ornamental Gardening and Forestry, Uzbekistan
SBWMAT	Sugd Basin Water Management Authority in Tajikistan

SCVMIC	Scientific Center of Vegetable-Melon and Industrial Crops, Armenia
SDC	Swiss Development and Cooperation Agency
SIAT	Scientific-research Institute of Agriculture, Turkmenistan
SIC-ICWC	Scientific-Information Center of the Interstate Coordination Water Commission of the Central Asia
SPCA	Scientific Production Center for Agriculture, Uzbekistan
SRI	Dokuchaev Soil Research Institute
SRILP	South-west Research Institute of Livestock and Plant production, Kazakhstan
SSBWMAU	Syrdarya-Sukh Basin Water Management Authority in Uzbekistan
SSU	Samarkand State University, Uzbekistan
STLRI	Sugd branch of the Tajik Livestock Research Institute
STR	Small Transboundary Rivers
STT	Small Transboundary Tributaries
SVTC	State Variety Testing Commission
TAAS	Tajikistan Academy of Agricultural Sciences
TRIF	Tajikistan Research Institute of Farming
TSAU	Tashkent State Agrarian University
TSR	Transboundary Small Rivers
TSWMSPDI	Turkmen State Water Management Scientific Production and Design Institute
TWMP	Transboundary Water Management Project
UCWU	Union of Canal Water Users
USAID	United States Agency for International Development
USPCA	Uzbek Scientific Production Center for Agriculture
USU	Urgench State University
USWU	Union of System Water Users
UWU	Union of Water Users (same as UCWU)
UzRIHVW	Uzbek Research Institute of Horticulture, Viticulture and Winemaking named after M. Mirzaev
UzRIKSHDE	Uzbek Research Institute for Karakul Sheep Husbandry and Desert Ecology
UzRIPI	Uzbek Research Institute of Plant Industry
UzSPCA	Uzbek Scientific and Production Centre of Agriculture
VSRI	Vegetable Scientific Research Institute, Azerbaijan
WB	World Bank
WCAFPU	WCA K.Umarov in Ferghana Province of Uzbekistan
WG	Working Groups
WMO	Water Management Organization
WORLDVEG	The World Vegetable Center
WPI-PL	Water Productivity Improvement on Plot Level project
WUA	Water Users' Association
WUG	Water Users Group
ZEF	Center for Development Research, University of Bonn

If you have any questions, comments or requests, please feel free to contact us using the details below.

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