ICBA-ICARDA project report

Documentation on identified 'hot spots' and boundaries of different categories of marginal lands with potential for winter forage in Koybak cooperative and Karabuga villages (Karakalpakstan)

Summary

The Central Asia region is facing serious food security challenges with the need to feed larger number of people amongst increasingly limited water resources and highly variable climatic conditions. Intensive water use for irrigation are also taking priority over the scarce freshwater resources, leaving agriculture to use low-quality and mineralized water with adverse effects on agricultural productivity as most of the commonly cultivated crops, like cotton, wheat, corn are sensitive to salinity. Adding to the complexity, climate change projections for the region indicate considerable negative impact on farm-level productivity. Identifying stress-tolerant alternative crops is therefore seen as an important strategy to improve agricultural production and sustain the livelihoods of the poor farmers – especially those dependent on marginal quality land and water resources.

Utilization of marginal water resources along the Amu Darya River, for example, is one important area where greater collaboration is needed. There is a necessity for a review of policies and reinforcing regional synergies for addressing climate change and to reduce the conflicts that exist for water and land management. Many private farms and vulnerable groups have no choice but to use degraded natural resources with negative impacts on the ecosystem and increased vulnerability to food insecurity.

Various studies conducted in the rural areas of CA river basins (WB, 2009) showed that the percentage of the population with low incomes is associated with the unreliable supply of water for irrigation and land degradation (i.e. soil salinity and waterlogging). The regional losses each year just from salinization have been estimated to be at least $2 billion (or roughly 5% of the region's GDP), and it is a problem faced by all CA countries.

Review on successes and failures of feed production on marginal lands in the Aral Sea Basin.

With current knowledge, the concept of marginal land and water resources can be defined as the lands that are physically inaccessible or with soil and climate restrictions, or with high environmental risk and fragile ecosystem services, and with low production and therefore unprofitable (Lal, 2009). The concept is often interchangeably used with other terms such as unproductive lands, waste lands, underutilized lands, saline lands, abandoned lands, or degraded lands (FAO, 1976; Lal, 1991; Sugrue, 2008; Wiegmann et al., 2008; Khujanazarov et al, 2014). Soil scientists and agronomists often adopt physical marginality and production marginality of lands based on soil suitability and restrictions for the purpose of land use planning. Marginal lands generally refer to the areas not only with low production, but also with limitations that make them unsuitable for agricultural practices and ecosystem function (Heimlich, 1989; Hart, 2001).

Marginal lands have been also defined as the land uses at the margin of economic viability (Strijker, 2005). Schroers (2006) defined more clearly an economically marginal land as "an area where a cost-effective production is not possible, under given site conditions, cultivation techniques, agricultural policies as well as macro-economic and legal conditions".

The main challenge, however, to the use of marginal environments for agricultural production is the need to develop sustainable and economically viable production systems. This depends on the identification of appropriate cultivars and the production and management systems that fit into novel environments. Nutrition deficits are predicted to intensify in many vulnerable lower-income countries of the region which are facing highly variable weather and deteriorating land and water resources. In this context introduction of crops, with high nutritive value combined with stress-tolerance will indeed be of great value in meeting the twin challenges of abiotic stresses and malnutrition.

However, quantitative assessment of land marginality with respect to environmental suitability, ecological services, and sustainability is limited because of a lack of suitable metrics and criteria for multiple comparisons. The criteria should also reflect the synergy of multiple land functions and management goals such as forested land, grasslands or rangelands, saline lands and other potential usable land resources besides crop land uses (Toderich et al., 2013). Therefore, single index or criterion cannot fully meet these needs. (Akhtar & Robertson, unpublished data).

The main objective of the current ICBA/ICARDA collaborative work is identifying and testing potential winter fodder forage sources for livestock in different categories of marginal lands in Karakalpakstan.

This paper considers how different categories of marginal lands and mineralized waters can contribute to create additional nutrition values for livestock and agropastoral communities through cultivation of arid/semiarid salt loving plants (halophytes) and salt tolerant non-traditional crops. An attempt has been taken to describe different categories of marginal lands and identify economical value (biomass potential in particular) of each land category to improve winter forage production for livestock feeding.

Investigation sites and methodology

The project is being conducted at Koybak livestock cooperative, Karauzyak District, Karakalpakstan.

Fig 1. Location of investigated area in Uzbekistan (a), route map of target sites (b) and its terrain view in Google Earth

Several filed expedition missions and laboratory work were performed in 2015 on assessment of the biomass potential of different land categories and to reveal the quantitative and qualitative characteristics of main vegetation types. To achieve the goal various biotops with different level of soil salinization and vegetation condition were investigated across Karauzyak district with the purpose of identification of main land types in project area.

