Theoretical and experimental substation of the parameters of hulls that form furrows

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Abstract. In all countries the creation, operation and use of energy- and resource-saving, high-performance machines for turning the soil and preparing crops for planting plays an important role. In particular, in this direction it is important to carry out specific scientific and practical research on the preparation of a universal machine and the technological operation of its main nodes, as well as the achievement of resource savings in the case of interaction with the soil. A semi-screw body was selected as a furrow forming device of the machine that prepares the soil for planting potatoes in the field, and its parameters were theoretically and experimentally justified. Mathematical analysis, the most important principles and methods of classical mechanics were used in the conducted research. According to the results of theoretical and experimental scientific research, the covering width of the housing, which ensures compliance with the requirements of the formation of the nucleus by consuming less energy, should be 200 mm, and the minimum height of its pillar and column should be 330 mm and 560 mm. and the length of the wing should be between 515-545 mm.

1 Introduction

In the world, at the same time, the development and use of resource- and energy-saving and high-efficiency working parts in preparing the soil for planting crops is of great importance. At the moment, great attention is being paid to the development of machines that perform all the technological operations of preparing the soil for planting potatoes in the field by preparing the soil and preparing the seed in one go.

Research on the improvement and use of modern machines and aggregates for soil cultivation, theoretical and experimental justification of the parameters of their working parts V.I. Kurdyumov [1], Sharonov, B.C. [2] Lakhmakov [3], F.M. Mamatov [4-8], B.S. Mirzayev [7-11] and Kodirov [12-15] others.

However, in these studies, the justification of theoretical and experimental parameters that ensure high quality of work with low consumption of resources and energy in soil cultivation for planting potatoes has not been fully studied.

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2 Methods and results

Mathematical analysis, the most important principles and methods of classical mechanics were used in the conducted research.

Theoretical and experimental studies were carried out to justify the parameters of the casings of the machine that prepares the soil for planting potatoes in one pass of the field. As a result, the construction scheme of machine bodies implementing the technology of preparing soil for planting potatoes was developed (Fig. 1). It consists of column 1, tipper 2, harrow 3, guide blade 4.

We determine the parameters of the core forming bodies based on the main process of core formation during machine operation.

2.1 Basing the parameters of the box forming body

An important function of the machine's left and right tipping parts is to form the initial pile. As a furrow, a semi-screw body was chosen because it rotates the soil well and pushes it to the side relatively less.

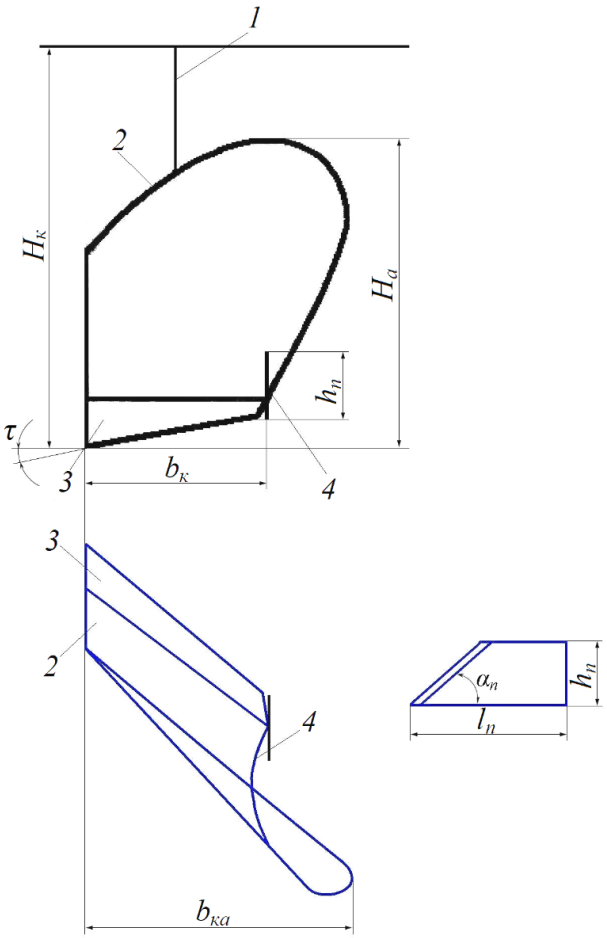


Fig. 1. The main parameters of the hull forming the furrow: 1 – a column; 2 – tipper; 3 – ploughshare; 4 – guide knife.

