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F. Mamatov, X. Maxamov, R. Tovashov, et al.

Machine for Cultivation and Sowing of Cereal Seeds on Sloping Fields

F. Mamatov[1], X. Maxamov[2, a)], R. Tovashov[1] and B. Qurbonov[2]

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

[a)] Corresponding author: rmaxamov@mail.ru

Abstract. Conventional tillage and seeding technologies and machines contribute to water erosion in sloping fields. The study aims to develop the technology of simultaneous cultivation and sowing of seeds on sloping fields and the machine for its implementation. The studies applied the laws and rules of theoretical mechanics, mathematical statistics, mathematical planning of experiments and methods of strain gauging, as well as the methods given in the existing regulatory documents. To protect the soil and sowing on sloping fields, a new technology for tillage and sowing is proposed and a machine for its implementation. Coulters in the developed machine are located relative to the toe of ripper working tools on three levels. Furrow formers are installed along the line of third level coulters, at those coulters of the upper level are installed with alternation on rippers of the first and second row to the right from the symmetry line of furrow formers, coulters of the third lower level are installed on rippers located in front of furrow formers, and coulters of the second level with alternation on other rippers between neighboring furrow formers. The furrow former is made in the form of a hemispherical disc. A machine for tillage and sowing of cereal seeds was designed and manufactured, and its economic tests were conducted. According to the research results, the machine for tillage and sowing on sloping fields reliably performs the specified technological process, and by its characteristics, fully meets the requirements of agronomic equipment and technical specifications. The calculations showed that the use of the developed machine helps to reduce operating costs by 32.82% when processing and sowing seeds on sloping fields.

INTRODUCTION

The problem of soil protection from erosion is relevant for many countries with the arid climate of the world, including the territory of Uzbekistan. The eroded lands in Uzbekistan area is 1772.3 thousand hectares or 40% of the total arable land area. Of these, 721.900 hectares were subjected to irrigation erosion, about 50.000 hectares to cliff erosion, 746.000 hectares to dry surface erosion and 300.000 hectares to wind erosion [1].

Research is being conducted worldwide to develop new scientific and technical solutions for anti-erosion resource-saving technologies and equipment to prepare the soil for sowing before sowing [2-11]. In particular, in addition to tillage, work may be carried out on the creation, development, justification of technological processes and parameters of seeders and their working parts. A.Nesmiyan, V.Kurdyumov [15] on the development and application of methods and machines for sowing cereals, the study of their characteristics and justification of their parameters, processes are occurring in the soil under the influence of working bodies P.Burchenko [13], C.Meresky [14, 15], A.Vagin [16], I.Panov [18], G.Plyushev [19], G.Sineokov [21], F.Mamatov [24-27], and erosion soils on slopes B.Mirzaev [24-27], A.Zhilyakov [29], etc on the creation of processing and planting technologies and technical means for their implementation, the justification of the technological processes under study.

The study aims to develop the technology of simultaneous cultivation and sowing of seeds on sloping fields and the machine for its implementation.

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METHODS

The studies applied the laws and rules of theoretical mechanics, mathematical statistics, mathematical planning of experiments and methods of strain gauging, as well as the methods given in the existing regulatory documents.

The proposed technology simultaneously performs the following processes (Figure 1): deep tillage without tillage, loosening the topsoil and weed killing, planting grain at three different depths, anti-erosion trenches and burying the grain thrown on the surface of the field with the resulting soil to open the trenches, forming ridges.

The proposed technology is carried out as follows. Initially, loosening the soil to a depth of a with inter-tracking equal to $2b_p$, where b_p - the width of the inter-row crops, while loosening the soil, sowing seeds 1 on the soil surface to the left of the formed furrows and sowing seeds 2 second level at a depth of a_2=6-8 cm between the formed furrows 4, then carry out loosening between loosened strips, Simultaneously with loosening made sowing seeds on the soil surface of the second row to the left of the formed furrows, the second level between the seed rows of the second level and the sowing of seeds 3 third level at the bottom of the cultivated soil in the line forming furrows 4, then formed anti-erosion furrows 4, cover them with soil seeds 1 sown into the field surface and forming over them ridges 5.

During tillage, ridges with a height h are formed at the bottom of the soil. All this contributes to the protection of crops from erosion processes, ensures the prevention of water erosion processes on sloping fields and increases yields.