Old irrigated agricultural lands - with relatively deep water table and low or moderate salinity (N 42°36′ E 059°28′); 2) around artesian freely flowing wells and along drainage channels - with moderate salinity(N 42°46′ E 59°53′), 3) saline depressions named solonchaks - with shallow water table and high salinity (N 42°45′ E 059°55′).

Vegetation analysis

Quantitative and qualitative assessment of vegetation condition of these 4 land categories were performed during the spring and autumn seasons of 2015 in order to identify. Field investigations included the identification of species composition, canopy cover and biomass production. Vegetation descriptions were done using 2 m x 50 m transect (in plant communities of sandy desert, marginal lands) and 1 x 1 m frame quadrate (in field margins), in three replications. Below we give the results of the field data with the most focus on biomass potential of the each land category.

Soil analysis

Analysis of soil samples from the pilot sites was completed to determine the type and extent of salinity and soil fertility, followed by field experiments to study the planting of salt-tolerant crops on marginal lands and technology of cultivation of halophytes were developed. Content of Na+ and K+ in upper soil horizons (0-15 cm) were determined in water extracts from 100 mg air dry samples by atomic absorption spectrometry (Hitachi 207, Japan).

Plant material

All target sites were described in terms of vegetation plant communities, and botanic composition. Above-ground biomass of 13 species (*Tamarix ramosissima, T. hispida, Karelinia caspia, Haloxylon apphyllum, H. persicum, Lycium turcomanicum, Salicornea europea, Suaeda ssp., Salsola pualsenia, Salsola ssp., Climacoptera lanata, Alhagi pseudoalhagi, Artemisia diffusa*) was collected for further analysis

Ions contents in plants

Content of Na^+ and K^+ in the leaves or photosynthetic shoots were determined in water extracts from 100 mg dry (80^oC for two days) samples by atomic absorption spectrometry (Hitachi 207, Japan).

Statistical analysis

All of the physiological measurements were performed 5-6 times, and the means and standard errors (SE) are calculated using Sigma Plot 12.0 statistical program. Comparisons of parameters were made between treatments using analysis of variance (ANOVA) with a post hoc Tukey test. Differences were considered significant at $P < 0.05$.

Preliminarily Results and Discussion

The climate is extremely continental with cold, dry winter and hot, dry summers. On climatic indicators the territory of downstream of Amudarya is characterized by high dryness, low snow (dry and severe) in the winter. Thanks to nature of a climate and moisture of territories, original soil types and groups were formed here, which are divided on different types of soil. Total area of Aral Sea Basin makes approximately - 42,233,9 thousand hectares, out of which irrigated area makes 1,288,1 thousand hectares. Soils of the area are characterized as old-irrigated meadow-alluvial, sand-desert, sandy, grey-brown soils and in some places are covered by saline soils, soils are of takyr type and strongly saline, with a special dark covering, alkali soil.

Highest level of salinity (186-267 mS/m under 0.5m water table level) was observed at sites along the roads, where gleyic solonchaks (WRB, 2014) were formed with poor vegetation (2-4 species). Sites near the fields and in abandoned fields/lands were also characterized as relatively high levels of salinity (68-178 mS/m at 0.5m shallow water table level), but with more diverse vegetation (5-6 species). In sites adjacent to artesian wells there are soils with less salinity (28-62 mS/m at 0.5m), but with more mosaic structure of the soil cover: haplic arenosols (Calcaric) and brunic arenosols (Calcaric) (WRB, 2014) soils; sites, located at the borderline of irrigated agricultural lands and sandy desert about of 25-35 km from Koybak farm is being represented by sandy soils with low salinity. However, the calculation of toxic salts showed that the value of the salinity of the soil, even for this site, in which the groundwater level varies 8-40m depth, lies at the threshold of toxicity (> 0.1% of the amount of toxic salts). Among anions dominated high content of HCO3 and SO4, and ions of K and Na among cations. Salinity of sandy soils is defined by aeolian salts transportation from the nearby salt marshes and accumulation on sand surface in the form of newly formed salt crystals of different crystallographic structures.

In the territory of the irrigated land there are basically concentrations of meadow-takyr and meadow-desert (18,3 %) and meadow-alluvial (68,9 %) lands. During the last years on the one hand in connection with reduction of receipt of Amudarya water, and on the other due to fall of level of subsoil waters in downstream of river Amudarya, considerable changes took place which characterize transition from meadow to desert soil type, which means increasing of aridization in the project areas. Another prominent feature of the site is a process of formation of unsuitable for use sand-saline soils as a result of drying of huge territories of deltoid lakes and a sea-bottom.

Ground water salinity varied between 3g/l and 7.9g/l from spring to summer, and irrigation water salinity varied between 2.6g/l and 3.1g/l with sulphate as the predominant anion and sodium as the predominant cations in both ground and irrigation water.

