Combined tool for improving arid pastures

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Abstract. The purpose of the study is to substantiate the advantages of the combined tool developed by the authors for improving pastures. The device of a tool for improving pastures is given. The results of comparative tests of existing guns and a mock-up sample of a combined gun are presented. During field experiments, fuel consumption, unit performance, soil crumbling, hardness, humidity, and soil density were determined. The calculation of the technical and economic indicators of the tool was carried out. According to the results of tests and calculations, it was found that the combined tool surpasses the existing tools used to improve pastures in terms of the main technical and economic indicators. At the same time, the developed tool allows to increase labor productivity by 6.1 times and reduce fuel consumption by 84.7%. As a result, annual labor savings amount to 823.1 people • h, operating costs will decrease by 82.5%.

1 Introduction

Al-Bahli [1], Y. Islomov [2], I. Ergashev were engaged in research on the development of technology and technical means for improving pastures [2-5], Z. Shamsutdinov [6], F. Mamatov [7-12], B. Mirzaev [9,11], Aldoshin [12], Kh. Ravshanov [8], S. Gapparov [7] and others. However, the developed technical means do not meet modern requirements for maximum conservation of existing plants during strip tillage, energy and resource conservation, and the ability to simultaneously sow seeds of various phytomeliorative plants [4-9].

2 Materials and methods

In order to check the operability of the combined tool, comparative field studies were conducted.

For this purpose, a mock-up sample of a four-row combined gun equipped with experimental working bodies was made.

To improve the arid pastures of Uzbekistan, technical means have not been developed to date, or have not been brought to production. In this regard, comparative experimental studies

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were carried out with tools used in production: the PN-3-30 plow, the BZST-1 harrow and the SZ-3.6 seeder. Two similar plots of 50x100m (0.5 ha) were selected for experiments.

The soils of the experimental field are light low-power gray soil, with deep groundwater (more than 50 meters). Soil samples for moisture determination were taken with a special drill along the horizons 0-10, 10-20, 20-30, 30-40 cm (5 samples from each horizon).

The density of the soil was determined using a cylinder whose height was 5 cm. and the diameter is 10 cm.

Technical means were aggregated by the MTZ-80 tractor of class 1,4. 3 operations were alternately carried out on the first site: plowing, harrowing and sowing.

3 Results and discussion

The results of the obtained data on soil hardness show that the greatest soil hardness is 3.37 MPa in a layer of 20-30 cm. This indicator is 46.8% higher than in the 0-10 cm layer and by 8.01% in the 10-20 cm layer and more by 19.9% of the hardness index at a depth of 30-40 cm.

Studies have shown that the soil density of the experimental field is the highest 2.45 g/cm^3 in a layer of 20-30 cm, while in other layers it ranges from 1.38 to 2.28 g/cm^3 (Table 1). This can be explained by the fact that there is a gypsum layer in the 10-30 cm layer. In addition, overgrazing, grazing on moist soil after precipitation also leads to an increase in soil density.

Table 1. Test conditions.

№	Name of indicators	The value of indicators
1.	Microrelief	Flat with a slight slope
2.	Relief	Plain
3.	Background	The vegetation cover before processing is ephemeral-ephemeroid with an admixture of sagebrush
4.	Soil type	Light low-power gray soil, sandy loam on proluvial deposits
5.	Mechanical composition	Light gray light loam. Loose - lumpy; permeated with small plant roots.
6.	Soil moisture (%) by layers, cm 0-10 10-20 20-30 30-40	 10.50 10.55 10.43 9.88
7.	Soil hardness (MPa), by layers, cm 0-10 10-20 20-30 30-40	 1.79 3.10 3.37 2.70
8.	Soil density (g/cm^3) 0-10 10-20 20-30 30-40	 1.50 2.38 2.45 1.35

Agrotechnical and energy indicators were determined simultaneously. The results of measuring the indicators of the compared aggregates are shown in Table 2. A fragment of the work of the experimental combined tool in Figure 1 and 2.

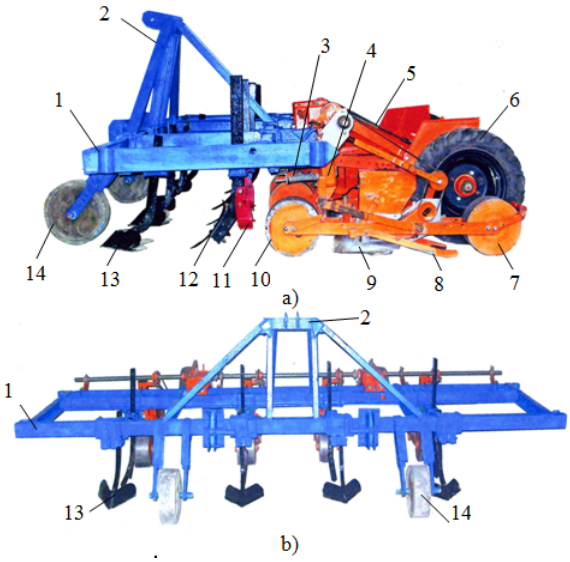
Table 2 shows that the combined aggregate is second only to the crumbling of the soil. However, according to other indicators, the combined gun is significantly superior to serial guns. So, when using a combined tool for processing and sowing 1 ha of area, 0.56 hours of time, 3.8 kg of fuel are required. When using serial guns, 3.45 hours (1.9 hours for plowing, 0.22 hours for harrowing and 1.33 hours for sowing) of time, 24.9 kg of fuel (15.6 kg for plowing, 2.7 for harrowing, 6.6 kg for sowing) are required for each hectare.

