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MILLING SPEED OPTIMIZATION

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ABSTRACT
The article considers the question of the optimal impact speed during the destruction of soil lumps from an energy point of view, proposes a new methodology for assessing based on newly formed surfaces after the destruction of soil lumps, derives a dependence for determining the specific energy spent on crushing soil lumps, presents the experimental procedure and experimental results on Based on the data obtained, conclusions are drawn.

Keywords: Impact velocity optimization method, elastic deformation, plastic deformation, specific work, specific energy, degree of grinding, fraction, newly formed surfaces, diameter of soil lumps, impact velocity, moisture of soil lumps.

INTRODUCTION
Assessing the quality of work of the working bodies of rotary machines in terms of energy intensity is a very important indicator when comparing the working bodies and designating the speed regime for grinding soil lumps and clumps, since the working body of a rotary machine rotates at a higher speed than the translational speed of the unit. It is known that the energy intensity of the process of tillage according to V.P. Goryachkin is proportional to the square of the speed of movement of the working body in the soil environment, the higher the speed, the greater the energy spent on processing.

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The quality of the soil treatment is determined by the size of the soil fractions obtained after treatment (Dexter, 2004b). The soil structure obtained by tillage largely depends on the state of the soil (Dexter, 1979; Berntsen & Berre, 2002). This must be taken into account when comparing aggregate distributions by fractions obtained for various soils or implements. Dexter (1979) proposed a soil structure to be created by tillage, depending on the type of implement, the number of implement passes, the depth of tillage, soil management, yield, soil water content and soil compaction. The average diameter of the fractions after soil treatment decreases with increasing specific energy of the unit.

Berntsen & Berre (2002) showed that on four soils with a clay content of 15 to 45%, energy consumption of about 50 J / kg led to a significant reduction in fraction size. Further crumbling of large fractions caused an increase in energy consumption. Berntsen & Berre (2002) suggested, for analysis of energy efficiency when crumbling, the initial state of the soil can be taken into account by correlating the increase in the total surface with the original surface and by correlating the specific energy reserve with the specific destruction energy needed to destroy the coma or shift the soil.

Consequently, the energy efficiency of the developed tools and their differences between each other depends on the initial state of the soil (Hadas & Wolf, 1983; Berntsen & Berre, 200). The soil structure formed during processing is determined by the moisture content in the soil. There is humidity at which soil cultivation is optimal, and is called optimal humidity for soil cultivation. It is defined as humidity at which the fraction of small fractions produced by the aggregate is the largest, or, conversely, the fraction of clumps produced is the smallest (Dexter & Bird, 2001; Dexter, 2004b).

As can be seen from the above judgments of the researchers, the quality of the soil treatment mainly depends on its moisture and does not take into account the technological and geometric parameters of the tillage machine or we can say that the technological parameters of the working bodies, for example, the processing speed, have not been evaluated.

There are many methods for assessing rotary working bodies, but they do not allow rationally choosing the limits of the speed of soil cultivation.

Degradability of soil lumps and methods for assessing working organs were worked by Degraf G.A. [94], Baymetov R.I. (1972), Akhmetov A.A. (1991), Inoyatov I.A. (1997) and many others. The research conducted by these researchers came down to justifying the parameters of the working body, with various evaluation criteria. Among

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the works performed, the experiments conducted by R. Baymetov (1972) deserve special attention, in which specific crushing work was taken as the criterion for evaluating the work of the deformer. Specific work on crushing does not reveal the essence of the issue, it can only be used to compare the results of the work of the studied working bodies, because specific crushing work will always decrease with increasing speed, at which the degree of crumbling of soil lumps increases. Therefore, it is impossible to determine the optimal crushing rate. In addition, the destructibility of soil lumps, depending on the size, moisture, and impact velocity of the working body, was not taken into account in this work either.

Based on the foregoing, a new technique is needed to determine the critical speed limits at which fracture begins, depending on the size of the soil lump, and the optimal crushing rate.

METHODOLOGY

1. Determination of newly formed surfaces after crushing of soil lumps and blocks.

$$\Delta S = S_2 - S_1, \qquad (1)$$

where S_1 - the total surface of the piece before crushing, m^2;
S_2 - total surface of all particles after crushing, m^2.

