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ABSTRACT

In this article describes the results of theoretical research to determine the design of an improved, soil-deepener plug that allows the soil to be loosened without compaction, along with plowing, and the longitudinal distance from the soil-deepener to the body behind it.

Keywords: Plug, outer body, mechanization, soil-deepener, chisel softener, dense compensation, energy consumption, work quality, energy-saving.

1. INTRODUCTION

Cultivation of agricultural crops in the world, Improving tillage machines and aggregates while maintaining soil fertility, as well as the use of advanced technologies and modern technical means to obtain high yields from them is leading. “Globally, more than 1.8 billion hectares are cultivated annually to grow a variety of agricultural crops” [1], work quality and High productivity, as well as the development of energy-resource-efficient tillage machines and equipment is one of the important tasks. In this direction, certain achievements have been made in developed foreign countries, including: the United States, Germany, the Netherlands, England, Italy, the Russian Federation, Belarus, Ukraine, and others, plowing of lands in these countries and in the “push-pull” system during pre-sowing processing, that is, special attention is paid to the use of plows, combined machines, and working bodies, consisting of working parts that hang from the front and back of the tractor [2]. Ensuring high yields of agricultural crops and annual tillage of up to 30-35 cm of topsoil in arable lands in order to improve the physical and mechanical properties of the soil, lower plaster, gravel and without overturning the sandy part and without removing it from the field surface, it is required to soften to a depth of 10–15 cm [3].

In this direction, including, The process of basic tillage technological work, that is, loosening the subsoil layer along with plowing, work quality and high productivity, energy-saving, it is important the work process is developed to develop improved soil-deepener plows.

Radical reforms in agriculture of the Republic, as a result of profound structural changes, the creation of promising agro-technologies for the production of abundant and quality crops from agricultural crops, Significant work is being done to modernize them, to save manual labor and resources, to introduce technical means that maintain soil fertility and ensure the quality of work. In the Action Strategy for the five priority areas of development of the Republic of Uzbekistan for 2017-2021, including “modernization of agriculture, and further improvement of the reclamation of irrigated lands for accelerated development, development of diversified farms and to create favorable conditions for sustainable and effective development of agriculture, equipping with the necessary agricultural machinery, extensive use of high-yield agricultural machinery» [4] functions are defined. In carrying out these tasks, quality tillage of lands is of great importance due to the development of improved soil-deepener plows.

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Soil-deepening plug with an improved work process does not installed a soil-deepening plug behind of the final body and the bottom of the furrow formed from it is not softened. The bottom of this furrow is softened at the next pass of the unit, after the tractor wheels have passed. To do this, a soil-deepener, which is going installed on the back of the last body of the plug, is designed to soften the bottom of the furrow, which is not softened in the front passage of the agregat in its of frame.

That is, it is mounted on the back of the tractor wheels moving from the furrow formed in the front passage of the unit softening their traces. As a result, existing soil-deepener plugs, defects that occur when used with wheeled tractors, that is, the compaction of the bottom of the furrow softened by the tractor wheels and they completely eliminate the deterioration of traction, catch properties. The work process an improved soil-deepener consists of: frame 1, mounted suspension 2, housings 3, earthing pads 4 mounted on their columns and a support wheel 5 (figure 1).

