Front-mounted plow for smooth, non-furrow plowing with offsets

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Abstract. The purpose of the study was the development of a front plow with angle clamps, which performs, smooth plowing. The authors have developed an improved front plow with angle clamps. The constructive scheme of the plow has been given. The basic principles and methods of classical mechanics, mathematical analysis and statistics were used in this study. Experimental studies have justified the processing depth within the limits of 10-12. 5 cm and the width of the capture of the angle is within the range of 7.5-10 cm. Economic tests have established that the developed front plow reliably performs the specified technological process and its performance indicators meet agrotechnical requirements. The use of a frontal plow for smooth, plowing provides a reduction in direct costs for processing 1 hectare of area compared to the technical means used by 26.8 %.

1 Introduction

Today, energy and resource-efficient flat plowing technology is one of the most efficient, modern and promising technologies. According to the tillage method, flat tillage plows are divided into traditional rotary tillage plows and frontal tillage tillers that turn the tillage to 180° degrees [1-8].

In the traditional method of flat plowing, the angle cutter cuts the upper part of the soil plow and throws it to the bottom of the furrow. As a result, the quality of plant remains is burying and the angle of rotation of the soil is increased. In this case, the angle cutter performs the technological process together with the plow body, ie in the direction of the trajectory of the soil plow, which rotates the main body. Corners of various shapes and constructions are widely used in the world today [18-21]. Angle cutters are aimed at performing two main functions in the process of technological work, ensuring the quality of good burial of plant debris and reducing the unevenness of the plowed field surface [9-11].

Research on the use of different types of angle cutters installed on traditional plows, the study of their performance and the justification and improvement of their parameters V.A.

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When machined with frontal plugs, its housings are symmetrical to each other, so their edges mutually touch and compress as the blades rotate 180° at the edge of their blades. This allows the soil to accumulate in front of the housings and cause them to become clogged. It is known that clogging the soil in front of the hull requires excessive energy consumption [1-8; 12-17]. To overcome this shortcoming, it is advisable to install a corner cutter on the front plugs.

In this technology, the left and right upper edges of the sledge hammer are first cut with an angle cutter and rolled in the middle, and then the sledge hammer is rolled 180° at the boundary of its owner. The angled plow overturns without any obstacles, improves the quality of plowing and reduces traction [29-30].

2 Methods

The authors have developed a design scheme of a front plow with angle brackets (Fig. 1). The front plow consists of a frame 1, right-and left-turning housings 2 and 3 with working surfaces oppositely located to each other, ploughshares 4, a support-leveling roller 5, disc knives 6, two support wheels 7, angle brackets 8 and a mounted device 9.

During the operation of the frontal plug, the left and right upper edges of the sledge hammer are first cut with an angle cutter and rolled in the middle, and then the sledge hammer is turned 180° at the boundary of its owner. Angled plows can be rolled over without any obstacles, improving the quality of plowing and reducing traction.

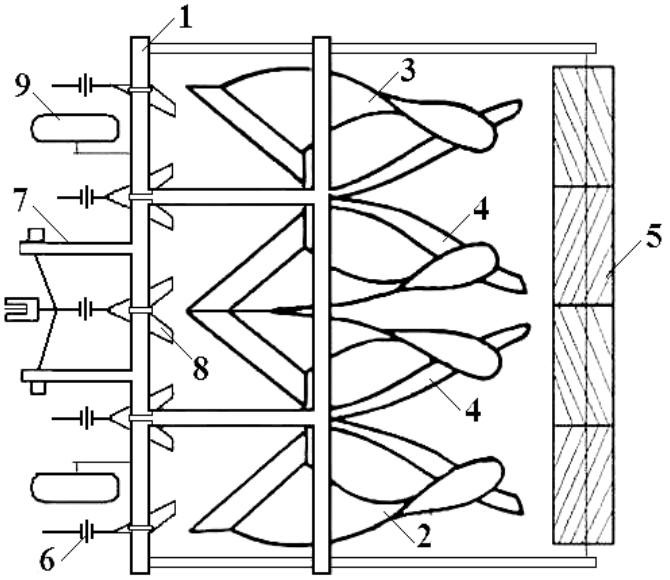

Fig.1. The design scheme of the front plow with angle brackets: 1-frame; 2 and 3-right-and left-turning bodies; 4-paddles; 5-roller; 6-disc knife; 7-support wheel; 8-angle bracket; 9-attachment device

The body consists of welded boots and a lemex attached to it, a chisel, a pole, a tipper and a wing attached to its back. A series of disc blades and support wheels are produced. The

adjustment mechanism of the front wheel support wheels allows you to change the depth of plowing in the range of 22-30 cm.