In territory of the meadow-swamp land, located in the plain areas of Karauzyak district, mostly in the agricultural irrigated zone, a mismanagement and dysfunction of drainage collector system is observed.

№	Crops	Regions and Republic				Total, Aral Sea basin
		Khoresm	Karakalpakstan	Kizilorda	Dashaguz	
1.	Cotton	95,1-110,9	74,0-129,8	87,9 - 110,5	197,8-208,8	454,8 - 560
2.	Cereals	48,6-72,7	52,8-114,9	8,6 - 51,2	80,4-93,4	190,4 - 332,2
3.	Vegetables	10-12,6	4,6-8,7	0,3 - 12,6	5,2-6,3	20,1 - 40,2
4.	Melons	3,6-4,9	4,4 – 7,3	1,5 - 4,9	3,8-4,1	13,3 - 21,2
5.	Gardens and perennial plantings	9,4-11,4		6,6 - 11,5	4-15	20 - 37,9
6.	Maize for grain				1,5-2,5	1,5 - 2,5
7.	Maize for silage				4,5-8,7	4,5 - 8,7
8.	Barley				20,4-53,6	20,4 - 53,6
9.	Other crops	10-41	24,0-39,0	8,2 - 42,4	57,9-87	100,1 - 209,4
10	Rice			4,0 - 110	2,9-29,4	6,9 – 139,4

Farming system and traditional crops production

The areas of these lands are made roughly by 40-50 % from the general arable land of 6,4 th. ha (Republic Karakalpakstan) in a zone of meadow-swamp soils, as a whole drainage systems are in satisfactory conditions.

The main crops cultivated in Aral Sea basin include: cotton, wheat, rice, corn, lucerne and other vegetable-melon crops. Leading crop is the cotton, which makes 30-50 % from a total area. Its total area fluctuates from 456,6 to 560 thn. ha. in this zone variety of cotton C-4727, Chimbay 3010, Tashkent-6, etc.are cultivated

For the last years, in connection with reduction water content of the rivers, the area of rice was reduced from 110,0 th. ha (1980) to 4,0 th. ha. Rice varieties UzROS-59, Uzbek-5, Dubovski-120 and Nukus-2 etc are released for this zone.

Wheat cultivation started since 1990, and for the last years its area occupies within 190,4-332,2 th. ha.

For the considered period the area of the main cultivated irrigated crops (th. ha) fluctuate:

Changes of land use/land cover types

After the independence of Uzbekistan, country faced the problem of providing the population with grain products, and therefore the area under wheat was increased and by present time the area of this type of land users for R. Karakalpakstan makes 65-70 th. ha. where it is resulted the areas of cultivation grain crops in limits 52,8-114,9 th..ha).

As a whole on Republic Karakalpakstan in connection with reduction of receipt of a river drain (water supply now has been reduced on the average to 25-30 %, and in shallow years by 50-60 %) there were following changes in land tenure:

- The areas of pasture-hay-makinging lands were sharply reduced (especially in an irrigation zone) to 50-65 % in comparison with 1965-1970;
- The areas of crops of rice were reduced in 25 times R. Karakalpakstan.
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Major factors of formation of the salt affected soils in Aral Sea basin include:

- evaporation of surface and ground waters which more than in 10 times exceeds quantity of rainfall;
- the readily soluble salts flowing with surface and ground waters from regions of formation of a surface drain;
- hydraulic pressure of ground water, which creates a continuous ascending current of ground waters from depressions to a surface;
- close occurrence of mineralized ground waters (strong saline soils and Alkiline lands);
- vegetation (more often halophytes), raising concentration of soil solutions;
- content of salts in irrigation water and other

Feed systems

There are two types of animal industries: large-scale (LS) farms and containing cattle in house conditions.

Both use four power supply systems:

1. Pastures for grazing of cattle.

2. Grazing on vegetation near to channels, lakes, the rivers, forests and fields.

3. Grazing on stubble (basically in the autumn and in the winter). Some lay lands also are used for grazing.

4. Cattle feeding in house conditions by collected forages (basically during the winter period).

Mapping studies associated with marginal land assessment

This map roughly provided the locations of potential marginal production area in the Karauzyak district identified 12 categories of marginal lands using climate and soil restrictions. Most of these mapping studies were mainly derived from soil and agricultural production analysis, but less on the aspects of environmental quality, ecosystem functions, and sustainability.