To determine the values of S_2 and S_1, we assume, that pieces of crushed material before and after crushing consist of cubes whose sizes are equal to the average diameter of the sample D and particles of the crushed product d.

Then the number of particles (n) resulting from the crushing of the sample

$$n = \frac{Q}{q_i} = \frac{D^3}{d^3}, \qquad (2)$$

here Q an dq_i are the mass of pieces before and after crushing.

If we assume that the crushing results in particles of the same size, then

$$S_1 = 6D^2 \quad \text{и} \quad S_2 = 6nd^2, \qquad (3)$$

Substituting the values of n, S_1, and S_2 in relation (3.6), we obtain

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$$\Delta S = 6D^2\left(\frac{D}{d} - 1\right), \qquad (4)$$

or, denoting, $i = \frac{D}{d}$ we can write

$$\Delta S = S_1(i - 1). \qquad (5)$$

From this it is obvious that the new surfaces formed during the crushing of the samples are equal to the surface of the original sample, multiplied by the degree of grinding without a unit.

When crushing lumps, crushed particles usually have not the same dimensional characteristics, which entails large errors when averaging them. This is especially noticeable if there are large pieces in the crushed product. To take into account the heterogeneity of the grinding composition, the particles were divided into fractions and the newly formed surfaces were determined from them in the crushing process as follows:

$$S = S_2 - S_1 = \frac{q_1}{\gamma_0 \cdot d_1^3} \cdot 6 \cdot d_1^2 + \frac{q_2}{\gamma_0 \cdot d_2^3} \cdot 6 \cdot d_2^2 + \cdots + \frac{q_n}{\gamma_0 \cdot d_n^3} \cdot 6 \cdot d_n^2 - 6D^2 =$$
$$6D^2\left[\left(\frac{q_1}{d_1} + \frac{q_2}{d_2} + \cdots + \frac{q_n}{d_n}\right) - 1\right] = 6D^2\left(\frac{D}{Q}\sum\frac{q_i}{d_i} - 1\right), \qquad (6)$$

here Q – mass of soil lump, kg;

q_i – mass of individual fractions, kg;

γ_0 – fraction density, kg/m^3;

$d_i = (d_u + d_l)/2$ – average diameters of narrow classes, m; d_u – is the upper diameter of the fraction, i.e. the size of the sieve through which the material passed; d_l – is the lower diameter of the fraction, i.e. the size of the sieve hole on which the material was held.

In the same way, it can easily be shown that when crushing q' a kilogram of bulk material consisting of identical pieces with an initial size D_m, the newly formed surfaces will

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$$\Delta S = 6D^2\left(\sum \frac{q_i}{d_i} - \frac{q'}{D_m}\right). \qquad (7)$$

Moreover, if we assume $d_i = d_m$, то, obviously $\sum q_i = \Sigma q'$ then

$$\Delta S = \frac{6q'}{\gamma_0}\left(\frac{1}{d_m} - \frac{1}{D_m}\right). \qquad (8)$$

If pieces of material before and after crushing are taken as a ball, then the newly formed surfaces will be equal

$$\Delta S_b = \frac{\pi}{6}\Delta S_i, \qquad (9)$$

here ΔS_b, ΔS_i - newly formed surfaces during crushing of spherical and cubic samples. Samples and pieces of lumps after crushing by us were taken as a cube for the following reasons:

a) we could not get samples that have exactly a spherical surface;

b) there are always bumps on the surface of the sample and pieces after crushing, which will increase the overall bump;

c) particles after crushing have an arbitrary shape.