The main parameters of the developed angle grinder include: height 22 cm; length 27 cm; the angle of entry into the ground for the angle cutter is 50°; wing opening angle 32°; torsion angle 55°; the angle of inclination of the side edge is 36°; the angle of inclination of the working edge relative to the horizontal plane is 31°; processing depth 12 cm; coverage width 10 cm.

The experiments examined the effect of the angle of the cutting depth on the energy performance and agronomic performance of the plow. The depth of processing of the angle cutter was changed at intervals of 2.5 cm between 5, 7.5, 10, 12.5 and 15 cm. The depth of tillage was measured to the nearest 0.1 cm from the bottom of the field to the point where the lateral deformation of the soil begins.

3 Results and Discussions

Fig. 2 shows a graph of the change in the degree of soil compaction and the resistance of the plow to traction depending on the working depth of the angle cutter.

As can be seen from the graph, the gravitational resistance of the plug varies according to the law of the sunken parabola, depending on the depth of processing, that is, it decreases in the range of 10-12.5 cm. This is due to the fact that at a depth of 10-12.5 cm, the plowshares are cut at an angle without touching each other, and are completely rotated within the boundaries of their position, so the resistance of the plug to gravity is low. When the cutting depth of the soil plow angle is more than 12.5 cm, it is difficult to move the soil along the surface of the plow working in the closed zone, and as a result of its accumulation in front of it, the gravity of the plow increases.

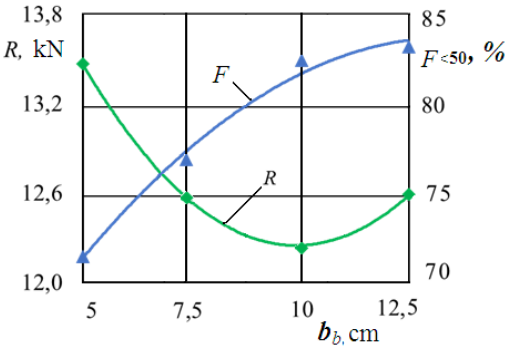

Fig.2. Graph of change of plow resistance (R) and level of soil compaction (F) depending on the working depth (a_b) of the angle cutter

When the tillage depth was 10-12.5 cm, the degree of soil compaction increased, ie the amount of fractions smaller than 5 cm increased. This figure did not change significantly at a depth of 12.5-15 cm. Simultaneous cutting and crushing of the top two corners of the soil layer, as well as crushing by the overturner, increases the degree of soil erosion.

Experimental studies have examined the effect of the angle of inclination on the quality and tensile strength of the plug. To do this, the coverage width of the corner cutter was changed to 5, 7.5, 10 and 12.5 cm at 2.5 cm intervals.

Figure 3 shows a graph of the resistance of the plow to traction and the degree of soil erosion depending on the coverage width of the angle cutter.

As can be seen from the graph, the gravitational resistance of the plug varies according to the law of the concave parabola, depending on the width of the coverage, ie decreased by

7.5-10 cm, increased by 10-12.5 cm. This is due to the fact that the soil piles, which are cut at an angle of 7.5-10 cm, are completely rotated at the boundary of their position without touching each other, which reduces the resistance to pulling the plug. When the width exceeds 10 cm, the drag resistance of the plug also increases due to the increase in the drag resistance of the angle cutter. This means that the minimum traction resistance will be achieved when the coverage of the angle cutter is 10 cm.

