Disc rotary plough for agriculture mechanization

Shuxrat Ishmuradov*, and *Ramzjon* Hamroev

Tashkent State Technical University, Tashkent, Uzbekistan

Abstract. This article presents the design of a disc rotary plough and the results of tests conducted on the MTZ-82 tractor. The driven unit does not divide the field into planks, but moves in a shuttle way and performs smooth ploughing without formation of furrows and ridges. For this purpose, the main diagonal plough frame is rotated around a pivot by means of a pivot mechanism, i.e. a hydraulic cylinder, and is brought into working position by turning the soil plates to the right and left. While setting the diagonal plough frame to the right or left side in operation, the posts hinged to the frame are rotated around their axis by means of a pivoting mechanism and a rod, ensuring that the angle of the working disc is maintained and is in a convenient position in relation to the direction of travel. At the same time, the plough's support wheel is rotated by 180° and is moved to the desired position by means of a link.

1 Introduction

In recent years, disc ploughs, i.e. disc-shaped ploughs, have been widely used worldwide for ploughing fields. Due to the fact that in addition to the forward movement of the working tools, the disc ploughs have less traction resistance than inclined ploughs and work without getting stuck in weeds and crop residues. In addition, disc ploughs are simpler in design than rotary ploughs, require less repair and maintenance, as cutting blades wear less and are constantly self-sharpening (due to rotation), and due to their length (compared to plough blades) discs last several times longer than ploughshares [1].

Based on the above, a disc plough turning the cultivated land both to the right and to the left has been developed and tested for cultivation of cereals, repeat and other crops in the fields of the experimental site of the Research Institute of Mechanisation and Electrification of Agriculture [2].

The construction scheme of disc rotary plough is shown in Figure 1.

suspensions of disc rotary plough 1, main diagonal frame 2, disc working tools 3, support disc 4, hydraulic cylinder 5, working tool columns 6, joint 7, support disc links 8, rotary mechanism frame 9, adjustment mechanism support disc 10 and disc working tool columns 11 [3,4].

The drive unit does not divide the field into planks, but moves in a shuttle manner and performs even ploughing without the formation of furrows and ridges. For this purpose, the main diagonal plough frame 2 is rotated around the pivot 7 by means of a pivot mechanism, i.e. hydraulic cylinder 5, and is brought into working position by turning the soil plates to the

* Corresponding author: hamroyevr@mail.ru

right and left. In the process of setting the diagonal plough frame to the right or left side in work, the struts hinged to the frame are rotated around their axis by means of pivot mechanism 9 and link 6, and the angle of disc setting the working bodies should be in a suitable position in relation to the direction of movement. At the same time, the plough support wheel is rotated by 180^0 and moved to the required position by means of link 8 [5,6].

2 Materials and methods

Thus, each time when reaching the beginning and end of the ploughed field, the plough's working bodies are set in the tipping position to the right or left, and the tractor is turned around and lowered again next to the ploughed field, and as a result, the land is ploughed evenly without ridges and irregularities. The smooth running of the plough is ensured by a support disc mounted on its rear side.

The plough is coupled with tractors of 1.4-2.0 class.

The working width of the plough is 120 cm.

The working width of the implement is 30 cm.

The plough is equipped with discs (working elements) with a spherical surface with a diameter of 650 mm and a radius of curvature of 700 mm.

The angle of installation of the working tools in relation to the direction of travel is to be adjusted within 35-45º (with an interval of 5º), and the angle of installation in relation to the vertical - within 15-25º (with an interval of 5º).

The longitudinal distance between the implements is 70 sm.

Vertical distance from the support plane of the working tools to the bottom surface of the frame - 700 mm.

The support disc adjusts the depth of immersion of the implements in the ground within the range of 20-30 cm without a stop.

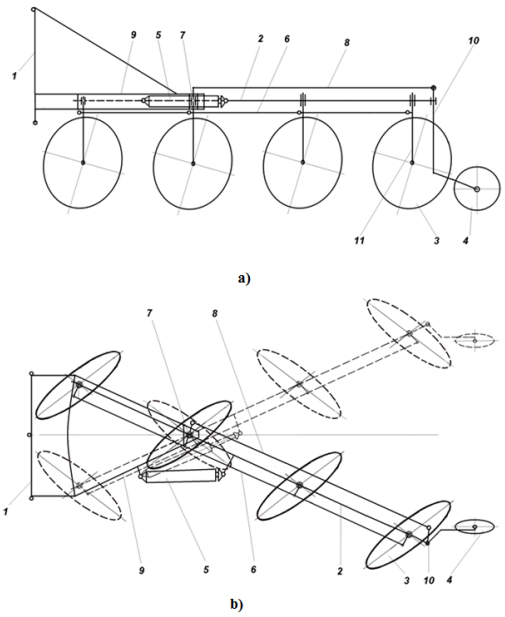

Fig 1. Design diagram of disc rotary plough: a, b- side and top views, respectively; 1 - suspension device; 2 - main diagonal frame; 3 - disc working bodies; 4 - support disc; 5 - hydraulic cylinder; 6 - rod connecting the columns; 7 - hinge; 8 - support disc rod; 9 - rotary mechanism frame; 10 - support disc adjustment mechanism; 11 - column disc working bodies.

