Partnerships for Enhanced Engagement in Research (PEER)

ANNUAL SCIENTIFIC REPORT

(for the period 01 July 2012-31 December 2014)

Utilization of low quality water for halophytic forage and renewable energy production

Grant Award Number: AID-OAA-A- 11- 00012

Financially supported by USAID- National Science Fund (NSF)

Tashkent -2014

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Uzbek Research Institute of Hydrometeorology
Samarkand State University

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Executive summary

The proposed project focuses on

This report contains the major findings of the project for the period 01 July 2012. – 30 May 2013.

Project Main Goal: The main goal of this project is to identify the benefits of cultivation of halophytes to improve economic utility of marginal lands and waters.

The main objectives:

- to examine the feasibility of use of non-conventional water sources (hot artesian saline ground water, saline lake water) to irrigate halophytic crops on marginal soils;
- to determine how use of halophytes affects water quality of nearby lakes and water bodies;
- to examine if halophytes can be cultivated on marginal soils to produce biomass for biofuel or fodder;

Introduction

Land degradation, in particular soil salinization, is one of the major factors threatening the sustainability of irrigated agriculture in the newly independent states of the Central Asia (CA). According to recent estimates, approximately 60% of the total 7.5 million ha of irrigated lands of the region are salt affected, which has reduced potential yields of cotton and wheat crops by as much as 50%. This has resulted in lower farm incomes and increase in poverty. The viability of irrigated agriculture in Kazakhstan, Tajikistan and Uzbekistan is threatened by secondary soil salinization. This resource degradation issue is the consequence of a range of factors, including inadequate provision of surface and subsurface drainage, poor water management practices resulting in rising groundwater tables, insufficient surface water supplies and the use of poor quality water for irrigation. The consequences of inappropriate irrigation and drainage management lead to increasing of rural poverty, household food insecurity, and environmental degradation all of which threaten regional economic development (Gupta et al, 2009). Two major pillars of agricultural production in CA are a) irrigated agriculture, which has led to severe soil salinization, leaving vast tracts of land degraded and b) livestock production, which often secures income for poor households, but suffers from a severe gap in fodder supply, especially in late autumn-early spring seasons (Toderich et al., 2009).

Another major factor contributing to increasing soil salinity is the poor quality of return flow from irrigated lands to water bodies that has a profound affect on the water quality of major river systems. About 40% of the total water applied through irrigation is returned to rivers with a consequent deterioration in water quality.

Target areas:

Shur Koshkopir Lake is one of the lakes studied by NSF EAR-0838239 “Investigating pesticide contamination in small lakes in Khorezm, Uzbekistan” (PI: L. Saito, University of Nevada Reno). Results from NSF EAR-0838239 determined that the lake is a little over 100 years old with a sedimentation rate of about 0.5 cm per year. From 2006 to 2008, the salinity of the lake ranged between 2 and 6 g/L (average ~3 g/L), with the highest salinity occurring in summer 2008 when lake levels dropped very low. Examination of Shur Koshkopir cores show increases in organic matter over time from when the lake formed to peak concentrations around 1963. Since that time organic matter concentrations have stabilized but have not recovered to peak concentrations. The reason for this decline in lake productivity (production of organic matter) is unknown, but the pattern is similar in other lakes. Salinity increases may be a contributing factor in limiting lake productivity. Average annual precipitation in Khorezm province is 92 mm per year (Wehrheim and Martius 2008).

The second field site for halophyte cultivation is located in the sandy desert of southwest Kyzylkum at **Madaniyat experimental station,** Academy of Sciences of Uzbekistan**.**. The climate is dry continental with hot summers and cold winters. Most of annual precipitation (67%) is as snow and rain in spring (March-April) and only 23% occurs September-December. The average annual temperature is 29°C, with maximum of 46°C in July and minimum of 5-11°C in January and extreme minimum of -40°C. The mean annual precipitation received as snow and rain ranges 80-110mm. The soil is highly saline in the top soil and in the lower layers. The predominant salinity type is sulphate-

chloride. Two artesian hot springs will be used for the irrigation of halophytes and salt tolerant crops. Ground water salinity varies from to 2.0-8.2 g/L. Sodium and magnesium are the dominating cations. Average electric conductivity of the irrigation artesian spring water varies between 3.30 to 12.1 dS/m, and pH between 7.3 to 8.1.

1. Water, soil and plant quality analysis for major ions and nutrients, mineral contents.

Monitoring of water quality of water (biophysical parameters including EC; temperature; TDS) of Koshkupur Lake water (Khoresm district) and artesian thermal water (Kyzylkesek , Central Kyzylkum) is continued . Soil and water samples continued to be collected in September –October for chemical analysis at laboratory at NIGMI under leadership of Bahriddin Nishonov.

In accordance with work plan for the period from 10.01.2012 to 31.12.2012 following work was performed by Dr Bahriddin Nishonov

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1. Analyzed soil samples from the pilot site Shurkul selected in September and November 2012 and from the pilot site Kizilkesek selected in August 2012 of the horizons 0-20cm, 20-40cm, 40-60cm, 60-80cm, 80-100cm to determine the type and extent of salinity and soil fertility.

Investigated parameters: pH, conductivity, carbonates (alkalinity), chloride, sulfate, calcium, magnesium, sodium, dry residue, nutrients (potassium, phosphorus, nitrogen), humus, soil organic carbon (TOC).

2. Analyzed water samples from the lake and irrigation canal Shurkul Koshkupur, Khoresm Khorezm, selected in September and November 2012 and from artesian wells and the reservoir near the pilot area Kizilkesek to determine the suitability of water for irrigation.

Investigated parameters: pH, hardness, ammonia, nitrite, nitrate, phosphate, total phosphorus, hydrogen, chloride, sulfate, sodium, potassium, calcium, magnesium.

3. Soils in the pilot area Shurkul have medium and strongly chloride-sulphate type of salinity. On the top layer of soil chloride content varies 0.065-2.340% and sulfates 0.100-0.860%. Humus content in the upper layer ranges 0.317-1.709%.

4. Mineralization of Shurkul Lake Water in September 3.3 g / l (September) - 3.5 g/l (November), and the salinity of the channel - 0.7 and 0, 85 g / l, respectively.

5. The mineralization of thermal artesian water and irrigation water at Kizilkesek site was 2.4-2.5 g/l.

2. Assessment of livestock forage potential of halophytes and salt tolerant crops for the contents of protein, lipids/fat and hydrocarbons (October –December 2012)

Assessment of livestock forage potential of halophytes and salt tolerant crops are analyzed for the contents of protein, lipids/fat and hydrocarbons. Forage collection in the filed of five species of wild halophytes during flowering and at the early seed maturation stages (at thee end of September 2012), transportation, preparatory plant drying, grinding to flour etc. was done by ICBA with assistance of Dr Larisa Mejlunyan (Chemistry

Institute of Plant Substances) team and Dr Valentina Popova, Laboratory of Environmental Research, Samarkand State University.