Six land categories were surveyed to assess the potential fodder sources of the study area. Following potential fodder sources were found in the surveyed area:

1. **Natural rangelands**. This type of land categories covers significant part of the area and includes fodder sources in ***sandy***, ***halophytic*** and ***tugay*** vegetation. Current type of fodder sources is appropriate for free grazing. Fodder demand of the livestock in this type of land can be covered to some extent during all seasons of the year if vegetation is rationally used.
2. **Irrigated lands**. Fodder sources distributed in field margins and along the irrigated and drainage channels. This type of fodder sources represents high green biomass which is more appropriate for hay making/harvesting than for free grazing due to the cultivation of main crops in surrounding areas.
3. **Householder plots**. Fodder sources of this type of land represented by irrigated forage crops as maize, alfalfa and some others. Fodder quantity produced in household plots is mostly used for cattle, but insufficient for whole year round use.
4. **Abandoned and in-use croplands**; coast of drainage and watering channels; the territories around settlements; native desert and riparian zones. As a result of conducted field surveys, mainly 4 land categories were differentiated in a project territory: (1) Field margins; (2) Marginal lands in salt affected soils; (3) Tugay forests; (4) Sandy desert.
5. Desert margins
6. Solonchaks /salt marshes lands

As field surveys showed that around 35-40% of irrigated agricultural lands represent very low profitableness. The income from harvest is too beyond the benefit from the land. For this type of lands it is recommended to shift conventional crops to new and ecologically easy adapted crops.

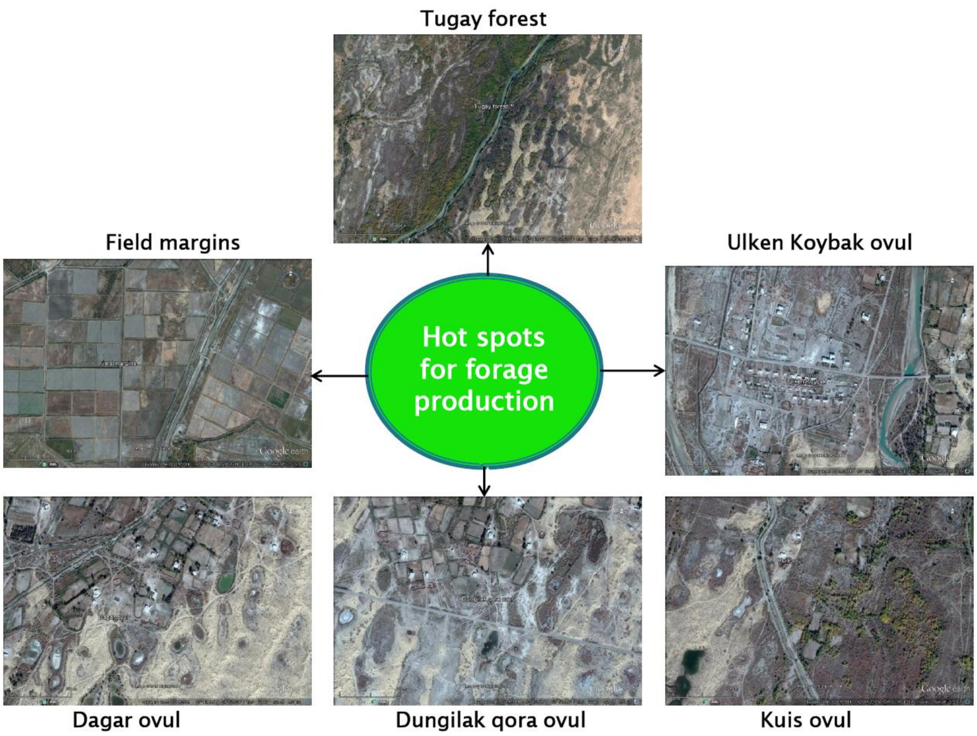

Fig.2. Land categories for forage production in investigated area

Field investigations were conducted to identify the forage biomass of the selected land categories. Development of the integrated matrix of the dominant plants with their quantity, quality and distribution characteristics are currently undertaken. This matrix will allow selecting appropriate plant species for further forage harvesting to strengthen fodder basis for sustainable livestock production. Organizing *fodder-harvesting* stations at farm and district level is of high importance in the region.

To provide an ecological basis for the regeneration and the sustainable use of the vegetation at the transition between irrigated agriculture (Karabuga villages) and sandy Kyzylkum desert (Koybak and Ermak Farms, joint investigation are being carried out at the five study sites located in Karauzyak region, Karakalpakstan.

The composition of the vegetation and the botanic diversity are being study. The selection of the forage species is made on the basis of its water-use –efficiency, productivity, capability of pastures regeneration was considered. The first results and an outlook for the forthcoming research activities are presented in this research paper.

The cause of land degradation is overuse of the indigenous vegetation, arising from the pressure of the populations’s growing demand for livestock feed and fuel. In the continental, cold-winter desert of Karakalpakstan, the overexploitation of the indigenous vegetation of the transition between irrigated agriculture and sandy sand coverage of crop lands is taken place. Along the northern margins of Kyzylkum desert (on the territory of Ermak Farm the results of inappropriate resources exploitation are particularly serious because, under the prevailing winds, the increased sand and salt drifts/storms by such changes severely endangers the settlements. Winter livestock forage production concentrates on the species indigenous to the studied areas.