Table 2. Evaluation of the results of the compared aggregates.

Name of indicators	The value of indicators			
	PN-3-30	BZTS-1,0	SZ-3,6	Sample
Aggregated tractor	MT3-80			MT3-80
Driving speed, km/h	6.2	6.2	2.1	6.2
Depth of tillage:				
-installation, cm	30	5-10		20
-average, cm	26.2	7.5		19.1
-standard deviation	1.6	1.8		1.2
- coefficient of variation, %	6.1	24.0		6.3
Grip width:				
-installation, power	90	400	360	240-360
-average, m	91.7	390	360	360
-standard deviation, m	4.4	8.9	-	-
- coefficient of variation, %	7.8	2.3	-	-
Uncultivated area, %	0	0	0	80
Degree of soil crumbling, %	76.9	86.4	-	73.9
Surface ridges, cm	7.9	5.6		6.2
Fuel consumption, kg/ha	15.6	2.7	6.6	3.8
Productivity, ha/hour	0.53/2.5	4.6/15	0.75/3.5	1.78

The combined gun consists of a frame 1, a hitch 2, a spring 3, a grooved rack 4, a V-belt transmission 5, a support-drive wheel 6, a leveling and rolling roller 7 and 10, a closing working body 8, a coulter 9, wings 11, a ripper 12, a furrow maker 13 and a support wheel 14. With the forward movement of the gun, the furrow maker 13 cuts through the sod and turns it over with a shift to the sides, forming a groove. The following ripper 12 and wings 11 produce layer-by-layer loosening of the soil. As a result, four processed strips are formed. Leveling roller 7, (Figure 2) moving along the loosened strip, crumbles lumps and compacts the soil, thereby leveling the soil surface in the loosened strip. The coulter 10 pushes the soil apart and forms two narrow parallel grooves for seeds. Simultaneously with the spreading of the soil, the wedge-shaped seals of the coulter form the profile of the bottom of the groove and seal it in order to create an influx of moisture to the seeds of phytomeliorants from the lower layers. The seeds of phytomeliorants come from the seed box through a seeding machine, which ensures a uniform flow of seeds into the grooves formed. Incoming seeds are divided into two streams and fall to the bottom of the furrow. Closing working bodies bring down the soil from the gentle slopes of the furrow and cover the seeds that have already arrived in the furrows with soil. The soil in the strips is compacted by a rolling roller 10. The pressure of the coulter 9, rollers 10 and 7 on the soil surface is adjusted using a spring 3, depending on the condition of the soil and the speed of movement. The deepening of the coulter is adjusted using a grooved rack 4 (Figure 1).

The drive of each seeding unit of the section is carried out from the support-drive wheel 6 using V-belt gears.



a) front view, b) side view

Fig. 1. General view of the combined four-row gun.

Fig. 2. Fragment of the combined tool operation.

The calculation of economic efficiency is based on the use of indicators of comparative tests of the unit, labor and monetary costs.

Table 3. The main economic indicators in the operation of a new machine.

№	Name of indicators and unit of measurement	Designation	Indicators
1.	Saving of workers during the operation of machines, $Э_т=Э_{тгб}-Э_{тгн}$, people•h	$Э_т$	823.1
2.	Savings from capital investment $Э_к=К_{кб}-К_{кн}$, sum	$Э_к$	66435.95

3.	Annual savings from reduced costs $Э_и=И_{гб}-И_{гн}$, sum	$Э_и$	22006654.91
4.	Annual economic efficiency $Э_{гэ}=(П_{удб}-П_{удн}) \cdot W_{эн}$, sum	$Э_{г.э.}$	29173196

The calculations show that when using a combined tool, the cost of operating the machine will decrease by 82.5%.

4 Conclusions

It is established that the combined tool exceeds the existing tools used to improve pastures by the main technical and economic indicators. At the same time, the developed tool allows to increase labor productivity by 6.1 times and reduce fuel consumption by 84.7%. As a result, annual labor savings amount to 823.1 people • h, operating costs will decrease by 82.5%.

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