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RESTORING DEGRADED RANGELANDS IN UZBEKISTAN*

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Abstract

Recognizing the importance of a solution of desertification problem and struggle with consequences of drought, and other question connected with its, Uzbekistan in 1995 jointed to International Convention on struggling with desertification. More than 85 percent of the territory of Uzbekistan consists of desert and semi-desert. The total area of pastures in Uzbekistan is 23 million ha, or half of the total territory. During the past 15-20 years, there has been an extensive degradation of pasture land (especially in chul), due to the unbalanced use of pasture in cattle breeding, lack of maintenance of pastures and other human activities. According to the National Action Program, the dominant causes of land degradation are through processes of wind and water erosion, though the situation is compounded by other human factors contributing to transboundary water and soil contamination. Strong wind activity, ploughing of mountain slope lands, inappropriate irrigation and cattle grazing practices have resulted in the vast erosion of all soil types in Uzbekistan. Some 65-98% of agricultural lands are subject to a significant erosion process.

Keywords: restoration, strip tillage, phytomeliorants, forage productivity, Uzbekistan

1. Introduction

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Uzbekistan is located in Central part of Central Asia. The large part of republic, extending, from north-west to south-east, is plain, engaged the deserts and steppes, the south-east part engaged the hills and mountains.

Use by person of lands in drought zones as a pastures, changes of adapted systems, conversion of natural grassland to cropland with large temporary and space fluctuations of precipitation, soil humidity and productivity of plants resulting in rapid expansion of land desertification in the arid and semiarid region of Uzbekistan (Chub et al., 1999).

Causes can be categorized and briefly summarized in three groups: a) natural factors (solar radiation, windy regime, high evaporation, slopes of lands surface, soil salinity, growth and encroachment of mobile sand bodies zoogenic factors and etc.); b) anthropogenic factor (roads, moving technics, irrigation, agricultural practice, ranching, mining, tourism, woodcutting, excessive pasture of cattle, military factor, etc.); c) a combination of (a) and (b) (the degradation of vegetative cover due to overgrazing, soil erosion, water logging, salinization of irrigated lands etc.). The mail desertification processes recorded in the Central–Aral region were a decline in the groundwater level, increased mineralization and chemical pollution of water-resources, soil salinization, the spread of xerophytic and halophytic vegetation, and deflation and aeolian accumulation, with the development of salt storms (Saiko and Zonn, 2000).

A survey of the world’s deserts and processes of desertification identifies those that are strictly due to physical factor and those that are anthropogenic (Kassas, 1977). Discussions of the causes, indicators of desertification, restoration technologies applied in the Central Asia region represented in the literature (Ergashev et al., 2005; Mahmudov, 1998; Mahmudov et al., 2001). References to restoring degraded rangelands of Central Asia started in the late 1950 (Ergashev et al., 2005; Mahmudov, 1998). Restoring by strip tillage treatments serves to protect soil from wind and water erosion, increases forage productivity of rangelands (Ergashev et al., 2005). The vegetation recovery of severely degraded areas by means of natural succession processes is very slow, if not impossible, and that active intervention in the form of restoration technologies has to be applied.

As in similar arid zone countries, the Uzbek rangelands display a meager botanical diversity, sparse vegetation, and consequently, low forage productivity. Vegetation growth is after unreliable and varies from year to year because of inter – and intra-annual variation in climate and precipitation. Most of the research results lead to the conclusion that the availability and potential offered by the Middle and Central Asian native phytogenetic resources and their introduction by appropriate cultivation practices was the best way to improve and/or restore poor or degraded rangeland in the region. Collection, evaluation, conservation and utilization of native desert vegetation is a major goal in the rehabilitation of desert environments (Mahmudov, 1998).

