INTERNATIONAL JOURNAL OF RESEARCH IN COMMERCE, IT,

ENGINEERING AND SOCIAL SCIENCES

ISSN: 2349-7793 Impact Factor: 6.876., Volume: 16 Issue: 05 in May 2022

EVALUATION OF THE WORK OF THE WORKING BODIES OF ROTARY AND COMBINED MACHINES

Otaxanov Bakhrom Sadirdinovich,
Namangan Engineering and Construction Institute, Associate Professor, Candidate of Technical Sciences. e-mail: baxromo1001@gmail.com

Qidirov Adxam Rustamovich,
Namangan Engineering and Construction Institute, teacher of the department "Technological machines and equipment" e-mail: aqidirov@gmail.com

Annotation: *The article analyzes the evaluation of the quality of work of rotary and combined machines for pre-sowing processing. The hypotheses of grinding solid materials from the point of view of tillage are considered and the advantages and disadvantages are determined. Based on the analysis, a method for assessing the quality of work of rotary and combined machines is proposed, based on determining the specific kinetic energy during soil cultivation, and a method for its determination is described.*

Key words: *seedbed preparation, loosening, harrowing, leveling, crumbling, specific work, formation of new surfaces, soil fractions, soil deformation, elastic deformation, plastic deformation, specific kinetic energy.*

Introduction.

To create favorable conditions for seed germination, pre-sowing soil treatment is used, which is a particularly significant technological process, which includes a number of technological operations, such as cultivation for loosening the surface layer of the soil, harrowing to preserve soil moisture and crushing lumps, rolling for compaction and leveling, which reduces the size of the unevenness of the soil surface [1]. According to the results of theoretical and experimental studies, it has been established that in the processes of rolling and leveling, which are performed at the final stage of pre-sowing cultivation, the soil surface is compacted in some cases due to the indentation of soil aggregates, as well as due to soil deformation up to certain factions. A high degree of deformation of soil aggregates is a negative factor that can lead to an increase in erosion-hazardous particles, which is unacceptable according to the requirements of the standard [2]. The quality of pre-sowing tillage is determined by measuring the depth of the treated layer, ridges, lumpiness of the surface, the degree of soil compaction, as well as the structure of the soil, the values of which affect the physical and technological properties of the soil. As a result of the analysis of scientific and technical literature, a single quality criterion has not been established that evaluates the work of tillage machines, both as separate working bodies and as part of combined units [3].

Crushing or crumbling is the main method of preparing the soil for sowing, in which, from a physical and agrotechnical point of view, the array is destroyed, crushed, and come to an optimal state for sowing, germination and growth of seeds of agricultural crops, and in the economic aspect, soil fertility increases. Such a factor as the degree of crumbling depends not only on the technological parameters of the machine-tractor unit, but also on the design features of the working bodies of tillage machines [4].

The development of a constructive-technological scheme of tillage tools with the inclusion of issues on improving the working bodies and the creation on this basis of a design that allows to reduce the speed of the working bodies without reducing the quality of crumbling is an urgent problem against the backdrop of the trend of saving energy [5].

Establishing relationships between energy costs and the dimensions of the final and initial pieces of material, their shape, physical and mechanical properties, etc. is the main issue in the theory of grinding [6].

According to the hypothesis of P. Rittinger (1867), the work during the grinding of the material is proportional to the area of the newly formed surface.

But Rittinger's Theory does not take into account changes in the shape of bodies during grinding. As a result, it is not suitable for describing crushing processes in cases where the finished product has a small specific surface area [7].

The theory of Kirpichev V.L. is known. (1874) and F. Kick (1885), in which it was established that the energy required for the same change in the shape of similar and homogeneous bodies is proportional to their volumes.

The considered grinding hypotheses reflect only a part of the complex processes occurring during grinding. The Kirpichev-Kik theory estimates the energy spent on the deformation of the material, and does not take into account the costs of the formation of new surfaces. It is advisable to use it for coarse and medium crushing, when the influence of newly formed surfaces is insignificant [8]. Rittinger's theory does not take into account the energy costs for the elastic deformation of the pieces. It is most applicable for fine crushing and grinding of materials.