Data on nutritional and forage values of halophytes compared with fodder salt tolerant crops is given in Table 1,2.

Table1. Chemical composition and energy value of forage for some fodder salt tolerant crops, grown in mixed plantation with halophytes at Kyzylkesek site (calculated at air dried matter, %)

Investigated species	Stage of ontogenesis	Chemical composition, %					Gross energy	
		Crude protein	Crude fat	Cellulose	Nitrogen non extractive substances	Ash	Kkal	Mdj
Alfalfa (Sceptre variety from ICBA)	flowering	16,1	1,6	11,6	60,8	9,1	4162	17,4
Licorice	fruit maturation	20,7	4,2	33,4	33,3	7,51	4417	18,4
Pearl millet (Hashaki variety)	flowering	13,3	1,1	22,4	47,2	7,9	3834	16,0
Sorghum (ICSR 93046 variety)	flowering	13,0	1,2	17,7	50,1	4,0	3761	15,7
Maize	flowering	10,6	1,5	23,0	40,8	8,3	3476	14,5

Table 2. Chemical composition and energy value of forage for some fodder halophytes, sampled at flowering stage (Average data 2012, Kyzylkesek site

Investigated wild halophytes	Chemical composition, %					Gross energy	
	Crude protein	Crude fat	Cellulose	Nitrogen non extractive substances	Ash	Kkal	MDz
Suaeda paradoxa	23,6	2,8	20,9	27,5	21,9	3662	15,3
Climacoptera lanata	22,6	2,4	18,6	27,6	27,5	3474	14,5
Atriplex nitens	9,0	1,47	31,6	45,7	10,5	3964	16,5
Halostachys belangeriana	14,7	3,2	27,9	14,3	38,5	2934	12,2
Karelinia caspia	5,6	1,2	21,5	52,7	16,5	3614	15,1

3. Seed collection mission of halophytes, studies of fruit morphology, seed quality, storage conditions

ICBA in collaboration with Institute of Botany (Dr Tamara Matyunina team) in late October and beginning of November conducted a filed work expedition in

Central and East-southern Kyzylkum. Younger master students were involved in this practical filed work. Seeds of 14 wild halophytes were collected, documented and stored. Under laboratory condition seed quality analysing, seed vigour and rate of their germination are studying prior seed sowing under filed conditions in spring 2013. Botanic characteristics including morphology of seeds for some economic-valuable species are started. Manuscript of the manual is expected to be ready at the end of June 2013. The practical manual on fodder and bioenergy halophytes is preparing in English with translation in Uzbek languages for interested agropastoralists, herders, land users, students and others people groups.

4. ***Conducting batch-test and continuous mode laboratory experiments: Anaerobic degradation of halophytes***

Batch-test and continuous mode laboratory experiments on anaerobic degradation of halophytic biomass is monitored at the Department of Applied Ecology, National University of Uzbekistan . Two younger female students from this University and Mr Yuriy Mun (ICBA master student) are involving in this activity under leadership of Drs Natalya Akinshina and Kristina Toderich. Anaerobic reactors (12 units) are permanently working for butch-tests on anaerobic digestion of plant biomass.

1. Anaerobic reactors (12 units; 500 mL) were designed for batch-tests on anaerobic digestion of plant biomass. Anaerobic sludge was taken from "Salar" Waste water treatment station in Tashkent city and Institute of Microbiology of Academy of Science of Uzbekistan.

Reactors are operated in mesophylic conditions (35°C) with stirring.

Few series of experiments on anaerobic digestion of different plant biomasses were conducted. Anaerobic reactors (500 mL volume) were fed by dried and milled plant biomasses, weights of biomasses corresponded to 1 g of organic matter.

Halophytes collected in Kyzylkesek site in September 2012 (*Karelinia caspia, Atriplex nitens*) contain only 14-18% mineral compounds from dry weight.

Biomass of conventional grass (*Cynodon dactylon*) is mostly presented by organic matter (about 90% DW).

2. Organic Carbon in plant biomass was measured using spectrophotometer Jasco V-530 (Japan). Obtained preliminary results are presented in table 3 and figure 1.

Table 3. Ash content and Organic Carbon in dried matter of plant biomasses.

	Organic Carbon (mgOC/gDM)
Halostachys belangerana	137,5
Salicornia europaea	150,0
Climacoptera lanata (1)	181,3
Climacoptera brachiata (2)	216,3
Suaeda paradoxa	208,8
Atriplex nitens	315,0
Karelinia caspia	328,8
Cynodon dactylon	355,0

We can range biomass under investigation in accordance with Organic Carbon content:

Hal < Sal < Cli(1) < Cli(2) < Sua < Atr < Kar < Cyn.

It is supposed that amount of organic carbon correlates directly with biogas production in process of anaerobic digestion of different kinds of biomasses. That is why we could conclude that biomasses of halophytes *Atriplex nitens, Suaeda paradoxa* and *Karelinia caspia* and glicophyte *Cynodon dactilon* are more preferable to use for biogas production.

