Combination machine for soil cultivation and sowing grain

Xo'jaxmat Maxamov[1*], *Rustam* Tovashov[2], *Bekzod* Tovashov[2] and *Farruh* Jabborov[2]

[1]Karshi State University, Karshi, Uzbekistan
[2]Karshi Engineering Economic Institute, Karshi, Uzbekistan

Abstract. The purpose of the study is to substantiate the design scheme and parameters of the working bodies of a combined machine for tillage and sowing grain on sloping lands. The authors have developed a machine that performs technological operations for tillage, grain sowing, and ridge formation to prevent water erosion. The design diagram is given. The basic principles and methods of classical mechanics, mathematical analysis, and statistics were used in this study. Theoretical and experimental studies have established that using a chisel-shaped ripper with loosening knives as a loosening working body provides high-quality loosening of the soil. When the longitudinal and transverse distances between the rippers are 62.5 and 15 cm, respectively, the longitudinal distance between the rear ripper and the housing is 60 cm, and the transverse distance between the buildings is 90 cm, high-quality soil loosening, and grain sowing are achieved with minimal energy consumption.

1 Introduction

Today, the development and application of energy-efficient, labor-intensive, and combined machines for pre-sowing tillage is a world leader [1-27]. "Globally, the area under cultivation before planting is 1.6 billion hectares. One of the important tasks is the development of energy-resource-efficient technologies and high-efficiency machines and devices. At the same time, great attention is paid to the development of combined machines for water and wind erosion tillage [28] and soil erosion tillage and sowing in one pass from the field [29].

Research is being carried out worldwide to develop resource-saving technologies for protection against wind and water erosion in the main tillage and new scientific and technical bases of technical means to implement them [29]. It is important to develop machines and justify the technological process for planting and ensure resource efficiency in the interaction of working parts with the soil [29]. For this reason, it is necessary to develop machines equipped with working bodies that form ridges at the bottom of the slope and on the field surface, which protect sloping soils from water erosion [30].

Analysis of the literature shows that in Uzbekistan, it is necessary to develop

*Corresponding author: rmaxamov@mail.ru

technology and special tools for tillage without tillage [31] unexplored. Therefore, it is important to conduct experimental research on the substantiation of the design parameters of the combined machine for tillage and tillage without tillage on sloping soils.
The purpose of the study is to substantiate the design scheme and parameters of the working bodies of a combined machine for tillage and sowing grain on sloping lands.

2 Methods

The object of the study was a combined machine for anti-erosion treatment and planting on sloping lands.
Based on the theoretical research results [31-33], an experimental copy of the combined machine was prepared, the main parameters of which are given in Table 1.

Experimental research was conducted in the fields of Meylisay lalmi farm and Kashkadarya region and the Scientific Research Institute of Agricultural Mechanization. In the experimental studies, the longitudinal distance between the working bodies of the combined machine and the speed of the aggregate movement were studied and the effect of soil compaction quality, tillage depth, formed ridge height, and machine traction resistance.

Quality of soil compaction and depth of cultivation TSt 63.04: 2001 "Testing of agricultural machinery. Machines and tools for surface treatment of the soil. The program and methods of testing. In this case, the depth of processing was determined by immersing a line with a cross-sectional area of 1 cm^2 (1x1 cm) to the bottom of the treated layer. Measurements were made with an accuracy of 0.1 cm. At both speeds, 50 measurements were made in four repetitions.

Samples were taken at a depth of 0.25 m^2 in five repetitions to determine the crushing quality of the softened layer soil. The obtained samples were passed through sieves with holes diameter of 50, 25, and 10 mm. The mass of soil and lumps remaining in each sieve and passed through the last sieve was weighed on a LIBOR EL-600 scale, and the amount (in percent) of fractions larger than 50 mm, smaller than 50-25, 25-10, and 10 mm was determined. When sifting the soil, a transition procedure was applied from a sieve with large holes to a sieve with small holes. The measurement accuracy was 10 g by fractions.

Table 1. Basic parameters of the combined machine

№	Parameter	Working bodies
1	Coverage width of the combined machine, m	3.6
2	Number of machine softeners, pcs: previous next	 11 12
3	Type of hump generator	корпус
4	Number of machine housings, pcs	4
5	Longitudinal distance between machine softeners, m	0.35-0.75
6	Transverse distance between machine softeners, m	0.15
7	Longitudinal distance between the machine body and the outlet softener, m	0.4-0.7
8	Transverse distance between machine bodies, m	0.9

The tensile resistance of the combined machine was determined by "Testing of agricultural machinery. Energy assessment methods" installing the tensometric fingers on the laboratory-field copy according to Tst 63.03.2001.