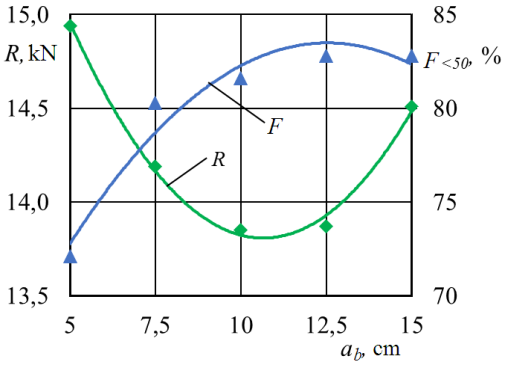

Fig.3. Graph of change of gravity resistance of the plow (R) and degree of soil compaction (F) depending on the coverage width of the angle cutter (b_b)

As the coverage width increased from 7.5 cm to 10 cm, the level of soil compaction increased steadily, and after 10 cm this figure did not change significantly. This can be explained by the fact that when the coverage of the angle cutter is in the range of 7.5-10 mm, the blade turns into its own boundary without any obstacles.
Based on the results of theoretical and experimental studies, an experimental sample of a frontal plow was made. Table 1 shows the technical characteristics of the developed plow.

Table 1. Technical characteristics of the developed plow

Name of indicators	According to agrotechnical requirements	Based on the test results
Type	-	Mounted
Aggregate tractor class	-	4-5 (Magnum, MX, T-4A)
Work speed	km/h	6.5 – 8.5
Coverage width	m	2.1
Processing depth: - corpses - angle cutters	cm	 25 12.5
Number of housings	piece	4
Housing is a type of work surface	piece	screw type
Number of angle cutters	piece	4
Dimensions of the angle cutter: - height - length - width	mm	 2200 2700 1000
Mass	kg	1200

The main parameters of the improved frontal plug include: body coverage width 52 cm; number of buildings 4; longitudinal distance between disc blade and angle cutter 16 cm; longitudinal distance between angle grinder and body 27 cm; processing depth 25 cm;

coverage width 2.1 m; operating speed 7.5 km / h (Figure 4).
These tests revealed the following characteristics of the plug: coverage width; depth of plowing; completeness and depth of burial of plant remains; degree of soil erosion.

Fig.4. Experimental model of a frontal plow with a corner-mounted plow

Field and farm tests were conducted on farms in Kashkadarya region in order to obtain the results of economic tests and determine the economic performance of the angle-cutting front plow with the recommended parameters.
Type soil is light gray soil. The hardness and moisture content of the soil along the horizons 0…10, 10…20, 20…30, 30...40 cm was 2.98; 3.95; 4.78; 4.81 MPa and 9.5; 10.8; 15.5; 13.7 %.
Quality indicators of angle cutter front plug defined by TSt 63.04:2001 "Testing of agricultural machinery. Machines and tools for surface tillage" VATST 63.02: 2001 " Tests of agricultural machinery. Machines and tools for deep tillage».
The angle-cut frontal plug developed in the tests was aggregated into a Magnum and a T-4A tractor. The tests were performed on grain-free fields (Fig. 5).

Fig.5. A fragment of the work of a front plow with a corner plow

The results for plow coverage, plowing depth, plant burial depth and depth, and soil compaction are presented in Table 1.

Table 2. Test results of the front plow

Name of indicators	Indicator value	
	According to agro-technical requirements	**Based on test results**
Speed of motion, km/hour	6.5-8.5	7.5
Capture width: M_{ave}, cm ±σ, cm *v*, %	 ±10 cm - <10	 211.2 2.9
Processing depth: M_{ave}, cm ±σ, cm *v*, %	 30 each - <10	 25.8 1.78 8.97
Degree of embedding of plant residues, %	>95	95.6
Depth of embedding of plant residues: M_{ave}, cm ±σ, cm	 >10 -	 13.3 1.8
The number of fractions of the following sizes, % >50 mm 50-25 mm <25 mm	 < 10 - > 5	 5.1 11.1 83.8
Specific fuel consumption, kg / ha	-	26.21

From this information it is clear that all the quality indicators of the angle-cut frontal plow fully meet the requirements of agrotechnics.

The angle-cut frontal plug developed in the tests performed the specified technological process completely and reliably, and no serious shortcomings were observed. The test results are in full compliance with the requirements.

Calculations show that the use of the developed angle-cut frontal plow reduces the direct (operating) costs per 1 hectare by 26.8%.

4 Conclusions

a) It is established that the processing depth of the angle pickup should be within 10-12.5 cm, and the capture width of the angle pickup should be within 7.5-10 cm.
b) It is established that the developed front plow reliably performs the specified technological process and its performance indicators meet the agrotechnical requirements.
c) The use of a front plow for smooth, rowless plowing reduces the direct cost of processing 1 hectare of area in comparison with the technical means used by 26.8 %.

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