Investigation and substantiation of the parameters of the plow body angle lift

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Abstract. Currently plowing fields from under various agricultural crops is carried out with reverse plows in Uzbekistan. Their use can dramatically reduce labor and money costs for conducting current and capital field planning. With the supply of energy-rich wheeled tractors to the Republic of Uzbekistan, one of the most effective ways to increase the productivity of plowing units at present is to increase the plow's working width by increasing the number of housings. Increasing the number of hulls on revolving ploughs, equipped with pre-ploughs, this leads to a sharp increase in the metal and energy consumption of ploughs, since the latter have a double number of working elements. Therefore, an important role is played by the optimal placement of plow bodies along the plow course and the maximum reduction of distances between them, when using angle plates on the bodies instead of traditional pre-plows. The article discusses experimental influence of the angle-lift radius of curvature, the installation height, and the installation angles in the longitudinally-vertical and transversely-vertical planes on the traction resistance of the hull and the depth of embedding of plant remains was studied by MRI.

1 Introduction

It is known that the formation turnover during plowing is used to restore the structure of the soil, deep embedding of fertilizers in the soil. Plant and crop residues, weed control, as well as for high-quality sowing, as the undeveloped plant mass creates certain obstacles to the movement of the seeder coulters and disrupts the technological process of sowing cultivated plants.

On reverse plows, wide application in our country is currently used as sealing working bodies for pre-plows or angle clamps.

The corner pick in the classic version consists of a blade, a bent post and a yoke, by means of which it is attached to the spire of the plow frame. The bottom angle of the angle pick-up blade rests on the chest of the body blade. The purpose of the angle picker is the same as that of the preplug - to separate the upper part of the formation in front of the rack and dump it to the bottom of the furrow. Providing at the same time high-quality sealing of plant residues in the arable horizon and increasing the angle of rotation of the formation.

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The principal difference between the uglosnim and the pre-plow is that the uglosnim performs the technological process of plowing together with the plow body, if the formation from the pre-plow should fall to the bottom of the furrow before it is overtaken by the formation. Cut and wrapped by the main body, that is, there is a separate independent movement of the layers, then the angular contact meets the layer when it is already on the path of rotation by the main body [1,2].

This difference, as well as the double number of working bodies on rotary plows, create the advantages of a corner plow over a pre-plow when plowing fields with general-purpose plows. These advantages are manifested primarily in reducing the metal consumption of the plow, the energy consumption of plowing, and increasing the reliability coefficient of the technological process.

In addition, in many fields, due to the strong lodging of loaves and poor-quality straw harvesting, it is almost impossible to plow with serial general-purpose plows equipped with pre-plows, as they are often clogged with plant residues. As a result of frequent stops of the plow cleaning unit, the quality of plowing significantly worsens, productivity decreases and machine operators ' fatigue increases. Therefore, machine operators often work without pre-plows, which, although it reduces the clogging of plows, significantly worsens the embedding of crop residues in the soil [3-5].

Therefore, when plowing fields from under grain crops, one of the most effective ways to eliminate the plow faces with plant residues, improve the quality and productivity of the unit, as well as reduce the metal and energy consumption of the plow is to use angle plates on the plow bodies instead of pre-plows and upper-tier buildings [6-8]. The purpose of the angle picker is the same as that of the preplug – to finish the upper part of the formation and dump it to the bottom of the furrow, while ensuring high-quality sealing of plant residues in the arable horizon by increasing the angle of rotation of the formation [9].

The main difference between the angle picker and the plow driver is that the angle picker carries out the technological process together with the plow body. It meets the formation when it is already on the trajectory of turning the body. This difference creates the advantages of the uglosnim over the pre-plow when plowing fields with general-purpose plows and the upper bodies when plowing with two-tier plows. These advantages are manifested primarily in reducing the metal consumption of the plow, the energy consumption of plowing, and increasing the reliability coefficient of the technological process [10,11].