Below there are the important parameters of the housing affects the quality index and energy efficiency indicators (Fig. 1): body height H_m; coverage width of the corpus $b_к$; body tipper height and width $H_к$ and $b_{ка}$; the angle of entry of the ploughshare into the soil ε; the angle of installation of the ploughshare relative to the wall of the egate $\gamma_л$; angle of slope according to the base of the plow share τ.

In the theoretical framework, we find the important parameters of the wheel from the point of view of the formation of the required height and shape of the shaft. Based on the results of scientific research conducted by many scientists, we consider the shape of the initially formed cross-section of the core to be sinusoidal (Fig. 2). This pattern is equal to the specified row spacing $B_м$ from both ends of the width b_1 кенгликдаги and a thick slabs should be cut and turned opposite to each other in the middle. Then the smallest scope of work will be like this

$$b_{k\,min} = \frac{Bm}{4} \tag{1}$$

(1) according to the expression, $b_{кmin}$ = 17,5 cm when to plant potatoes with a row spacing of 70 cm. Taking into account the relief plane of the field profile and the vibrations of the machine in the horizontal plane

We determine the processing depth of the hull from the condition that the overturned blade is stable, that is, it does not roll back.

$$a \le \frac{b_k}{1.27} = 15.75\ cm \tag{2}$$

In this case, the processing depth along the edge of the casing

$$a_e = a - \frac{1}{2}\, b_k tg\tau \tag{3}$$

(3) according to the expression, when $b_к$ = 20 cm and τ = 6°, the maximum processing depth of the case is a_{max} = 14.7 cm. In the process of turning, the volume of the soil increases. When this situation is considered a_{max} = 0,76, $b_к$ = 15,2 cm.

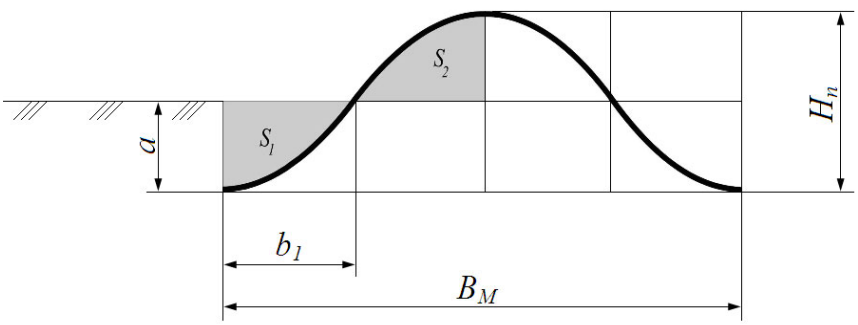


Fig. 2. Scheme for determining the coverage width of the body taking into account the above, we accept the processing depth of the case as a = 15 cm.

2.2 Basing the body tipper height

In order to determine the height of the body shaft, we will see the operation of tilting the blade under the action of the body and the guide blade.

Due to the fact that the rolling process of the sheet is carried out in a closed cutting state and the edges are deformed during this operation, its shape changes. The soil cut from the bottom of the plow with the coulter and guide blade rotates around the center of gravity and rises almost motionless laterally until its edge D touches the edge of the field. It is then rotated around D and placed on the surface of the field. According to Fig. 3, when OE is

perpendicular to the surface of the field, it is at the top, that is, OX. Taking into account the above, we find the height of the case

$$H_a = a + OE = a + \sqrt{a^2 + (b_n - \Delta_n^2)} \quad (4)$$

where b_n – is the width of the palm, $b_к = b_n$;

Δ_n – the width of the deformed part of the blade, cm.

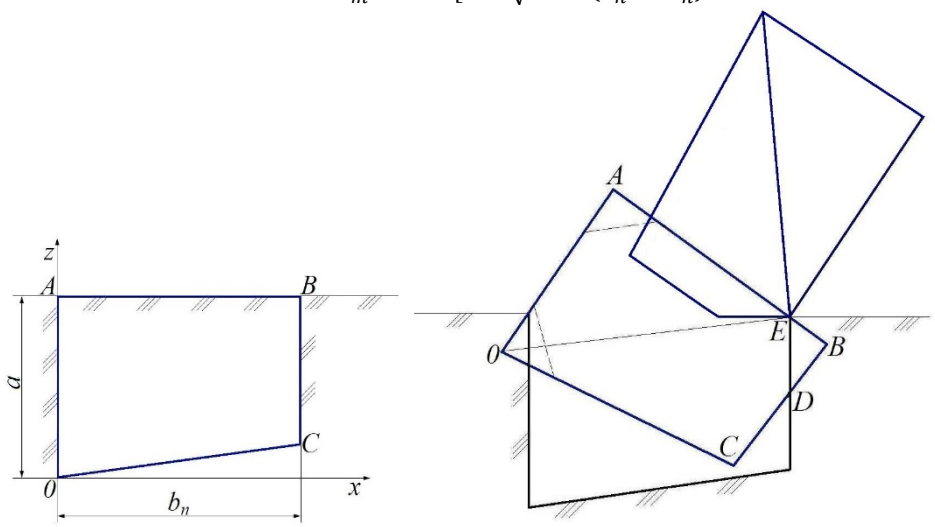
(4) to expression a = 15 cm, Δ_n = 10 cm and $b_к$ = 20 cm put H_a = 33 cm we determine that it should be.

