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SUBSTANTIATION OF THE COVERAGE WIDTH OF THE BODIES OF THE FRONTAL PLOW FOR FLAT PLOWING FOR CLASS 4 TRACTORS

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ABSTRACT	**KEYWORDS**
Substantiation of the coverage width of the bodies of the frontal plow for flat plowing for class 4 tractors.	Resource-saving, frontal plow, combined, energy, open furrow, advanced technology, body, plug.

Introduction

In the agricultural production of our republic, comprehensive measures are being taken to reduce labor and energy consumption, save resources, grow agricultural crops based on advanced technologies, and develop highly productive agricultural machinery. However, currently, preparing fields for high-quality sowing in a short period of time with a single pass of machines is an urgent scientific problem. In addition, multiple passes of machines over the cultivated land lead to excessive compaction of the soil, increased energy consumption, and ultimately a decrease in productivity. Therefore, the development of new techniques and technologies for preparing soil for planting repeated crops, as well as their introduction into production, is an urgent issue. The Strategy of Actions for the Further Development of the Republic of Uzbekistan for 2017-2021, among other things, sets the following tasks: "... to more than double the volume of gross domestic product by 2030, to optimize the arable land for 2017-2020, to rationally use land and water resources, and to introduce modern intensive agricultural technologies" [1]. In implementing these tasks, one of the important issues is to obtain high yields from technical crops and reduce their cost, including through the technical and technological modernization of machines and devices that provide high-quality processing of the land in one pass.

In the cultivation of repeated crops, especially in the conditions of Uzbekistan, flat plowing is required to obtain a double crop from the land, and the advantages of this method are clearly demonstrated. Flat plowing plows can be divided into two main groups according to the method of turning the soil clod:

- flat plowing plows based on traditional technology;
- promising flat plowing frontal plows without a furrow.

An analysis of the scientific and technical literature on scientific research conducted in scientific centers, universities and research institutes of leading countries on the creation of flat plowing frontal plows for class 4 tractors indicates that significant theoretical and practical results have been achieved in this area. The study of flat-ploughing frontal plows for class 4 tractors was carried out by scientists from different countries, including V.A. Sakun, V.V. Sharov, A.I. Panov, V.M. Matsepuro, V.G. Valimov, Y.P. Lobachevsky, F.M. Mamatov, I.T. Ergashev, Y.P. Polous, Kh. Ravshanov and others [1-12].

According to the results of numerous observations conducted by scientists of the Research Institute of Agricultural Mechanization and Electrification, on the surface of the plowed field, mounds (marza) 120-150 cm wide, 28-30 cm high and open furrows (ditches) 120-210 cm wide and 30-36 cm deep are formed. Open furrows in the field worsen the operating conditions of machine-tractor units, increase the resistance of machines and tools, make it difficult to harvest, and do not allow the units to operate at high speed. Open furrows, especially on slopes, lead to the development of water erosion [1].

According to the studies, the total surface area of open furrows and marzas negatively affected by them is from 6.5% to 19.5% of the total surface area of the field [2]. In order to level out the irregularities in the open fields and ridges and fully prepare the land for planting, the aggregates are passed over the field surface 2-4 times. However, this method does not achieve leveling of the land surface. As a result, under the influence of the running parts of heavy tractors and tillage machines, the soil is compacted, its physicochemical properties, water and air exchange processes deteriorate, its fertility decreases, yield decreases by 12-30%, and erosion processes increase due to the rapid decomposition of organic matter [5].

When using flat plowing technology, the above-mentioned negative aspects are eliminated, ridges and ridges on the field surface are not formed, the flatness of the field surface is preserved, additional work is not performed to prepare the land for planting, favorable conditions are created for the subsequent technological process, labor productivity increases, the time until planting the second crop is significantly reduced, energy and resources are saved, moisture accumulation in the soil layer where root nutrients are obtained is improved, the soil is protected from water and wind erosion, productivity increases by 3-7%, sowing work can be carried out simultaneously with plowing, and the possibility of obtaining a double crop from the land arises. According to scientists from the Research Institute of Agricultural Mechanization and Electrification, when using flat plowing, the work performed on the leveling processes during the main and pre-sowing tillage of the soil is reduced by 30% [4].

A characteristic feature of the new technology of the plow without a tine is that the soil clod is turned over at the edge of its place (Fig. 1). This method of plowing is the most rational and requires the least energy consumption. The working bodies of the plow, which implements this technology, are located in a straight line perpendicular to the direction of movement (frontal). The length of the frontal plow does not depend on the width of the plow (Fig. 1). This makes it possible to manufacture them in suspended and even wide-ranging versions. In addition, on their basis it is possible to create combined agricultural machines that perform several operations in one pass through the field [2-12].

A flat plow without a furrow consists of at least two working elements: the main body, which acts on the lower edge of the blade, and an additional body (stubble), which in the first stage of the rotation of the blade affects its side, and in the second stage - on its upper side [2-12].