The location of the angle picker directly on the plow body allows you to reduce the longitudinal distance between the plow bodies as much as possible, and therefore improve its load capacity. This is due to the fact that on the technological process of plowing, that is, for the independent movement of layers.

2 Methods

The influence of the radius was studied experimentally (**R**) curvature of the angle gauge (Figure 1). heights (**N** installation angles (α and β) in the longitudinally-vertical and transversely-vertical planes on the traction resistance of the body and the depth of embedding of plant residues. The depth of embedding of plant residues was determined by digging out and measuring with a measuring ruler the depth of their occurrence from the plowing surface with an accuracy of ± 0.5 sm, and to determine the traction resistance of the hull, a special strain gauge unit was used, the schematic diagram of which is shown in Figure 2.

Frames 21 of bearings 22 are rigidly attached to the frame 1. In the inner ring of bearings 22, a beam 3 is pressed, to which the rack 2 of the strain-measuring plow housing 11 is rigidly attached. The beam 3 has the ability to move in the axial direction by 15-20 mm.

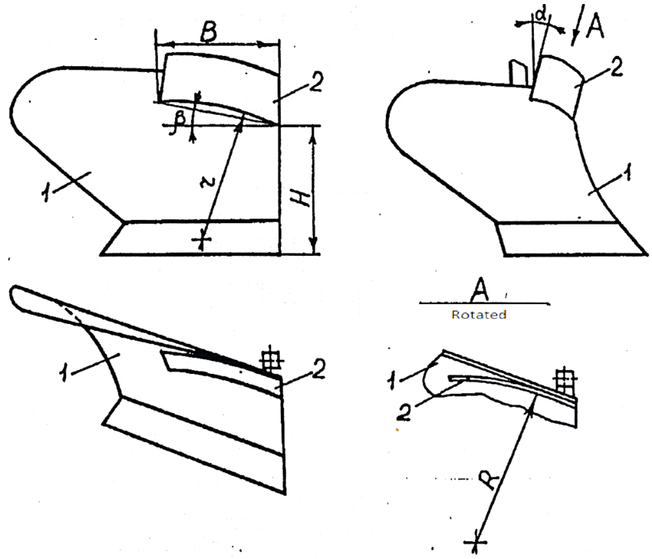

Fig. 1. Plow body equipped with angle sensor:1-housing; 2-corner image.

So that the housing does not make a rotational movement in the bearings 22 relative to the frame, it is held from this by a multi-link (19, 16, 20) lever, which is rigidly attached to the frame 1 and the rack of the housing 2, allowing the housing 11 to move only in the axial direction. This is due to the fact that the connecting rod 16 rotates in the hinges 17 and 18 only in the longitudinally vertical plane (drawing plane). The load cell 6 is rigidly attached to the frame 1 through the rack 4. The adapter 8 connects the load cell 6 to the rack 2 of the plow housing 11. The angle pick-up 10 is rigidly attached to the rack 2 of the housing 11 through an adapter 9, a beam 7 and a rack 5.The front plow housing 12 and a ski 13 are also attached to the frame 1. The rack 14 has a screw notch 24, which is necessary to change the position of the ski in the vertical direction. On the frame 1, a nut 23 serves for this purpose, the levers 15 together with the fingers 25 create a hinged strain gauge installation system.

The adapter 9 located between the angle finder 10 and the beam 7 has 3 degrees of freedom, which allows the angle finder to rotate around 3 mutually perpendicular axes.

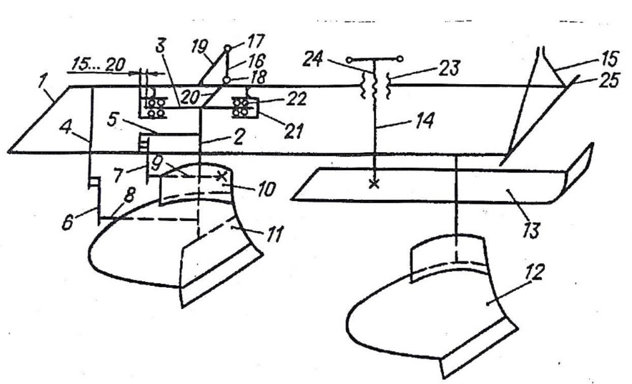

Fig. 2. Schematic diagram of the strain gauge installation.

