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# INVESTIGATION THE IMPACT OF THE CONSTRUCTIVE PARAMETERS OF THE WORKING BODY THE TILLAGE MACHINE ON THE ENERGY INTENSITY AND QUALITY OF SOILTILLAGE

*The study of the technological process and design parameters of the tipping working tool was carried out. The most favorable conditions for plants are created when the cultured soil layer is differentiated by its structural composition. At the same time, clods with a size of 5 to 20 mm should prevail in the surface layer of the soil, and in the seed bed - from 0.25 to 10 mm.*

*Means of mechanization of soil cultivation in systems of zero, minimum and zero tillage, which provide the necessary conditions for growing agricultural crops, were analyzed.*

*It was established that in order to obtain a fine-grained structure of the soil in the area of seed placement, it is not necessary to grind it intensively and thereby increase the energy intensity of the process. The necessary structure can be obtained by combining the operation of grinding the soil and its fractional distribution along the processing depth.*

*The influence of the geometric parameters of the slope of the inclined disintegrator according to quality and energy indicators of zero tillage. A high concentration of these row crops leads to the accumulation of harmful weeds, diseases and pests.*

*It was determined that the use of tillage technologies on sloping fields, which are adapted to flat conditions and do not take into account the peculiarities of the relief, leads to intensive development of erosion processes. Modern tools for the main cultivation have their shortcomings: the chisel does not grind the soil enough and does not cut the roots of the weeds; a plow sole is created with a flat cutter; the plow not only creates a footing, but also covers the crop residue, turning the soil over, creating conditions for water and wind erosion. One of the ways to improve the quality of the main tillage will be the use of loose plows with inclined working bodies, which ensure high-quality loosening over the entire width of the tillage unit, eliminate soil compaction and leave stubble on the field surface.*

***Keywords:*** *soil, tillage, tillage machine, parameters, working body, chisel, plow, quality.*

**Introduction.** The analysis of applied soil processing technologies shows that the existing working bodies do not always require high-quality soil preparation for arable crops and do not create conditions for protection against the destruction of the upper fertile layer. In the technology of growing agricultural crops, pre-sowing processing is one of its main elements. The high quality and timeliness of the pre-sowing treatment depends on the preservation of reasonable moisture, the evenness of the field surfaces, the destruction of weeds and the depth of sowing of cultivated crops [1].

Preserving fertility is one of the main tasks of agricultural production. Earnings are justified by the working bodies of machines and units aimed at creating better conditions for cultivated plants by changing its water-air, thermal and nutritional regimes.

Mechanical cultivation should reasonably provide the treated layer with optimal loosening to ensure favorable conditions for the growth of agricultural crops. It is important that during mechanical processing such a tense state is reasonably created, which ensures minimal destruction of aggregates.

Black earth soils with high agrophysical properties are favorable for the cultivation of plowed crops [1, 2]. This culture does not develop well on heavy soils that are poorly amenable to processing, fully warmed up, and poorly accessible for air and especially moisture penetration. Sandy and saline soils are also unsuitable for obtaining high yields [3].

One of the essential agrophysical indicators is the volumetric mass, which characterizes its density. Water, air, thermal conditions of the soil, the intensity of microbiological processes, the spread of the root system, etc., are related to it. most arable crops react noticeably to the density of the soil.

Modern global trends in the production of environmentally friendly products require the abandonment of chemical means of weed control. The working bodies of ground processing machines do not provide a rational impact on grounding from the point of view of agricultural and ecological requirements [3].

Therefore, in order to improve the grounding processing processes, a comprehensive approach to the issues of reducing the destruction by the working bodies of machines and tools of the grounding structure and the development of technological processes that ensure the optimization of its agrophysical properties is necessary.

***Analysis of recent research and publications*.** An important and time-consuming process for row crops was and remains the main soil treatment. Its theoretical foundations are covered in the works of many domestic scientists [4-7, 9-12].

The main processing should: a) create a better structure of the arable layer to regulate the water, air, heat and food regimes; b) clean the arable layer from weeds, agricultural pests and the beginnings of diseases; c) regulate the processes of decomposition of organic matter in the arable layer.