Saline field margins in mixed farms: The margin of a former cotton and rice paddy field (0.05 ha), which has been out of cultivation for about 10-15 years, was selected on Ilyas Farm in Karabuga village. A mini-pump was installed for irrigation at the drainage canal on the margin of a rice field. The field was irrigated on 30 June with saline water from the drainage canal (4000-6500 ppm) for growing of multi-purpose crops (forage inclusive) of non-traditional forage crops.

Field margins. This type of lands is one of the most occurred land category across cropland areas with high biomass potential. According to our calculations, the proportion of field margins is 6,4 hectares out of 100 ha cropland (Fig 3).

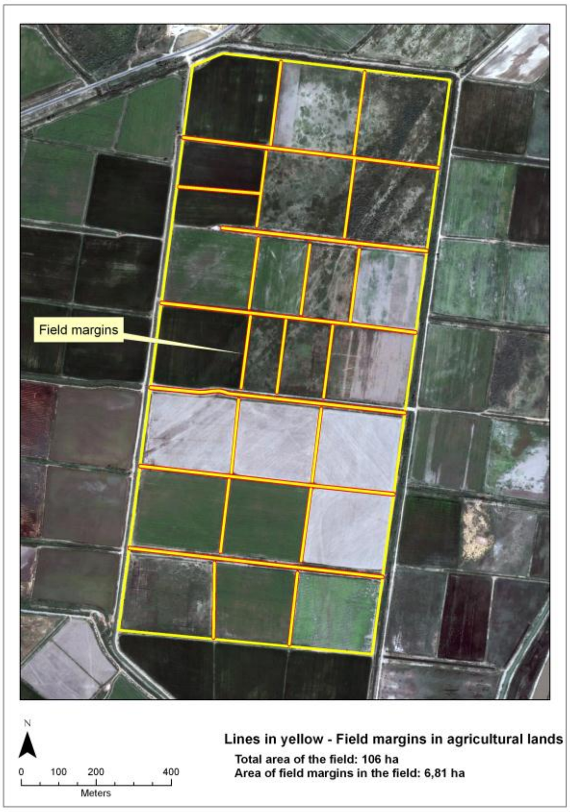

Fig. 3. Calculation of spatial distribution of field margins in cropland areas

The vegetation composition of field margins consists of mostly *Glyzyrhyza glabra, Phragmites communis, Poa pratense, Apocynum scabrum, Cynadon dactylon* species. Usually they form dense vegetation stand with about 85-90% canopy cover. According our field observations, biomass production varies depending on the plant density and consists of 7,9 ton in scarce, 9,5 in moderate and 18,4 ton in densely plant stand, but with an average of 11,9 ton forage per hectare (Fig 4.).

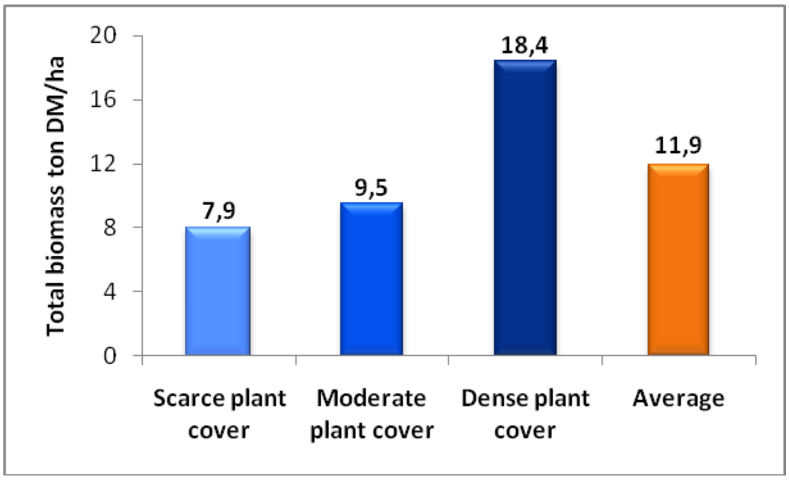

Fig. 4. Biomass potential of field margins in their plant covers with different stand

Marginal lands in salt affected soils. It is the widely distributed type of land category with different microphytocoenosis. The mobility of salts is highly facilitated by both chemical properties of soils and the aridity of the climate. Plants under such environments face multiple stresses caused by high temperatures, water and soil salinity, high PH and long-term water-shortage. There are limited numbers of native species along Amudarya River Basin able to establish themselves at these soils and produce palatable biomass. The limits of mineralization of the marginal water optimum for crops growth and green biomass accumulation were found to be varied in the range of 2000-8200 mg/l-1. The soil salinity at the root zone was about 45 dS/m-1, salinity level of the ground water was 8.0-16.5 dS/m-1 inappropriate for the irrigation of traditional agricultural crops. Monitoring system for controlling interaction of chemical content of non-conventional irrigation water, salt affected soils through plants aboveground biomass over several sites in downstream area of the Amudarya River flow was established.