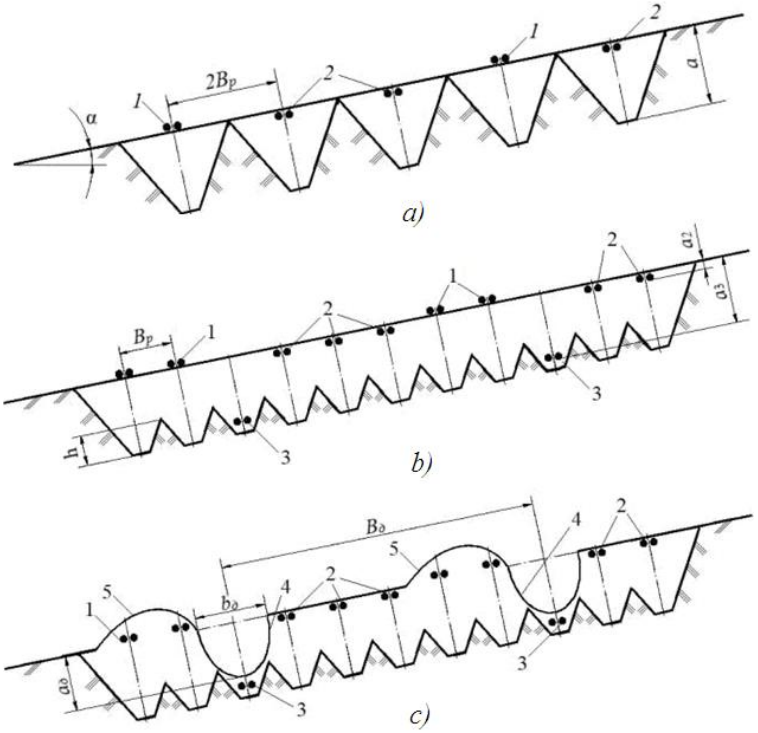

FIGURE 1. Scheme of technology for sowing areas and forming hills from water erosion with tillage: *a* is the appearance of the cross-section of the field after treatment with the first row of softening claws; *b* is the appearance of the cross-section of the field after treatment with the second row of softening claws; *c* is the appearance of the cross-section of the field after the formation of ditches and ridges with ridges

In addition to the treatment of the proposed gentle fields, a design scheme of the machine was developed to implement the technology of sowing cereals and forming hills from water erosion.

The machine (Figure 2) is equipped with plasticizers first row 4 and 6, the upper, middle, equipped with a frame 1, tank 2, planting 3, plow 5 and 7 at high and medium height relative to the plow blade and a second row of softening feet 8, 10 and 9, with sockets 5, 7 and 11, located at a lower height, and the belt 12. Workers of the first and second rows are arranged in staggered order.

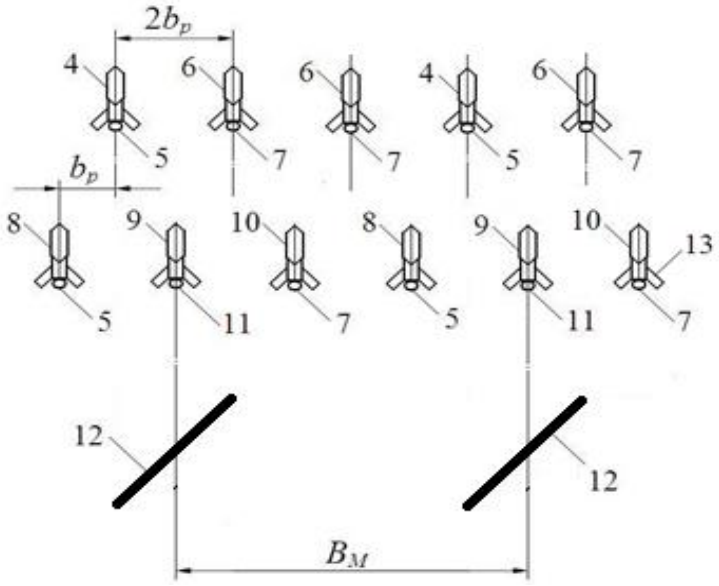

FIGURE 2. Diagram of the relative positioning of the machine tools: 4, 6, 8, 9, 10 are softening tines; 5, 7, 11 are coulters; 12 are combs; 13 are knives

The softening blades have 4, 6, 8, 9 and 10, and are equipped with 13 softening blades (Figure 2). The distance between the traces of the softening feet is equal to the distance between the rows of grains b_p. The hub generators are made in the form of 12 semi-planar discs, mounted on the symmetry axis of the softening bodies 9, equipped with lower sockets 11. Lower ridge blade 12 must be set to a depth a3, i.e. $h \geq a_3$, relative to the low-lying plough. Otherwise, the cultivator will shear the soil over the 12 sown seeds and reduce the planting depth.

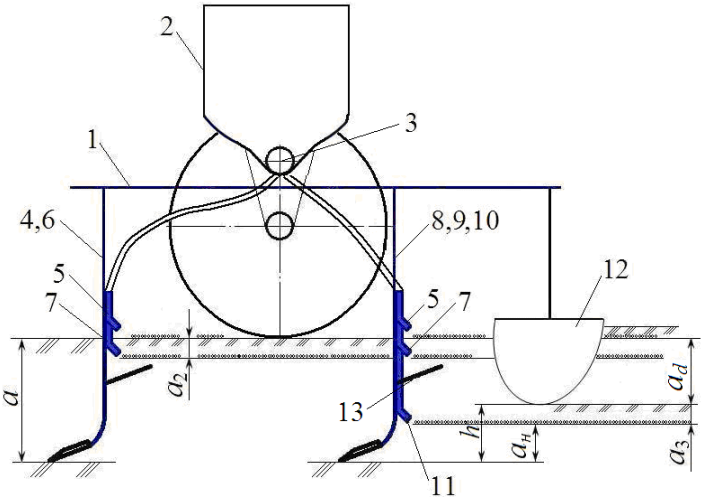

FIGURE 3. Constructive scheme of tillage and sowing of grain crops:
1 is frame; 2 is tank; 3 are seeders; 4, 6, 8, 9, 10 are softening tines; 5, 7, 11 are coulters; 12 are combs; 13 is knife