Scientists, studying the plow ball, showed that if there are at least 40-45% of water-resistant lumps larger than 0.25 mm, then the indicators of density, hardness, general porosity and aeration porosity are within optimal limits. In black soil, the arable ball contains 55-60% of such lumps.

Therefore, if the minimum tillage depth is not limited by the requirements related to the clogging of fields or the biological and agrophysical properties of the soil, then there is no need for deep tillage of the soil [5-6].

Studies show that zero tillage is most acceptable for winter wheat and rye, less so for spring cereals and annual grasses; surface - additionally for buckwheat; these methods are not suitable for row crops.

An important condition is the type of soil, its agrophysical and agrochemical properties, in particular, granules of metric composition and density, water-holding capacity, content of humus and other nutrients [5]. It can be assumed that on cultivated black soil with a high content of humus and nutrients, light and medium granules of metric composition, zero and surface methods of the main soil cultivation can be used for grain two years, and on gray forest soils, as a rule, medium and heavy granules of metric composition, with a lower content of humus and nutrients - no more than one year in a row.

It is well known that zero and surface treatments of the soil provide the best results in dry years, especially for sowing winter crops, when later plowing leads to drying of the arable layer, and excluding treatments or carrying them out only in a layer of 0-10 cm allows to preserve moisture and, mainly, to avoid excessive soil compaction [7].

Therefore, one of the tasks of this study is to find a technological process for optimizing the physical and mechanical condition of the soil. This will create the most favorable conditions for the growth and development of plants, which will reduce energy overspending on the process of pre-sowing mechanical soil treatment and increase productivity.

The purpose of the work is to increase the efficiency of soil cultivation with an inclined plow by substantiating its design parameters.

***Materials and methods*.** If the field is slightly overgrown with weeds and the soil is in good condition, it is not necessary to use traditional tillage systems for all crops, which include stubble peeling, plowing, and pre-sowing tillage. These methods can be replaced by tillage with simultaneous sowing [8].

Soil protection against erosion consists of preventive measures to prevent its development and specific measures to eliminate erosion where it has already developed. Therefore, in erosion-dangerous areas, where natural conditions (climate, topography, soil properties, etc.) contribute to the occurrence and development of erosion, agriculture should be soil protective (against erosion). Since the runoff is formed from the watershed, anti-erosion measures should cover the entire territory from the watershed parts to the lower parts of the slopes [9].

The most important methods of anti-erosion tillage include: tillage across the slope (contour tillage); grooving, rolling and punching of finches and pairs; plowing with soil deepening, flat-cut processing, chiselling, cracks and rotation of the soil, production of drainage ditches in areas with a predominance of storm erosion, leveling of gullies and connecting furrows [9].

A reliable, widespread method of soil protection against wind erosion is no-shelf tillage. This treatment allows you to save up to 85% of stubble and other plant residues on the surface of the fields, which prevent snow from blowing away and increase the moisture reserves in the soil. In winter, the stubble protects the field from winds and contributes to the even distribution of snow, which contributes to the faster development of seedlings and their resistance to wind. Further preservation of stubble during sowing and plant development protects the soil from spring and early-year wind erosion [9].

Loosening without layer turnover helps to increase the yield of cereals by 15-20%, perennial grasses by 10-18% [9].

soil tillage should be carried out without a shelf using chisel tools with straight and inclined working bodies, they have high agronomic, anti-erosion and economic efficiency.

Taking into account the great prospects for the development of chisel tools, work is underway all over the world to create chisel deep looseners.

***Results.*** Ripper plows with working bodies of an inclined type provide a minimum of costs, qualitatively loosen the soil, preserve plant residues as much as possible, do not turn over the layer, and improve fertility (Fig. 1).

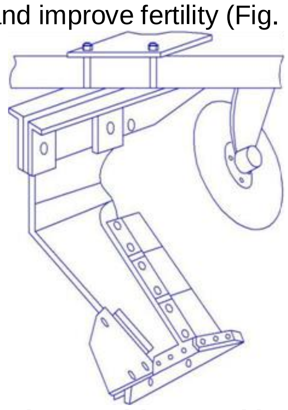

**Fig. 1. Chisel working body with a rack inclined in the direction of travel.**

Obliquely mounted housings - rippers of such a plow, deepen to a depth of 35 ... 45 cm, provide loosening of the arable and subarable layer not due to the forces of squeezing and turning the layer, like conventional plows, but due to chipping from the blade and chisel, due to the bending of the layer, due to abrasion during the movement of layers relative to each other [9].

