TO THE CALCULATION OF THE PARAMETERS OF THE ATTACHMENTS OF THE FRONT AND REAR PARTS OF THE PLOW ACCORDING TO THE "PUSH-PULL" SYSTEM

Mansurov Mukhtorjon Toxirjonovich
Namangan Engineering Construction Institute
Namangan, Republic of Uzbekistan

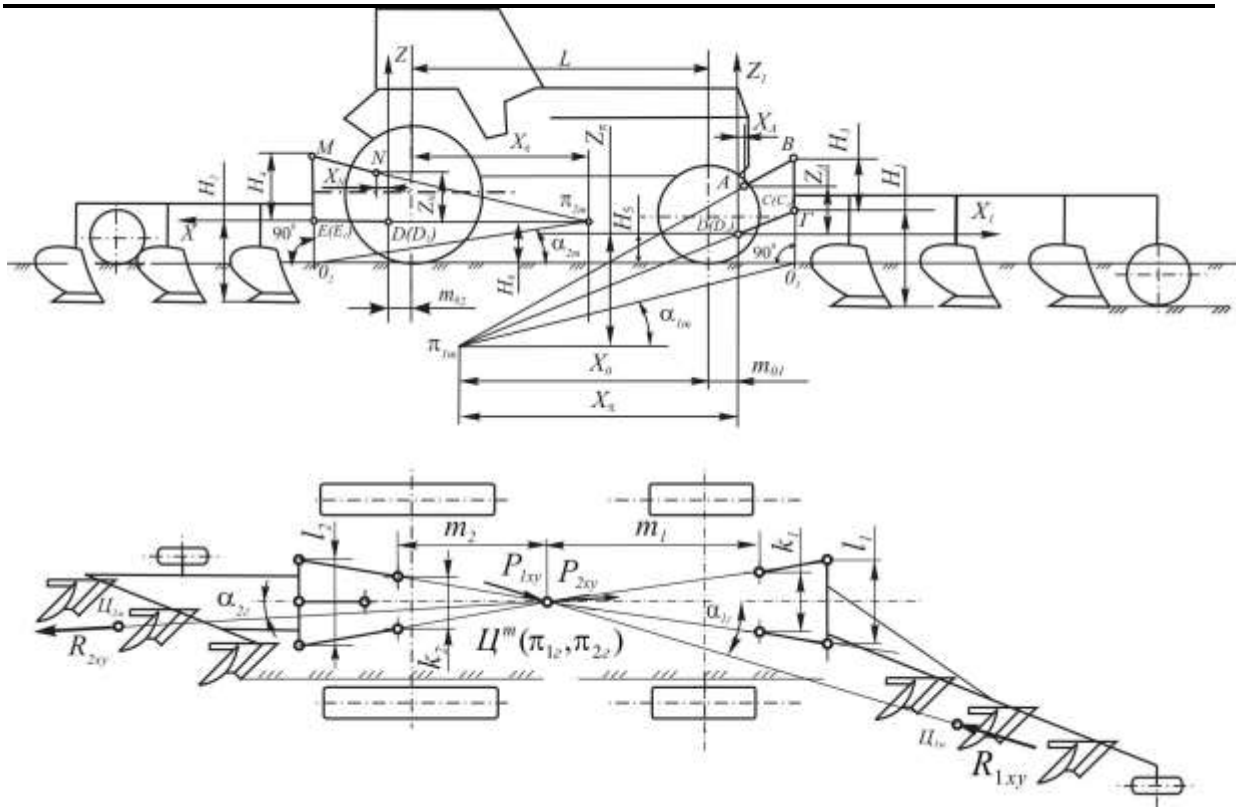
Summary: In the world, the leading place is occupied by the improvement of tillage machines and units, as well as the use of advanced technologies and modern technical means for cultivating crops, obtaining high yields from them while maintaining soil fertility. If we take into account that “more than 1.8 billion hectares of land are cultivated annually in the world for the cultivation of various agricultural crops,” then one of the most important tasks is the development of energy-saving tillage machines and tools with high quality work and productivity. In countries developed in this direction, including the USA, Germany, Holland, England, Italy, the Russian Federation, Belarus, Ukraine and others, certain successes have been achieved, where special attention is paid to the use of plows, combined machines and working bodies for the main and pre-sowing tillage according to the “push-pull” system (push-pull), i.e. tillage machines, consisting of working parts mounted on the tractor in front and behind.

Keywords: soil-cultivating machines according to the "push-pull" system, front and rear parts of the plow, horizontal plane, distance, rectilinear movement.

It is known [1-12] that one of the important ways to reduce energy consumption and increase labor productivity in tillage is the use of tillage machines according to the “push-pull” system (pull-push), because at the same time, due to an increase in vertical loads, slipping of tractor propellers and their traction and coupling qualities are improved. Based on this, we conducted research on the development and justification of the parameters of tillage machines according to the "push-pull" system for the main and pre-sowing tillage in the conditions of the Republic of Uzbekistan.