2. Kinetic energy spent on crushing soil blocks and lumps. With the collision of the soil lump and the working body in motion, the equation of conservation of momentum has the form:

$$m_1 \cdot \overline{U_1} + m_2 \cdot \overline{U_2} = m_1 \cdot \overline{\upsilon_1} + m_2 \cdot \overline{\upsilon_2}, \qquad (10)$$

here m_1, m_2 – mass, respectively, of the pendulum and soil lump, kg;
$\overline{U_1}\ \overline{U_2}$– speed to collision of the pendulum and soil lump, m/s, respectively;
$\overline{\upsilon_1}, \overline{\upsilon_2}$ - velocity after collision of the pendulum and soil lump, m/s, respectively.
Projecting (10) onto the *X* axis, we obtain

$$m_1 \cdot \overline{U_{1x}} + m_2 \cdot \overline{U_{2x}} = m_1 \cdot \overline{\upsilon_{1x}} + m_2 \cdot \overline{\upsilon_{2x}}, \qquad (11)$$

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If, take into account that

$$\overline{U_{2x}} - \overline{U_{1x}} = k(\overline{v_{1x}} - \overline{v_{2x}}) \quad (12)$$

then we have

$U_{1x} = v_{1x} - (1+k) \cdot \frac{m_2}{m_1+m_2} \cdot (v_{1x} + v_{2x});\ U_{2x} = v_{2x} - (1+k) \cdot \frac{m_2}{m_1+m_2} \cdot (v_{1x} + v_{2x})$. (13)

At $v_{2x} = 0$, we get

$$U_{1x} = v_{1x} - (1+k) \cdot \frac{m_2}{m_1+m_2} \cdot v_{1x};\ U_{2x} = -(1+k) \cdot \frac{m_2}{m_1+m_2} \cdot v_{1x}$$

$$S_{1x} = S_{2x} = -(1+k) \cdot \frac{m_2}{m_1+m_2} \cdot v_{1x} \quad (14)$$

In our case, the blow is not elastic; therefore, k = 0. Then

$U_{1x} = v_{1x} - \frac{m_2}{m_1+m_2} \cdot v_{1x};\ U_{2x} = -\frac{m_2}{m_1+m_2} \cdot v_{1x};\ S_{1x} = S_{2x} = -\frac{m_2}{m_1+m_2} \cdot v_{1x}$. (15)

Kinetic energy lost on impact

$$\Delta T = \frac{S_{x1}^2}{2m_1} + \frac{S_{x2}^2}{2m_2} = \frac{S_x^2}{2m_1m_2}(m_1+m_2). \quad (16)$$

If consider (2.25) then

$$\Delta T = T_1 - T_2 = \frac{m_1m_2{v_{1x}}^2}{2(m_1+m_2)}. \quad (17)$$

One of the main constant values of indicators of soil lumps is the value of the specific energy for crushing.

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When determining the energy spent on the formation of new surfaces, it is necessary to collect and take into account all the particles obtained by crushing the sample. For this purpose, after crushing by impact on a pendulum device, the soil collected on a sailing film was divided into fractions in sieves with sizes of 10, 25, 50, 100 mm.
The value of the specific energy on newly formed surfaces during crushing is defined as the ratio of the kinetic energy spent on crushing to a unit of newly formed surfaces defined by formula 6, i.e.

$$\alpha_s = \frac{\Delta T}{\Delta S}. \qquad (18)$$

When crushing lumps, after the impact, the crushed pieces are discarded in the direction of movement of the deformer, we do not calculate separately the rejection energy, since this is inevitable, therefore, we take the impact energy as the fracture energy.

EXPERIMENT RESULTS

To determine the correctness of the assumptions and deduced dependencies, experiments were carried out on the destructibility of lumps and blocks on a pendulum device. For this, samples were prepared, soil lumps with diameters of 10, 20, 30, 40, 50, 60, 70, 80, 90, 110 mm spherical in shape. The destruction of the lumps was carried out on a pendulum device. The speeds of the end of the pendulum were assigned by deflecting the pendulum bar by a certain angle from the vertical. All conditions for obtaining reliable data are met.
Each sample of the destroyed soil lumps was collected separately and sieved on sieves of sizes 10, 25, 50, 100 mm and weighed separately by fractions.