Soil cultivation with an inclined ripper contributes to a better and more uniform crushing of soil aggregates along natural interfaces with less soil spraying with the formation of a good stubble soil protective layer. The main elements of the working body of the inclined type, which work most intensively and determine the nature of the technological process, are an inclined rack with a plowshare and a chisel. In the general case, the stand with the share and the chisel work like two-sided wedges (Fig. 2).

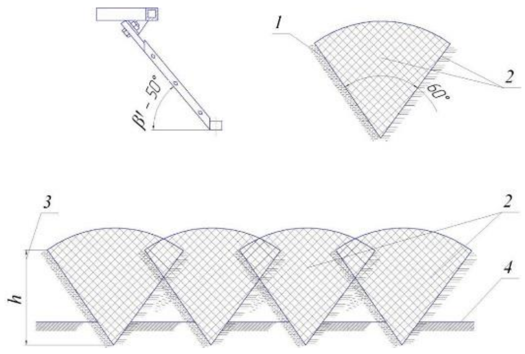


**Fig. 2. Scheme of tillage with an inclined working body: 1 - compacted zone; 2 - cultivated soil; 3 - loosening depth; 4 - plow sole.**

During the operation of the soil loosening machine, about 30% of the total energy consumption is spent on the rotor drive. One of the main factors determining the energy intensity of the rotor blade is the profile of its working edge. When the rotor blade interacts with the soil, the torque is not a constant value and changes over time depending on the position relative to the separating grid. The justified profile of the rotor blade provides the best conditions for soil transportation at the initial moment of its entry into the soil and minimal energy consumption for its drive.

However, the resulting shape of the working edge of the knife does not ensure minimum energy consumption for the work of both a separate knife and the rotor as a whole. The most complete indicator of the operation of the rotor blade is the energy consumption for performing one complete cycle, that is, one revolution of the blade [10].

The rotor blade is acted upon by the normal force of soil pressure *qfdl*, the force of friction of the soil against its cutting edge *qfdl,* and the force of friction against the side surface (Fig. 3).

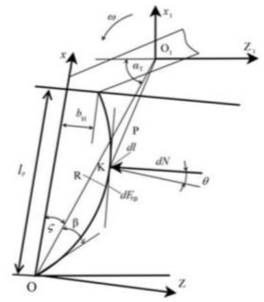

**Fig. 3. Forces acting on the rotor blade**

The torque on the drive of one rotor blade is calculated according to [10]:

$$dM_0 = \frac{g\rho(1+tg\theta)\sqrt{1+Z'^2}}{\sqrt{1+tg^2\theta}}dx \qquad (1)$$

where g is the specific normal pressure of the soil on the edge of the knife; ρ is the radius of rotation of the elementary platform; θ is the angle between the direction of action of the normal force and the perpendicular to the radius of rotation of the elementary plane.

The specific normal pressure of the soil on the edge of the knife is determined [11]:

$$g = Kh^{n-1} \qquad (2)$$

where K and n are constant coefficients that depend on the physical and mechanical properties of the soil; h is the distance from the soil surface to the elementary plane:

$$h = \frac{[K_1 \sin(\alpha_T+\varsigma) - \cos(\alpha_T+\varsigma)]x - [\sin(\alpha_T+\varsigma) + K_T cos(\alpha_T+\varsigma)]Z}{\sqrt{K_1^2+1}} + \frac{R(\cos\alpha_T - K_1 \sin\alpha_T) + b}{\sqrt{K_1^2+1}} \qquad (3)$$

where $K_1$ and b are constant coefficients determined by the thickness of the soil layer on the grid and its distance to the axis of rotation of the rotor; $a_T$ is the current rotation angle of the radius vector ($a_T$ = wt) R is the radius of the rotor. V is the angle between the OX coordinate axis and the radius vector.

