Analysis of Desert Rangeland Improvement Technologies

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Abstract: In the world, areas prone to desertification and potentially dangerous due to desertification occupy an area of about 52 million square kilometers. Degradation of desert pastures has a negative impact on food security, agricultural production, and environmental ecology. 21 million hectares of Uzbekistan (47% of the total land area) are occupied by desert pastures, more than 50% of which have been degraded to varying degrees. The article analyzes a number of ways to improve these degraded areas, and in addition to this, the technology of planting with discontinuously strip tillage is proposed. It is theoretically based that when using this technology, the tillaged area is 1-3%, and the preserved vegetation cover is 97-99%.

1 INTRODUCTION

Globally, desertification-prone and desertification at risk areas cover approximately 52 million sq km, and economic losses from desertification alone are estimated at US$42 billion annually. The phenomenon of "desertification" occurs mainly as a result of irrational use of natural resources of the land (Eduardovich, 2016). According to the latest United Nations data, more than 20 percent of Central Asia's total land area is degraded, which is about 80 million hectares - almost four times the size of Kyrgyzstan. This situation affects approximately 30% of the population of the region (Davronov, 2022).

Degradation of desert pastures has a negative impact on food security, agricultural production, and environmental ecology. Desert pastures are important from a socio-economic point of view and serve as one of the main natural resources for maintaining ecological balance in the region, ensuring food security, developing animal husbandry and improving the living standards of the population. For this reason, it is necessary to improve the natural conditions, contours, soil, variety and amount of plants and the level of water supply of pastures.

In particular, 21 million hectares of our Republic (47% of the total land area) are occupied by desert pastures, of which more than 50% have been degraded to varying degrees, 11 million hectares of pastures have decreased in natural fodder production potential and have become unusable (Bean et al., 2004).

In these pastures, due to the insufficient implementation of the irregular grazing system and the sharp increase in the number of livestock, the pastures are under great pressure. There are several ways to improve pastures and they are listed below:

Improvement by planting *(by planting seedlings of phytomeliorational plants)* - this method involves growing seedlings in separate plots or greenhouses and then transplanting them as seedlings *(indooror bare roots)* to suitable plots. Plants are often grown in

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greenhouses for ≥ 1 year to regenerate before planting (Avdeeva et al., 2022). The use of seedlings with a closed root system in planting has a number of important advantages compared to seedlings with an open root system. In particular, seedlings with a closed root system take root better even in unfavorable conditions, are resistant to transportation over long distances, and significantly extend the seedling period of the plant. In addition, seedlings with a closed root system are important because the roots are protected and the seedlings are not damaged during planting (Brown et al., 1979).

Improvement by seeding *(seeds of phytomelioration plants)* - Usually, sowing of seeds is carried out by hand, with seeders and with the help of airplanes, depending on the size of the cultivated area. Sometimes the seeds are covered with husks or covered with a protective mulch to conserve moisture and reduce the risk of being killed by insects and animals that feed on the seeds (Mwebaze, 2002).

Many scientists have conducted scientific research on the development of technologies that improve the condition of pastures by planting seedlings and seeds abroad; (Mwebaze, 2002; Serebrova et al., 2011; Thom et al., 2011; Yang et al., 2012; Rayburn & Laca, 2013; Zhao, 2017; Ivansova et al., 2019). On the development and improvement of technologies and technical means of improving the state of pastures with the help of seeds and seedlings of phytomeliorative plants even in the conditions of Usbekistan (Olmosov, 2019), (Gafurova & Nabiyeva, 2019; Ergashev et al., 2020; Farmonov et al., 2020; Farmonov, 2021; Khudoyberdiyev et al., 2021), other scientists, researches on planting seedlings of phytomeliorative plants conducted by (Makhmudov et al., 2006).

