Combined tool for improving arid pastures

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Abstract. In this article, the state and the main factors leading to the degradation of pastures of Uzbekistan are considered. To solve this problem, the technology and planting scheme are proposed, and a constructive scheme of combined soil-processing and planting tool for its implementation is developed.

1 Introduction

Arid pastures of Uzbekistan, occupying over 80% of agricultural land, have low productivity and are characterized by a large amplitude of fluctuations in the yield of feed by year and season. Tens of millions of sheep, cattle and other farm animals are kept here every year. However, these lands are used extensively: mainly as natural pastures with unstable and unproductive vegetation cover. Attempts to intensify pasture land use without the use of appropriate reclamation technologies in this zone lead to degradation [1-3]. Figure 1 shows the main factors leading to the degradation of pastures.

At the same time, the experience accumulated by science and practice in improving pastures indicates that intensive use with the use of effective improvement technologies prevents the degradation of pastures, promotes the restoration of the ecological and biological potential of degraded landscapes, increases the productivity of forage lands by 1.5...2 times, improves the conditions of keeping and feeding animals [4-8].

2 Materials and methods

One of the effective methods of improving pastures in arid zones is phytomelioration, i.e. sowing seeds of some desert plants from grasses, semi-shrubs and shrubs or planting their seedlings. However, the improvement of pastures by sowing seeds of phytomeliorants requires a significantly long time to include it in use. In addition, the sowing of phytomeliorant seeds is mainly carried out manually, the use of grain-grass seeders, which are not adapted for sowing phytomeliorant seeds, is partially practiced.

There is a combined tool for sowing phytomeliorant seeds in arid zones of Uzbekistan, which consists of two functional parts. The tool was tested in the conditions of the arid zone located in the Nurata district. However, the tool has not yet been put into production.

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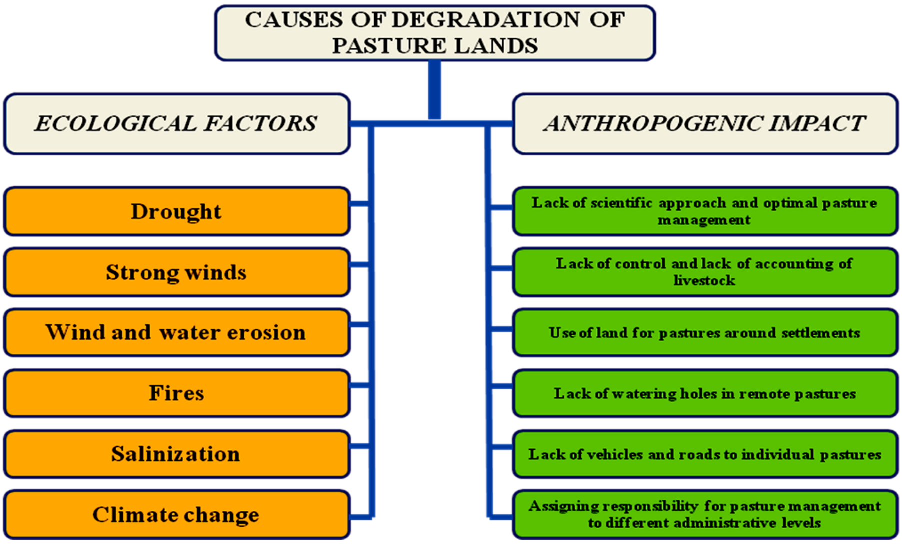


Fig.1. Causes of pasture degradation

Analysis of the results of domestic and foreign research indicates that the most acceptable method of improving pastures is strip tillage using combined aggregates and planting seedlings of phytomeliorative plants in these strips.

Based on this, the authors propose a resource-saving, environmental protection technology based on strip tillage and planting of plant seedlings of phytomeliorants, and also developed and conducted laboratory studies of a combined tillage-planting tool for its implementation. Seedlings of phytomeliorative (plants obtained by sowing seeds and intended for their subsequent planting in improved pasture areas) of phytomeliorative plants are used as planting material.

The proposed technology represents the following operations: formation of a protective furrow (Fig.2.1, a), loosening of the soil within the open furrow (fig.2.1, b), the formation of a landing slot (fig.2.1, c), placement of seedlings in the planting slot (Fig.2.1, d) and soil compaction around seedlings (fig.2.1, e)