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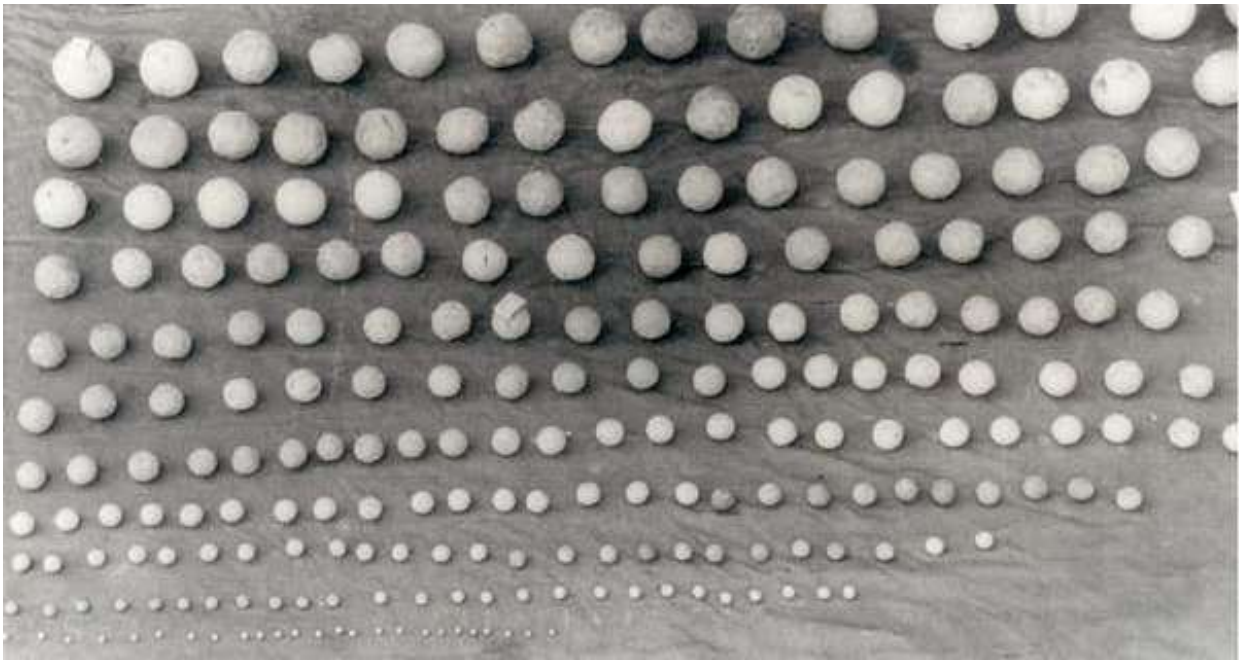

Fig. 1. Samples prepared for testing.

The results of experiments to determine the specific energy per unit of newly formed crushing surfaces are shown in Fig. 2.

From these results it can be seen that the energy consumption for crushing lumps of large sizes (more than 90 mm) decreases during the transition from static to dynamic. This indicates that, at all impact speeds, the degree of crumbling of the soil lump of large sizes is insignificant.

When crushing lumps of smaller sizes (up to 60 mm), the specific energy consumption per unit of newly formed surfaces increases in a straightforward manner, but with less intensity.

The dependence of the specific energy consumption for the formation of new surfaces on the size of soil lumps only states the conclusions made above and indicates that at lower speeds and with lump sizes over 90 mm, the energy consumption of crushing changes according to the hyperbolic curve.

Based on the data obtained, it can be concluded that for crushing soil lumps from the point of view of energy intensity, the impact speeds in the range of 7 ... 9 m / s are optimal.

The decrease in specific energy consumption during the transition from static to shock loads can be explained by a decrease in the yield zone. A further increase in energy

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intensity with an increase in impact velocity is explained by the fact that the temporary resistance of the soil increases with an increase in velocity.