Improvement through water resources - to improve degraded desert pastures, rainwater harvesting basins are used to irrigate plants, and water trucks are used if it is not raining. Practical work on this method of solving the problem has been started in many countries of the world with desertification and degradation problems. As an example, Israel's anti-desertification program focuses on centralized water management (Farmanov, 2021). In addition, it is possible to restore desert pastures through spring water (Ergashev et al., 2020). Many foreign scientists have conducted scientific research on the role of water resources in the improvement of desert pastures and the development of improvement technologies, through them (Orlander & Due, 1986; Dehghanisanij et al., 2006; Cirelli et al., 2009; Cui et al., 2015; Yi & Zhao, 2016; Marin et al., 2017; Cui et al., 2017; Zhao, 2017; Pfeil, 2018; Orlovsky & Zonn, 2019; Dor-Haim et al., 2023).

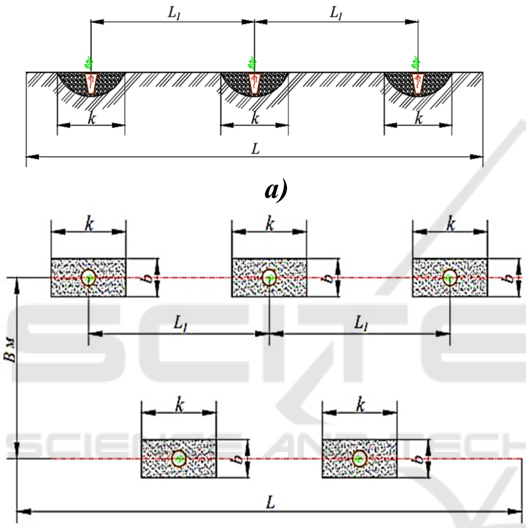
Improvement through fertilization *(various soil enrichment additives)* - Improves soil composition using additives, fertilizers, and other methods to promote ecosystem-friendly soil properties when improving degraded desert grasslands. Adding fertilizers or organic matter (which increases the soil's water-holding capacity) will improve soil conditions (Çaçan & Kokten, 2019). Several scientists have conducted scientific research on the use of fertilizers and organic matter in enriching the composition of degraded grassland soils. There are (Kulakov, 2006; Zotov et al., 2011; Scott & Prater, 2018; Çaçan & Kokten, 2019; Chen et al., 2022; Namozov et al., 2022; Qin & Zhao, 2023).

Improvement by exposure to soil - Rehabilitating degraded soils helps reduce erosion and stabilize soil, and is used to provide shade structures that help protect plants, protect seeds, and more (Bauman, 2020). Scientists who conducted scientific research in this regard (Yang et al., 2012; Kimiti et al., 2016; Stephen et al., 2016; Lopez et al., 2019; Khujanazarov et al., 2021).

Improvement without impacting the soil - it means protecting pastures whose productivity is decreasing for a while from livestock and other influences. In this case, the existing plant cover will develop, and productivity will increase due to the reduction of external influence. Many scientific studies have been carried out by world scientists on the approaches to solving the problems related to the degradation of deserts and pastures, and technologies have been developed by scientists to solve the problem (James, 2014; Bauman, 2020; Tlili et al., 2021). Depending on the degree of degradation, the region where desert pastures are located requires the use of the above-mentioned improvement technologies.

2 MATERIALS AND METHODS

One of the effective ways to improve pastures in drought protection is phytomelioration, that is, planting seeds of some desert plants from shrubs, semi-shrubs or quality seedlings. However, when improving pastures by seeding of phytomeliorative plants, it takes a long time for the seeds to germinate and be used as feed. In addition, seeding of some phytomeliorative plants requires manual implementation. In this case, improvement of pastures by planting seedlings is considered to be an acceptable solution, as well as the loss of the area where seedlings are planted and the increase in volume of dry areas. For planting seedlings of phytomeliorative plants, the discontinuous strip planting technology has been developed, by which it is possible to achieve the preservation of the plant cover of the intermediate area of the planted seedlings (Fig. 1). In the proposed technology of discontinuous strip cultivation (Fig. 1, a and b), an area with width ***b*** and length ***k*** (k-constant number) is cultivated in the pasture and seedlings of phytomeliorative plants are planted in this area.In this case, the L_1-k distance between the tillaged areas is left uncultivated. B_M between tillaged rows can change depending on the type of plant to be planted.



a)

b)

a) *longitudinal section;* ***b)*** *top view.*

Figure 1: A technological scheme for improving pastures by planting closed-root seedlings.