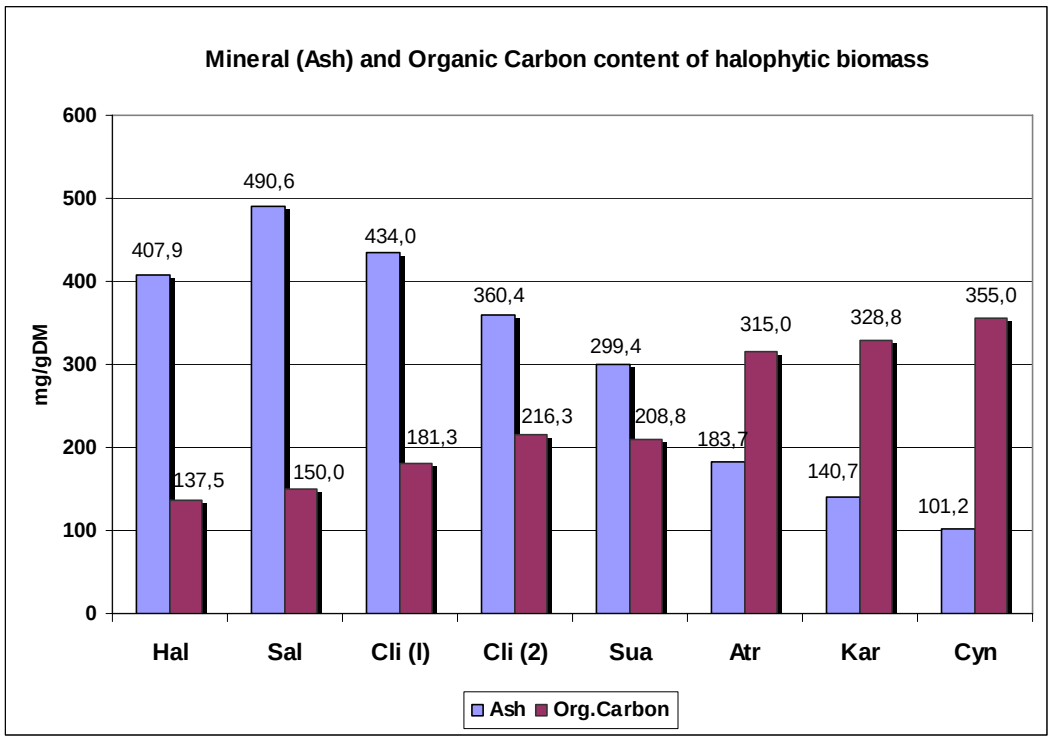
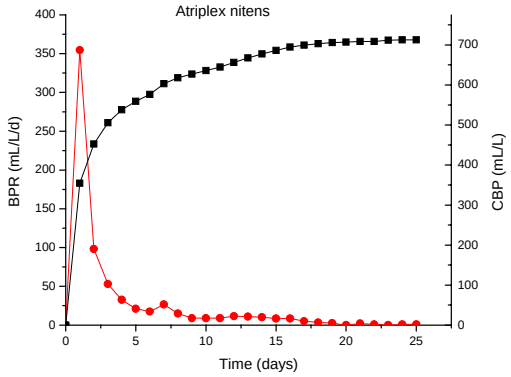
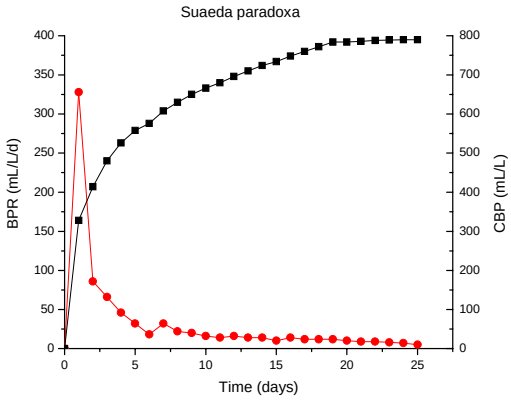


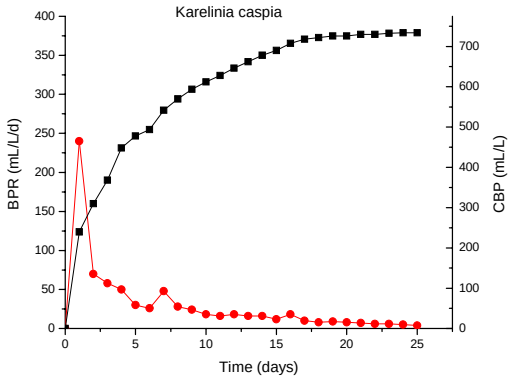
Figure 1. Mineral and Organic Carbon content in plant biomasses

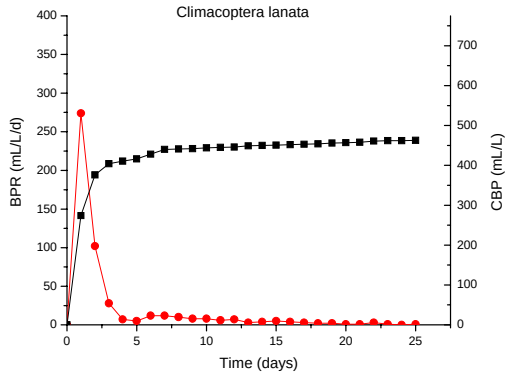
The question is to determine biodegradability of organic fractions of biomasses under investigation.

Preliminarily laboratory results on potential use of plant biomass of halophytes for biogas production are presented. It was found that anaerobic digestion of 1 g organic matter of plant biomass can produce approximately 180-420 mL of biogas (with 70% of methane-gas at least). Maximal biogas production was showed by conventional grass *Cynodon dactilon* (422,5 mL/gOM) and halophytic species *Suaeda paradoxa* (395), *Karelinia caspia* (367) and *Atriplex nitens* (356,5). Organic matter of other halophytes seems to be less biodegradable for anaerobic bacteria at 35°C. We have got only 180-230 mL of biogas at anaerobic digestion of 1 g organic matter of *Climacoptera spp*.


Atriplex nitens
BPR (mL/L/d)
CBP (mL/L)
Time (days)


Suaeda paradoxa
BPR (mL/L/d)
CBP (mL/L)
Time (days)


Karelinia caspia
BPR (mL/L/d)
CBP (mL/L)
Time (days)


Climacoptera lanata
BPR (mL/L/d)
CBP (mL/L)
Time (days)