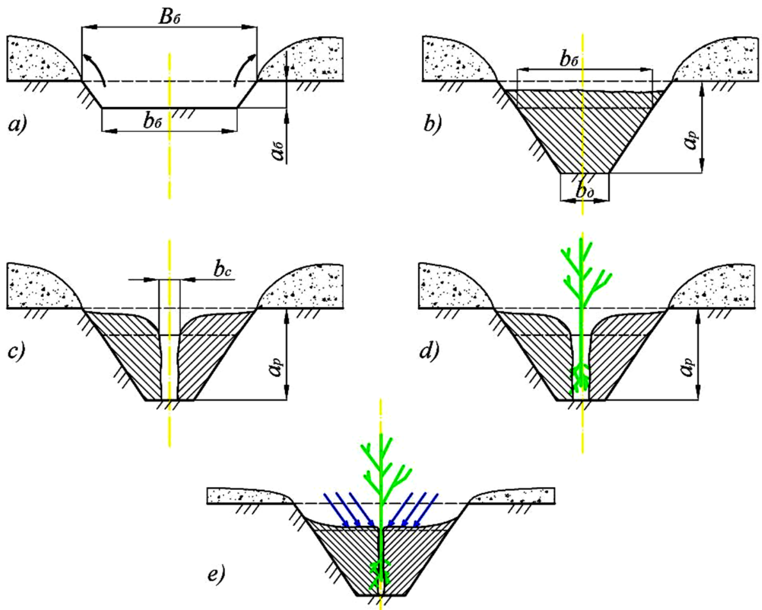
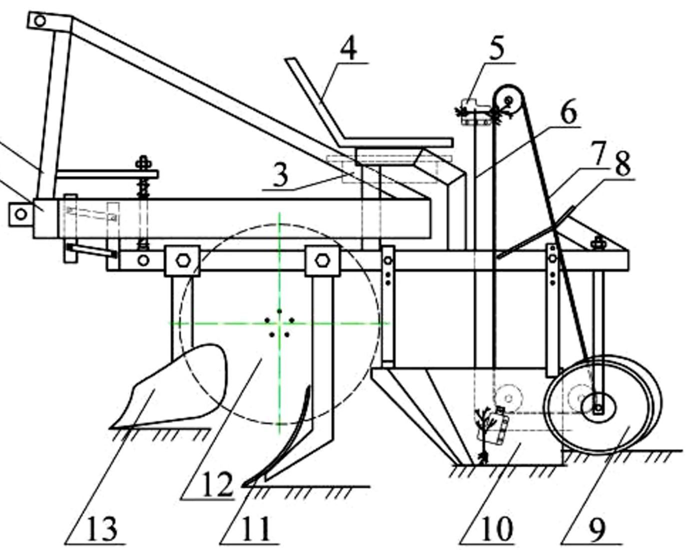
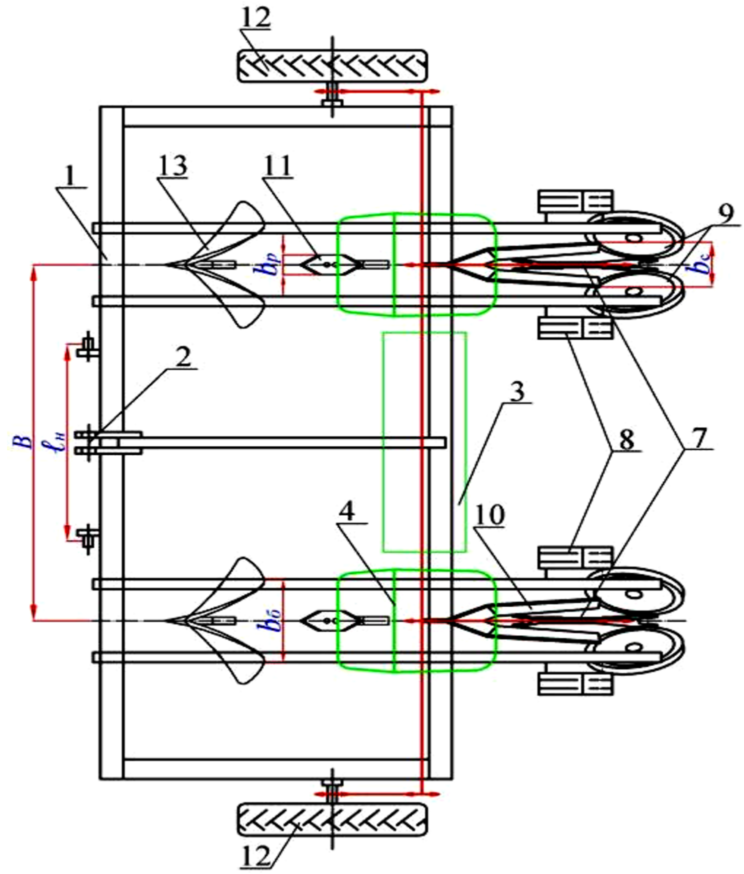


Fig. 2. Technological process of tillage and planting seedlings of phytomeliorants.

To implement this technology, a combined tillage-planting tool is proposed (Fig.3). The combined tool consists of a frame 1, a hinged device 2, a basket for seedlings 3, a seat for the operator 4, a clamp 5, a template 6, a chain 7, a shelf 8 for the operator's legs, compacting rollers 9, a coulter 10, a ripper 11, the support wheels 12 and the furrower 13.



a)



b)

Fig. 3. Design scheme of the combined tillage-planting tool. a) side view; b) top view

The principle of operation of the tool is as follows.