If we take the length ***L*** and width ***B*** of the area where seedlings are planted, then the tillaged area with a continuously strip (width ***b***) is determined as follows.

$$F_1 = b \cdot L \cdot \frac{B}{B_M}, \quad (1)$$

Here $\frac{B}{B_M}$ – represents the number of rows to be worked at B_M row spacing in a pasture of width ***B***. When planting seedlings in discontinuously strips in pastures, we determine $\frac{L}{L_1} = n_p$, since the length of the uncultivated distance ℓ through the distance L_1 between seedlings is equal to $\ell = L_1 - k$.

Here ***k***- is a fixed number, equal to $k=1$

n_p -Represents the number of seedlings to be planted in each row.

(1) Using the expression, the surface area of the same-size ***(B, L)*** field when discontinuously tillaged is determined as follows.

$$F_2 = b \cdot n_p \cdot k \cdot \frac{B}{B_M}. \quad (2)$$

Since the total area of the pasture is $F_t = B \cdot L$, we find $B = \frac{F_t}{L}$.

Then for continuously tillage technology cultivated area equal to

$$F_1 = \frac{b \cdot F_t}{B_M}. \quad (3)$$

And the total uncultivated area surface equal to

$$F_{con} = F_t - \frac{b \cdot F_t}{B_M}. \quad (4)$$

For discontinuously strip tillage technology, cultivated area will be equal to

$$F_2 = \frac{b \cdot k\, F_t}{L_1 \cdot B_M}. \quad (5)$$

And the surface area of the total uncultivated area is found from the following expression.

$$F_{dis.c} = F_t - \frac{b \cdot k F_t}{L_1 B_M}. \quad (6)$$

From the expressions **(1)** and **(2),** it is possible to calculate the cultivated strip width ***b*** for 1 ha area *(L=100m, B=100m)* and the cultivated area surface for B_M between the rows in a discontinuously tillage and a continuously tillage.

Using expressions **(4)** and **(6),** it will be possible to determine the surface of the field that has not been cultivated in in a discontinuously tillage and a continuously tillage for planting seedlings of phytomeliorations.

3 RESULTS AND DISCUSSION

The area of influence on the soil surface of each tillage and planting method was analyzed for discontinuously tillage and continuously was determined by comparison (Figures 2, 3 and 4). For both methods, the values of the distance between rows B_M *(1)* B_M*=1,2 m; 2)* B_M*=2,4 m; 3)* B_M*=3,6 m)* and the strip width ***b,*** were taken as equal (Figures 2, 3). The influence of the distance between rows B_M on the area of the tillaged field F_1 in continuously strip planting was studied (Fig. 2).

In Figure 2, it can be seen that the values of the distance between the rows B_M and the width of the strip ***b***, increase in accordance with each other, and the value of the tillaged area surface F_1 increases. At B_M*=3,6 m* and ***b****=0,15 m* the total tillaged area of 1 hectare of field is F_1=361,1 m^2. At B_M=1,2 m and b=0,15 m the total tillaged area of 1 hectare of field is F_1=1250 m^2. The effect of the number of seedlings n_p on the surface of the tillaged area F_2 was studied (Fig. 3). It turned out that the value of the distance between the rows B_M is directly proportional to the value of the number of planted seedlings n_p. That is, in Figure 3, it became known that as the values of B_M decrease, the value of n_p also decreases. It was found that the decrease in the number of planted seedlings n_p directly affects the decrease in F_2 of the cultivated field surface (Fig. 3).

In discontinuously strip planting, between the rows B_M=3,6 m and width of tillaged strip b=0,15 m the cultivated area for 1 hectare will be equal to F_2=83,3 m^2 and the number of seedlings to be planted is n_p =560 pcs, if between the rows B_M=3,6 m and the width of the tillaged strip b=0,15 m the cultivated area for 1 hectare will be equal to F_2=250 m^2 and the number of seedlings to be planted is n_p =1667 pcs.