In a real grinding process, the deformation of pieces and the formation of new surfaces occur simultaneously.

In this regard, many scientists sought to evaluate these phenomena in a complex. So, P.A. Rebinder (1940) and F. Bond (1951) proposed to determine the energy consumption during crushing, taking into account the work, both the deformation of the pieces and the formation of new surfaces [9].

Materials and methods.

Many researchers have worked on evaluating the effectiveness of the working bodies. The studies carried out by these researchers boiled down to substantiating the parameters of the working body, with various evaluation criteria. Among the works performed, special attention should be paid to the experiments carried out by R.I. Baimetov, on which the specific work for crushing was taken as the criterion for evaluating the work of the deformer [10, 11].

In [12], the assessment of the degree of destruction of soil aggregates by average size was carried out by comparing the data on the size before and after leveling the soil.

A method for evaluating the functioning of working bodies and machines for pre-sowing soil treatment, as well as a sieve method for determining the parameters of soil aggregates, was applied. Moreover, the average diameter of the soil aggregate in a single soil volume was determined by the expression

$$h_0(d_{s.a.}) = f(D_{s.a}). \quad (1)$$

where h_0 – defining characteristic of soil volume $V_{\text{п а.}}$, мм;

$d_{\text{п.а.}} = (d_{1\text{па}}, d_{2\text{п.а.}}, d_{3\text{па.}}, \dots, d_{n\text{па}})$– parameters of soil aggregates of soil volume $V_{\text{п.а}}$ in the form of a soil sample with an undisturbed structure, mm;

$d_{\text{п.а.}} = (d_{1\text{па}}, d_{2\text{п.а.}}, d_{3\text{па.}}, \dots, d_{n\text{па}})$ – parameters of soil aggregates of the average soil volume $V_{\text{п.а}}$, мм.

To directly calculate the average size of soil aggregates, they took their shape in the form of a ball and used data on particle size, quantity, and mass of each soil aggregate. They take this indicator as a basis [13]. Since the size of each soil aggregate is laborious to determine, recommendations are applied to determine the clodiness, structural coefficient [14, 15, 16].

ISSN 2349-7793 (online), Published by INTERNATIONAL JOURNAL OF RESEARCH IN COMMERCE, IT, ENGINEERING AND SOCIAL SCIENCES.,
under Volume: 16 Issue: 05 in May-2022
https://www.gejournal.net/index.php/IJRCIESS

Moreover, if there are appropriate standards and recommendations for soils and peat, then the determination of these indicators for soils does not have a single methodology.

Assuming that soil aggregates for the most part have the shape of a ball or as close as possible to it [17], it was proposed to determine the average size of averaged soil aggregates,

$$D_{\text{п.а}}^{\text{ср}} = \frac{\sum_{i=1}^{N} \frac{m_i}{d_{i\text{ф}}^2}}{2 * \sum_{i=1}^{N} \left(d_{i\text{ф}}^2 + d_{\text{па}}^2\right) * (d_{\text{п.а.}+1} + d_{\text{па}}} ,(2)$$

where m_i– weight of the i-th fraction of soil aggregates, g;

$d_{i\text{ф}}$– actual diameter of soil aggregates, mm;

$d_{i\text{па}}$–diameter of soil aggregates of the soil volume in the form of a soil sample with an undisturbed structure, mm.

The value of the average size of soil aggregates during soil deformation after the passage of active working bodies - cutters, cultivators - taking into account the presence of weeds, straw, stubble in the soil, with the formation of soil aggregates of the corresponding shape [18], can be determined by the expression

$$D_{\text{ф}} = \frac{m}{\sum_{i=1}^{N} \frac{m_i}{d_i}}. \qquad (3)$$

The presence of several indicators of the variable soil structure, taking into account the initial granulometric composition, as well as the type of soil, its physical, mechanical and technological properties, serves as the basis for determining the quality criterion of the leveling technological operation when comparing various technological processes and structures of working bodies for pre-sowing soil treatment. As a criterion, it is proposed to use the indicator [19], determined from the ratio

$$K_{quality} = \frac{D_{s.a}^{middle}}{D_{middle}}. \qquad (4)$$

Defined indicator $K_{\text{кач}}$ varies in the range from 0 to 1.0, and the more uniform the deformation of the soil profile, the closer the indicator $K_{\text{кач}}$ to the unit. When assessing innovative soil-cultivating working bodies of active, passive and combined action in laboratory conditions, the specified criterion is in the range of 0.80 ... 0.90, however, in the field it was found that the quality criterion is in within the range from 0.40 to 0.50 [20].

