INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH AND ANALYSIS

ISSN(print): 2643-9840, ISSN(online): 2643-9875

Volume 06 Issue 04 April 2023

DOI: 10.47191/ijmra/v6-i4-08, Impact Factor: 7.022

Page No. 1390-1397

Innovative Approaches and Technologies to Increase the Productivity of Foothill Pastures Prone to Drought in the Upper Reaches of the Kashkadarya River

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ABSTRACT: The article describes the characteristics of the types of pastures of the Kamashi district in the Kashkadarya region, the degree of degradation and ways of their rational use. Materials on the species composition of vegetation cover and the improvement of degraded pastures by the introduction of long-term drought-resistant forage species within the framework of the SATREPS BLUE project are presented.

KEYWORDS: Pastures, degradation, forage plants, yield, soils, seeds, restoration technologies, agroforestry, biodiversity

INTRODUCTION

The high sensitivity of desert and mountain ecosystems to climate change, combined with natural and anthropogenic desertification processes, make Uzbekistan one of the countries with the most serious land degradation. According to recent estimates, over 16.4 million hectares, i.e. 73% of the total area of pasture lands and hayfields, are subject to degradation as a result of overgrazing, the influence of man-made factors and climate change. The digression of pastures leads to the loss of their feed capacity. The natural vulnerability of pasture ecosystems is enhanced by the actions of local communities that overexploit natural resources (including pasture lands).

The pasture territories of the adyr zone of the Kamyshi district are devoid of semi-shrubs- shrubby vegetation. In livestock farms, coarse feed is harvested and purchased annually (about 30-40%) in large quantities for livestock for the winter and throughout the year, which significantly reduces the efficiency of animal husbandry.

PURPOSE AND OBJECTIVES

The aim of the work was to study the condition of various types of pastures in the Kamashi district of Kashkadarya region, the degree of degradation and ways of their rational use. The obtained materials are used in the development of scientific and practical foundations for the adaptive use of agroecological resources, including optimization of flora composition, assessment of biological diversity and identification of the resource potential of natural vegetation.

MATERIAL AND METHODS OF RESEARCH

The object of research is the pastures of the Kamashi district of the Kashkadarya region, the lands of the farms "Altinboev Yeri", "Sora ibn Islom" and "Yashin Makon", specializing in pasture animal husbandry and rain-fed crop production.

During the study, the following methods were used: The description of vegetation, taking into account its floral composition, was carried out according to the Drude method generally accepted in geobotany [2]. The vegetation areas are specified on the basis of literature data and surveys of distribution areas within the Kamashi district of Kashkadarya region. We used the traditional route method of geobotanical research, as well as methods of cameral decryption of satellite images from Landsat, MODIS and Google. To study the seasonal dynamics of the feed mass on the control pasture plots, sections with an area of 10 m^2 were laid, mowing was carried out, then the biomass of forage plants and their nutritional value were determined by laboratory methods [1].

The types of pastures were determined in accordance with the scheme of the typology of pastures of Uzbekistan (Guidelines for the geobotanical survey of natural forage lands of Uzbekistan, 1980) [2]. Contour areas were determined using GIS methods. Age-related changes of plants according to the method of T. A. Rabotnov [4]. Phenology was performed according to the method of I. N. Beideman [5]. The species belonging of the plants was indicated in accordance with S. K. Cherepanov [6] and the plant definitions of Central Asia and the identifier. Keys to the Plants of Central Asia (vol. I-X, I968-I993).

Research Area

Brief description and location of the plots

The research plots were selected within the framework of the SATREPS project to implement the monitoring system "crops-soil-water-land use-crop production" and to evaluate the results in quasi-real time of changes in water resources and land use, as well as the effects of demonstrated BMPs and reclamation programs.

Kamashi district is located within the catchment basin of the Kashkadarya River, which includes the micro-catchment of the Langar River and partially the Katta-Uryadarya and Yakkabagdarya rivers and extends from the central part of the Kashkadarya region to its eastern border with the Surkhandarya region. The terrain is located at an altitude within 1000 m, it is a hilly, gently sloping foothill plain ("Sora ibn Islom" and "Altynboev yeri"). The Yashin Makon farm is located on a steeply sloping foothill plain. The foothill loess hills are separated by wide ravines and valleys. The flat part is formed by the erosive-accumulative activity of the Langar River and shallow-water sais. The soils of the Kamyshi district were formed in the high-altitude belt of serozems - typical and dark serozems.