According to Gintiburger et al., (2003) restoration technologies varies according to the expected type of pasture and the intended period of grazing. Range improvement is carried out using a mixture of seeds of fodder species (phytomeliorants) of various life forms. Restoring range for spring-summer use includes strip ploughing to a depth 0.20-0.22 m, 12-24 m wide depend on degradation degree and seeding dwarf shrabs *(Kochia protrata, Comphorosma Lessingi, Salsola Arientalis, Ceratoides evermanniana*) and herbaceous (*Poa bulbosa, Malcolmia spp, Astragalus agameticus*) by proportion 70:30% respectively. Creating autumn-winter pastures implies sowing shrubs (*Haloxylon aphyllum, Salsola Paletzkiana, S.richteri, Halothamnus subaphylla*) and dwarf shrubs (*Salsola Arientalis, Artemisia diffusa, Kochia protrata, Ceratoides evermanniana, A. halophila*) by proportion 25:75. Seeding shrubs (*Haloxylon aphyllum, H. persicum, Salsola Paletzkiana, S. richteri, Ephedra strobilacca, Calligonum spp.*), dwarf shrubs (*Kochia protrata, Salsola Arientalis, Ceratoides evermanniana, Artemisia diffusa, Artemisia turanica, A. ferganensis*) and grasses

(*Poa bulbosa, Agropyron desertorum*) by proportion 20:65:15 took place at the improving or creating all-year round range.

All of these technologies include ploughing treatment that leads to acceleration of soil erosion. Ploughing kill all plant splices, bare soil surface leads to increasing erosion of soil. Recently, there has been a tendency to reduce the number of cultivations and the area of cultivated soil. Widely used Conservational Tillage, Strip Till and No-Till systems (Idowu et al., 2017; Krauss et al., 2017; Mirzaev et al., 2019a; Mirzaev et al., 2019b; Novatzki et al., 2017; Zikeli and Gruber, 2017).

Strip Till system has the following advantages: conserves energy because only part of the soil is tilled; reduces soil erosion because most of the soil remains covered with crop residue throughout the year; releases less carbon into the atmosphere and maintains higher levels of soil organic matter; warms the tilled strips sooner in the spring to promote seed germination and plant emergence; conserves soil moisture because most of the soil surface area is covered with crop residue (Novatzki et al., 2017).

The main purpose of this paper is research the possibility of the restoring or improving of the rangelands with minimum soil tillage and sowing phytomeliorants, and maximum keeping of existing vegetation cover.

Based on the goal, the following **research tasks** are defined:

- site selection, study of soil and climatic conditions of field research sites;
- development of field research methods;
- determining conservation of existing species and their recovering ability;
- comparative studies of germination and development phytomeliorants under plowing and strip tillage;
- assessing of the dynamics of growing of the plants;
- comparative studies of restoring degraded rangelands by sowing phytomeliorants and without sowing;
- determining of total forage productivity restored areas at strip tillage and at plowing.

2. Materials and methods

The experiments were organized in two places: Kizilkum and Nurata stations of the Karakul Sheep Research Institute. The Nurata station is located at 50 km far from Nurata town to the east, Navoi region, Uzbekistan. The restoration area at Kizilkum station is located 130 km north-west of Navoi (Fig.1). Those regions have an arid continental climate, with warm dry summer, short and cool winter, comparatively average rainfall in spring, autumn and winter. The average annual temperature at Kizilkum station is +15.3 °C, at Nurata +14.9 °C, the coldest and warmest temperatures of -31.9 and -26.9 °C in January, +48.9 and +43.0 °C in July respectively.

The 50 – year mean annual precipitation is 251 mm, wich mainly occurring between November and April. The restoration site soils are sandy loam at Kizilkum and grey loam soil at Nurata which are highly susceptible to wind and water erosion. The dominant plant species are: a) at the Kizilkum station: Haloxylon aphyllum, H.persicum, Calligonum, Ammodendron Conollii, Ephedra strobilacea, Salsola Paletzkiana, S.richteri, Astragalus spp., Aristida karelinii, A.pennata, Ferula asso foetida, Carex physodes, Malcolmia spp, Coelpinia linearis at all; b) at the Nurata station: Poa bulbosa, Carex Phytulis, Artemisia diffusa at all.

Fig. 1. Degraded area where restoration technologies were applied
▲ - Nurata station; ● - Kizilkum station

Investigation site of 100m x 50m was selected in area with lowe vegetation cover. The site was subdivided into 10m x10m subplots. Plant species was recorded in there 1 x 1m quadrates in each subplot before and after treatments.

