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Research of the Connection Scheme of an Improved Small-Leveler with a Tractor

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ABSTRACT. The results of theoretical studies to substantiate the communication scheme of an improved small-leveling device with a tractor are given. It has been established that in order to ensure good soil compaction and reduce energy-material consumption, the improved low-leveling device must be connected to the tractor by means of a parallelogram mechanism and, in the process of its operation; its longitudinal links must occupy a horizontal or upward deflected position.

KEYWORDS: Improved small equalizer, leveling working body, compacting working body, four-link mechanism, parallelogram mechanism, forces acting on the small equalizer, energy-material intensity, quality of work.

I. INTRODUCTION

It is known [1] that the main task of pre-sowing tillage is leveling the surface of the fields, compacting the soil to the required degree, grinding large lumps and creating a finely waxy loose layer for quality sowing of seeds of agricultural crops. At present in our country for this purpose, small equalizers MV-6.0, MV-6.5 and others are widely used. However, they have technical and technological drawbacks leading to a decrease in the quality of work and labour productivity, as well as an increase in fuel consumption, labor costs and other expenses. In this regard, we have developed an improved low-leveling device and conducted studies to substantiate the optimal values of its parameters, ensuring the required quality of work with minimal material and energy costs.

II. SIGNIFICANCE OF THE SYSTEM

In the article of theoretical studies to substantiate the communication scheme of an improved small-leveling device with a tractor are given. The study of literature survey is presented in section III, methodology is explained in section IV, section V covers the experimental results of the study, and section VI discusses the future study and conclusion

III. LITERATURE SURVEY

Mala levelers are mainly used in irrigated agriculture zones, particularly in Central Asia, Afghanistan, Pakistan, India and the Middle East. In these countries, the creation of mala-levelers and the study of their parameters involved MA. Akhmedzhanov, V.N. Sokolov, A. Egamov, M.P. Kalimbetov [2-11]. On the basis of these studies, low-leveler MV-6.0 and MV-6.5 were developed and put into production. However, as noted above, these mala-levelers have significant drawbacks.

IV. METHODOLOGY

The improved low-leveling device consists of a frame 1 (Fig. 1), equipped with a hinged device (not shown in Fig. 1), and a leveling 2 installed on it and sealing 3 working members. In the course of work, the leveling working body eliminates the irregularities present on the soil surface, and the sealing working body produces its compaction.

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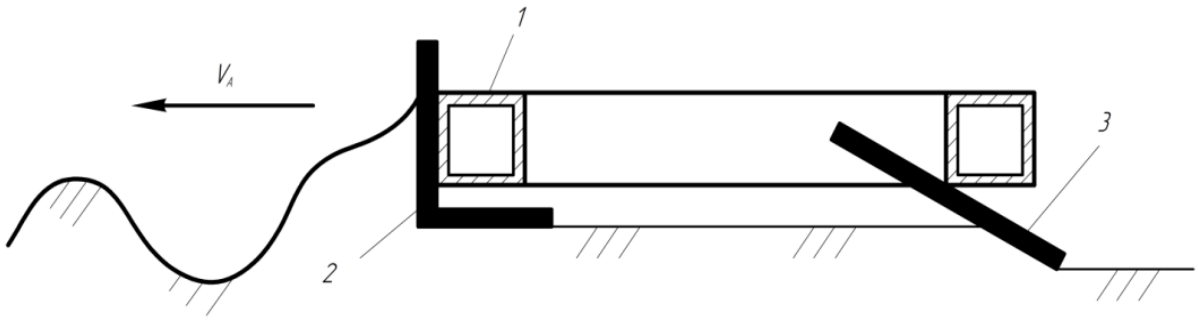


Fig.1. Technological process of work of the improved small equalizer.