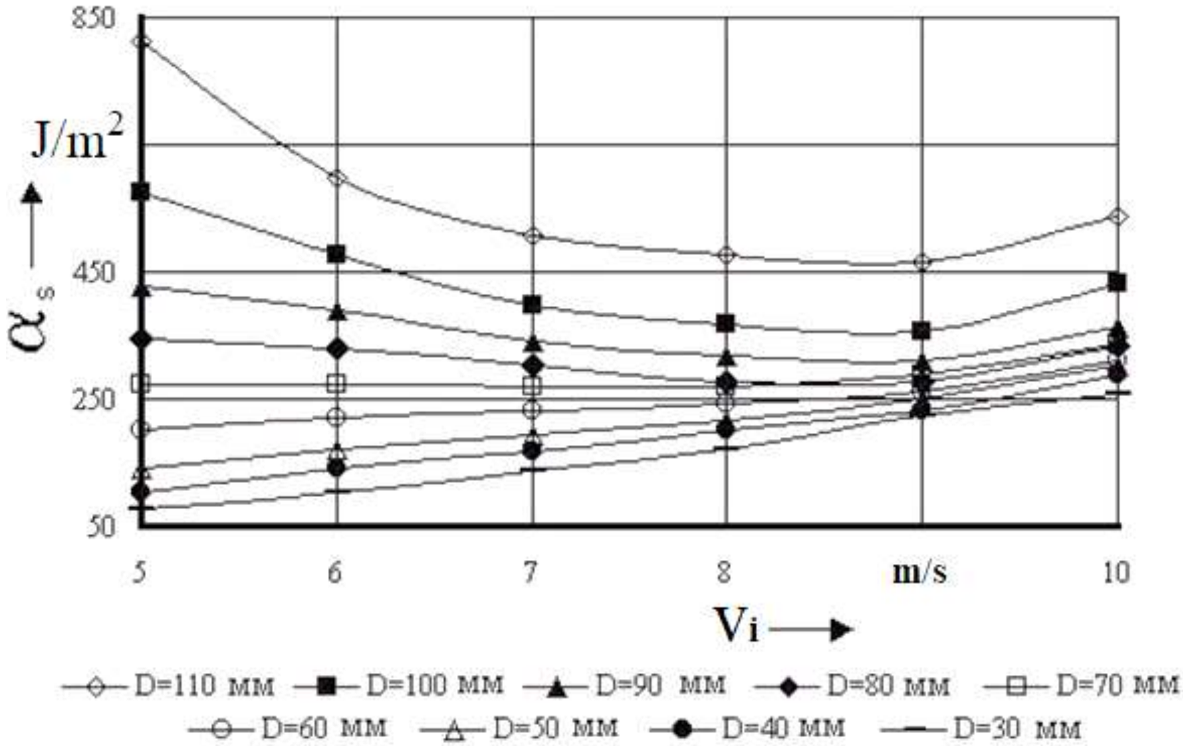

Fig. 2. The dependence of the specific energy consumption per unit of newly formed surfaces of crushed lumps on the impact velocity at W = 9.4%

CONCLUSIONS

1. An increase in the diameter of the lump at all humidity entails a decrease in the critical rate of its destruction according to the law of hyperbola.
2. The soil lump, when exposed to an impact load, is destroyed along the sections of weak bonds, which are usually larger in large lumps than in small ones. Therefore, in the destruction of small lumps, the impact speed should be greater.
3. In the impact of the working bodies on the material, the movement is communicated only to the particles closest to the place of impact. The sharper and faster the impacts, the deformation penetrates to a shallower depth, that is, the deformation in the material is local in this case. Therefore, to increase the degree of crumbling of lumps of large sizes, it is necessary to strike at a speed not exceeding the propagation velocity of plastic deformations of the soil.

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4. An increase in the impact velocity to 7 ... 9 m / s helps to increase the degree of crumbling of the soil lump, a further increase will entail an unjustified increase in the cost of specific energy for crushing the soil lump.

REFERENCES

1. Akhmetov A.A., Allanazarov M.A. et al. Justification of some parameters of the RBR - 4 rotary non-power ripper // Mechanization of cotton growing. 1991.- p. 4-5.
2. Baymetov R.I. On the crushing of the soil with combined tools of pre-sowing treatment // Mechanization of cotton growing. 1972, No. 10. p. 4-5.
3. Berntsen, R. & Berre, B. 2002. Soil fragmentation and the efficiency of tillage implements. Soil and Tillage Research 64, 137-147.
4. Dexter, A.R. 2004b. Soil physical quality: Part II. Friability, tillage, tilth and hard-setting. Geoderma 120, 215-225.
5. Dexter, A.R. & Bird, N.R.A. 2001. Methods for predicting the optimum and the range of water contents for tillage based on the water retention curve. Soil and Tillage Research 57, 203-212.
6. Hadas, A. & Wolf, D. 1983. Energy efficiency in tilling dry clod-forming soils. Soil and Tillage Research 3, 47-59.
7. Inoyatov I.A. Substantiation of the parameters of the grinding and sealing body of the rotary non-power ripper. Dis. for the degree of Candidate tech. sciences. Yangiyul, 1997.
8. Keller, Thomas. (2004). Soil Compaction and Soil Tillage–Studies in Agricultural Soil Mechanics.
9. Otahanov B.S. (2013) Determining the speed limit // Scientific Review Theory and Practice, №2, p. 61-62
10. Otahanov B.S., Payziev G.K. Xojiev B.R. (2014) Variants of the impact of the working body of a rotary machine on soil blocks and lumps. Scientific Life, 2014, No. 2, 75…78
11. Кидиров А. Агротехнические показатели машинно-тракторного агрегатов //ББК-65.32 я43 И 665 ISBN 978-5-98660-319-3 Инновационное научно-образовательное обеспечение агропромышленного комплекса: Материалы 69-ой Международной.