Were determined conservation existing species and their recovering ability (Experiment 1). Amount of each type of the plant species are determined on untilled and strip tilled sub-plots. For recovering the plants, damaged during soil tillage, number of plants is determined before tillage - at February and after – at April.

Experiment 2 implies comparative studies of germination and development phytomeliorants under plowing at the depth 0.20 m and strip tillage at the same depth. Strip tillage treatment implies a cultivation action with sub-soiler implements to a different depth and 150mm wide. Distance between strips was 600…700mm. The sowing phytomeliorans was made at February, number of germinated species is determined on each sub-plot at April. Field germination of plants was determined by counting the emerged seedlings from the number of seeds that were sown. The dynamics of growing of the plants was assessed upon their height, which was determined in each quarter, four times at year by measuring the height of 25 plant specimens at the beginning, middle and end of the field. The productivity of fodder mass of shrubs and draftshrubs was determined by the transect method, in grassy species - by continuous mowing of 1 m^2 of area.

Soil samples were collected in January, March, May, July and September at three points in each sub-plot. For seeding treatments were selected shrabs (Haloxylon aphyllum, H.persicum, Salsola Paletzkiana, S.richteri, Ephedra strobilacca, Calligonum spp.) dwarf shrabs (Kochia protrata, Comphorosma Lessingi, Salsola Arientalis, Ceratoides evermanniana), grasses (Poa bulbosa, Agropyron desertorum). This species characterized by their ability withstand long droughts and low humilities, nutrient deficiencies, high soil salinity, extreme high summer and low winter temperatures

For interpretation of the data in this study least significant difference (LSD) values were reported at the 5% level of significance.

3. Results and discussion

3.1. Changes in plant species following strip tillage of soil without sowing phytomeliorants

Total forage productivity plant species after strip tillage was about 38% more than at the undisturbed plots. (Table 1). Plant species such as *Malcolmia graniflora* Bge. (16.4%), *Leptaleum filifolcum* (15.5%), *Eremopurum orientalis* (L.) (13.6%), *Certocephalus falcatus*

(L.) Pere (8.2%), *Euphorbia cheirolepis* Fisch (7.7%) were the dominant species and give more than 50% of total product. Strip tillage serves to better accumulation of water and allows increasing of forage productivity of desert plants.

Table 1. Forage productivity some types of grasses after strip tillage without sowing, (center/hectare)

Name of the plants	***Productivity, c/ha***			
	Native range	Percentage	After soil strip tillage	Percentage
Aegilops Eguarrosa L.	0.05	3.2	0.03	1.4
Bromus tectorum L.	0.31	19.5	0.31	14.1
Carex physodes Bieb	0.23	14.5	0.07	3.2
Ceratocephalus falcatus (L.) Pere.	0.12	7.2	0.18	8.2
Euphorbia cheirolepis Fisch	0.12	7.5	0.17	7.7
Eremopyrum orientalis (L.)	0.10	6.4	0.30	13.6
Leptaleum filifoleum (willd)	0.14	8.8	0.34	15.5
Malcolmia grandiflora Bge.	0.14	8.8	0.36	16.4
Papaver pavoninum Schenk	0.16	10.2	0.23	10.4
Schismus arabicus Nees	0.08	5.1	0.04	1.8
Ziziphora tenuior L.	0.03	1.9	0.06	2.7
Other	0.11	6.9	0.11	5.0
Total	1.59	100	2.2	100

Thus, according to the results, strip tillage of pastures without planting phytomeliorants helps to increase pasture productivity by 38% due to better moisture accumulation during precipitation.

3.2. Restoring degraded rangelands by sowing phytomeliorants

Germination ability, output of germinated plants and total forage productivity restored sites were determined by different technologies of preparing of soil. Mouldboard ploughing at the depth 20-22 cm following hand sowing and hurrowing were compared by strip tillage (15cm x 70cm) at the same dept and sowing by combination machine. As a phytomeliorants were taken Haloxylon aphyllum, Halothamnus subaphyllus, Ceratoides eversmanniana, Kochia protrata, Salsola orientalis.