This article presents the results of research on the justification of the parameters of the front and rear parts of the plow, developed according to the "push-pull" system.

The main parameters of the attachments of the front and rear parts of the plow according to the “push-pull” system are (see Fig. 1):



Rice. 1. Scheme for determining the parameters of the attachments of the front and rear parts of the plow using the "push-pull" system

l_1, l_2 - respectively, the horizontal distance between the lower attachment points of the attachments of the front and rear parts of the plow;

H_1, H_2 - respectively, the vertical distance from the reference planes of the front and rear parts of the plow to the lower attachment points of their attachments.

Distances l_1 and l_2 determined based on the conditions that the instantaneous centers of rotation $\pi_{1г}$ and respectively, the front and rear parts of the plow in the horizontal plane were placed in the center of pressure $Ц^m$ running gear of the tractor in this plane, because only in this case it will be possible to ensure the rectilinear movement of the aggregate [13]. In this case, to calculate the specified distances, the following expressions were obtained

$$l_1 = \left(1 + \frac{l_{1б}\cos\varepsilon_1}{\sqrt{m_1^2 + (0{,}5k_1)^2}}\right)k_1 \qquad (1)$$

and

$$l_2 = \left(1 + \frac{l_{2б}\cos\varepsilon_2}{\sqrt{m_2^2 + (0{,}5k_2)^2}}\right)k_2, \qquad (2)$$

where $l_{1б}, l_{2б}$ - respectively, the length of the lower longitudinal rods of the front and rear hitch mechanisms of the tractor;

m_1, m_2 - accordingly, the horizontal distance from the fixed hinges of the lower longitudinal rods of the front and rear hitch mechanisms of the tractor to the center of pressure of the tractor propellers;

k_1, k_2 - respectively, the transverse distances between the fixed hinges of the lower longitudinal rods of the front and rear hitch mechanisms of the tractor;

ε_1, ε_2 - accordingly, the angles of inclination to the horizon of the lower longitudinal rods of the front and rear hitch mechanisms of the tractor in the working position.

Distance H_1 Distance H_2 vertically from the supporting surfaces of the front and rear parts of the plow to the lower attachment points of their attachments, we determine from the conditions for ensuring their penetration to a given depth and uniformity of travel at this depth.

As is known [14], in order to fulfill the indicated conditions, the angles of inclination to the horizon α_{1m} and α_{2m} (see in Fig. 1) conditional lines of rods $O_1\pi_{1m}$ and $O_2\pi_{2m}$ front and rear parts of the plow in the longitudinal-vertical plane, i.e. lines passing through instantaneous centers of rotation π_{1m} and π_{2m} and projections of the lower attachment points of the attachments of the front and rear parts of the plow on the soil surface (in Fig. 1 points O_1 and O_2), must not exceed the allowable limit, i.e.

$$\alpha_{1m} < [\alpha_m] \qquad (3)$$

and

$$\alpha_{2m} < [\alpha_m], \qquad (4)$$

where $[\alpha_m]$ - the permissible limit of the angles of inclination to the horizon of conditional lines of rods of the front and rear parts of the plow in the longitudinal-vertical plane.

Using the diagrams shown in Fig. 1, corners α_{1m} and α_{2m} express in terms of the parameters of the front and rear hitch mechanisms of the tractor and the hitches of the front and rear parts of the plow

$$\alpha_{1m} = artg\left\{\left\{\left\{\left[\left\{Z_A\left[\sqrt{[(l_{1á})^2 - 0{,}25(l_1 - k_1)^2] - (H_1 - H_5 - h)^2} - X_A\right] - (H_1 + H_3 - H_5 - h - Z_A)X_A\right\}\times\right.\right.\right.$$

$$\left.\left.\left.\times\sqrt{[(l_{1á})^2 - 0{,}25(l_1 - k_1)^2] - (H_1 - H_5 - h)^2}\right]:\left[\left[\sqrt{[(l_{1á})^2 - 0{,}25(l_1 - k_1)^2] - (H_1 - H_5 - h)^2} - X_A\right]\times\right.\right.$$

$$\left.\left.\times(H_1 - H_5 - h) - (H_1 + H_3 - H_5 - h - Z_A)\sqrt{[(l_{1á})^2 - 0{,}25(l_1 - k_1)^2] - (H_1 - H_5 - h)^2}\right] - H_5\right\}:$$

$$:\left\{\left\{\left[\left\{Z_A\left[\sqrt{[(l_{1á})^2 - 0{,}25(l_1 - k_1)^2] - (H_1 - H_5 - h)^2} - X_A\right] - (H_1 + H_3 - H_5 - h - Z_N)X_A\right\}(H_1 - H_5 - h)\right]:\right.\right.$$