INNOVATIVE TECHNOLOGICA
METHODICAL RESEARCH JOURNAL
ISSN: 2776-0987 Volume 2, Issue 8, August, 2021

12.Отаханов, Б. С. (2014). ОБЪЕМ СВОБОДНОЙ ВЫГРУЗКИ ПОЧВЕННОЙ ФРЕЗЫ. Вестник развития науки и образования, (4), 11-13.
13.Отаханов, Б. С. (2013). ОПРЕДЕЛЕНИЕ СКОРОСТНОГО РЕЖИМА ОБРАБОТКИ ПОЧВЫ РОТАЦИОННЫМИ МАШИНАМИ. Научное обозрение: теория и практика, (2), 61-62.
14.Отаханов, Б. С., Умаралиев, Ю. Ю., Тухлиев, Г. А., & Разаков, А. Я. (2013). Кинетическая энергия и скорость гибкого рабочего органа при ударе о комок. Научное обозрение: теория и практика, (2), 63-66.
15.Отаханов, Б. С. (2013). Расчет длины пути резания. Europaische Fachhochschule., (4), 126.
16.Отаханов, Б. С., Нажмиддинова, Ё. Р., Саидмахамадов, Н. М., & Тургунов, Б. (2014). Обоснование формы и параметров гибкого рабочего органа ротационной почвообрабатывающей машины. Научная жизнь, (4), 65-70.
17.Отаханов, Б. С., Замонов, Ж. Р., Тухлиев, Г. А., & Разаков, А. Я. (2014). Совершенствование процесса технологии фрезерования дорожных покрытий. Вестник развития науки и образования, (1), 24-27.
18.Отаханов, Б. С., Киргизов, Х. Т., & Хидиров, А. Р. (2015). Определение диаметра поперечного сечения синусоидально-логарифмического рабочего органа ротационной почвообрабатывающей машины. Современные научные исследования и инновации, (11), 77-83.
19.Тухтакузиев, А., Мансуров, М. Т., & Тошпулатов, Б. У. (2019). ИССЛЕДОВАНИЕ РАВНОМЕРНОСТИ ГЛУБИНЫ ОБРАБОТКИ ПОЧВЫ ПОЧВООБРАБАТЫВАЮЩИМИ МАШИНАМИ. In ВКЛАД УНИВЕРСИТЕТСКОЙ АГРАРНОЙ НАУКИ В ИННОВАЦИОННОЕ РАЗВИТИЕ АГРОПРОМЫШЛЕННОГО КОМПЛЕКСА (pp. 382-387).
20.Ботиров, А. Г., Негматуллаев, С. Э., & Мансуров, М. Т. (2018). ГНЕЗДУЮЩИЙ АППАРАТ СЕЯЛКИ. Экономика и социум, (5), 223-227.
21.Ботиров, А. Г., & Мансуров, М. Т. (2017). УСОВЕРШЕНСТВОВАНИЕ ПОСЕВНОЙ СЕКЦИИ. Научное знание современности, (6), 48-51.
22.Абдулхаев, Х. Г., & Мансуров, М. Т. (2017). ВЛИЯНИЕ УГЛА НАКЛОНА К ГОРИЗОНТУ ТЯГИ РОТАЦИОННОГО РЫХЛИТЕЛЯ НА ПОКАЗАТЕЛИ ЕГО РАБОТЫ. In Научно-практические пути повышения экологической устойчивости и социально-экономическое обеспечение сельскохозяйственного производства (pp. 1219-1221).