The degree of soil compaction under the influence of an improved low-leveling agent depends on the pressure force on the soil of the sealing body: as this force increases, the degree of soil compaction under the action of the low-leveling equipment increases, and decreases with decreasing. On the basis of this, we determine the force of pressure on the soil of the sealing working body of the improved low – leveler. To do this, consider the forces acting on the improved small equalizer, in the process of its work. The improved small equalizer can be connected to the tractor by means of a four – link (in Fig. 2 diagram ***a***) or parallelogram (in Fig. 2 diagram ***b***) mechanisms. In both cases, the following forces act on the improved low – leveler:

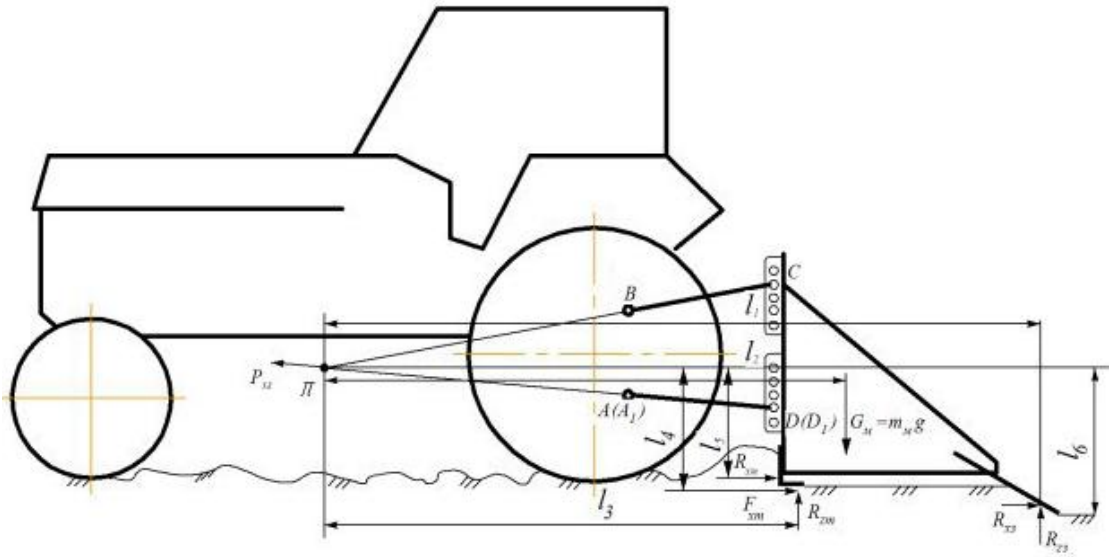
$G_м=m_мg$ is gravity (where $m_м$ is the low – equalizer mass; g is the acceleration of gravity),H;

R_{xm}– is the resistance force arising from the displacement of the soil (in the direction of motion) by the leveling tool of the improved low – leveling device, H;

R_{zm} – vertical reaction of the soil to the leveling tool of the improved low – leveling device, H;

F_{xm} – is the friction force of the soil acting on the leveling tool of the improved low – leveling tool, H;

$R_{xз}$, $R_{zз}$ – longitudinal and vertical components of the reaction forces



a)

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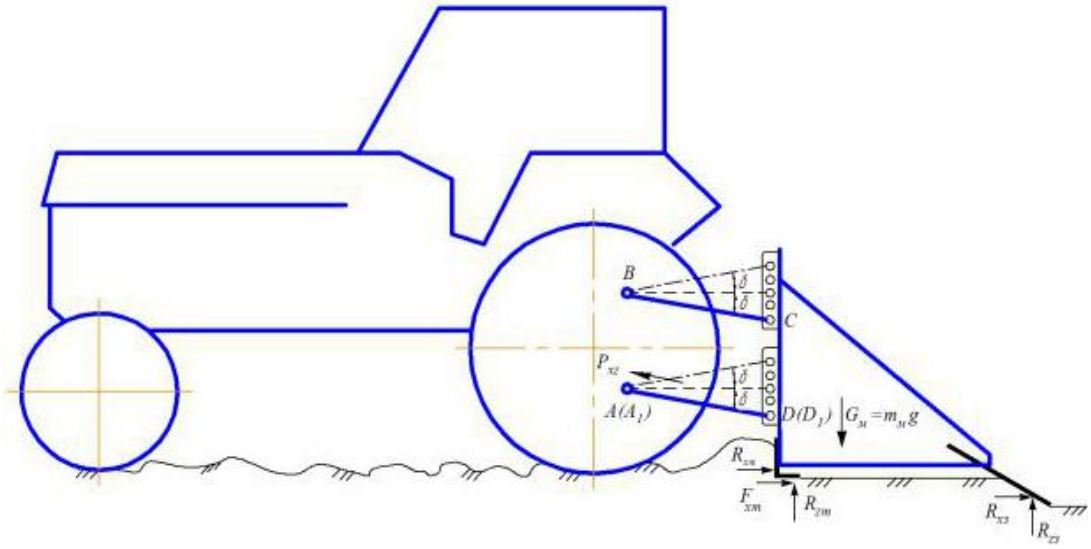

b)

Fig.2. Communication scheme of an improved low – leveling device with a four – link tractor (a) and parallelogram (b) attachment mechanisms.