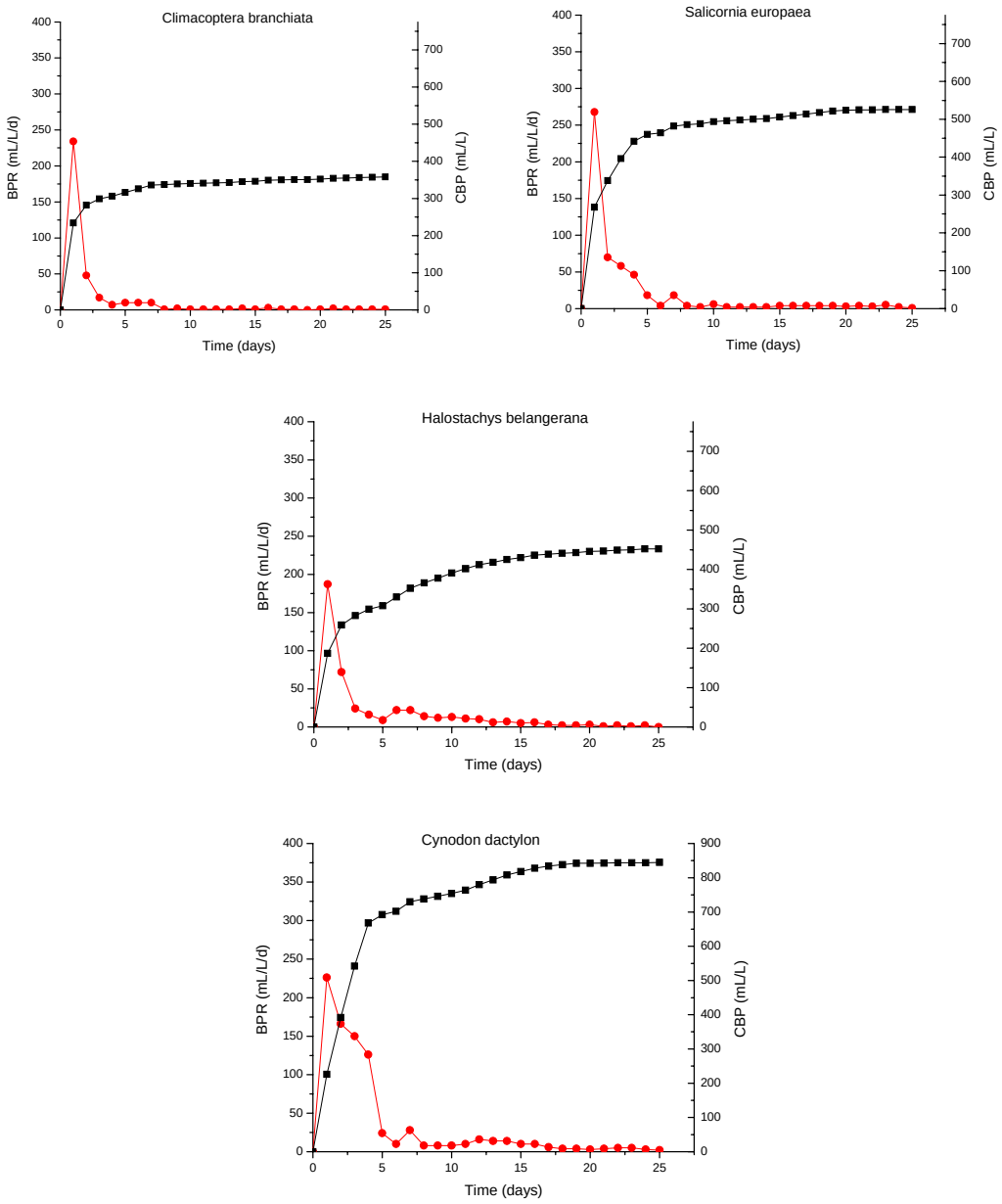


Fig. 2. Preliminary data on biogas production rate (BPR) and cumulative biogas production (CBP)
in mesophylic conditions.

Anaerobic digestion of 1 g OM *Salicornia europaea* produced 263 mL of biogas; and *Halostachys belangerana* – 226 mL.

It is proposed that Halostachys sp., Salicornia sp. and Climacoptera sp. contain considerable quantity of inert (nonbiodegradable) organic fractions.

Table 4. Biogas production potential of different kinds of biomass (anaerobic digestion, 35°C, batch-tests)

	mL/gOM*	mL/gDM**
Halostachys belangerana	226	134
Salicornia europaea	263	134
Climacoptera lanata	231,5	131

Climacoptera branchiata	179	114,4
Suaeda paradoxa	395	276,7
Atriplex nitens	356,5	291
Karelinia caspia	367	315,4
Cynodon dactylon	422,5	379,7

**OM – Organic matter;*
***DM – Dried matter.*

At the same time it should be noticed that biomasses of *Atriplex*, *Suaeda* and *Salicornia* have considerable amount of easy biodegradable organic fractions among total organic matter.

Since field operations were completed earlier in 2012, in coordination with ICBA expertise it was decided to test salinity resistant alfalfa in Shurkul lake site. Alfalfa was planted in late summer of 2012 in the low saline part of the experimental area. However, results show that seedling establishment of alfalfa in such saline environment was not possible.

Planned sowing activities of halophytes in pure stands were completed in late February 2013. In consultation with ICBA it was decided to replicate trials of Kyzylkesek site with the help of ICBA field assistant. Kyzylkesek site has been established earlier and successfully running. As of the time of the report, there was no seed germination at Shurkul lake site.

Intercropping of salinity resistant crops were planned to be completed in late April 2013. Regular soil and water sampling is carried out and sent to the laboratory according to the training and instructions received from the collaborating partner from Uzhydromet that analyses collected samples.

About 150 young trees/shrubs (*Catalpa bignonioides*, *Elaeágnus angustifólia, Robinia pseudoacacia…)* and numbers of halophytic germplasms were sown in new agricultural plot in Kushkupir site, Khorezm region.

Data collected at the end of crops vegetation in Koshkupur lake areas shown 75% of survival of trees/shrubs (*Catalpa bignonioides*, Populus diversifolia, Ailanthus altissima *Elaeágnus angustifólia, Robinia pseudoacacia, Morus alba, M. nigra, Ulmus densa, Armeniaca vulgare*), planted based on ICBA guidelines in March 2014. The most tolerant to soil salinity and mineralized irrigation water was marked for *Elaeágnus angustifólia, Populus species,* Ailanthus altissima, Populus diversifoolia, Prúnus armeniáca *and* numbers of halophytic species shown good performance at the new farmer lands at Kushkupir site, Khorezm region.

Salsola sclerantha, Climacoptera lanata, Climacoptera brachiata, Suaeda paradoxa, Kochia scoparia, alfalfa, Glycyrrhiza glabra, Atriplex nitens, Helianthus tuberosus and

others were grown productively on marginal water and lands in Madaniyat farm (Central Kyzyl-Kum). It was shown that it is possible to get high yield of halophytic biomass (for fodder or bioenergy production) using hot mineralized water and low-fertile soils. Green biomass yields of halophytes are listed below:*Salsola sclerantha – 20,05 t/ha; Climacoptera lanata – 29,10 t/ha; Suaeda paradoxa – 28,15 t/ha; Kochia scoparia - 34,10 t/ha; Glycyrrhiza glabra - 33,84 t/ha; Atriplex nitens – 48,95 t/ha.* At the second year best performance under irrigation with mineralized water was marked for alfalfa, sorghum and pearl millet, planted in pure stands or mixed with halophytes. Farmer was able to get profit both from green forage and grain production. Local producers could increase yield by using different biosaline technologies (Toderich & Ismail Shoaib, 2007). Bellow is an overview of halophytes in pure stands or mixed with non-traditional salt tolerant crops to be recommended for diversification of incomes for desert agropastoralists.

Karelinia caspia in flowering stage.

Kochia scoparia –a perspective fodder species for improving livestock feeding (40% of rough biomass of Kochia scoparia +30% of alfalfa +30 of pearl millet collected in panicle insertion stage)

Seed multiplication on sorghum trial at Kyzylkesek farm ; farmer used special fish net for protection seeds against birds; also farmer was trained how to get profit from seed sale .

Pearl millet Hashaki1 - new released in Uzbekistan variety for green forage and grain production was recommended to be cultivated in Kyzylkesek on saline soil in combination with legume. Farmer got forage rich in protein + cellulose during late summer –autumn periods. Both of these crops shown good regrowth after two cuttings.