Based on the mathematical expressions defined above, we will be able to compare the technologies of planting seedlings of phytomeliorative plants using conventional *(overall)*, continuously strip and discontinuously strip tillage of the soil (Fig. 4).

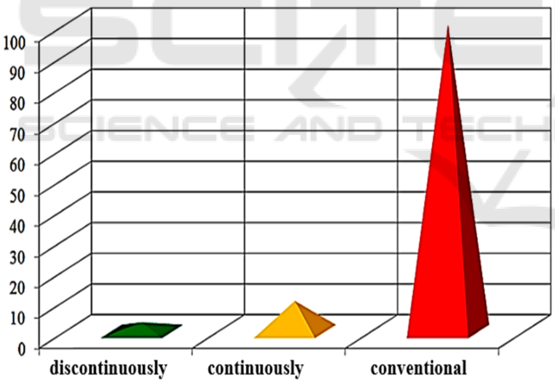
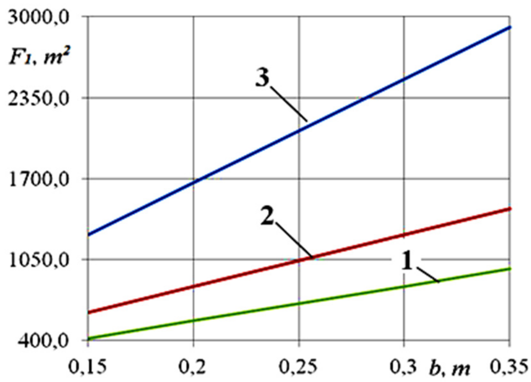


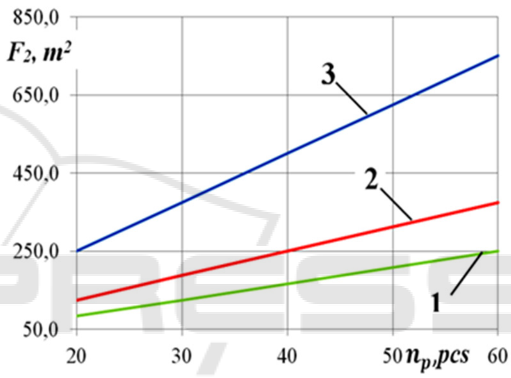
Figure 4: The effect of different (discontinuously, continuously and conventional) technologies on the soil in relation to the area of the tillage.

As can be seen from the given figure 4, the technologies of continuously strip, discontinuously strip and conventional (overall) soil tillage differ from each other in the fact that the area of the tillaged soil is different.



1) BM=1,2 m; 2) BM=2,4 m; 3) BM=3,6 m.

Figure 2: Effect of row spacing B_M on cultivated field surface F_1 in continuously strip planting.



1) BM=1,2 m; 2) BM=2,4 m; 3) BM=3,6 m.

Figure 3: The effect of the number of seedlings nk on the surface area of the tillaged area F2 in discontinuously strip planting.

4 CONCLUSIONS

Currently, there are various ways to prevent degradation of pastures and to improve them, conventional, continuously strip and discontinuously strip tillage of pasture soils, sowing of seeds and planting of seedlings technologies are used. If we consider the surface of cultivated areas to be 10,000 m2, the surface area to be cultivated during planting with conventional tillage will be 100%. Theoretical calculations showed that in continuous strip tillage, the soil is tillaged up to 4-12% of the total area, while in discontinuous strip tillage only 1-3% of the total area is tillaged. This allows to plant up to 560-1667 seedlings in the tillaged area and ensures that the natural vegetation cover in the area is preserved to 97-99%. Thus, when improving pastures by sowing seeds of phytomeliorative plants, continuously strip tillage is considered promising, and when improving by planting seedlings, discontinuously strip tillage is considered most promising.

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