Before and after the experiments, the load cell 6 was calibrated. At the same time, it was loaded to 14 kN every 2 hours.0± 0.05 kN.

3 Results

The results of the experiments are shown in Figure 3, 4 and 5. Analysis of the experience results shows, what about increasing the height **H** installation of the angle picker on the plow body blade depth ***h*** embedding of plant residues in the soil first decreases (by 3 sm), and then grows (by 7 sm). This is because, what if **H**=30 sm provides a drop of the soil cut by the uglosnim to the bottom of the furrow of the body.

From these experiments, it follows that with increasing height **H** angle pick-up settings on the dump from 26 to 38 sm the traction resistance of the hull with an angle sensor is reduced by 0.8 kN. This can be explained by the fact that the coal miner cuts off a smaller part of the reservoir, in addition, it does not interfere with the formation to make a revolution, i.e. it interacts less with it and has a lower energy intensity.

It is established that when V<7 km/h the angle picker does not throw the soil into an open furrow, but dumps it on the wrapped formation, which, during its rotation, captures the latter and, by inertia, throws it onto the slope of the previously fallen formation. Sealing depth **h** at the same time, it does not exceed 11 sm (Figure 4). At 7< V<9 km/h uglosnim throws the plant mass into an open furrow and therefore **H** increases. By V>9 km/h the corner picker throws plant remains on the slope of a previously dumped formation and their sealing with the hull worsens.

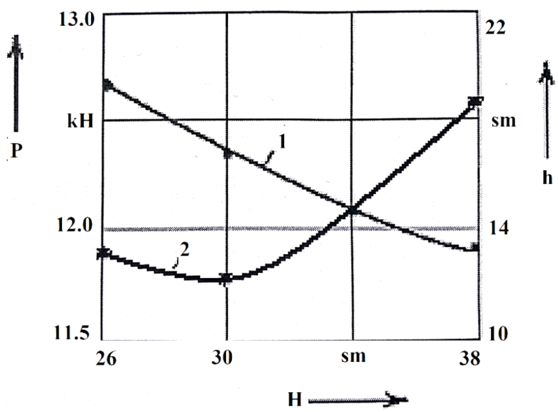

Fig. 3. Dependence of traction resistance **R** housing (1), depth of embedding of plant residues **h** (2) from height **H** installing a corner pick-up on the dump.

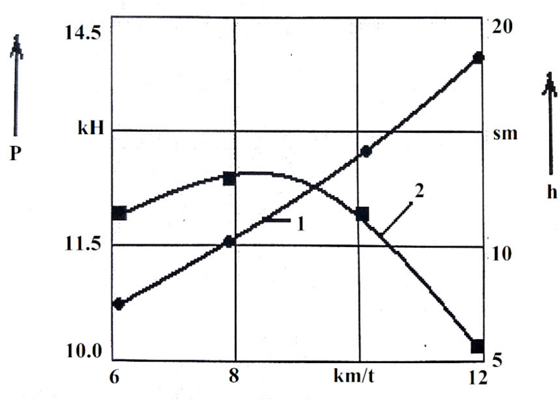

Fig. 4. Dependence of traction resistance **R** housing (1), depth of embedding of plant residues **h** (2) from speed **V** plowing operations.