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3 Results and Discussion

As a result of the analysis of the research work, there are [31-33] avalanches of scientific research conducted, and [34] of them have a machine for processing and planting in the land, and a new technology for processing and planting, and a combination was developed that carried out it. A distinctive feature of this technology is that when preparing the soil for planting, it is subjected to non-destructive processing and, at the same time, sowing seeds and forming a mower.

To substantiate the design scheme of the combined machine implementing the above technology and the types of working bodies, the aggregates for tillage developed by researchers and the design of the combined machines for soil preparation and sowing were sufficiently analyzed. As a result, a structural scheme of a combined machine that implements the technology of tillage and planting on sloping lands was developed (Fig.1). It consists of a frame 1 equipped with a suspension device, a softener 2 attached to the frame, softener blades 3, a bunker 4, a seed drill 5, support and drive transmission wheels 6, and a channel opener 7.

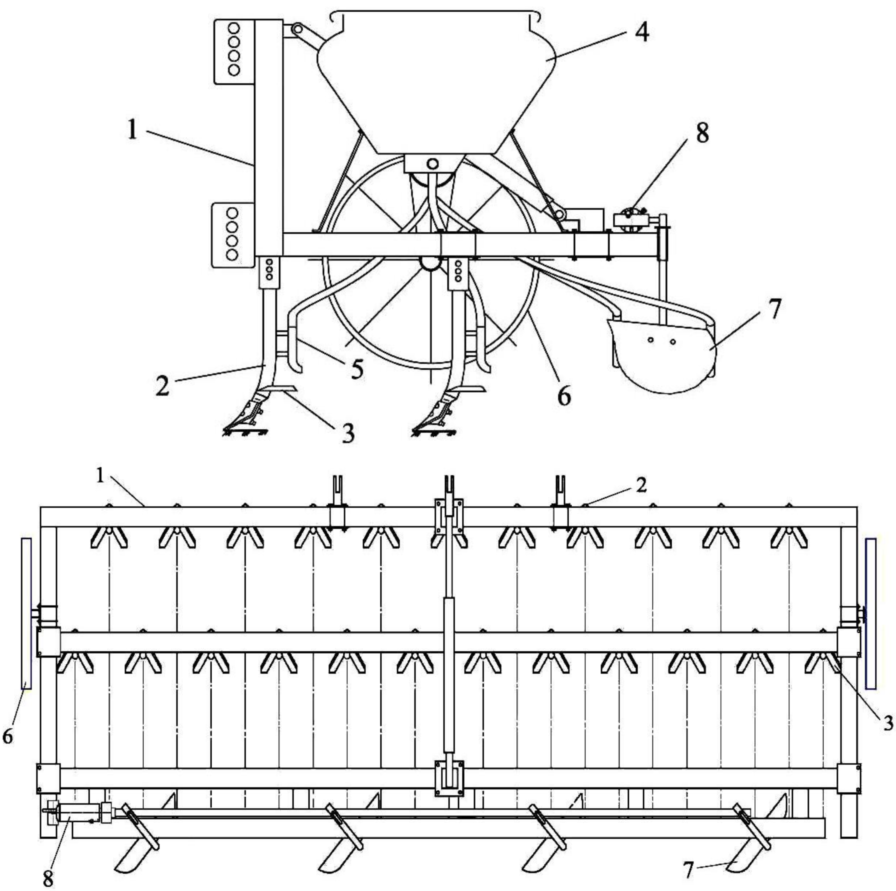

Fig. 1. Design scheme of the combined machine: 1 is frame; 2 is softener; 3 are softener blades; 4 is bunker; 5 is seed drill; 6 is base wheel; 7 is corpus

The total coverage width of the combined machine is 3.6 m, forming four rows of ridges with a row spacing of 90 cm. The machine forms three buds in one pass, sowing seeds in

rows with a row spacing of 15 cm.
The working bodies of the combined machine include softeners and housings. The machine determined their parameters based on the specifics of the work process.
To determine the longitudinal distance between the machine softeners (Figure 2), we use the following expression:

$$L_i \geq l_0 + l_1 + l_m = l_0 + a_i tg(\alpha_i + \varphi) + l_t \quad (1)$$

where l_0 is the distance from the scanner to the softener handle, l_t is the width of the softener handle.
(1) We find that the longitudinal distance between the softeners casting the values $l_0 = 16.7$ cm, $l_t = 10$ sm $\varphi = 25°$ [34], $\alpha_i = 30°$, known to the expression, must be at least L_i=62.45 cm.

