

PAPER

DETERMINING THE RESISTANCE OF GRAVITY OF THE CHISEL SOFTENER OF AN IMPROVED DEEP SOFTENER PLOUGH

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Abstract

This article focuses on research aimed at reducing energy consumption during the deep softening of the earth's ploughing layer. The study primarily emphasizes improvements to the technological process, driven by theoretical research findings. The goal is to enhance the efficiency of energy use while maintaining or improving the effectiveness of the soil softening process, which is crucial in agriculture for facilitating easier tilling and better soil conditions. By refining the process based on theoretical analysis, the research seeks to develop strategies that not only optimize energy consumption but also contribute to more sustainable agricultural practices.

Key words: plough, body, knife, frame, tractor, support wheel, longitudinal section, hanging device, bracket, deep softener, chisel softener, dense heel, energy-efficient, construction, fuel, processing depth, resistance of gravity.

Introduction

In the world, energy and resource efficiency is the most important issue in creating new agricultural techniques and technologies and improving existing machines. "More than 1,8 billion hectares of land are cultivated annually for the cultivation of various agricultural crops worldwide" [1] considering, one of the important tasks is the development of machines and devices for soil cultivation with high work quality and productivity, as well as energy and resource efficiency. In this regard, great attention is being paid to the development of

plows that soften the subsoil at the same time as plowing. Some progress has been made in developed foreign countries in this direction, including the USA, Germany, the Netherlands, England, Italy, the Russian Federation, Belarus, Ukraine and other countries. [2].

In the world, scientific and research work is being carried out aimed at developing new scientific and technical bases of plows that soften the subsoil at the same time as plowing the fields where agricultural crops are grown. In this direction, among other things, the development of deep

Compiled on: March 18, 2026.

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softening plows, which softens the subsoil at the same time as plowing the land freed from agricultural crops, has high work quality and productivity, is energy-resource efficient, and has an improved technological process, is gaining importance.

At present, in order to soften the layers under the drive, which contain gypsum, gravel and sand, hand-made deep softeners of various constructions are used. This leads to increased consumption of labor, fuel and other operational costs and excessive soil compaction. Also, when processing through the existing working bodies with a deep softener, a secondary dense heel layer is formed in the soil. This, in turn, has a negative effect on the deep development of plant roots and high yield. The analysis of the conducted literature and research results show that the main soil treatment, i.e. plowing, along with the softening of the subsoil in one pass of the aggregate, has been showing its effectiveness in the world experience.

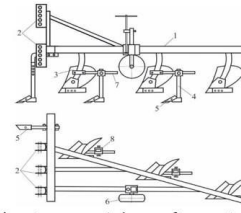
But two-level PD-3-35 plugs equipped with deep softeners in the form of an arc claw, designed for this high-energy consumption technological process, have a number of technical and technological shortcomings and are not suitable for use in the field due to their high energy consumption. Also, our scientists have proven that a secondary dense heel layer is formed in the subsoil layer when treated with arc-shaped plow softeners.

Currently, subsoil softening is carried out either before plowing, or after plowing with soil softeners and two-tier plows equipped with soil softeners. Based on the above, reducing the energy consumption of this process by improving the technological process of deepening the soil along with plowing is one of the urgent problems in the agricultural sector. [5].

Materials and Methods

In order to study this problem and solve the problem, a laboratory-field device was developed. The device was made in suspension version for assembly with 3-4 class tractors (MX-135, MXM-140, MXM-240, New Holland T7060). Figure 1 shows the structural scheme of the laboratory-field device.

Experimental plough with pit softener (Fig. 1) consists of a frame 1, hanger device 2, body 3, deep softener 4, chisel-softener 5, support wheel 6,



1-frame; 2-hanger device; 3-corpus; 4-deep softener; 5-chisel-softener; 6-support wheel; 7-longitudinal section; 8-bracket

Figure 1. Construction scheme of the improved deep softening plough

longitudinal section 7 and bracket 8.

It is possible to change the longitudinal distance between the plug body and the furrow softener installed behind it, the distance between the furrow softener installed behind the tractor wheel and the first body of the plug, and the depth of cultivation of the furrow softener (Fig. 2).



Figure 2. Side view of the deep softener plough

Results and Discussion

Based on previous studies, we determine the resistance of the chisel-shaped deep softener according to the following expression [?]:

$$R_u = B_u \left\{ \frac{Tr_u}{\sin \gamma_u} + K_\varepsilon \frac{h}{\cos \frac{1}{2}(\varepsilon_u + \varphi_1 + \varphi_2)} \times \left[\sin \frac{1}{2}(\varepsilon_u + \varphi_1 + \varphi_2) + tg \varphi_1 \cos \frac{1}{2}(\varphi_1 + \varphi_2 - \varepsilon_u) \right] \right\} +$$

$$+ h_\lambda B_u \rho \left\{ L_u g \frac{\sin \varepsilon + tg \varphi_1 (\cos \gamma_u ctg \gamma_u + \sin \gamma_u \cos \varepsilon_u)}{\cos \varepsilon - tg \varphi_1 \sin \gamma_u \sin \varepsilon_u} + \right.$$

$$\left. + V^2 \frac{\sin^2 \gamma_u [\sin \varepsilon + tg \varphi_1 \sin \gamma_u (ctg^2 \gamma_u + \cos \varepsilon_u)]}{ctg \varepsilon_u - tg \varphi_1 \sin \gamma_u} \right\} \times \left(1 + \frac{W}{100} \right), \quad (1)$$

where:

- R – drag resistance of the chisel-shaped deep softener, N;
- T – hardness of the soil layer being processed by the chisel-shaped deep softener, Pa;

- b – thickness of the chisel-shaped deep softener blade, m;
- γ_u – angle of installation of the chisel blade relative to the edge wall, ;
- ε_u – angle of deviation of the resultant soil resistance forces acting on the chisel-shaped tool relative to the horizon, ;

$$\varepsilon_u = \arctg \frac{\tg \alpha_u}{\sin \left[\arctg (\sin \alpha_u \ctg \beta_u) \right]};$$

- ρ – density of the soil layer processed by the chisel-shaped deep softener, kg/m³;
- W – soil moisture, %.