The arid lands of the foothills of the project area are used as rain-fed arable land for growing grain crops, Carthamus tinctorius, and as pastures for grazing livestock. Due to frequent droughts, farmers suffer losses, they receive profits only in favorable years (1 time in 3-5 years). Degradation of agricultural lands, droughts and water scarcity, aggravated by climate change, violate the integrity and stability of natural ecosystems, the stability of the agricultural sector and threaten the well-being of the rural population. To improve the situation, the region needs innovative approaches and technologies

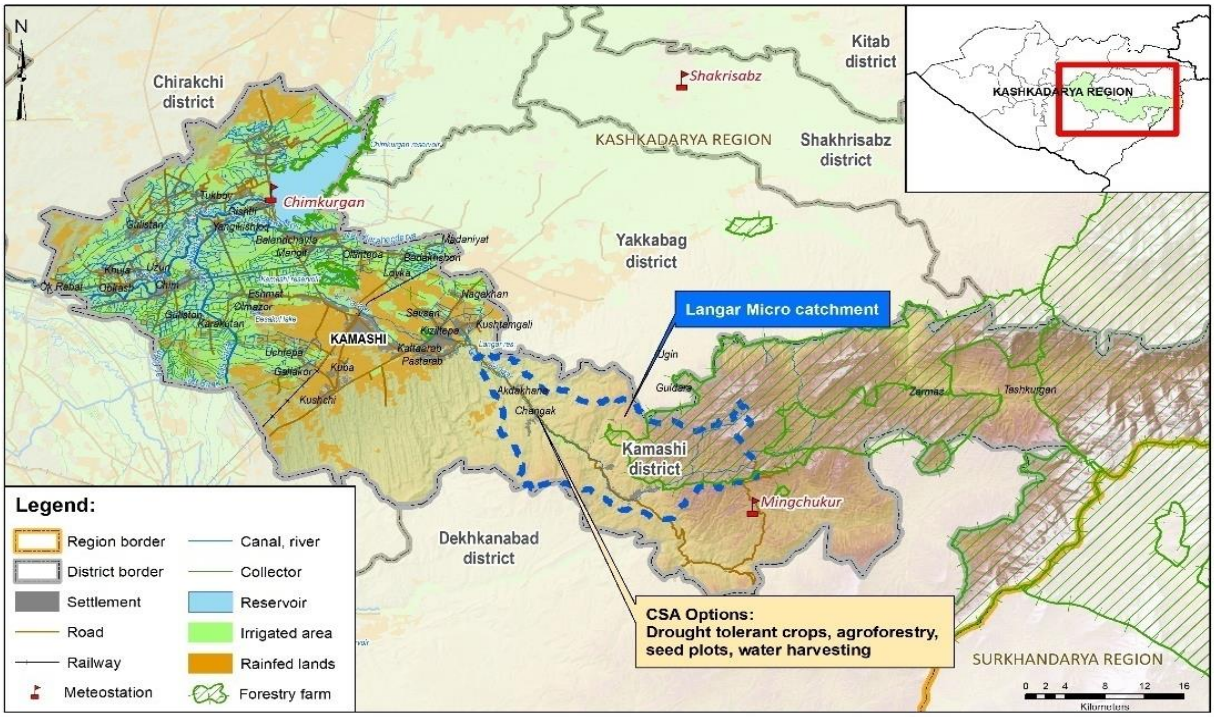

Fig. 1. Map of Kamyshinsky district

RESULTS AND DISCUSSION

Natural pastures

The yield of natural pastures varies sharply by year and season and is, in bad years, 0.1 -0.15 and less t/ha, in good years up to 0.4-0.45 t/ha. The year 2021 was very lean, there was a slight amount of precipitation, the yield on natural pastures was only 0.02 t/ha. The average yield of this type of pasture over the years is 0.503 t/ha in spring, 260 kg of feed units per 1 ha, contains 25 kg/ha of protein. The seasonality of use is summer [2]. In the spring of 2021, the average yield was about 0.42 t/ha.