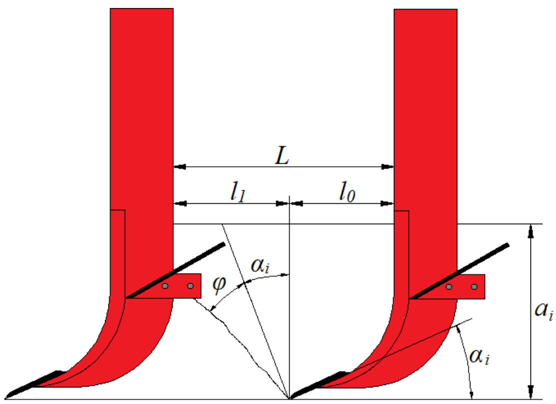

Fig. 2. Longitudinal distance between machine softeners identification scheme

The longitudinal distance between the machine softeners is determined by its effect on the performance of the machine. The processing depth of the machine softeners was set at 25 cm and that of the housings at 15 cm. The longitudinal distance between the machine softeners was changed from 35 cm to 75 cm at 10 cm intervals.

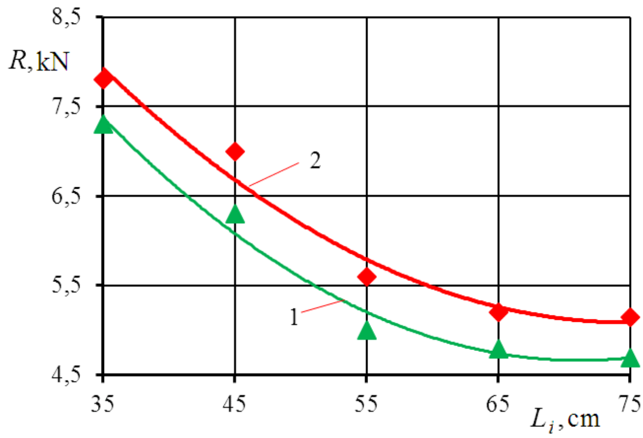

Fig. 3. The resistance of the softeners to gravity varies depending on the longitudinal distance between them: 1, 2 – when the speed of movement of the unit is 6 and 8 km/h, respectively

According to Figure 3, an increase in the longitudinal distance between the softeners from 35 cm to 65 cm at both speeds of the combined machine reduces the gravitational resistance according to the law of the sunken parabola, while an increase from 65 cm to 75 cm almost does not change this figure. At the same time, the increase in the longitudinal distance between the softeners from 35 cm to 75 cm led to a decrease in the degree of soil compaction.

The longitudinal distance between the body and the next softener is calculated to determine the effect on the performance of the machine. The longitudinal distance between the softeners was L_i=62.5 cm, the transverse distance between the softeners was L_i=15 cm, the transverse distance between the bodies was L_k=90 cm, and unit speed 6 and 8 km/h., the working depth of the machine softeners was set at 25 cm, and that of the housings at 15 cm. The longitudinal distance between the machine body and the next softener was changed from 40 cm to 70 cm at a distance of 10 cm.

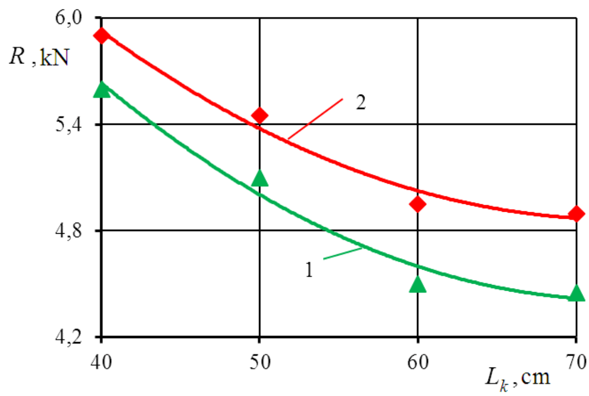

Fig. 4. The resistance of the working bodies to gravity varies depending on the longitudinal distance between the housing and the outlet softener: 1, 2 are when the unit speed is 6 and 8 km/h, respectively

From Figure 4, it can be seen that at both speeds of the machine, the increase in the longitudinal distance between the housing and the rear softener from 40 cm to 70 cm decreases the gravitational resistance according to the law of the sunken parabola. An increase in the longitudinal distance between the body and the subsequent softener from 40 cm to 70 cm resulted in a decrease in the degree of soil compaction.

4 Conclusions

1. The analysis of the design features of existing machines and tools used to prepare the soil for sowing grain on sloping lands provided the possibility of developing the tool's design, which allows you to prepare the soil for sowing, sowing, and the formation of water-retaining ridges.
2. A chisel-shaped ripper with loosening knives as a loosening working body ensures high-quality loosening of the soil.
3. It is established that at the longitudinal and transverse distances between the rippers, respectively, 62.5 and 15 cm, the longitudinal distance between the rear ripper and the body 60 cm, the transverse distance between the bodies 90 cm, high-quality loosening of the soil and sowing of grain with minimal energy consumption is achieved.

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