We determine the height of the body according to this formula is based on the condition that the blade passes easily under the frame and does not clog it with various plant residues and soil.

$$H_m - 1.25Ha \quad (5)$$

Putting the value of H_a according to (4) to (5), we get the following

$$H_m = 1.25[a + \sqrt{a^2 + (b_n - \Delta_n^2)} \quad (6)$$



a) *b)*

Fig. 3. Scheme of overturning of the soil slab under the influence of the body.

For bodies working in closed cutting conditions, its height is increased to the processing depth, i.e.

$$H_k = 2.25a + 1.25\sqrt{a^2 + (b_k - \Delta_n^2)} \quad (7)$$

Putting a = 15 cm and $b_к$ = 20 cm in the expression (8), we determine that the minimum height of the body should be $H_к$ = 56.25 cm.

On the basis of the technological parameters of the casing defined above, it is possible to determine the shape and cross-sectional surface (S) of the blade it processes. (Fig. 3, *a*). The mutual equality of the cross-sectional surfaces of right- and left-turning blades ($S_ў = S_ч$) we determine the cross-sectional surface and the center of gravity of the right-turning plane. The cross-sectional surface of the shell processed by the body consists of a rectangle and a triangle.

According to Fig. 2, the general surface of the cross-section of the hull is processed

$$S_{um} = S_1 + S_2 \quad (8)$$

Correspondingly, the surfaces of quadrilateral *АВСД* and triangular *ОДС* are S_1 and S_2

$$S_1 = (a - b_n tg\delta)b_n \quad (9)$$

$$S_2 = \frac{1}{2} b_k^2 tg\delta \quad (10)$$

Putting the values of S_1 and S_2 according to (9) and (10) into (8), we get the following result

$$S_{um} = ab_k - \frac{1}{2} b_k^2 tg\tau \quad (11)$$

3 Results and discussion

Experimental studies were carried out in order to verify the results of the theoretical studies and to determine parameter indicators of the machine that prepares the soil for planting potatoes in the field, which implements the quality of work according to the requirements with low energy consumption. For this purpose, left- and right-turning types of housings were made (Fig. 5).

Experimental studies were conducted in order to study the effect of the length of the body tippers on the performance of the device. For conducting experiments, flippers with a wing length of 485, 515, 545 and 575 mm were prepared (Fig. 6). The speed of the aggregate is 6-9 km/h, the working depth is 15 cm, and the longitudinal distance between the bodies is 400 mm.

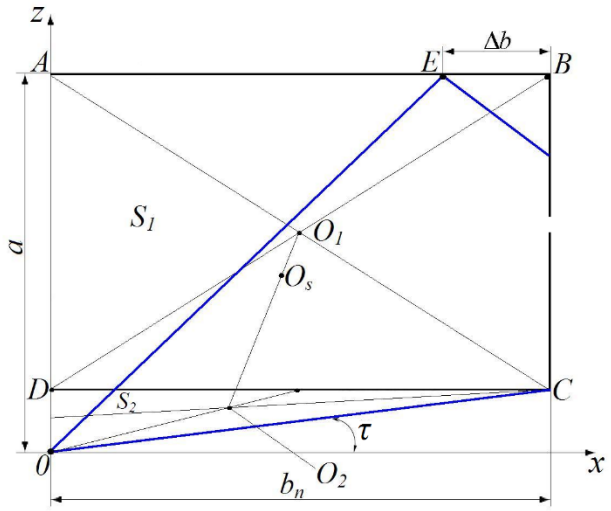


Fig. 4. A scheme for determining the cross-sectional area and center of gravity of the hull.

When the length of the wing of the body increases from 485 to 575 mm at both speeds of the working bodies of the device, the length of the wing of the pusher is ℓ = 575 mm (1), ℓ = 545 mm (2), ℓ = 515 mm (3) ℓ = 485 mm (4) flippers that are the height of the profile (H) first increased and then decreased according to the law of the bubble parabola.