When the tool moves, the furrower (Fig. 3) 13 cuts through the covered soil layer and wraps it to the sides, forming a groove, the ripper 11 following it processes the soil to the required depth, resulting in a treated strip of soil for planting seedlings. The coulter, moving along the treated soil, forms a landing slot. The operator, sitting on the seat 4, takes the seedlings from the basket 3, sets them on the clamp 5 and holds them until they are securely fixed. The clamps 5 are mounted on a chain 7, which is driven from the support wheels 12 through intermediate gears. The seedling, together with the clamp 5, descends into the formed landing slot of the coulter 10 and is held in an upright position until the soil is sealed around the seedling, the rolling rollers 9 produce soil compaction on both sides of the seedling.

To conduct field experimental analysis, a layout sample of a two-row combined tool for planting seedlings was developed (Fig. 4).

a)

b)

c)

Fig.4. A layout sample of a two-row combined tool. a –side view; b – rear view; c – the technological process of the tool.

The following qualitative indicators of the work of the tool were determined depending on the speed of movement: the depth of tillage, the seedling planting depth, the deviation from the vertical of the planted seedlings after the passage of the tool.

3 Results and discussion

The results of determining these indicators are shown in the Table 1.

Table 1. The results of measuring the qualitative performance of the combined tool, depending on the speed of movement

№	**Qualitative indicators of the tool**	**At the speed of movement V=0,84 m/c**	**At the speed of movement**	**At the speed of movement V=1,4 m/c**

				V=1,12 m/c	
1	Depth of tillage, cm	$\overline{x}$	20,42	20,23	20,25
		σ	0,96	1,03	1,13
		$\overline{V}$	4,70	5,09	5,58
2	Depth of planting root part, cm	$\overline{x}$	13,8	14,81	11,01
		σ	1,30	0,65	0,31
		$\overline{V}$	9,42	4,39	2,82
33	Deviations of seedlings in the direction of movement, deg.	$\overline{x}$	109,8	102,1	94,3
		σ	13,7	11,1	4,9
		$\overline{V}$	12,47	10,87	5,19

The data given in the table are obtained at an installation tillaging depth of 20 cm. Analysis of the results showed that changes in the speed of movement from 0.84 to 1.4 m / s (3 ... 5 km / h) have no significant effect on the depth of tillfge.

The average depth of tillage at V1 = 0.84 m / s by triple repetition is $\overline{x_1}$ = 20.42 cm, at V2 = 1.12 m / s, $\overline{x_2}$ = 20.23 cm, and at V3 = 1.4 m / s, $\overline{x_3}$ = 20.25 cm, i.e. the difference does not exceed 2%. (fig.5.)

At these speeds, the tool moves fairly evenly, as evidenced by the value of σ and $\overline{V}$, which does not exceed 5%.

Fig. 5. Measuring the depth of tillage

The depth of embedding is important for the survival of the seedling, because the longer the root part in the soil, the larger the habitat area, including the provision of water.

a) b)

c)

Fig. 6. General view of planting process, a) at a speed of 0.84 m/ s. b) at a speed of 1.12 m / s. c) at a speed of 1.4 m / s

According to the table, it can be concluded, that the depth of planting worsens with a change in speed from 0.84 m/s to 1.4 m/s and it decreases from 13.8 to 11.01 sm. However, a further increase of the speed planting depth is reduced or not sealed at all. This can be explained by the fact that with increasing speed, most of the loosened soil is dumped to the sides, which further leads to a shortage of soil for sealing.

The amount of deviation of planted seedlings from the vertical depends on the ratio of the speed of the tool and the speed of the conveyor of the feeding mechanism. In experiments, the conveyor speed of the feeding mechanism is set to V2=0.84 m/s, 1.12 m/s and 1.4 m/s.

When measuring, the angle of inclination in the direction of movement is assumed to be positive, against the direction of movement negative.

The table shows that at speeds V1 = 0.84 and 1.12 m / s, all seedlings are deflected in the direction of movement. The average value of the angle of inclination of seedlings at V1 = 0.84 m/s is $\bar{x}_1 = 109.8°$, at V2 = 1.12 m / s this value is $\bar{x}_2 = 102.1°$. However, at the speed of movement of the unit V1 = 1.4 m / s, this indicator is different, the inclination of all seedlings towards the direction of movement means that at the time of sealing, the absolute speed of the seedling is not zero, the speed of the conveyor chain is greater than the speed of the tool.

The angles of inclination of seedlings at V3 = 1.4 m / s has a lower value, the average value is $\bar{x}_3 = 94.30$. At the same time, a negative angle means that the slope was formed under the influence of other factors, mainly sealing rollers.

4 Conclusions

Thus, with an equal speed of the tool and the speed of the conveyor chain, zero absolute speed is provided when planting of the seedlings.

The use of the proposed tool allows for strip tillage, furrow formation, planting of seedlings and their sealing in one pass. The cultivated part of the soil with a row spacing width of 60...90 cm and a strip width of 15 cm is 15... 25%, pastures between the strips are preserved 75... 85%. Planted phytomeliorative plants help to increase the yield of pastures, prevents wind and water erosion of the soil.

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