$$:\left[\left[\sqrt{[(l_{1á})^2 - 0{,}25(l_1 - k_1)^2] - (H_1 - H_5 - h)^2} - X_A\right](H_1 - H_5 - h) - (H_1 + H_3 - H_5 - h - Z_A)\times\right.$$

$$\left.\left.\left.\times\sqrt{[(l_{1á})^2 - 0{,}25(l_1 - k_1)^2] - (H_1 - H_5 - h)^2}\right] + \sqrt{\left[(l_{1á})^2 - 0{,}25(l_1 - k_1)^2\right] - (H_1 - H_5 - h)^2}\right\} \qquad (5)$$

and

$$\alpha_{2m} = arctg\left\{H_6 - \frac{X_N(H_2 + H_4 - H_6 - h) - Z_N\sqrt{l_{2á}^2 - (H_6 + h - H)^2}}{(H_4 - Z_N)\sqrt{l_{2á}^2 - (H_6 + h - H)^2} - X_N(H_6 + h - H_2)} \times \right.$$

$$\left. \times \left[(H_6 + h - H_2)\right]: \left[\left| \frac{X_N(H_2 + H_4 - H_6 - h) - Z_N\sqrt{l_{2á}^2 - (H_6 + h - H_2)^2}}{H_4 - Z_N - X_N \dfrac{H_6 + h - H_2}{\sqrt{l_{2á}^2 - (H_6 + h - H_2)^2}}} \right| + \right.\right.$$

$$\left.\left. + \sqrt{l_{2á}^2 - (H_6 + h - H_2)^2} \right]\right\}, \qquad (6)$$

where X_A,Z_A - correspondingly horizontal and vertical distances between the fixed hinges of the front linkage of the tractor;

H_3 - vertical distance between the lower and upper attachment points of the front of the plow;

H_5 - vertical distance from the supporting surface of the tractor to the fixed hinges of the lower longitudinal rods of the front linkage mechanism of the tractor;

h - specified processing depth;

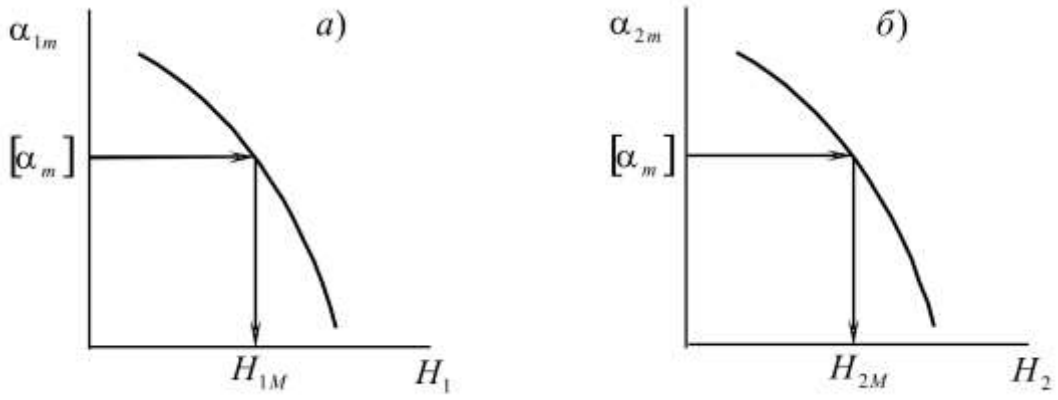
X_N,Z_N - correspondingly horizontal and vertical distances between the fixed hinges of the rear linkage mechanism of the tractor;

H_4 - vertical distance between the lower and upper attachment points of the rear of the plow;

H_6 - vertical distance from the supporting surface of the tractor to the fixed hinges of the lower longitudinal links of the rear linkage mechanism of the tractor.

Because options X_A, Z_A, $l_{1б}$, H_3, H_5, as well as X_N, Z_N, $l_{2б}$, H_4 and H_6, included in (5) and (6) are standardized [14] or known from the tractor, conditions (3) and (4) are mainly ensured by choosing the distances from the support surfaces of the front and rear parts of the plow to the lower attachment points of their attachments, i.e. e. distances H_1 and H_2.

To determine the values H_1 and H_2, providing condition (3) and (4), according to expressions (5) and (6) graphic dependencies are built $\alpha_{1m} = f(H_1)$ and $\alpha_{2m} = f(H_2)$(rice. 2) and of them by a given value $[\alpha_m]$values are determined H_1 and H_2, as shown in fig. 2.



a and b respectively $\alpha_{1m} = f(H_1)$ and $\alpha_{2m} = f(H_2)$

Rice. 2. Dependencies $\alpha_{1m} = f(H_1)$ and $\alpha_{2m} = f(H_2)$

Thus, as a result of the studies carried out, analytical dependencies were obtained for calculating the parameters of plow attachments using the “push-pull” system.

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