Halophytic pasture with Atriplex (annual high value herb)

Field of alfalfa at seed maturation stage (2d year of vegetation)

During the PEER reporting period it was found that ecosystems of marginal borderline areas, located between old irrigated and Kyzylkum Desert zones, as it was a case in Koshkupur (Khoresm region) and Kyzylkesek (Navoi region) are vulnerable in term of climatic extremes and availability of water resources, characterized by saline ground water or mixed water quality. In addition soils are affected by secondary salinization being difficult to be managed by using conventional methods. Therefore

reclamation of these marginalized resources is growing halophytes salt tolerant fodder crops, cereals and oil plants to enhance the natural resources management, improve food security and diversify income of agropastoralists in these remote desert areas. International Center for Biosaline (ICBA) and Uzbek Institute of Karakul Sheep Breeding and Desert Ecology within PEER project activity in summer 2014 have been cooperating on development and promotion of innovative low cost technologies biosaline agriculture in the region. A socio-economic evaluation shown an environmentally and economically feasibility to use dual –purpose crops in pure and/or in mixed composition for improvement of forage production and livestock feeding system using marginal saline water for irrigation. One of the promising research areas was the diversification of agro-biodiversity of crops by use of alternative well adapted salt and drought tolerant crops, such as sorghum (*Sorghum bicolor*), pearl millet (*Pennisetum glaucum*) and various species of legumes (alfalfa, licorice, soya bean, mung bean, vicia and cow pea). Diversification provides for replacement or alternating of traditional crops (e.g. cotton, wheat, corn, rice), growing of which on marginal lands is difficult or not possible. Adaptation to local conditions and cultivation of different non traditional crops including halophytes has two main advantages: first, it creates a stable grain production and fodder supply necessary for the development of local livestock feeding system, and secondly, their cultivation will help prevent erosion and improve soil productivity. Recommendation for utilization of low quality water is also beneficial in these areas.

Chapter 6. Assessment of livestock forage potential of halophytes and salt tolerant crops for the contents of protein, lipids/fat and hydrocarbons

Assessment of livestock forage potential of halophytes and salt tolerant crops are analyzed for the contents of protein, lipids/fat and hydrocarbons. Forage collection in the field of five species of wild halophytes during flowering and at the early seed maturation stages (at the end of September 2012), transportation, preparatory plant drying, grinding to flour etc. was done by ICBA with assistance of Dr.Larisa Mejlunyan (Chemistry Institute of Plant Substances) team and Dr.Valentina Popova, Laboratory of Environmental Research, Samarkand State University.

Assessment of livestock forage potential of halophytes was analyzed for the contents of protein, lipids and hydrocarbons.

Chemical composition and energy value of some halophytes and salt-tolerant plants.

A)

Plant species	Ash (%)	Organic fraction in dry matter (%)	Carbon fraction in dry matter (%)	Soluble carbohydrates (%)	Proteins (%)	Oxalic acid (%)	Total lignins (%)
Tamarix hispida	22,8-37,1	62,9-77,2	50,0-61,0	7,4-9,7	5,1-6,3	1,0	24,8-33,7
Halostahys belangeriana	32,1-41,1	58,9-67,9	48,0-55,0	5,1-5,7	10,1-11,8	9,3-12,3	22,6-29,1
Halocnemis strobilaceae	39,9	60,1	48,0	6,0	7,2	9,3	37,3
Anabasis europaea	32,6	67,4	33,0	7,9	4,7	19,9	25,5
Kalidium caspicum	34,2	65,8	50,0	7,1	7,3	8,1	27,3
Suaeda spp.	32,2-43,1	56,9-67,8	38,0-49,0	3,1-10,8	5,6-1,4	3,4-7,9	23,4-16,9
Climacoptera lanata	29,0-47,2	52,8-71,0	38,0-53,0	7,9-12,6	5,1-13,3	3,5-6,0	15,4-34,3
Salicornia europoea	35,3-48,0	52,0-64,7	33,0-48,0	9,3-9,9	4,4-5,8	1,8-2,6	10,3-18,2

Laboratory analysis of nutritional value of halophytes and salt tolerant crops will continue.

Socio-economic overview was done for the Kizylkesek village, Madaniyat community settlement, Kanimekh district, Navoi region, Uzbekistan

The aim of this study is to gain qualitative insight into the daily rural life of different groups, and understand social-economic and environment interactions within Madaniyat community. The specific emphasis is drawn on rural community perspectives, views towards their needs in infrastructure, natural resources (rangeland, water and forest) use, and livestock husbandry. This study also tries to understand the nature of social and economic relationships of local community population with various organizations, hierarchies and institutional structures.

1. Methodology

This study was based on primary qualitative data collected by group of young Uzbek scientists of diverse backgroundwithin the territory of Madaniyat settlement. The approach used for this part of assessment can be classified as Rapid Rural Appraisal (RRA). RRA methods help to understand livelihoods of different rural groups in relatively short period of time.RRAis based on the following principles:

1. Quick and cost-effective;
2. Multidisciplinary teams (at least social and technical sciences being present);
3. Optimal ignorance: donot collect more information than strictly needed; as far as possible theinformation should come from the people themselves;
4. Triangulation: in order to ensure that the crucial information is valid, information from one person ischecked by seeking it from another person as well;
5. Observations in the village, the houses and the fields are seen as a valuable source of information

Primary RRA tools employed during our field data collection were the following:

a. *Participatory mapping*. This is an efficient data collection tool in terms of receiving schematic information from group of people in relatively short time. This is a participatory session, where diverse rural representatives gather and encouraged to draw various community related maps under facilitation. In our study we applied 3 types of participatory maps:

   - Rural infrastructure and community resources map
   - Community needs assessment
   - Network influence and resource management map

b. *Focus group discussions*. This instrument is handful in situations, where groups of community representatives are gathered (in)formally (e.g. workshops, social events, tea breaks etc.) and one can discuss and receive decent opinion over particular topic, phenomenon or discourse.

c. *Formal and informal Interviews*. These methods were used to approach selected community representatives such as Shirkat leaders, pastoral shepherds, farmers with particular knowledge about resource use and rural livelihoods.

d. *Dialogues with key resource persons*. These are the people who have extended experience in interacting within communityactively: e.g. school teachers, veterinary, medical practitioner, local leaders etc.

e. Transect walks and participant observations. These included walking with shepherds along a grassland transect, and spending time in daily life in farmer's family.

f. Observations.

2. Background to the community

a. Geography: Number of total territorysquare (in hectares), including pastoral areas, forests, marginal areas, villages; Rivers, mountains, hills etc.

b. Climate: average seasonal temperature, precipitation etc.

c. Demography: The population of Madaniyat settlement is about 600 people comprising 75 household families. If available, please include number of men and women; birth/death rate; age of people, ethnic origin, minorities, disabled etc.

d. Agro-ecologic conditions: type of soil, tree species, crops and forage sawn (including yields), types of seasonal pasture vegetation and yields; number and types of animals; water resources etc.