Table 2. Number of sowing and germinated seeds at plowing and strip tillage

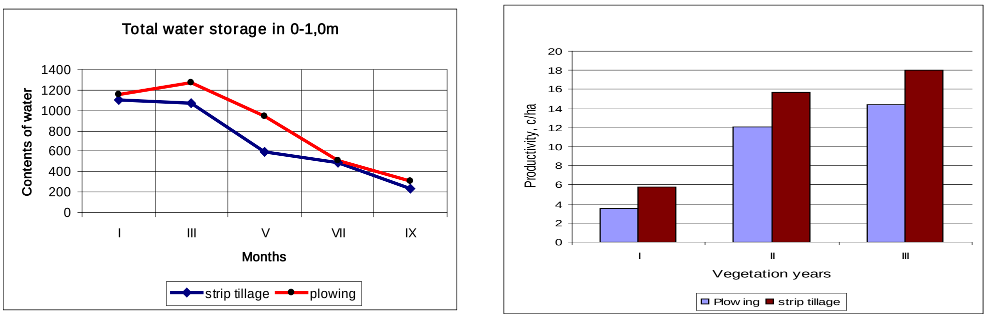
Plant	***Plowing***				***Strip tillage***			
	Number of seeds	%	Germinated seeds	%	Number of seeds	%	Germinated seeds	%
Haloxylon aphyllum	215	100	4.95±0.11	2.3	215	100	8.72±0.52	4.0
Halothamnus subaphyllus	50	100	8.57±0.91	17.0	50	100	6.42±1.54	12.8
Ceratoides eversmanniana	80	100	9.12±1.14	11.3	80	100	8.77±1.97	10.9
Kochia protrata	850	100	4.7±0.62	0.55	850	100	4.17±1.54	0.49
Salsola orientalis	230	100	10.6±1.42	4.6	230	100	10.2±1.89	4.4
Total	1425	100	37.9	2.65	1425	100	38.2	2.68

Number of sowing and germinated plants is shown in Table 2. Germinated plants at plowing were 0.55-17.0%, mean germinating ability was 2.62%, at strip tillage respectively –

0.49-12.8%, mean value – 2.68%. On germination ability difference at compared variants was not significant. However, with strip tillage of 15 cm wide, with a row spacing of 60 cm, about 25% of the area is processed, existing plants are preserved in 75%. The energy consumption for cultivation is also reduced in proportion to the area of the cultivated soil.

Total water storage at the plowing in the January was about 5.0%, in May about 38% more than at strip tillage (Fig. 2a). Top layer of soil accumulate more precipitation water at plowing, but due to increasing evaporation at the July water contents at this compared variants are not significant.

Total forage productivity restored areas at strip tillage were always more than at plowing (Fig. 2b). At the first year after treatments total productivity plots at strip tillage was (35.6%) more then at plowing plots, these differences were 21.2% at the second and 18.9% at the third years. Strip tillage increase productivity due to storage (keeping) natural plants and creating favorable conditions for growing of sowing and existing plants.



a) b)

Fig. 2. (*a*) Total water storage in 0-1.0 m; *(b)* Total forage productivity of restored ranges

Fig. 2 illustrates the differences between the results after the evaluation of the proposed scenarios with GaBi and SimaPro software. It can be observed that they indicate a negative impact for all indicators. Irrespective of the software applied in data processing, after the evaluation of the results with both tools, it was found that *scenario 3*, which includes: temporary storage, collection and transport, sorting with recycling of metals and glass, landfill and leachate treatment could be considered as the most suitable scenario for *C&DW* management system from the environmental point of view.

3.3. Restoring by sowing phytomeliorants at different combination of components

Germination and survival ability, dynamics of growing, output of germinated plants and total forage productivity were investigated at different depth of seeding, depth of tillage and different combination of the components at strip tillage technology. Germination and growing sowing phytomeliorants and minimum output of germinated plants were at the depth of seeding 1-2cm and at the tilling depth 20 cm.

Results of survival ability at the first year after treatments were shown at the Fig. 3.