ISSN: 2776-0987 Volume 2, Issue 8, August, 2021

23. Мансуров, М. Т., & Расулов, А. Д. (2016). Теоретическое обоснование параметров выравнивателя-уплотнителя комбинированной машины по системе push-pull для предпосевной обработки почвы. Молодой ученый, (8), 256-259.
24. Tukhtakuziyev, A., & Mansurov, M. T. (2015). Research of stability of tractor with frontand rear-mounted tools against sidewise skidding. Tractors and Agricultural Machinery, (9), 34-35.
25. Tuhtakuziev, A., & Mansurov, M. T. (2015). Issledovanie ustojchivosti traktora s orudijami perednej i zadnej naveski protiv bokovogo zanosa. Traktory i sel'hozmashiny, (9), 34-35.
26. Tukhtakuziev, A., & Mansurov, M. T. (2015). Research of resistance on the tractor equipped with implements at front and backside lift hitch contrarily the sidewise skidding. Europaische Fachhochschule, (6), 76-77.
27. Tuhtakuziev, A., & Mansurov, M. T. (2015). Issledovanie ustojchivosti traktora s orudijami perednej i zadnej naveski protiv bokovogo zanosa. Traktory i sel'hozmashiny, (9), 34-35.
28. Мансуров, М. Т., & Тухтакузтев, А. (2015). Исследование устойчивости трактора с орудиями передней и задней навески против бокового заноса. Тракторы и сельхозмашины.-2015.-№ 10.-С. 34-35.
29. Тухтакузиев, А., & Мансуров, М. Т. (2015). Исследование устойчивости трактора с орудиями передней и задней навески против бокового заноса. Тракторы и сельхозмашины, (9), 34-35.
30. Тухтакузиев, А., & Мансуров, М. Т. (2015). Исследование устойчивости прямолинейного движения трактора с орудиями передней и задней навески. In Интеллектуальные машинные технологии и техника для реализации Государственной программы развития сельского хозяйства (pp. 125-128).
31. Тухтакузиев, А., & Мансуров, М. Т. (2015). Исследование устойчивости прямолинейного движения трактора с орудиями передней и задней навески. In Интеллектуальные машинные технологии и техника для реализации Государственной программы развития сельского хозяйства (pp. 125-128).
32. Тухтакузиев, А., Мансуров, М., Расулжонов, А., & Каримова, Д. Научные основы обеспечения равномерности глубины работы почвообрабатывающих машин. Ташкент: Издательство TURON-IQBOL.–2020.

ISSN: 2776-0987 Volume 2, Issue 8, August, 2021

33. Абдулхаев, Х. Г., & Мансуров, М. Т. (2017). Влияние угла наклона к горизонту тяги ротационного рыхлителя на показатели его работы. In Научно-практические пути повышения экологической устойчивости и социально-экономическое обеспечение сельскохозяйственного производства (pp. 1219-1221).
34. Мансуров, М. Т., & Тухтакузтев, А. (2015). Исследование устойчивости трактора с орудиями передней и задней навески против бокового заноса. Тракторы и сельхозмашины.-2015.-№ 10.-С. 34-35.
35. Tukhtakuziev, A., & Mansurov, M. T. (2015). Research of resistance on the tractor equipped with implements at front and backside lift hitch contrarily the sidewise skidding. Europaische Fachhochschule, (6), 76-77.
36. Тухтакузиев, А., Мансуров, М., Расулжонов, А., & Каримова, Д. Научные основы обеспечения равномерности глубины работы почво-обрабатывающих машин. Ташкент: Издательство TURON-IQBOL.–2020
37. Мансуров М.Т. Научно-технические решения агрегатирования почвообработывающих машин, состоящих из рабочих частей, навешиваемых спереди и сзади на колесные тракторы. Автореферат дисс. ... доктора техн. наук (DSc). – Ташкент, 2018. – 54 с.
38. https://www.indianjournals.com/ijor.aspx?target=ijor:aca&volume=11&issue=6&article=102.