In the second softener row in front of the softener blade relative to the softener clamp axis, in the second softener clamp row relative to the symmetry axis of the top layer of softener clamps, in the middle softener clamp row Softeners in the middle are installed on the claws alternately.

The ridge is designed as a passive semi-planar disc. This reduces the ejection range of the soil particles, resulting in the desired ridge level. The cross-sections of the ridges cut through the elliptical soil blades and turn them sideways. In this case, firstly, a ridge is formed from water erosion, and secondly, the soil is poured on the seeds

sown on the field's surface. That is, they are buried. Forming ditches and ridges on the sown field protects the crops on sloping fields from water erosion.

Machine for tillage and sowing on sloping fields works as follows. At first, softening bodies 4 and 6, located at a distance of $2b_p$ in the transverse plane to each other in the first row, soften the soil to a depth a, and blades installed in them kill weeds and soften the top layer of soil to the required depth (Figure 3). Simultaneously with softening, the seeds are thrown to the field's surface in the left part of the ditch formed by high-reliability pots 5 and 7 on the first row of working tools and pots set on the middle height within the formed ditches a_2=6-8 cm. The seeds are sown at depth. Gaps between the first softening tines and softening tines are then softened by softening tines 8, 9 and 10 in the second row and blades installed on them.

In this case, the second row on the left side of the ditch formed plinths average height of 5, and a_2 = 6-8 cm deep between the rows of seedlings on the right side, along the middle line of the ditch, formed low-height pits. Seed is sown into the given soil. The cross-section of the hump cut the elliptical stem, and to the left throws the planted pod on the surface of the field and forms a hump. This will create ditches and gutters to prevent water erosion. The first and second row softening tines will create high pits in the bottom of the plow. Ridges on the bottom of the plow and the field's surface protect the crop from water erosion on slopes.

RESULTS AND DISCUSSION

Based on theoretical and experimental studies, a machine for tillage and sowing of sloping cropland (conditional model KPM-3.6-ZT) was developed, its prototype was manufactured and used in farms of Kamashi and Karshi districts of the Kashkadarya region, field and farmer trials were conducted.

FIGURE 4. Working process of the unit with a YUMZ-6AL tractor

The following machine parameters for tillage and seeding on sloping fields were determined during one pass: speed, tillage depth, cover width, soil compaction quality, hump width and height, labor productivity, fuel consumption.

The specified quality indicators of the machine TST 63.02: 2001 "Agricultural Machinery. Machines and weapons for deep processing of mail. Programs and methods of testing" and Tst 63.03: 2001 "Agricultural technical equipment rigs. Method of energy autumn".

Tests of the experimental machine were carried out on the fields of the Kamashi district of the Republic of Uzbekistan, intended for sowing cereals.

During the tests, the machine was coupled with MTZ-80 (YUMZ-6AL) tractor.

Soil type is typical light gray soil. Stiffness and moisture content of horizons 0-10, 10-20, 20-30, 30-40 cm are 2.15; 2.88; 3.30; 3.90 MPa and 15.8; 16.9; 17.3; 17.1%. The propensity field is 80.

In the tests, the embedment depth was set at 25 cm, but the average was 24.5 cm in practice. On average, fractions smaller than 25 mm were 81.53%. The width of the top of the ditch was 22.8 cm, the depth of the ditch was 13.4 cm, and the height of the ridges was 10.4 cm (Figure 4).

TABLE 1. Machine testing results

№	Indicator name	According to agrotechnical requirements	Based on the test results
1	Operating Speed , km/h	6 - 8	7.15
2	Sowing depth (softeners), cm: $M_{mid.}$		
	±σ	22 - 25 cm	24.5
	v; %	±2	1.8
		<10	6.2
3	The amount of the following size fractions in the soil in the plot treated with softening claws, %		
	< 50 mm	< 10	9.3
	50-25 mm	-	9.17
	> 25 mm	> 80	81.53
4	Seed depth, cm	7-8	7.6
5	Depth of the excavation, cm	-	11.2
6	Width of hump, cm	-	24.8
7	Hump height, cm	-	10.4
8	Fuel consumption, kg/ha	-	20.7
9	Machine capacity, ha/h	-	2.51

According to the test results, the performance of the machine fully meets the agrotechnical requirements for tillage.

CONCLUSIONS

The machine for tillage and sowing of sloping fields developed based on research reliably performs the specified technological process. By its characteristics, it fully meets the requirements of agricultural engineering and technical specifications.

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