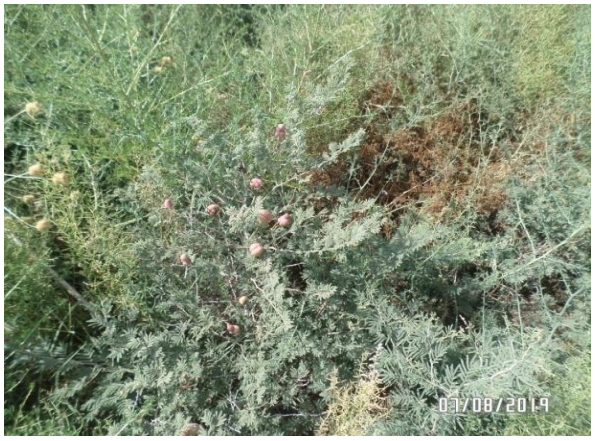

Photo 1 and 2. Natural pastures

By autumn and winter, there is practically no fodder left on this type of pasture, except for vegetation that is poorly eaten, weedy and poisonous. The yield on adjacent pastures in the autumn period is about 0.01 -0.02 t/ha and consists of poorly eaten plants, mainly by *Prosopis farcta (Banks & Sol.) J.F.Macbr.,* which is about 60-70% in pasture grass. In places, there is a *Trichodesma incanum*, a perennial poisonous plant from the family of *Boraginaceae*, common in Central Asia, growing in foothill areas on rain-fed lands. The stems of this weed are branching, usually form a bush up to 1 m high, densely shrouded in silvery-white hairs.
This type of pasture is seasonal; it is used only in the spring-summer season. Therefore, on this type of pastures, it is necessary to sow perennial species of shrubs and semi-shrubs that used to grow on this type of cenoses, but as a result of anthropogenic impact fell out of these communities. Table 1.

Table 1. Seasonal yield of natural pastures

Types of pastures	Yield, t/ha			
Pastures of the Adyr zone	spring	summer	autumn	winter
	0.35	0.04	0.01	0

Photo 3. Kamashi pastures

Photo 4. Degraded pastures

Recently, due to a sharp increase in the number of livestock, the yield of natural pastures has noticeably decreased. 2019 and 2022 were very favorable for the development of pasture vegetation, the yield of foothill pastures in the spring period was 0.61-0.70 t/ha. Table 2.

Table 2. Dynamics of the number of species, changes in the projective coverage and yield of pastures of the Kamashi district in 2019-2022

№	Number of species, pcs	Plant height, cm	Projective coverage,%	Yield, t/ha	Sheep capacity, head/ha
2019 year					
Farm "Altinbayev yeri"	4	39	45	3,8	0,47
Farm "Soro ibn Islom"	5	35	50	4,0	0,50
Farm "Yashil makon"	9	49	80	6,1	0,76
Average value	6	41	58,3	4,63	0,58
2020 year					
Farm "Altinbayev yeri"	5	47	45	3,5	0,44
Farm "Soro ibn Islom"	6	40	55	4,1	0,51
Farm "Yashil makon"	12	55	80	6,8	0,85
Average value	8	47,3	58,3	4,8	0,60
2021 year					
Farm "Altinbayev yeri"	3	25	35	2,5	0,31
Farm "Soro ibn Islom"	4	30	35	3,2	0,40
Farm "Yashil makon"	9	45	70	4,2	0,52
Average value	5	33,3	46,7	3,3	0,41
2022 year					
Farm "Altinbayev yeri"	5	40	55	3,2	0,40
Farm "Soro ibn Islom"	6	40	70	4,2	0,52
Farm "Yashil makon"	12	50	85	7,0	0,88
Average value	8	43,3	70,0	4,8	0,60

According to Table 2, in 2020, the percentage of projective coverage on the Adyrs ranges from 45 to 55%, on the low mountains 80.0%. Pasture yields also from 0.38 to 0.68 t/ha. Sheep capacity, on average is 0.44-0.85 heads per 1 ha of pasture territory, these pastures are seasonal and are intensively used by the local population for grazing animals, recommended for use in spring - summer periods of the year and haymaking. In the most favorable climatic conditions in 2019 and 2022, the height of herbaceous plants was 41.0 - 50.0 cm, and in arid 2021, 25.0 cm.