Analysis of the experimental results shown in Figure 5 shows that with an increase in the angle of inclination of the angle picker to the vertical in the longitudinally vertical plane, the depth of embedding of plant remains initially increases slightly (by 5 sm), and then decreases (by 10 sm). This is explained by the fact that at $\alpha < 10^0$ the angle picker works like a regular soil-shifting plate. Moreover, the formation is cut by the blade of the angle picker along its entire length and the contact of the formation with the rear surface of the angle picker creates an additional frictional force that prevents the movement of the soil.By α=10-20^0 the angle picker begins to direct the soil towards the open furrow and therefore **h** growing. At $\alpha=30^0$ the soil from the uglosnima is thrown out on the slope of the previously dumped formation and the depth of **h** somewhat reduced.

Optimal location of the angle picker to the layer being wrapped as the angle increases **α** reduces the traction resistance of the hull with an angle gauge of 0.96 kN

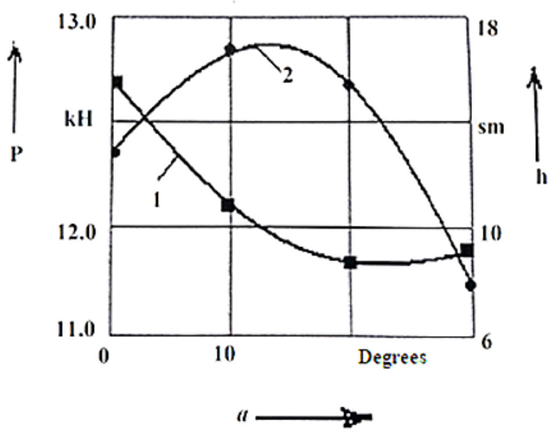

Fig. 5. Dependence of the traction resistance P of the body (1), the depth of embedding of plant residues ***h*** (2) from the angle of inclination of the angle gauge to the vertical in the longitudinally vertical plane.

Change in traction resistance **R** cases with an angle view and sealing depth ***h*** plant residues depending on the height **N** angle adjustment and speed settings **V** ploughing and cornering **α** the slope of the angle limit can be expressed by the following empirical expressions obtained by the least squares method /4/:

$$R = 17.27 - 0.25\ N + 0.0029N^2 \quad (1)$$

$$h = 92.61 - 5.39\ N + 0.00906v^2 \quad (2)$$

$$R = 8.66 + 0.205\ v + 0.01938v^2 \quad (3)$$

$$h = -26.708 - 9.764\ v - 0.5874v^2 \quad (4)$$

$$R = 12.58 - 0.062\ \alpha + 0.00132\alpha^2 \quad (5)$$

$$h = 12.10 + 0.759\ \alpha - 0.0299\alpha^2 \quad (6)$$

Verification of these expressions showed that the difference between empirical and experimental data does not exceed 3.6 %.

4 Conclusions

With an increase in the height of the angle finder installation on the plow body dump from 26 to 30, the angle finder drop distance of the cut part first increases, and if the height is more than 30 sm - decreases. Accordingly, it first decreases by (3 sm) and then grows by (7 sm) depth of embedding of plant residues in the soil. The traction resistance of the hull with the angle finder decreases by 5.6 % with an increase in the height of the angle finder installation on the dump. With an increase in the plowing speed, the range of soil removal by the angle finder increases. At speeds less than 7 and greater than 9 km/h the depth of embedding of plant residues in the soil is reduced from 13 to 11 sm and from 13 to 5 sm accordingly. At plowing speeds of 7 < V < 9 km/h the depth of embedding of plant residues is within 13 ... 15 sm. When increasing the speed from 6 to 12 km/h the traction resistance of the angle-locked housing increases by 31%. With an increase in the angle of inclination of the angle finder to the vertical in the longitudinally vertical plane, the range of discarding the cut-off part of the formation by the angle finder increases by 26 sm, and the depth of sealing when increasing the angle of inclination to 20 degree. Growing by 5 sm, and then decreases by 10 sm. To ensure high-quality embedding of plant residues in the soil with minimal energy consumption, the height of the angle picker on the dump should be about 30 sm, plowing speed within 7.... 9 km/h, the angle of inclination of the angle sensor to the vertical in the longitudinally vertical plane within 10 ... 20^0.

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