3. Initial findings

Community infrastructure and natural resources mapping

*Infrastructure:*The participatory session on community infrastructure mapping has shown that rural households of Madaniyat Shirkat settlement have access to the following public infrastructure resourcesand services: transportation roads, post office, library,primary school, telephone line, electricity network, veterinary service, medical hospital (*see Fig.1*). One pharmacyand one grocery-store are available for community too. Although, these resources are available for clients, the quality of some public services is rather poor and infrastructure is maintained unregularly. Communal water network was functional during former Soviet period, but is not supplied any longer due to high water salinity levels and obsolete water pipes. Instead, households use water from local wells, artesian points or buy water container from private suppliers each season. Families keep water in traditional reservoirs (ranging from 2-4 m3) build in each household yard. Gas network has never been constructed in this settlement.Instead, rural families use fire-wood, coal or dried dung of animals to prepare food and heating houses during winter seasons. Fire-wood is usually bought officially from local Forestry Office, or harvested unofficially from local territories. High demand for fuel has caused wood logging and is one of the reasons of soil erosion around pastures. Transport communication between nearest town

and Madaniyat is organized regularly by private drivers, and public bus appears only once a week.

Natural Resources: There are 19 medium and small size water wells were mapped within *Madaniyat* community settlement. Waters artesian wells nearby Yangier village naturally flow into *Katta-Kol* lake located in the South-West (*see Fig.1*). This water is used communally by households and as well as for watering grazing animals by local households. Green areas in the map are protected territories and they belong to National Forestry Department under the Ministry of Agriculture. 10 forestry rangers permanently keep this territory safe from wood logging and they rent improved pasture areas to households for seasonal animal grazing, usually from April to August months. For each such case there is a legitimate contractual agreement signed between parties, whereas areas of leased pasture and number of animals indicated with respective penalties for cases of abuse. Total number of animals which belong to households was reported as following: 500-600 sheep/goats; 200 cattle; 150 camels; 75 horses. Shirkat farm, as reported, has 2000 heads of Karakul sheep; 70 horses and 70 camels. Totalsquare of pastures under *MadaniyatShirkat* farm was reported as about 300 thousand ha. Participants of mapping sessions also indicated that households can lease land plots from Shirkat farm for crop production, livestock grazing or gourd plantation (melon, pumpkin, water-melon etc.), as well as access distant pastoral territories.In practice, nonetheless, distant pastures are utilized rarely due to water shortage and poor vegetative biomass. However, respondents mentioned also that Shirkat farm pastures are usually less productive than they are in protected forestry areas.Each household have small plot of land around house for gardening and planting food crops for family consumption and marketing.

Community needs assessment

There were 12 people (5 women) participated in needs assessment sessions conducted with Madaniyat community. The participatory mapping was conducted in local school building. Respondents were diverse residents of local community working in different areas and with mixed level of education. List of the most critical needs of local community was brainstormed. Then this list was prioritized by selecting out (five "+ points" per each participant) most important ones amongst the listed needs. Active participation of respondents shows the following as the first priorityneeds:

1. *Public transport system – bus*, to access nearest town and cities. Among other listed need this one received 14 plus points by participants (*see listed Nr.1 in Fig.2*). This was one of the most critical needs because households wish to have decent transportation to access markets and be able to sell their produce for fair prices.

2. *Natural gas supply.*Extreme harsh winter seasons and daily need for fire-wood caused high demand and high prices for wood stocks and coal. In some cases families could not afford them. Therefore, not surprisingly, participants selected natural gas supply to households through communal network as a priority need for the community. This one was given 12 plus points (*see listed Nr.8 in Fig.2*).

3. *Local market.* This one among other needs received 8 plus points (*see listed Nr.5 in Fig.2*). In the view of respondents, the local residents could have active trade of necessary commodities with more beneficial terms if they would have *bozor* within their community territory.

4. *Compensation for adverse health effects (uranium ore)* – 8 plus points, listed Nr.11. This was explained by uranium ore excavation works functioning in the nearby of Madaniyat settlement. Residents believe they have harmful effects on their health and wish to be compensated by owners. It was mentioned, that additional coefficient calculations were paid by state during the former Soviet period. But nowadays this compensation scheme is not practiced anymore, as reported.

5. *Medical service* – therapeutics and dentist – 7 plus points, listed Nr.3 (see Fig.2). Participants emphasized, that local hospital has only one certified traumatology doctor as medical physician. Others are nurses and service personnel. This need was explained as critical, because sick people have to travel to nearest cities to seek treatment, whereas transportation, drugs and medical services are costly.

6. *Fresh water supply*– 6 plus points. Respondents listed their need for available fresh water at decent price within their community. Currently fresh water is transported by private entrepreneurs at high cost and not affordable for many households. Moreover, groundwater harvested from local sources has moderate to high level of mineralization. It is supplied for drinking by ruminant animals, used for crop irrigation, but almost not suitable for direct drinking, and hardly useful for food cooking.

7. *Access to part-time higher education*– also received 6 plus points (*see listed Nr.13 in Fig.2*). Part-time study at universities was cancelled by Government in 2004; now only full-time daily education is recognized. In practice, this hinders access of many rural youth to higher education. From the one hand, it is for financial shortage reasons in rural families, and on the other hand - due to early employment and labor support for family to sustain their household, which hampers long-term leave.

8. Other needs within the listed priorities received less attention. Thesewere the following:

    - Resuming communal water supply - 4
    - Fodder production - 4
    - Kindergarten - 4
    - Paynet(electronic payment system for mobile and communal services) - 4
    - Employment opportunities - 3
    - School teacher - 3
    - Public bath - 3

Informal Institutional Arrangements

Most of the local community households use Shirkat lands for animal grazing without any formal agreements.Shirkat leaders keep it in ignorance and do not go into conflicts with households. This was explained by existing social ties of ethnic families and community clans with Shirkat leaders. This was also affected by Government Resolution from 2008 on improvement of livestock production in rural areas, which keeps local households in more or less protected position from potential conflicts with Shirkat, the formal land user, or local leaders. Nonetheless, in practice the local Shirkat leader has powerful position and can influence households and their production systems. It was reported, that households not always use contractual agreement Forestry Department Office to lease improved pastoral areas, but rather negotiate it informally with rangers. One or two sheep are usually sacrificed for informal use of forest pasture per season.

Income Sources

Working age population mostly generate income from livestock rearing at pastures nearby village settlements, as well as seasonally by planting melon / water melon at gourd plantations. Some family members are employed permanently or seasonally by local Shirkat farm. Other families gain remittances earned by family members' seasonal work in neighbor countries, mostly Kazakhstan and Russia. The distance to the nearest market from Madaniyat, where households can receive decent price for their produce is about 70-120 km, and located in town Zarafshan, Kanimekh or Navoi Private entrepreneurs in trucks also visit Madaniyat regularly to buy vegetables, melon/water melon, pumpkin, meat, wool etc. from local households. But local communities have little bargaining power and prices for goods are usually far below of those in markets. In some cases, people simply negotiate exchange of their produce to other commodities, e.g. vegetable oil, rice, potato, carrot, flour, pesticides, clothes, household supply goods etc. Income sources of Madaniyat Shirkat farm were reported as following: 70% from sale of meat; 20% from sale of Karakul skin and 10% from milk and wool produce.