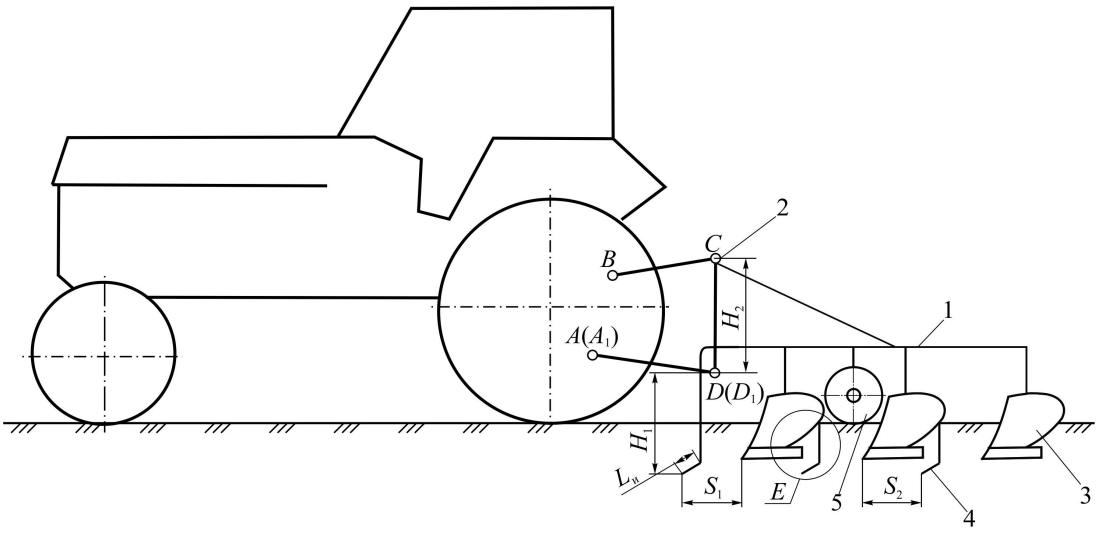

Figure 1. The work process has been improved, structural scheme of the soil-deepener plug: 1 frame; 2 – hanging device; 3 – corpus; 4 – soil-deepener; 5 – support-wheel

We determine the distance from the soil-deepener to the body behind it, provided that the pieces of soil thrown from its overturn during operation do not reach the soil-deepener. This is because otherwise the soil-deepener will also affect the soil overturned by the corpus. This leads to an increase in its resistance to gravity, as well as the appearance of unevenes on the field surface (figure 2).

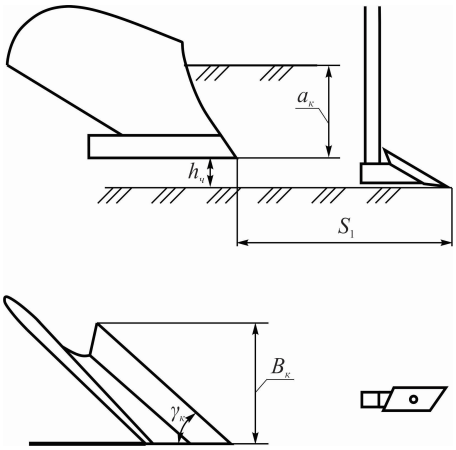

Figure 2. Schematic of determining the longitudinal distance from the soil-deepener to the corpus behind it

2. MATERIALS AND METHODS

Soil thrown from the corpus overturner to soil-deepener the following condition must be met in order not to reach it:

$$S_1 \geq Vt_y + L_u \cos\alpha_u, \tag{1}$$

here t_y – the time it takes for a piece of soil to fall from the overturner to the bottom of the furrow, s; (1) in the expression t_y we determine the time. To do this, we study the motion of a piece of soil being thrown from a plug in a transverse vertical plane (figure 3).

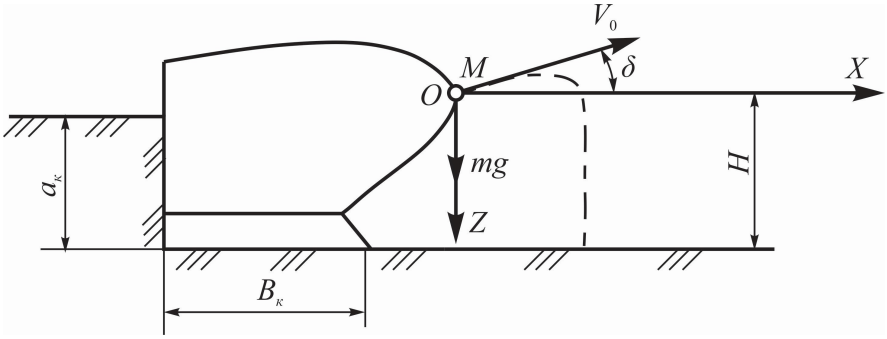

Figure 3. A piece of soil thrown from of the corpus plug a scheme for studying the motion in the transverse-vertical plane.

Part M of the soil is thrown by the overturner at point O in the transverse vertical plane at an angle δ relative to the horizon with the initial plane VO.