In marginal saline lands we have differentiated three types microphytocoenosis: Tamarix spp.; Karelinia caspica; Suaeda arcuata dominated microphytocoenosis.

Tamarix spp. microphytocoenosis is distributed in extended areas along the drainage channels and in abandoned lands with high soil salinity and shallow water table. Species composition of this microphytocoenosis is dominated by *Tamarix hispida*, *Tamarix laxa* and *Halostachys belangeriana*. Canopy cover is high and consists of between 45-50%. This microphytocoenosis produces high green biomass ranging between 2700-2800 kg DM/ha, but with almost no palatability (Fig 5.).

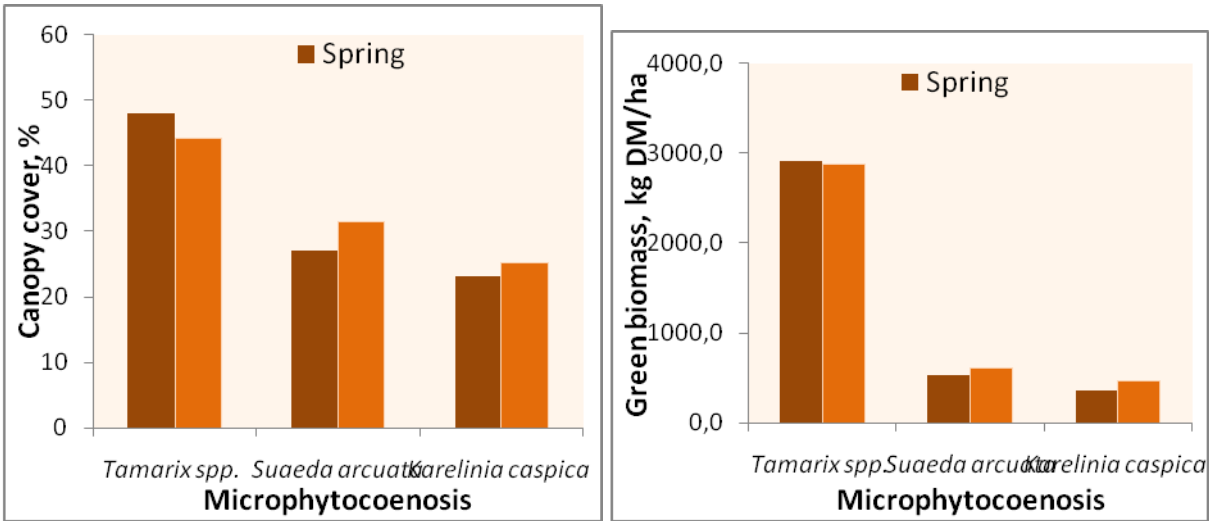

Fig. 5. Dynamics of canopy cover (left) and green biomass (right) of marginal lands

One of the distinctive characteristics of this microphytocoenosis is its highpotential in woody biomass production. Being perennial woody plants, *Tamarix hispida*, *T. laxa* and *Halostachys belangeriana* species significantly contributes to the accumulation of woody biomass in this microhabitat. According to field surveys, *Tamarix spp.* microphytocoensis produces woody biomass of 2,5 ton in scarce, 4,0 ton in moderate and 7,0 ton in dense vegetation condition (Fig.6.)

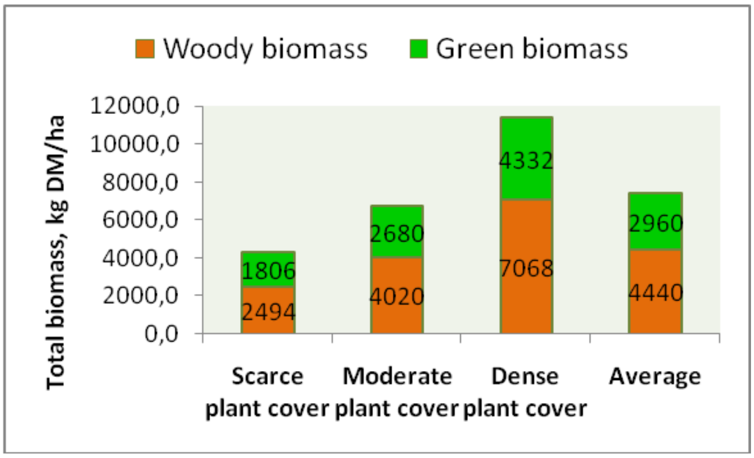

Fig. 6. Woody and green biomass potential of *Tamarix spp.* microphytocoenosis

***Karelinia caspica* and *Suaeda arcuata* microphytocoenosis** occupy relatively small areas compare to *Tamarix spp.* microphytocoenosis. Accordingly, they produces less biomass production ranging between 356-463 kg DM/ha in *Karelinia caspica* microphytocoenosis and 530-610 kg DM/ha *Suaeda arcuata* microphytocoenosis. As in Tamarix spp. the same these two microphytocoenosis has almost no palatability as a forage.