If the total number of germinated seedlings at the beginning of the study is taken as 100%, then after 6 months the number of remaining plants at the depth of tillage 10 cm was 60.6%, at the depth of tillage 15 cm 70%, and at the depth of tillage 20 cm 77%. This is can be explained by the accumulation of moisture in the soil. By increasing depth of tillage, the accumulation of moisture in the soil increases. As a result, more plants can survive in desert pastures. Some seedlings will die due to lack of moisture.

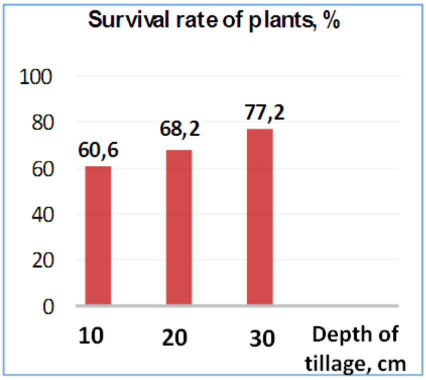


Fig. 3. Dependence of plant survival on the depth of strip tillage

Dynamics of growing were investigated at different combination of the components at strip tillage technology. It is known that agrophytocenosis of desert pastures consists of shrubs (S), dwarf shrubs (D) and grasses (G). In order to determine the optimal ratio of these components of phytomeliorants, sowing were carried out in the following proportions: $S_{25}+D_{50}+G_{25}$ (shrubs - 25%, dwarf shrubs -50%, grasses – 25%); $S_{50}+D_{25}+G_{25}$ and $S_{25}+D_{25}+G_{50}$. Results of dynamics of growing phytomeliorants at different proportion of components at the Table 3.

Table 3. Dynamics of growing phytomeliorants at different proportion of components

Variant of combination	*Component and proportion*	*Dynamics of growing, cm*			
		25.08.17	25.09.17	25.10.17	25.11.17
$S_{50}+D_{25}+G_{25}$	Haloxylon aphyllum. 50 %	58.3	64.7	69.4	71.8
	Salsola orientalis, 8 %	40.1	48.7	53.3	58.2
	Halothamnus subaphyllus, 9 %	16.7	21.2	23.7	25.8
	Kochia protrata, 8 %	56.4	72.1	79.8	83.2
	Climacoptera lanata, 13%	39.6	48.2	53.4	55.3
	Agropiton desertorum, 12 %	51.7	60.3	66.2	70.6
$S_{25}+D_{50}+G_{25}$	Haloxylon aphyllum, 25%	59.3	69.8	73.4	78.2
	Salsola orientalis, 16%	34.4	42.3	51.5	54.8
	Halothamnus subaphyllus,18%	15.2	18.3	21.4	25.7
	Kochia protrata, 16%	57.8	75.2	81.6	85.4
	Climacoptera lanata, 13%	36.5	46.8	52.3	55.1
	Agropiton desertorum, 12 %	50.2	61.4	67.7	69.7
$S_{25}+D_{25}+G_{50}$	Haloxylon aphyllum, 25%	53.6	67.2	70.7	73.5
	Salsola orientalis, 8%	45.9	59.4	62.3	66.4
	Halothamnus subaphyllus, 9%	15.7	19.1	23.3	26.4
	Kochia protrata, 8%	59.3	76.8	82.5	85.9
	Climacoptera lanata, 25%	41.2	53.6	57.1	59.5
	Agropiton desertorum, 25 %	54.3	61.8	68.1	73.6

As can be seen from Table 3, different plant species have different growth dynamics. Therefore, by the dynamics of growth it is difficult to determine the significant difference between combinations of the components at strip tillage. Because, the productivity of plants is not proportional to their growth. Productivity is mainly determined by the branching and number of leaves and other parts.

Therefore, studies have been carried out to determine the productivity of each species separately and the total productivity for different components. The productivity of fodder mass of shrubs and draftshrubs was determined by the transect method, in grassy species - by continuous mowing of 1 m^2 of area. Productivity plant species at the different proportion of components are shown in Fig. 4.