The working process of the technological module is as follows (Fig. 1). The soil is cut in a vertical plane by the blades 4, and in a horizontal plane by the coulters of the main bodies 1 and 3, as a result of which two blades are formed with a “short cut” of 35-70 mm. The main bodies, first independently, and then interacting with the stubble 2, rotate the blade and lay it on the border of its furrow. The blades extending from the working surfaces of the body and the plug are necessarily turned by about 160 ° and rest against each other with their sides, leaving a small free gap between their sharp sides and the bottom of the furrow. To eliminate this gap, level the plow surface and crush the clods, a light planar roller, hinged - elastically attached to the frame, is used. The roller 5 performs its functions due to the use of its own weight and the weight of the module and the vertical component of the soil reaction to the working bodies. The hinged elastic attachment of the roller to the frame allows the vertical force, which previously caused the formation of the “plug heel”, to be used for useful work - crushing the clods and leveling the plow surface [10; 11].

Advantages of the new technology of flat plowing and the combined frontal plow over traditional plows: agrotechnical - a well-structured open furrow and a continuous flat plowed surface without ridges are provided, increasing productivity by 15-18%; ecological - erosion-hazardous soil particles are buried in the furrow bottom, soil aggregates with a size of 0.25-10 mm are formed in the surface layer; energetic - fuel consumption is reduced by 25-28% [2; 3; 4].

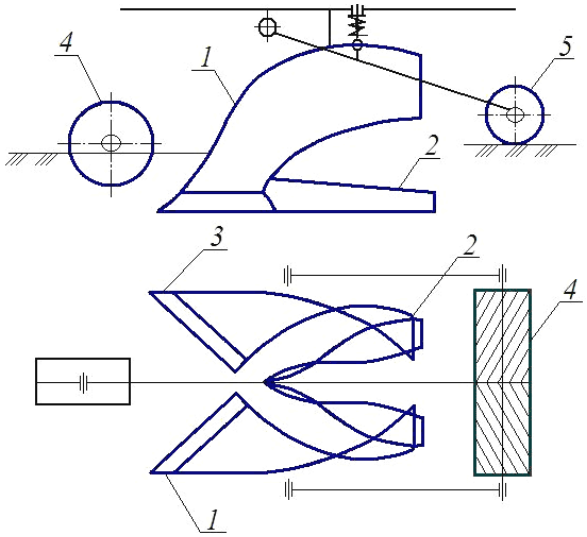

Figure 1. Structural scheme of a frontal plow with a roller: 1 – right-hand turning body; 2 – coulter; 3 – left-hand turning body; 4 – disk blade; 5 – base-leveling roller

Due to the reduction of additional operations to prepare the soil for sowing after plowing, the time and energy consumption for preparing the field for sowing is reduced by 1.5-1.8 times; design - material capacity is 50-100% less; ergonomic - symmetry and stability, the absence of complex hydromechanical systems, high maneuverability. The most optimal shuttle-like movement method in the field creates comfortable and safe working conditions for the operator; economic - due to the small material volume and optimal design, the price is 2 - 2.5 times lower than that of rotary plows, and 1.3 times lower than that of conventional plows. Due to low fuel consumption, high working speed and work efficiency, high economic efficiency is achieved [4; 7].

The coverage width V of the front plow is determined by the following expression [2]

$$B = \frac{\eta_m P}{K a_{\max}}, \qquad (1.1)$$

where η_t - is the tractor traction coefficient;
R - is the tractor's nominal traction force, N;
K - is the soil's specific resistance to plowing, Pa;
a_{max} - is the maximum tillage depth, m.
The T-4A chain tractor of the 4th class has a nominal traction force of 40 kN [2]. Taking this into account and assuming η_t = 0.95; K = 6.5•104 Pa [2] and a_{max}=0.27 m, it follows that the plow intended for use with the T-4A tractor should have a working width of 2.165 m.
The main condition for the smooth movement of the plowing unit when cultivating the soil with frontal plows is that the tractor's dimensions correspond to the plow's width. In this case, in order for the unit to move in a shuttle-like manner, the plow's working width should be greater than the tractor's width, i.e.

$$V_{pl} \geq V_{kol} + b_g + S,$$

where V_{kol} - is the tractor track, V_{kol} = 1384 mm;
b_g - is the track width, b_g = 420 mm;
S - is the distance from the trench wall to the edge of the chain, mm.
Then

$$V_{pl} \geq (1384 + 420) + 200 = 2004 \text{ mm}$$

This condition is satisfied when the number of corpuses is p = 4, i.e.

$$V_{pl} = p\, v_k = 4 \cdot 52{,}5 = 2100 \text{ mm}.$$

$$V_{pl} > V_{kol} + v_g.$$

The width of the frontal plow body, which is cultivated at a depth of 24-27 cm, should be in the range of 45-52.5 cm [Lobachevsky, Sharov, Mamatov, Ergashev]. To satisfy the condition according to (1.1), we assume the width of the body to be 52.5 cm.
Conclusion. The frontal plow for the T-4A tractor is a four-body plow, and the width of each body should be bk=52.5 cm.
Currently, the use of flat plowing technologies and plows that implement them in our country provides a sharp reduction in labor and operating costs and high yields from crops. It is expedient to develop a flat plow without a tine designed for class 4 tractors for the conditions of our republic and to substantiate its parameters.

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