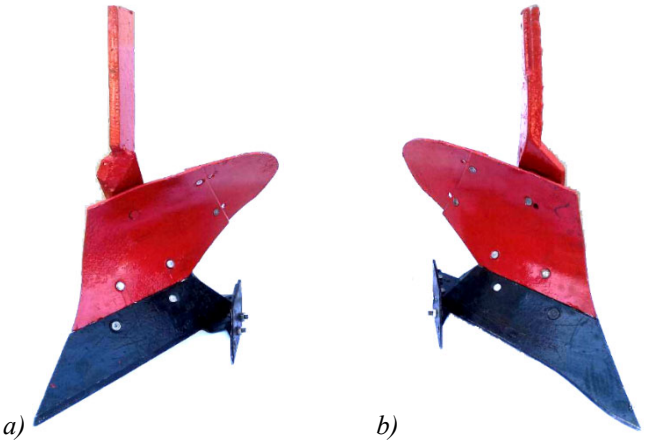


Fig. 5. The bodies that make up the powder: a – housing that flips to the left; b – housing that flips to the right.

This is due to the change in the distance of the particles of soil coming out of the wing. At small values of the wing length (less than 500 mm), the main part of the soil particles is thrown to a small distance and does not fall into the center of the forming pile. At large values of the wing length (greater than 545 mm), the main part of the soil particles is thrown far, that is, at a distance greater than half the distance between the bodies. As a result, the height of the breast is reduced. At the values of the wing length in the range of 515-545 mm, a wing of the required height is formed.

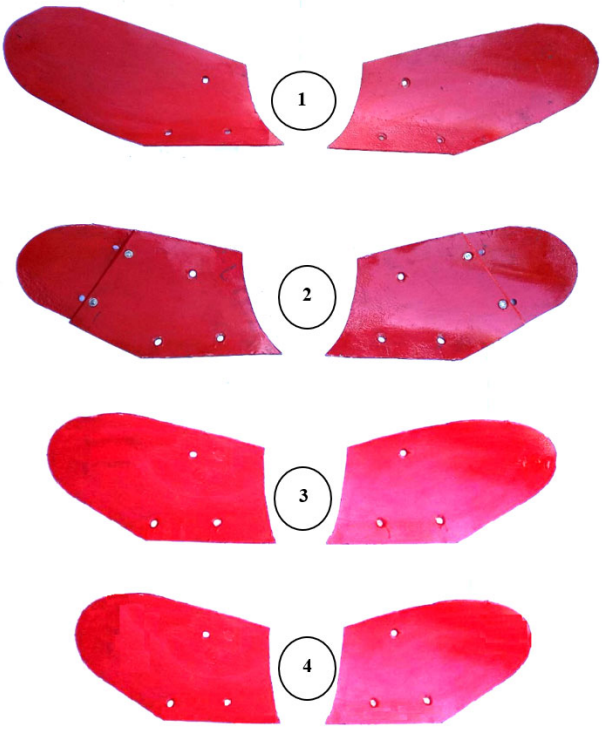


Fig. 6. Tumblers prepared for conducting experiments.

At both speeds, when the wing length of the hulls increased from 485 to 575 mm, the fraction of soil erosion increased according to the parabolic law, that is, the amount of fractions smaller than 50 mm in size increased.

This can be explained by the fact that the time of interaction with the soil overturner increases with the shortening of the blade length.

At values of wing length less than 515 mm, the level of soil compaction does not satisfy agrotechnical requirements.

At both speeds, the drag of the hulls increased proportionally in a straight line as the wing length increased. This can be explained by increasing the frictional forces on the soil overturner as the wing length increases.

Thus, the agrotechnical and energetic performance of the device directly depends on the length of the body tipper wing, and this distance should be in the range of 515-545 mm in order to perform the technological process with high quality of work with low energy consumption.

4 Conclusion

The working body of the punching machine is semi-spiral right- and left-turning housings, the working surfaces of which are directed towards each other and placed in a double position along the length, in this case, it realizes the desired work result with low energy consumption.

According to the results of the theoretical research, in order to achieve the required level of the formation of the nucleus with low consumption of energy, the width of the body is 200 mm, the body itself is semi-screw, the minimum height of its column and the tip should be 560 mm and 330 mm.

The results of the research experiments showed that, the length of the body tipper wing should be in the range of 515-545 mm in order to perform the technological process with high quality of work with low energy consumption.

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