This evaluation method also allows only to compare the results of the work of the studied machine-tractor units in terms of the quality of processing, and does not take into account the energy intensity of the processing process.

The specific work for crushing and the method of the average size of the soil aggregate 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 the specific crushing work will always decrease with an increase in speed, at which the degree of crumbling of soil clods increases [21]. Therefore, it is impossible to determine the optimal crushing speed. In addition, these works did not take into account the destructibility of soil clods depending on the size, moisture content and speed of impact of the working body. Considering the above shortcomings, a technique based on the determination of the energy expended on the newly formed surface has been developed [22].

Based on the above, it is necessary to determine the critical speed at which destruction begins, depending on the size of the soil clod, the optimal crushing rate, depending on the newly formed surfaces of crushed soil clods [23].

It is considered established that the general scheme of destruction of a solid body consists in successive elastic and plastic deformation and its rupture [24].

The work of the compression force of the sample is spent on elastic, plastic deformations and on the destruction of the sample. The total work of crushing can be represented as

$$A_{um} = A_{у} + A_{п}, \qquad (5)$$

where $A_{у}$ - work expended on elastic deformation of the sample,

$A_{п}$ - the work expended on plastic deformation for the formation of new surfaces.

The work of elastic deformations is proportional to the deformed volume of the body, that is.

$$A_e = \frac{\sigma_{п}{}^2}{200 \cdot E} \cdot \Delta V = k \cdot \Delta V \qquad (6)$$

where $\sigma_{п}$ - voltage corresponding to the limit of proportionality, Pa;

E - modulus of elasticity, Pa;

k – loosening factor;

ΔV - deformed body volume, м^3.

The change in soil volume after processing is determined by the loosening coefficient

$$k = \frac{V_2}{V_1}, \qquad (7)$$

where V_1 - soil volume before tillage, м^3;

V_2 - soil volume after tillage, м^3.

The work expended on plastic deformations and on the formation of new surfaces [25] is assumed to be proportional to the value of the latter

$$A_p = \alpha \cdot \Delta S, \qquad (8)$$

where ΔS - the surface newly formed during the crushing of the material, which can be defined as the difference,

$$\Delta S = S_2 - S_1, \qquad (9)$$

where S_1 - total surface of the piece before crushing, м^2;

S_2 - total surface of all particles after crushing, м^2.

To determine the values of S2 and S1, we accept, as suggested by the authors of [26, 27, 28], that the pieces of crushed material before and after crushing consist of cubes, the dimensions of which are equal to the average diameter of the sample D and particles of the crushed product d.

Then the number of particles formed as a result of fragmentation of the sample

$$n = \frac{Q}{q} = \frac{D^3}{d^3} \qquad (10)$$

here, Q and qi - mass of pieces before and after crushing.

If we assume that particles of the same size are obtained as a result of crushing, then

$$S_1 = 6D^2 \quad \text{and} \quad S_2 = 6nd^2, \; (11)$$

Substituting the values of n, S1 and S2 in relation (9) we obtain

$$\Delta S = 6D^2 \left(\frac{D}{d} - 1\right) \qquad (12)$$

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

$$\Delta S = S_1(i - 1). \qquad (13)$$

Отсюда очевидно, что образовавшиеся в процессе дробления образцов новые surfaces are equal to the surface of the original sample, multiplied by the degree of grinding without unity.