The pasture yield is slightly higher in the conditions of 2020 - 2022 and averaged 0.48 t/ha, in 2021 it is slightly lower than in 2020 and averaged 0.33 t/ha. The average sheep capacity in 2020 - 2022 is 0.6 heads /ha, and in the unfavorable 2021, 0.41 heads per 1 ha of pasture territory. In 2022, it was possible to keep more than 0.88 heads per 1 hectare on good plots.

RESULTS OF FIELD AND LABORATORY STUDIES OF FARM SOILS

The plot of the farm "Sora ibn Islom". The specialization of the farm is animal husbandry and rain-fed agriculture. The total area is 130 hectares, of which 75 hectares of acreage. 2 pilot sites were created within the Sora ibn Islom farm for testing, demonstration of quasi-real monitoring of evapotranspiration and phenological development of food crops (*Tríticum, Hordéum vulgáre*, *Carthamus tinctorius*, *Písum*, *Línum*). GIS linking of the Langar-Kamashi territory, farm and experimental plots with 9 types of crops, project area and plots to the FAO LUS/L digital map and the 1:100,000 Natural Reclamation Map was carried out to determine biophysical indicators and check the category of land use of experimental plots in the project area according to Kamashi. The study of soils in the farm, the morphological description of the soil profile was carried out on the basis of a soil section / pit with a depth of 2 m and 8 wells under each crop. The coordinates of the selection are given in Table 3, the location in Figure 2.

Table 3. Coordinates of wells

# well	Culture	N	E	Alt,m
1	*Písum*	38.72078	66.63722	981
2	Avéna	38.72081	66.63661	978
3	*Písum* -2	38.72247	66.63786	953

4	*Línum*	38.72500	66.63633	921
5	Solánum tuberósum	38.72597	66.63417	931
6	*Carthamus tinctorius*	38.72792	66.63575	895
7	*Kochia prostrata*	38.72811	66.63633	909
8	*Carthamus tinctorius*	38.72647	66.63858	904
9	The pit	38.71964	66.63700	998

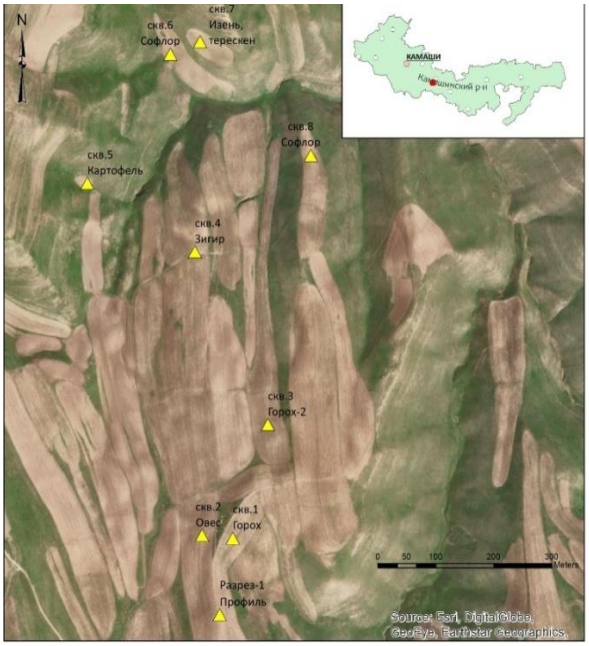

Figure 2. Location of soil sampling points

The soil cover on the site "Sora ibn Islom" is represented by bogar typical gray-earth carbonate soils formed on loess deposits. The soils are unsalted and not gypsum with a loamy texture (mainly medium and heavy loam with layers of sandy loam). The humus content varies from 0.4% to 1.48% and is classified as low for gray-earth type soils.

The plot of the farm "Altynboev yeri".

The demonstration site on the Bogar in the “Altynboev Yeri” farm was organized earlier as part of the GEF/FAO DS-SLM project in 2015-2018. Due to insufficient natural moistening of rain-fed lands, water erosion on the slopes, soil degradation is observed and the yield of winter wheat, which is grown without any crop rotation, is low and unstable. In some dry years, production costs are not compensated by the resulting harvest. After harvesting winter wheat, the field is a completely bare landscape, uncovered by vegetation.