Informal discussions with community representatives indicated the low level of income of the households. For instance the salaries of Shirkat farm employees were in range of UZS 80,000 to UZS 120,000, which is equivalent in local market exchange rates to USD 32 – 48 per month. This is surely not sufficient for a family of 5-6 people. Income from cropping and livestock rearing gives additional economic incentives for better off families, but not for resource-poor households.

4. Opportunities

Interviews have indicated positive dissemination of ICBA pilot farm experiences within the community households. Historically sand plot of Odiljon, theowner of pilot farm, is now turned to a green garden full of alfalfa, fodder and food crops. His animals gain weigh noticeably faster and he enjoys trading melons, water-melons and other garden produce seasonally with more benefits now with help of ICBA. Neighbor families are now realized real benefits and ready to disseminate this practice. Odiljon is also enthusiastic about sharing his experience and seeds for improving living conditions of his neighbors. Local Shirkat leader also interested in buying fodder crops from Odiljonand from anyone producing animal fodder in local harsh conditions. They are ready to render any necessary support. Odiljon uses local artesian water sources to irrigate his land plots. Successful results on cultivation of salt tolerant crops from ICBA like alfalfa , sorghum, pearl millet of the pilot farm also encouraged the Shirkat leader and the farmer to extend his land plot areas under lease and to plant more volumes of fodder crops next season. The farmer is also very enthusiastic about utilization of artesian water for other purposes, e.g. for

production of fruit and vegetables under greenhouse. The natural thermal temperature of artesian water is quite suitable for this purpose.

Training workshops and educational event within the Project period

A training monthly seminar was organized at Department of Applied Ecology, National University.

Date(s) of event: 20 December 2012

Brief description of event: Number of female participants:4

Number of male participants:2

Main purpose: presentations of first experimental results of Master students involved in the PEER project were discussed and topics of research were determined. Master students showed great interest to work with halophytes including structural and physiological mechanisms of salt tolerance; salt accumulation/excluding etc (Mrs Dilyafruz Arifhanova); Bioorganic mechanisms of degradation of halophytic biomass and biogas production under laboratory conditions (Mrs Maria Safonova) and salt removal mechanisms and augmenting the USDA's APEX model to be able to model halophytes and salinity dynamics (Mr Yuriy Mun). We are planing to try to model the PEER project's field sites in collaboration with Dr Saito Laurel Team, Nevada University.

During the reporting period a series of electronic conference on sharing of preliminarily results we are doing periodically with Dr Saito Laurel team.

In April 2013 we are planning to organize an Annual Project Planning Meeting in Tashkent to share results and outline the activities for next period. Prof Laurel Saito and Mikhael Rosen, Nevada University will also attend the meeting. Field visit to Kyzylkesek site and Koshkupur Lake areas will be organized.

In July 2013 a Field Day with involvement of local communities and administrative leaders, decision-markers will be organize at Shurkul-Koshkupur halopytic plants communities to demonstrate the technology of cultivation of wild salt loving and traditional salt tolerant crops irrigated with saline lake water and designated to be used for livestock feeding or raw material for renewable bio-energy production.

Thanks to the support of Dr Saito Laurel a Visiting International Fellowship (VIF) has been received by Dr Kristina Toderich to make an oral presentation at World Water and Environmental Resources Congress Cincinnati, Ohio, May 19-23, 2013. After the conference Dr. Saito is planning to organize several meeting at Reno University and filed sites. During her visit in Reno she will meet with potential collaborators at the University of Nevada Reno to develop proposals and papers on her work with halophytic plants, saline soil reclamation, and water quality improvement. She will visit field sites that are similar to her field sites in Uzbekistan to compare methodologies and data on the studies of water resources on agricultural lands. During her visit at UNR, she will give presentations about her research in Uzbekistan, and she will also visit with UNR's Cooperative Extension scientists about outreach activities they are doing related to saline agriculture issues. We will also plan field trips for Dr. Toderich to Pyramid Lake and Lake Tahoe where she can meet with researchers and representatives of the Pyramid Lake Paiute Tribe. Outcomes of the visit will be the development of research proposals to USDA and other organizations, and a proposal to NATO for a collaborative workshop related to the utility of halophytic plants in Central Asia, as well as collaborative papers.

During the reporting period we have communicated periodically with Dr. Saito via email and skype. In April 2013 we are planning to organize an Annual Project Planning Meeting in Tashkent to share results and outline the activities for next period. Dr. Saito and Dr. Michael Rosen of the US Geological Survey will also attend the meeting. Field visit to Kyzylkesek site and Koshkupur Lake areas will be organized.

In July 2013 a Field Day with involvement of local communities, administrative leaders, and decision-makers will be organized at Shurkul-Koshkupur field sites for halopytic plants communities to demonstrate the technology of cultivation of wild salt loving and traditional salt tolerant crops irrigated with saline lake water and designated to be used for livestock feeding or raw material for renewable bio-energy production.

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To build capacity among local farmers International Center for Biosaline Agriculture (ICBA) within framework of the project in collaboration with Samarkand State University, Khokimyat (local city administration) and Farmer Association of the Samarkand region, Ecological Movement of the Republic of Uzbekistan and CGIAR PFU (ICARDA, IWMI, CIP) for Central Asia and Caucasus, organized a **training seminar for farmers to present and discuss technological innovations in agriculture**

and food security – *Innovations in agriculture as basis for protection and rational use of natural, land and water resources*.

The main objectives of the meeting were:

- Disseminate achievements and best practices on improvement of productivity of marginal lands through conservation and management of irrigated, rainfed and rangelands agroecosystems;

- Knowledge sharing and familiarization with Farmers demands and constraints through a teleconference with farmer associations of Syrdarya, Khoresm, Andijan & Bukhara regions;

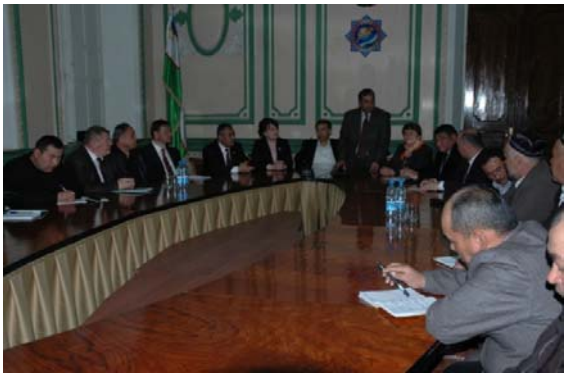
- Debates on development of institutional framework (legislation basis) on sustainable utilization and management of marginal resources.

The seminar was conducted during *March 5-6, 2014* at the Samarkand State University and attended by about *180 participants* (farmers, animal breeders, extension officers, scientists, policymarkers, private sector, students, international consultants and governmental leaders).