Sandy desert. This type of land is categorized as native rangelands, which is distributed in sandy soils and dominated by *Haloxylon persicum+Artemisia terrae-albae* plant community. Except dominant species, the vegetation is composed of diverse perennial semi shrub, shrub and herbaceous species as *Salsola richteri, Astragalus villosissimus, Convolvulus divaricatus, Ferula foetida, Aristida pennata, Ephedra strobilaecea.* Understory grass vegetation is mostly represented by *Carex physodes* and some other annual plants as *Eremopyrum orientale, Bromus tectorum, Ceratocephalus falcatus, Scabiosa olivieri* and others. According to field observations, the *Haloxylon persicum+Artemisia terrae-albae* plant community in sandy desert has an average canopy cover of 18-22%. Biomass production is higher in spring season due to vigorious growth of ephemers and epehemroids and consisted of 278 kg DM/ha. Total biomass production of the plant community has a little reduction in autumn season with 244,7 kg DM/ha (Fig.5). However, if to take into accound perennial species (by excluding ephemers and ephemeroids), biomass production of perennial plants increased from spring to autumn season due to the re-growth (flowering and fruitining) of *Artemisia terrae-albae* after drought season. This type of rangelands can be used under livestock grazing in spring and autumn-winter seasons.

Tugay forest. This type of land category is located along the irrigated chanals and small tributaries of rivers. The vegetation composition is consisted of *Populus diversifolia, Populus pruinosa, Clematis orientalis, Cynanchum acutum, Lolium sp., Apocynum scaprum, Alhagi pseudalhagi, Halostachys belangeriana, Tamarix sp.* The vegetation composition is also rich in palatable species and thus this type of vegetation can be used during the year, but local pastoralists prefers to have it in winter season since tugay forest can stand as a good shelter for livestock against cold weather. Biomass production of current tugay forest ranges between 450-520 kg DM/ha.

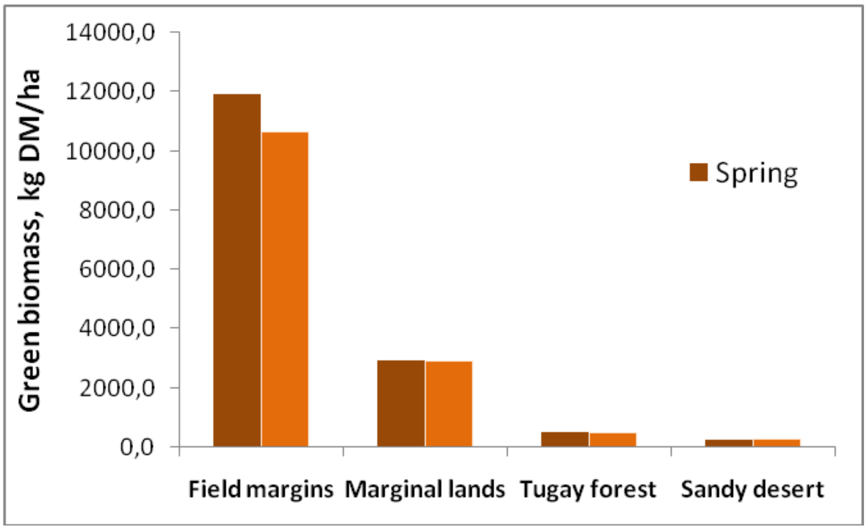

Fig. 7. Biomass potential of different land categories in project areas in Karakalpakstan

In conclusion, among the four land categories field margins and marginal lands has high potential in biomass production, but latter with almost no palatability (Fig 5). Relatively small biomass production potential belongs to tugay forest and sandy desert. Nevertheless, forage demand of the livestock mostly provided by these land categories due to the higher palatability properties of plant species. The vegetation of tugay forest and sandy desert rangelands serve as a main and important forage source during spring season due to vigorous growth of ephemers and ephemeroids and other perennial herbacious species.

Alternative use of marginal water and lands play a significant role in further development of climate change adaptation strategy leading to produce autumn-winter forage and improve feeding system for livestock, diversify animal products and incomes of local agropastoral communities by ensuring sustainable ecosystem function and resilience.