Expression (3.25) proposed by A.T. Imondosov [?] differs in that it takes into account the influence of the installation angle of the working surface relative to the transverse-vertical plane on the traction resistance.

When $\gamma_u \neq 0$, the soil is subjected to two types of deformation: compression and bending.

In conclusion, assuming:

$b = 0.057$ m, $T = 5 \times 10^6$ Pa, $t = 0.001$ m, $K_c = 3 \times 10^4$ Pa,

$\alpha_u = 30^\circ$, $\phi_1 = 30^\circ$, $\phi_2 = 40^\circ$,

$\rho = 1400$ kg/m³, $g = 9.81$ m/s², $W = 14\%$,

according to calculations using equation (1), it was determined that the traction resistance of the chisel-shaped deep softener is 0.63–1.17 kN at a working depth of 10–15 cm.

REFERENCES

1. http://evdemosfera.narod.ru/issl/issl/ek_zemlia
2. www.agroru.com/blog/novinki_agromislennogo
3. The President of the Republic of Uzbekistan dated February 7, 2017 Decree No. PF-4947 “On the action strategy for the further development of the Republic of Uzbekistan”.
4. O2019 of the President of the Republic of Uzbekistan Sh. Mirziyoyev Decision No. PQ-4410 dated July 31 “On measures related to the

rapid development of agricultural machinery, state support for the provision of agricultural machinery to the agrarian sector.”

5. of the President of the Republic of Uzbekistan on October 23, 2019 “Development of agriculture of the Republic of Uzbekistan on approval of the strategy for 2020-2030” Decree No. PF-5853.
6. O'z DSt 3355:2018 “Testing of agricultural machinery. Soil digging machines and weapons. Test program and methods”// Official publication. - Tashkent, 2018. - 32 p.
7. O'z DST 3193:2017 “Testing of agricultural machinery. The method of energy evaluation of machines”// Official publication. - Tashkent, 2017. - 21 p.
8. N.Murodov, U.Khasanov. Determination of resistance to gravity of working body with the pit softener installed in the two-layer plow during the main tillage, 2020 IOP Conf. Ser.: Mater. Sci. Eng. 883 012173, DOI 10.1088/1757-899X/883/1/012173.
9. U.I.Khasanov, R.Choriyeu, A.A.Juraev, SH.M.Kayimov, and K.S.Sobirov “Determining the longitudinal of the distance from the soil-deepener mounted on the work-improved plug to the over turner behind it”, Proc. SPIE 12296, International Conference on Remote Sensing of the Earth: Geoinformatics, Cartography, Ecology, and Agriculture (RSE 2022), 122960G (6 July 2022).
10. U.I.Khasanov, M.M.Makhmudova, A.A.Savridinov, K.S.Sobirov, & SH.T.Safarov. (2022). The Results of the Study of the Compactions of the Bottom of the Furrow in Plowing by Plug Corpusies as well as Tractor Wheels. Texas Journal of Agriculture and Biological Sciences, 4, 62–67.
11. A.Tuxtakuziev, U.I. Khasanov, M.Z. Ochilov. The results of experiments the width of the soil deeper like gougeand its impact on studying performance. ACADEMICIA: An International Multidisciplinary Research Journal, 2021.
12. Muradov N., Khasanov U. Determination of the tensile strength resistance of the working

body with a deep softener installed on a two-layer plow during the main processing process / / *mejdunarodnaya nauchnaya conference "stroitelstvo hydraulic vodn "resources"* (Conmechhydro), 23-25-aprelya Tashkent-2020. - P. 3-8.

13. Khasanov U. I., Savriddinov A. A., Sabirav K. S. the results of the experiment showed a deeper width of the soil, such as the angle of crushing, and its effect on the study of activity/ / *Journal of Applied Research* doi RA:10.47191 / *rajar* / v7i10.07,size: 07 issue: 10 October 2021. - P. 2570-2573.
14. Muradov N., Khasanov U. Determination of the tensile strength resistance of the working body with a deep softener installed on a two-layer plow during the main processing process / / "Construction mechanics, hydraulics and water resource engineering" (conmechhydro). - Membership fees, 2020. - P. 3-8.
15. Muradov N.M., Hasanov U.I., Ochilov M.Z. Scientific research on the construction of energyatejamkor plug / / *Международный научно-практический магазине "Глобальная Наука и Инноватион 2020: Централная Азия"*. - Казакстан, 2020. - Б. 51-54.
16. Mamadaliev M.Kh. Parameterization of Combined Aggregate Softener with Minimum Tillage: Diss. technical. science. - Yangiyul - Andijan - 2010. - 165 p.
17. Имандосов А.Т. Обоснование параметров и схемы расстановки корпусов двухъярусного плуга для работы на повышенных скоростях движения в зоне хлопководства : Автореф. дисс... канд. техн. наук. —Янгиюль, 1991. — 17 с