Substituting the value of ΔS from equation (13) into (8), we obtain

$$A_p = 6\alpha \cdot D^2(i - 1). \qquad (14)$$

When crushing samples, crushed particles usually have different dimensional characteristics, which entails large errors in their averaging. This is especially noticeable if there are large pieces in

ISSN 2349-7793 (online), Published by INTERNATIONAL JOURNAL OF RESEARCH IN COMMERCE, IT, ENGINEERING AND SOCIAL SCIENCES., under Volume: 16 Issue: 05 in May-2022
https://www.gejournal.net/index.php/IJRCIESS

the fragmented product [29]. 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 during the crushing process as follows:

$$\Delta S = S_2 - S_1 = \frac{q_1}{\gamma \cdot d_1^3} \cdot d_1^2 + \frac{q_1}{\gamma \cdot d_2^3} \cdot d_2^2 + \cdots \frac{q_1}{\gamma \cdot d_n^3} \cdot d_n^2 - 6D^2 =$$
$$6D^2 \left[\frac{D}{Q}\left(\frac{q_1}{d_1} + \frac{q_2}{d_2} + \cdots + \frac{q_n}{d_n} - 1\right)\right] = 6D^2 \left(\frac{D}{Q} \cdot \sum \frac{q_i}{d_i} - 1\right) \quad (15)$$

where Q – mass of soil clod, кг

q_i- mass of individual fractions, kg;

γ – fraction density, kg/m 3;

d_i = ($d_в$+$d_н$)/2 - average diameters of narrow classes, m;

$d_в$- upper fraction diameter, i.e. the size of the sieve opening through which the material passed;

$d_н$ - lower fraction diameter, i.e. the size of the sieve opening on which the material was retained.

In the same way, it can be easily shown that when crushing q' kilograms of bulk material [30], which consists of identical pieces with an initial size Dcp, the newly formed surfaces will be

$$\Delta S = \frac{6}{\gamma_0}\left(\sum \frac{q_i}{d_i} - \frac{q'}{D}\right). \quad (16)$$

However, if we assume $d_i = d_{cp}$, то, obviously Σq_i=q' then

$$\Delta S = \frac{6 \cdot q'}{\gamma_0}\left(\frac{1}{d_{midle}} - \frac{1}{D_{midle}}\right) \quad (17)$$

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

$$\Delta S_b = \frac{\pi}{6} \Delta S_i, \quad (18)$$

where, ΔS_b, ΔS_i - newly formed surfaces during crushing of samples of spherical and cubic shape.

We took samples and pieces of lumps after crushing as a cube for the following reasons:

a) we could not obtain samples with an exactly spherical surface;

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

c) particles after crushing have an arbitrary shape.

Now substituting the values ΔS when splitting a single piece from formula (3.12) in (3.5), we obtain

$$A_{П} = 6\alpha D^2 \left(\frac{D}{Q} \sum \frac{q_i}{d_i} - 1\right). \quad (19)$$

The total crushing work is equal to the kinetic energy of the sample, which is determined from the formula

$$A_{общ} = \frac{Q \cdot \vartheta_р^2}{2g} \quad (20)$$

where, Q - sample weight, kg;

$\vartheta_р$ – working speed of the working body.

From formula (3.3) we have:

$$A_p = A_{um} - A_e. \quad (21)$$

If we substitute the values of their components into the last equality; then we get

$$\alpha \cdot \Delta S = \frac{Q \cdot \vartheta_i^2}{2} - k \cdot \Delta V. \quad (22)$$

From this expression, it is possible to determine the value of the specific work required for the formation of units of the newly formed surface during soil crushing

$$\alpha = \frac{Q\cdot\vartheta_i^2}{2\Delta S} - \frac{k\cdot\Delta V}{\Delta S} \text{ ёки } \alpha = \frac{1}{\Delta S}\left(\frac{Q\cdot\vartheta_i^2}{2} - k\cdot D^3\right). \qquad (23)$$

The task can be simplified if we determine the expended kinetic energy by the following well-known formula

$$\Delta T = T_1 - T_2 = \frac{m_1\cdot m_2\cdot\vartheta_i^2}{2(m_1+m_2)}, \qquad (24)$$

where m_1 – weight of the working body, kg;

m_2 – mass of crushed soil, kg.

From the components of the formula, it can be seen that the increased mass and increased speed of the working body lead to an increase in the energy expended on crumbling the soil [31].