Being irrigated with low quality drainage and thermal artesian water species of genus Artemisia, Climacoptera, Alhagi, Glycyrrhiza, Kochia exhibited clear distribution patterns and their abundance and yield of green biomass varied significantly along salinity and aridity climatic gradients.

Saline lands of household farms in the Shirkat Koybak: In the Shirkat the areas dedicated to winter forage production differ from 0.002 ha to 100 ha, the latter is the case of Ermak Farm, a private farm specialized in winter forage production, mostly alfalfa for feeding Karakul sheep during the winter period. Twelve household farms (women) are engaged in testing non-traditional forage options on saline lands near their homes. The alternative forage crops are tested in mixed planting with different sowing practices. The tested crops are sesame, amaranth, vegetable legumes, topinambur, sunflower, sorghum, pearl millet, triticale, sweet clover, and sainfoin. So far most crops show promising results at the household farms areas (see photos below).

Agricultural sustainability and food security in arid and semi-arid areas of Karauzyak region are limited by the salinization of arable land, and by water availability. The biological potential of some agricultural crops to withstand the salinization and water deficit may become a key component of farming systems. Several forage crops were selected for this study to investigate their performance under saline water and soil conditions in the Karakalpakistan. Growth performance and yield productivity were analyzed at two soil salinity levels, calculated as total dissolved salts (TDS): low saline (< 0.9 g/l), and medium saline (> 1.5 g/l). The results showed insignificant differences between crop varieties in seed germination rate, plant height, and accumulation of green biomass, when cultivated on soils with light clay texture and low level of soil salinity (Table 1). A sharp decrease (by about 2.6 times) in plant density and survival rate is seen for maize grown on medium saline soil with heavy texture.

Agrobiological characteristics, forage and grain yields for salt and drought tolerant crops grown on marginal lands at Ylyas Farm in Karabuga, Karakalpakstan

Variety/Improved lines	Field seed germination rate (%)	Height of plant (cm)	Period of vegetation (days)	Yield of green forage (t/ha-1)	Grain yield (t/ha^{-1})
Pearl millet					
Hashaki1var.	90±1.3	182.5±1.5	81.5	34.9±5.8	2,0
HHVBCTall (improved line)	79±1.8		90,4	42.0±6.4	1,8
Sorghum					
SPV 11419 (Improved line)	74±2.0	280±2.0	96-110	97.0±4.9	5,3
ISCV 93046 (improved line)	69±2.8	226±2.1	95-125	93.0±5.2	3,2
Uzbekistan 18 var.	77±4.2	288±3.1	120-135	101,0±6.3	4,8
Vakhsh (multi-cutting)var.	75±3.4	195±2.0	115-135	82.0±4.8	3,8
Boy Dzhugara var.	90±5.0	258±1.9	120-135	113.0±5.2	5,8
Korabosh var.	62±4.3	181.0±6.0	80-110	58.0±6.0	4,0

Maize					
Uzbekiston 601 ECB (hybrid)	78±1.2	217.0±7.1	106.0±3.1	35.3±0.7	8,0
Karasuv350 AMB (hybrid)(early maturity after winter wheat)	69±31.6	199.5±9.5	94.0±2.5	30.2±0.2	6,0
Fodder beet (biannual plant)	67±4.9	76,4±6.3	After 80 days	Foliage fro animals	6.48 t/ha tuber production
Legumes					
Mung bean Durdona var	89-92	44-47	96-101	4,8 (foliage +pods	2.1
Mung bean Marjon var.	87-90	92-106	142-130	5,2(foliage +pods)	2.4
Soybean Uzbek 6 var.	65	68.6-72.0	136-145	9.0 ((foliage +pods)	No mature seeds
Yard long bean (Oltin soch) var.	58	63-65	80-96	3.2 (foliage +pods)	1.1-1.6
Cow pea (prostrate improved line)	84,0	48,0-54,9	96-112	4.0(foliage +pods)	0.9-1.2
Technical crops					
Sesame (Sesamum orientale (local var.)	90	155-185 cm	96-120	22.3-26.8	0.5-1.0
Sunflower (Helianthus annuus) Karlik var.	88	112-146	120-130	24.4-28.2	1.6-2.0
Topinambur (H. tuberosus) Mujaza var.	82	180-196	145-160	62.6-68.3 (including tuber)	-
Topinambur Fayaz Baraka var.	91	210-290cm	140-155	65, 6-72.0 (including tuber)	-

Outcomes: At least 1.5 ha planted for quality forage production in pure or mixed cropping systems at kishlak level; Protocols for data collection for comparative evaluation of agronomic characteristics of halophytes and salt tolerant fodder crops; Recommended levels of using halophytes and salt tolerant fodder for households in Koybak Shirkat is under development.

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