Soil on the sealing working body of an improved low-leveling device, H;

P_{xz} – tractor thrust force, H.

According to scheme ***a***in Fig. 2, the pressure force of the compacting working tool on the soil of an improved low – leveling device connected to the tractor through the four – link mechanism will be equal to

$$Q_б = R_{zз} = (m_м g l_2 + R_{zm} l_3 - F_{xm} l_4 - R_{xm} l_5 - R_{xз} l_6)/l_1, \quad (1)$$

Where l_1,..., l_6 – the shoulders of the forces acting on the improved low – leveling device in the longitudinal – vertical plane relative to its instantaneous center of rotation *"π"* in this plane.

V. EXPERIMENTAL RESULTS

Taking into account the fact that when an improved small leveling device is connected to the tractor by means of a parallelogram mechanism, all forces acting on it are considered to be applied to the lower movable hinge of the parallelogram mechanism, i.e. to the point D (D1) [12], from scheme b in Fig. 2 we obtain the following results:

I. The lower and upper thrusts of the tractor's hitch mechanism in the process of carrying out the technological process work in a position deflected down from the horizontal (in the diagram ***b***, fig.2 solid line)

$$Q_б = R_{zз} = m_м g - R_{zm} - (R_{xm} + F_{xm} + R_{xз}) tg\delta; \quad (2)$$

II. The lower and upper rods of the tractor's hitch mechanism during the execution of the technological process are working in a horizontal position (in the diagram b in Fig. 2, the panoramic line)

$$Q_б = R_{zз} = m_м g - R_{zm}; \quad (3)$$

III. The lower and upper thrusts of the tractor's hitch mechanism in the process of performing the technological process work occupying a position deviated from the horizontal upwards (in the diagram b in Fig. 2 the dash – dotted line)

$$Q_б = R_{zз} = m_м g - R_{zм} + (R_{xм} + F_{xм} + R_{xз}) tg\delta, \quad (4)$$

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where δ is the angle of inclination of the lower and upper longitudinal rods of the tractor's hitch mechanism to the horizon, deg.

Analysis of expressions (1) - (4) shows that when an improved low-leveling device is connected to the tractor by means of a parallelogram mechanism compared to the four-link mechanism, by varying the angle of inclination to the horizon, the longitudinal loadings of the tractor's hinge mechanism can be changed over a wide range compacting tool of the improved low-leveling device, and therefore changing the degree of soil compaction depends on its type and physico-mechanical matchmaking. In addition, as follows from expressions (4) when installing the longitudinal links of the tractor hinge mechanism with a deviation up from the horizontal, additional soil compaction is provided by the forces R_{xm}, F_{xm}, and R_{x3}. This reduces the consumption of mala-leveler.

When using the four-stage mechanism, it is impossible to vary over a wide range the pressure force of the compacting tool of the improved low-leveling device and additionally compact the soil due to the forces R_{xm}, F_{xm} andF_{x3}.

It should be noted that when an improved small leveling device is connected to a tractor by means of a parallelogram mechanism, changing the microrelief of the field surface and the physicomechanical properties of the soil does not change the installation positions of its working bodies, and therefore their degree of impact on the soil. The result is a uniform alignment and compaction of the soil surface.

When using a four – link mechanism, a change in the microrelief of the field surface and physicomechanical properties leads to a change in the installation positions of the working bodies, and therefore their degree of impact on the soil. As a result, uniform leveling and compaction of the soil surface is not achieved.

VI. CONCLUSION AND FUTURE WORK

It follows from the above that for a good leveling and compaction of the soil surface, as well as reducing the energy and material consumption of malevane, an improved low-leveling device must be connected to the tractor through a parallelogram mechanism, and the longitudinal thrusts of the tractor's hinge mechanism must work taking up a horizontal or deflected position.

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