The radius of gyration of the elementary plane ρ is determined [11]:

$$\rho = \sqrt{R^2 - 2R(x\cos\varsigma + Z\sin\varsigma) + X^2 + Z^2} \qquad (4)$$

The minimum radius of the rotor R is chosen in such a way that its blades pass through the gaps of the separating grid along its entire working length.

The shear angle is determined by:

$$\alpha_z = \frac{360^0}{2n} \qquad (5)$$

where n is the number of knives.

Changes in the required traction force with a change in the operating mode are calculated from [10]. This formula is rational when calculating traction resistance in full accordance with the laws of mechanics. Traction resistance of one working body of an inclined ripper [11]:

$$P = P_1 + P_2 + P_3 = Fg + kS + ESV^2 \qquad (6)$$

where $P_1$ is resistance, which does not depend on either the depth of plowing or the speed of movement, friction in the mechanisms of the working bodies; $P_2$ - resistance due to the deformation of the soil layer; f - coefficient of friction, S - area of formation deformation, m$^2$; G is the weight of the working body, kg; k is the coefficient characterizing the ability of the soil layer to resist deformation, for an average soil, k = 3000 kg/m$^2$; $P_3$ is the resistance caused when manpower (energy) is communicated to the soil layer; E - coefficient depending on the geometric shape of the working body and soil properties, E = 200 kg s$^2$/m$^4$; V is the speed of movement.

**Conclusions.** The main element of the inclined ripper is an inclined post with a plowshare and a chisel. In the general case, the plowshare stands and the chisel work like two-sided wedges. Based on the analysis of the trihedral wedge theory, it can be seen that it is applicable to the tools used, and to justify the design parameters of the new inclined ripper, its further development is necessary, including the latest developments in the field of agricultural mechanics.

The technological process of operation of a non-moldboard working body of an inclined type consists in the fact that the chisel, moving in the soil, deforms it, a compacted zone is formed in front of the chisel.

With further movement of the soil layer, the inclined post with a plowshare produces an oblique cut of the partially loosened layer, then, due to the porosity of the soil and the dispersed structure in it, under the action of the load, structural bonds are destroyed, the particles move relative to each other, the pores between them are filled, water and gases are displaced from stressed zone into an unstressed or less stressed one. This technology ensures the destruction of the plow plate, eliminates harmful soil compaction by heavy machines, increases soil resistance to water and wind erosion, and reduces weed infestation.

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**ДОСЛІДЖЕННЯ ВПЛИВУ КОНСТРУКТИВНИХ ПАРАМЕТРІВ РОБОЧОГО ОРГАНУ ГРУНТООБРОБНОЇ МАШИНИ НА ЕНЕРГОЕФЕКТИВНІСТЬ ТА ЯКІСТЬ ОБРОБІТКУ ГРУНТУ**

Проведено дослідження технологічного процесу та конструктивних параметрів похилого робочого органу. Підвищення рівня агротехніки є шляхом застосування нових сільськогосподарських машин і знарядь.

Встановлено вплив геометричних параметрів похилого розпушувача на якісні та енергетичні показники безполицевого обробітку ґрунту. Висока концентрація посівів даних просапних культур призводить до накопичення злісних бур'янів, хвороб і шкідників. Зниження загального рівня агротехніки обробітку кукурудзи та соняшнику в несприятливі за погодними умовами періоди не дає змоги достатньо протистояти сумісній дії шкідливих чинників і погоди, тому порушено питання щодо перегляду наявних та обґрунтування нових, більш ефективних, прийомів агротехніки їх вирощування.

Визначено, що використання на схилових полях технологій обробітку ґрунту, які пристосовані для рівнинних умов не враховують особливостей рельєфу, призводить до інтенсивного розвитку ерозійних процесів.

Одним із напрямів підвищення якості основного обробітку ґрунту буде застосування плугів розпушувачів із похилими робочими органами, що забезпечують якісне розпушування по всій ширині захвату стійки, усувають ущільнення ґрунту та залишають на поверхні поля стерню.

**Ключові слова:** ґрунт, обробіток, грунтообробна машина, параметри, робочий орган, плуг, якість.

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