From point O we pass the XOZ coordinate system. In this case, we direct the X axis horizontally to the right of point O, the Z axis vertically downwards.

We construct the differential equations of motion of a piece of soil in the XOZ coordinate system. They will have the following appearance:

$$m\frac{d^2X}{dt} = 0; \tag{2}$$

$$m\frac{d^2Z}{dt} = mg, \tag{3}$$

Here m – the mass of a piece of soil, kg;

g – free fall acceleration, m/s^2.

Integrating these equations, we obtain the following results:

$$\frac{dX}{dt} = C_1; \tag{4}$$

$$X = C_1t + C_2; \tag{5}$$

$$\frac{dZ}{dt} = gt + C_3; \tag{6}$$

$$Z = g\frac{t^2}{2} + C_3t + C_4, \tag{7}$$

Here C_1, C_2, C_3 and C_4 – Integral constants.

We define the integral constants C_1, C_2, C_3 and C_4 using the initial conditions. According to the diagram in figure 3 $t = 0$, $\frac{dX}{dt} = V_0 \cos\delta$, $X = 0$, $\frac{dZ}{dt} = -V_0 \sin\delta$ and $Z = 0$.

From these and using equations (4) and (7) we determine the integration constants: $C_1 = V_0 \cos\delta$; $C_2 = 0$; $C_3 = -V_0 \sin\delta$; $C_4 = 0$.

Given this, equations (5) and (6) have the following form:

$$X = V_0 t \cos\delta; \tag{8}$$

$$Z = g\frac{t^2}{2} - V_0 t \sin\delta. \tag{9}$$

The initial velocity in these equations can be determined by the following expression [5-8]:

$$V_0 = V\sqrt{2(1-\cos\gamma_к)}\cos\frac{\gamma_к}{2}, \tag{10}$$

in this case γ_k - the installation of the plug corpus relative to the furrow wall of the knife, degrees.

Given (10), expressions (8) and (9) have the following form:

$$X = V\sqrt{2(1-\cos\gamma_к)}t\cos\frac{\gamma_к}{2}\cos\delta \tag{11}$$

and

$$Z = g\frac{t^2}{2} - V\sqrt{2(1-\cos\gamma_к)}t\cos\frac{\gamma_к}{2}\sin\delta. \tag{12}$$

(3.18) we equate the right-hand side of the equation to the distance H from the point where the piece of soil falls from the overturner to the bottom of the slope:

$$H = g\frac{t^2}{2} - V\sqrt{2(1-\cos\gamma_к)}t\cos\frac{\gamma_к}{2}\sin\delta \tag{13}$$

Solving this equation with respect to t, we determine the time at which the piece of soil falling from the overturner falls to the bottom of the field:

$$t_y = \frac{\sqrt{2}\left[V\cos\frac{\gamma_к}{2}\sqrt{(1-\cos\gamma_к)} + \sqrt{V^2\cos^2\frac{\gamma_к}{2}(1-\cos\gamma_к) + gH}\right]}{g}. \tag{14}$$

3. RESULTS AND DISCUSSION

With this in mind, expression (3.7) has the following appearance:

$$S_1 \geq \frac{V}{g}\left\{\sqrt{2}\left[V\cos\frac{\gamma_к}{2}\sqrt{(1-\cos\gamma_к)} + \sqrt{V^2\cos^2\frac{\gamma_к}{2}(1-\cos\gamma_к) + gH}\right]\right\} + L_u\cos\alpha_u. \tag{15}$$

This is evident from the expression, the distance from the soil-deepener to the housing behind it: to the speed of movement of the unit, to the height at which a piece of soil falls from a plug and, depending on the mounting angle of the

corpus knife relative to the side walls, an increase in their distance leads to an increase in the distance under consideration, and a decrease in its distance. [6-10].

4. CONCLUSIONS

Studies show that $V = 2$ m/s, $g = 9{,}81$ m/s, $\gamma_к = 40°$ and $H = 0{,}5\text{-}0{,}6$ m accept, Calculations by expression (10) showed that the longitudinal distance from the soil-deepener to the body behind it should be at least 51 sm.

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