The technical characteristics of the disc rotary plough are given in Table 1 below.

Table 1. Technical description disc rotary plough.

Name of indicator	Indicator value
1. type.	Suspended
2. Class of tractor used	1.4-2.0
3. Number of enclosures, pcs.	4
4. Working speed, km/h	6-9
5. Working width, m:	
hulls	0.3
plough	1.2
6. Working depth, cm	25-27
7. Weight, kg	583
8. Angles of installation of the working elements, grad:	
relative to the direction of travel	adjustable 35-45 º
versus vertical	adjustable 15-25 º
9. Distance between working elements, cm:	
transverse	30
longitudinal	70
10. External dimensions, mm:	
length	2240
height	1210
width	1200
11. Productivity in basic working time per hec./h	0.72-1.08

3 Results and discussion

Tests were conducted on the field of the experimental plot of the institute, freed from winter wheat.

At the tests of disc rotary plough was aggregated with tractor MTZ-82 and Ozdst 3355: 2018 agricultural machinery tests. Machines and implements for deep tillage. Programme and test methods [7] its following indicators were determined:

- speed of movement;
- working width and working depth;
- the quality of soil destruction;
- completeness and depth of burial of plant residues;
- heights of irregularities formed on the surface and bottom of the plough were determined.

A description of the field on which the tests were carried out is given in Table 2 below.

Table 2. Description of the field on which the tests were carried out.

Name	indicator value
1. Soil moisture in layers (cm), %:	
0-10	7.3
10-20	10.9
20-30	14.2
2. soil hardness by layers (cm), MPa:	
0-10	2.03
10-20	2.79
20-30	3.27

3. Depth of irrigation troughs, cm: M_m $\pm\sigma$	 15.4 2.3
4. Plant residues per 1 m^2 surface, kg	0.670
5. Anguise height, cm: M_m $\pm\sigma$	 21.2 3.8

The results of the tests are shown in Table 3 below and in Figures 2. The position of the disc rotary plough is shifted to the right and left when working in the field**.**

Table 3. Test results disc rotary plough.

№	Name	indicator value	
		of the right tipping performance	**when working with tipping to the left**
1.	Travelling speed, km/h	7,3	7,8
2.	Working width, cm: M_{op} $\pm\sigma$	 121,2 2,74	 119,4 2,36
3.	Ploughing depth, cm: M_{op} $\pm\sigma$	 26,7 1,87	 27,4 2,04
4.	Number of fractions of the following sizes, %: >100 100-50 <50	 7,0,0 10,7,7 82,3,3	 3,8,8 11,5,5 84,7,7
5.	Burying plant residues: completeness, % depth, cm	 93,6,6 13,7,7	 92,8,8 12,8,8
6.	Height of irregularities formed on the ploughing surface, cm	5,6,6	4,7,7
7	Height of irregularities formed on the plough bed,cm	3,8,8	4,2,2

a)

b)

a, b - to the right and left of the plug, respectively working position with flip to the side

Fig. 2. Workflow of the disc rotary plough.

4 Conclusion

The results of the conducted tests are shown in Table 3 above, and Figure 2 shows the position of the disc swivel plough when working in the field with the transition to the right and left positions. The disc swivel plough reliably and completely fulfilled the technological process established in the tests, its performance characteristics were almost identical when working with the mass tipping to the right and left. Thus, each time the beginning and end of the ploughed field is reached, the plough's working bodies are set in the tipping position to the right or left, and the tractor is turned and lowered again next to the ploughed field, and as a result, the land is ploughed evenly, without ridges or irregularities. The smooth running of the plough is ensured by a support disc mounted on its rear side.

The association with the use of disc ploughs leads to inefficient use of farmland due to soil damage. Due to the uneven movement of the working organs, disc ploughs provide less turning response compared to cone ploughs. In addition, these ploughs require less repair and maintenance. This, in turn, contributes to increased economic efficiency. The conducted research confirms that the disc plough meets the established requirements and ensures that the performance indicators are met. These ploughs contribute to increased yields and soil conservation due to less loosening of the soil.

References

1. A. Tukhtakuziyev et al., IOP Conf. Ser.: Earth Environ. Sci. **868** 012058 (2021)
2. Kh. Ishmuratov et al., J. Phys.: Conf. Ser. **2176** 012096 (2022)
3. Sobir N. Norov et al., J. Phys.: Conf. Ser. **1515** 042016 (2020)
4. Sh.A. Sultanova et al., J. Phys.: Conf. Ser. **2176** 012007 (2022)
5. Dj.E. Saparov, S.A. Sultonova, E.C. Guven, D.I. Samandarov, A.M. Rakhimov, E3S Web of Conferences **461** 01057 (2023)
6. Sh.U. Zulponov, D.I. Samandarov, Sh.A. Sultanova, J.E. Safarov, E3S Web of Conferences **401** 05061 (2023)
7. Sobir Norov et al., E3S Web of Conferences **390** 01031 (2023)