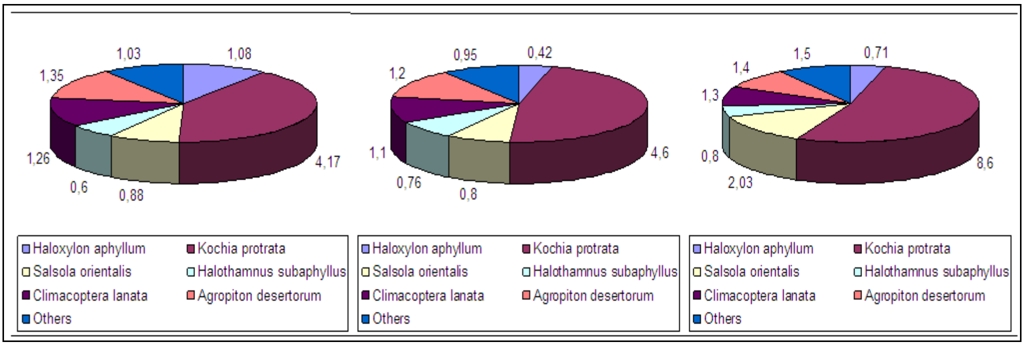


Fig. 4. Productivity of phytomeliorants at different proportion of components: (right) $S_{25}+D_{50}+G_{25}$; (middle) $S_{25}+D_{25}+G_{50}$; (left) $S_{50}+D_{25}+G_{25}$

Research results have shown that total forage productivity at the combination $S_{25}+D_{50}+G_{25}$ (16.34 c/h) was more than $S_{50}+D_{25}+G_{25}$ (10.37 c/h) and $S_{25}+D_{25}+G_{50}$ (9.83 c/h) 36.5% and 39.9 % respectively (Fig. 5). It was established that, according to the overall productivity of sown plants, combination $S_{25}+D_{50}+G_{25}$ has obvious advantages. This combination provides a better ratio between different plant species with their simultaneous co-existence and with this technology of strip tillage and sowing.

Degraded patch where restoration treatments were applied and this area after restoration is shown in Fig. 6.

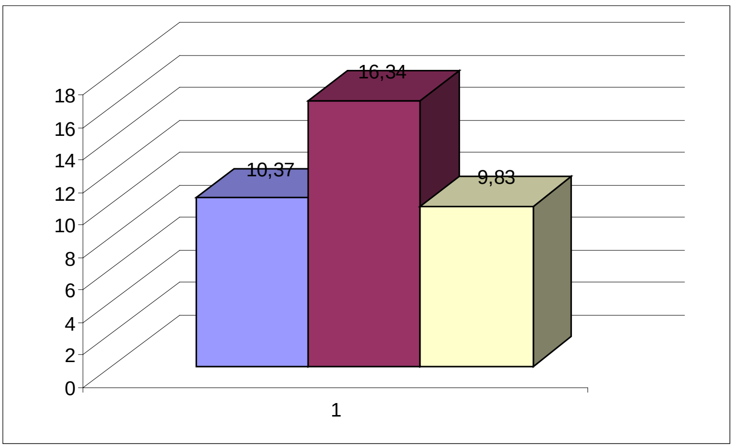


Fig. 5. Total forage productivity at different proportion of phytomeliorants

a)

b)

Fig. 6. Degraded patch where restoration treatments were applied (*a*);
Restoration site at the end of the first vegetation year (*b*)

4. Conclusions

Accumulation of water creates favorable conditions for growing desert plants. Strip tillage small areas without sowing phytomeliorants increases total forage productivity ranges.

Strip tillage allows keeping existing plant species and promotes better germination and establishment seeded phytomeliorants, total forage productivity at sowing of phytomeliorants more than at plowing and sowing.

Strip tillage and sowing phytomeliorants at the combination $S_{25}+D_{50}+G_{25}$ (Shrabs - 25%, Dwarf shrubs -50%, Grasses -25%) creats favorable conditions for seeded phytomeliorants and allows to create all-year-round pastures. Total forage productivity restored/improved rangelands considerably more than other combinations of components.

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