The kinetic energy of the expended energy per unit mass and newly formed surface can be determined by the formulas,

$$\alpha_m = k_n\frac{\Delta T}{m_2}, \ \alpha_S = k_n\frac{\Delta T}{\Delta S}. \qquad (25)$$

где $k_n = k_{опт}/k_ф$- soil moisture coefficient, buffer $k_{опт}$- optimal soil moisture, $k_ф$- actual soil moisture

When studying the rate of destruction of soil clods, the samples were adjusted to a spherical shape with a diameter of 10 mm to 110 mm in 10 mm increments to create the same test conditions.

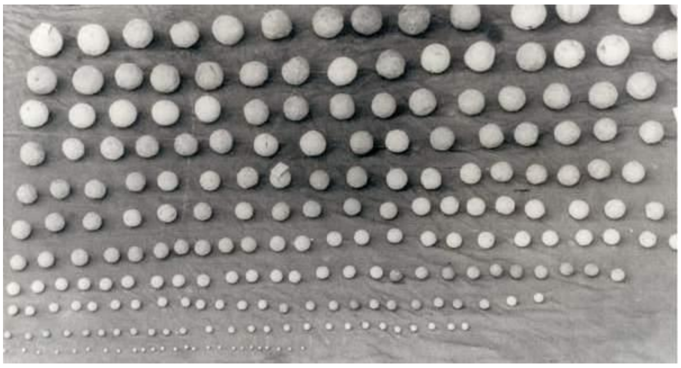

Fig.1. Samples prepared for testing.

The prepared samples were destroyed by impact in a pendulum device. Crushed soil clods were collected on a sail polyethylene film. The collected lumps were sifted through sieves with opening sizes of 50 mm, 25 mm, 10 mm and 5 mm. The sieved fractions were weighed to the nearest 0.1 gram.

On the basis of the data obtained, a three-dimensional dependence was constructed, displaying the response surface in Fig. 2. The response surface shows that at an impact speed of 5 and 6 m/s, with an increase in the sample size to 70 mm, an intensive decrease in the degree of crumbling of soil clods occurs. With a further increase in the diameter of the sample, the degree of crumbling of lumps does not change significantly. This, apparently, is due to the fact that the impact velocity is lower than the propagation velocity of plastic deformations. During the impact, very few cracks are formed along the cross sections of weak bonds, and the lumps are crushed into several pieces, the dimensions of which are larger than the boundary size (25 mm) of the degree of crumbling. This explains the sharp decrease in the degree of crumbling with an increase in their size to 70 mm.

ISSN 2349-7793 (online), Published by INTERNATIONAL JOURNAL OF RESEARCH IN COMMERCE, IT, ENGINEERING AND SOCIAL SCIENCES., under Volume: 16 Issue: 05 in May-2022 https://www.gejournal.net/index.php/IJRCIESS

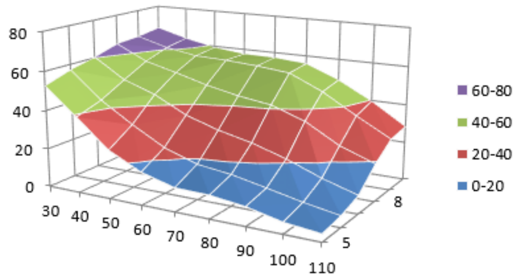

Fig. 2. Dependence of soil crumbling on size, impact speed at a moisture content of 9.4%.

At a speed of 7.8 m/s, the degree of crumbling of the samples changes almost in a straight line, which indicates that the impact speed is equal to or close to the speed of propagation of plastic deformations [32].

Starting from a speed of 8 m/s, and especially at a speed of 9, 10 m/s, the degree of crumbling of samples with a diameter of up to 80 mm changes slightly; with a further increase in the diameter of the samples, the curve of their degree of crumbling drops from 60% to 25%. In this case, what is assumed above also occurs. But due to the increase in speed beyond the limits of the propagation of plastic deformations, the intensity of crack formation increases, and the number of crushed soil pieces increases slightly. The shift in the intensity of the fall of the curve at an impact speed of 9 ... 10 m/s towards an increase in the diameter of the samples is explained by their mass or volume. Cracking in all sizes of soil clods is the same, but the sizes of crushed pieces are different, with small sample diameters, the size of crushed pieces is close to or less than the boundary size of the degree of crumbling, and with an increase in diameter, the size of the obtained pieces also increases and the degree of crumbling of the samples decreases [33].