Topics on promotion of innovation/best practices in conservation agriculture, biosaline agriculture and soil salinity management, pastures improvement, irrigation, land, water and dryland ecosystems function, thus familiarizing the trainees with novel approaches and new vision in agriculture and food security sectors were covered. Organized through the Farmers Service Association the participants learnt about salinity challenges, non-conventional crops and irrigation management, interaction of livestock, forages and salinity; farmers have an opportunity to learn on how to think about the management of salts, and the management of farming systems on saline lands, improving their knowledge in the sustainable use of salt-tolerant crops/forages, soil and water in the arid and semiarid environments. The importance of marginal quality water in agriculture and food security by ensuring agro-biodiversity conservation was the well-received topic at the seminar.

Farmers and researchers from 5 districts (Samarkand, Syrdarya, Andijan, Khoresm and Bukhara) also took part during the teleconference debates, moderated by Dr Akmal Karimov (IWMI-CAC). Farmers have shown great interest in transferring of innovations in agriculture, modern technologies in plants growing on degraded and marginal lands, effective methods of water use, adoption of conservation agriculture technologies, and

integrated pest control on main crops including vegetables. They also mentioned about the contribution and positive role of International programs in agriculture development and food security.



Apart to the meeting Samarkand State University in collaboration with Coordinating Committee for Development of Science and Technology at the Cabinet of the Ministers of Uzbekistan, Khokimiyat and Farmer Association of Samarkand region on *06 March 2014* at Agrarian College in Samarkand organized a *"Farmer Fair", where ICBA presented achievements on technological innovations in biosaline agriculture and food security in Central Asian countries.* The exhibition has been well received by the local audience.

As results, governments take the lead in scaling up technical innovations, and applying new knowledge to water and land use. But to inform policy and decide on appropriate strategies for water, agriculture, and the environment they need reliable information on water resources, cropping systems, and soil salinity. In his welcome remarks, Dr Dilorom Fayzieva, Member of the Deputy Group of Ecological Movement of Uzbekistan, Legislative Chamber of Oliy Majlis (Parliament) of the Republic of Uzbekistan mentioned that in recent year's climate changes, natural disasters, land and water quality deterioration had a negative impact on food security in Uzbekistan. She added, there is a need to accelerate technical and scientific development and diversification of agricultural sector including sustainable pastures use and conservation. Based on two days work with different stakeholders in Samarkand the representatives from the parliament of Uzbekistan suggested to initiate the development of National Concept and an institutional and policy framework for environmental management with special accent on marginal resources utilization, land /water and ecosystem management and conservation. It was concluded to organize such series of trainings in different districts of Uzbekistan, where experience of International organizations are crucial needed.

An international platform for exchange of knowledge and experience was conducted during the **2nd International Conference on Arid Land Studies1 (ICAL 2) on 'Innovations for sustainability and food security in arid and semi-arid areas' in Samarkand, Uzbekistan, 9-14 September 2014**. ICAL 2 builds on the outcomes of the International Forum on Desert Technology X and the 1st International Conference on Arid Land Studies (ICAL 1), organized in Japan in May 2011.

More than 220 experts, senior scientists from international research organizations, policymakers and other stakeholders from 24 countries convened on 10-12 September to share knowledge and experience in ensuring agricultural development and food

security in arid and semi-arid areas; to discuss prevention of salinization and sustainable management of natural resources; and to present best practices and technologies on soil improvement and optimization of crop production systems. And over half of the participants were young specialists and researchers. As part of the conference agenda, the Eurasian Soil Partnership2 (EASP) held its first Plenary and Steering Committee meetings on 10-11 September at Samarkand State University.

Knowledge sharing and results Dissemination

The followings presentations were prepared in the reporting period of the project:

1. D.Arifkhanova "Halophytes. Ecology and salt-tolerance mechanisms" ***(project meeting in NUUz)***
2. M.Safonova "The main principles of anaerobic fermentation for biogas production" ***(project meeting in NUUz)***
3. Yu.Mun "Alternative energy prospects" ***(project meeting in NUUz)***
4. K.Toderich "Agricultural research and development for saline lands (based on PEER project in Uzbekistan)" ***(meeting with representatives of USA Embassy, in NUUz)***
5. L.Saito "Review of US Partner Projects" ***(meeting in USA Embassy in Uzbekistan)***
6. N.Akinshina "Progress report. Halophyte's biomass as source of renewable energy" ***(Annual project meeting in ICBA,Tashkent-office)***
7. D.Arifkhanova "Some mechanism of salt-tolerance of *Tamarix hispida* and *Climacoptera lanata*, grown under Kyzylkum desert environments." ***(Annual project meeting in ICBA, Tashkent-office)***
8. B.Nishonov "Progress report on chemical analysis of soil and water in Central Kysylkum (Kysylkesek site) and Khoresm district (Shorkul-Kushkupir site)" ***(Annual project meeting in ICBA, Tashkent-office)***
9. K.Toderich "Progress report on PEER Projects: results, obstacles and perspectives" ***(Annual project meeting in ICBA, Tashkent-office)***
10. A.Butnik "Progress work on Manual on halophytes in Central Asia" ***(Annual project meeting in ICBA, Tashkent-office)***
11. L.Saito "Review of US Partner Projects" ***(Annual project meeting in ICBA, Tashkent-office)***
12. T.DeRuyter "Overview of APEX model on halophytes" ***(Annual project meeting in ICBA, Tashkent-office)***
13. K.Toderich "Domestication of wild fodder and medicinal halophytes for improvement of degraded desert marginal lands and better livelihood of agropastoralists" ***(USA, University of Nevada)***
14. T.DeRuyter, L.Saito, K.Toderich "Interdisciplinary modeling of halophytes for salinity management" ***(USA, University of Nevada)***
15. K.Toderich "Water resources evaluation: challenge and sustainable utilization in Uzbekistan" (***Carson City, USA***)
16. Multi-purpose use of marginal water and plant resources in Central Asia. Dubai, UAE, 4-6 June, 2014

17. Improving the productive use of marginal lands in irrigated farming and pastoral systems. Project proposal for Dryland Systems CRP (2013-2014…2016) IDOs-4.1. Fergana Meeting 12-14 August, 2014
18. Biosaline Agriculture Approach for Salinity Management, Food Security & Better Rural Livelihood. The 9th Eurasian Soils Science Congress , 14-17 October 2014, Antalya, Turkey
19. Salt tolerant plants for soil salinity control, sustainable fodder and bioenergy production in Central Kyzylkum. 2d International Conference on Arid Lands Studies, 9-14 September 2014, Samarkand , Uzbekistan
20. Modeling halophytic plants for sustainable agriculture and water resources. 2d International Conference on Arid Lands Studies, 9-14 September 2014, Samarqand, Uzbekistan.