The soil cover of the “Altynboev Yeri” farm is represented by a typical serozem composed of unsalted medium loams with deep groundwater that does not participate in the process of soil formation. The humus horizon extends to a depth of 50 cm with very low humus content – in the range of 0.50-0.60%. The content of nutrients in the soil - mobile forms of potassium is 173 mg/kg of soil, and phosphorus is 5.8 mg/kg of soil, and is classified as very low.

The plot of the farm "Yashin Makon".

Kashkadarya region, Kamashi district, Langar territory, Kizilkishlok village. The plot of the farm "Yashil Makon" located on N-38 41320E-066; 44320; alt 1109m. The land is used for natural pasture with a poor variety of vegetation. On pastures there is *Carex pachystylis*, *Poa bulbosa*. A valuable admixture in the herbage of these plants are *Leptaleum filifolium*. Annual *Astragalus filicanlis*, *Bromus tectorum*, *Cousinia, Ferula* and *Phlomis.*

Photos 5 and 6. Vegetation of the foothills

The yield of pastures of the studied territory is highly dependent on weather conditions and varies dramatically by year and season (from 0.35 to 0.70 t/ha). In terms of feed, the main forage plants of pasture lands are of poor quality: 1 kg of hay contains from 0.36 to 64 fodder units and from 11 to 73.0 digestible protein.

The degree of negative influence of pasture weeds depends on both the season and the type of animals. The number of plant species not eaten by sheep is relatively small. Heavy clogging of pastures is especially unfavorable for cattle and horses. In the summer, basically, only wormwood vegetation grows.

Creation of primary seed production sites

Within the framework of the GEF/FAO Projects "Support for solutions for the promotion and dissemination of sustainable land management SLM in Uzbekistan" and the SATREPS sub-project Development of quasi-real monitoring "culture-soil-water-land use-crop production", fodder plants, semi–shrub species were sown to demonstrate various technologies for the restoration of degraded lands: *Kochia prostrata, Astemisia diffusa, Halothamnus subaphylla, Ceratoides ewersmanniana*, types of herbs *Onobrychis horossanica, Poa bulbosa, Agropyron desertorum* and species of *Astragalus.*

Agrophytocenoses reduce the speed of winds, delay snow and protect the soil from deflation, create a milder microclimate in the strip itself and in adjacent areas of pastures. This creates more favorable environmental conditions for the growth and formation of a larger crop of pasture feed. The use of these methods makes it possible to increase pasture forage by 2-3 times.

The seeds produced can be used to restore degraded lands, spread to other farms. The created plantings will allow the use of pastures in all seasons of the year, have a beneficial effect on improving the state of the environment and contribute to the creation of a system of pasture use adapted to the conditions of global climate change. The slopes of hills subject to water erosion are strengthened, the water regime is improved and the upper fertile layer of the earth is preserved. Two innovative technologies have been introduced on the heavily degraded slope lands of the “Altinboev Yeri” farm.

Technology 1. Planting almonds and other tree species on small terraces:

The slopes of rain-fed lands require special processing techniques to improve the water regime and preserve the upper fertile soil layer. The technology being implemented includes the construction of small terraces on the slopes with the planting of *Prunus amygdalus* and other tree species. The width of the terraces is 1m, the planting scheme is 5x5 m. It is possible to sow drought-resistant plants between the terraces. The agroforestry site is fenced off from damage by cattle.

Of the planted tree seedlings, the *Ulmus densa* and the *Morus alba* took root best of all. *Haloxylon aphyllum* is developing well, *Juniperus* seedlings are in good condition, *Vítis vinífera* have developed well, and the condition of *Prunus amygdalus* is below satisfactory. The height of the *Haloxylon aphyllum* in the autumn-winter period is 155-220 cm. Photos 7 and 8.

Photos 7 and 8. Agroforestry, the state of tree species on the farm

Woody vegetation –*Morus alba, Ulmus densa, Juniperus* have taken root well on the created green umbrella, the height of the trees is 2.2-2.5 m.

Technology 2. Cultivation of drought-resistant crops on the bogar

The population living in the foothills is engaged in bogar farming and animal husbandry. The share of animal husbandry in the family budget is almost 90%. Therefore, to provide animal husbandry with feed, to solve the problems of the development of the industry, is an important task of agricultural science and practice. The introduction of drought-resistant desert forage plants will create additional feed stocks, ensure balanced nutrition of animals and reduce the load on pastures.

Table 4. Dynamics of fodder plants yields by year 2019-2022

№	Plant species	Yield, t/ha							
		2019		2020		2021		2022	
		Dry mass	seeds	Dry mass	seeds	Dry mass	seeds	Dry mass	seeds
1	*Kochia prostrata*	1.8	0.12	2.45	0.06	1.20	0.08	2.50	0.06
2	*Ceratoides Ewersmanniana*	1.4	0.11	1.51	0.05	1.05	0.06	1.86	0.09
3	*Halothamus subaphylla*	2.0	0.14	1.80	0.06	1.85	0.10	2.55	0.18
4	*Atriplex undulata*	1.8	0.14	1.65	0.06	1.65	0.11	0.85	0.05
5	*Onobrychis horossanica*	0.65	0.08	0.45	0.04	0.55	0.06	0.25	0.02
6	*Haloxylon aphyllum*	0.38	-	0.25	-	0.35	-	0.38	0.02
7	*Artemisia diffusa*	0.08	0.01	0.11	0.01	0.15	0.01	0.16	0.01
8	*Astragalus*	0.45	0.02	0.40	0.01	0.16	0.01	0.12	0.01

From the third year, a harvest of dry fodder mass of about 0.8-1.2 t/ha and seeds of 0.1-0.12 t/ha is formed. The largest yield of feed mass on the site was recorded in 2019 and 2021 -2.5t/ha, in the conditions of 2022, the yield of species was noticeably lower, due to high temperatures in July-August. Table 4.

With proper use of agrophytocenoses, i.e. with alienation or when grazing of plant mass by 70-75% and the possibility of plants to be seeded, these plant communities are able to self-regenerate for a long time. The ripened seeds will be carried by the wind, animals and spread over large areas.

Perennial forage plants - *Kochia prostrata, Ceratoides Ewersmanniana, Halothamus subaphylla, Haloxylon aphyllum, Atriplex undulata and Artemisia diffusa* are mown for livestock feed. The cutting of forage crops will allow to rejuvenate the plants, in the spring of next year, new young shoots will grow.

From the site of drought-resistant perennial fodder crops, using resource-saving technology, it will be possible to obtain about 200 - 240 kg of seeds from 2 hectares in the 3rd year of vegetation and use them in the future to improve degraded pasture areas

and sell them to farmers and dehkan farms. Additionally, 3.0 - 3.2 tons of dry weight can be obtained from a plot of 2 hectares, which will allow you to have a stable feed base throughout the year, or to graze in the pasture rotation system in the autumn - winter periods of the year.

In the third year, the fence can be moved to another site, seeds of the same fodder plants can be sown on a new site, and the original site can already be used as a seed growing site and as pastures. It is recommended to mow plants to a height of 10 - 15 cm, so that the aboveground buds of renewal are preserved, from which new shoots will grow next spring. Eating plants on pastures of 100% aboveground phytomass can lead to plant death and degradation of pastures.

CONCLUSIONS

The pastures of this zone are characterized by relatively low productivity and a significant degree of degradation of natural plant communities. The problem of land degradation and desertification in this area is more related to the plowing of significant areas for rain-fed crops of grain (Kamashi), which have low and unstable yields and very low profitability.

An increase in the number of sheep and an increase in the productivity of sheep almost completely depend on the state of pasture grass and the nutritional value of forage vegetation. In this regard, the development of a solution to the problem of livestock development and biodiversity conservation is one of the main tasks.

The created seed-growing areas can be further used as year-round pastures or hay fields. Grasses are cut off in spring and in the first half of summer, semi-shrubs in summer and autumn, and wormwood sprouting in the cenosis in autumn and winter. There is a lot of small undergrowth of plants that will grow large in the next year of vegetation.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest regarding the publication of this paper.

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