The efficiency of the combined machine depends on the quality of crushing soil clods, which is largely affected by the speed of impact of the working bodies on the soil clods. The efficiency of the crushing process of soil clods can be characterized by the value of specific energy, i.e. the energy spent on crushing a unit mass of a lump [34].

Increasing the size of the lump will lead to an increase in the total energy consumption at all values of the impact velocity.

The specific energy consumption of crushing per unit mass of soil clods at the same impact speed almost does not change with an increase in the size of soil clods. This makes it possible to conclude that an increase in the impact velocity will always lead to an increase in the total energy intensity of destruction [35, 36].

Experimental data to determine the specific energy per unit of newly formed crushing surfaces are shown in fig. 3.

It can be seen from these data that the energy consumption for crushing large lumps (more than 80 mm) decreases when moving from static to dynamic impacts. This indicates that, at all impact velocities, the degree of crumbling of a large soil clod is insignificant [37].

When crushing lumps of smaller sizes (up to 60 mm), the specific energy consumption per unit of newly formed surfaces increases in a straight line, but with a lower intensity [38].

The dependence of the specific energy intensity for the formation of new surfaces on the size of soil clods only states the above conclusions and indicates that at lower speeds and with clod sizes over 90 mm, the energy intensity of crushing increases along a logarithmic curve [39, 40].

Based on the data obtained, it can be concluded that for crushing soil clods, from the point of view of energy consumption, the optimal impact speed is 7 ... 9 m / s.

ISSN 2349-7793 (online), Published by INTERNATIONAL JOURNAL OF RESEARCH IN COMMERCE, IT, ENGINEERING AND SOCIAL SCIENCES.,
under Volume: 16 Issue: 05 in May-2022
https://www.gejournal.net/index.php/IJRCIESS

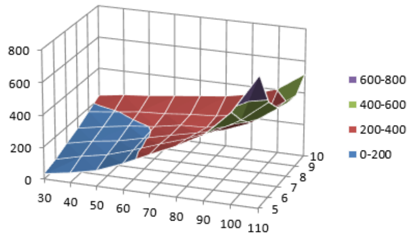

Fig.3. Dependence of the specific energy capacity on the size, impact velocity at a humidity of 9.4%.

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

An increase in the size of soil clods at all moisture levels entails a decrease in the critical rate of destruction. A soil clod, when exposed to a shock load, is destroyed along the cross sections of weak bonds, which are usually more in large clods than in small clods. Therefore, in the destruction of small lumps, the impact velocity should be greater.

In the impact action of the working bodies on the material, the movement is reported only to the particles closest to the place of impact. The sharper and faster the impacts, the deformation penetrates to a shallower depth, i.e., the deformation in the material in this case has a local character. Therefore, to increase the degree of crumbling of large-sized clods, it is necessary to strike at a speed not exceeding the rate of propagation of plastic deformations of the soil.

Increasing the impact speed to 7...9 m/s contributes to an increase in the degree of crumbling of the soil clod, a further increase will entail an increase in the cost of specific energy for crushing the soil clod.

The results obtained during laboratory and field studies on soils by the method of formation of new surfaces for the evaluation of the tested tillage working bodies make it possible to more fully assess the deformations of the soil profile.

References:

1. ГОСТ 16265-89 Земледелие. Термины и определения. М.: Издательство стандартов, 1991. 23 с.

2. ГОСТ 26244-84 Обработка почвы предпосевная. Требования к качеству и методы определения. М.: Издательство стандартов, 1984. 5 с.

3. Эргашев, Ш. Т., Отаханов, Б. С., & Абдуманнопов, Н. А. (2021). МАЛОГАБАРИТНАЯ ЗЕРНОСУШИЛКА ДЛЯ ФЕРМЕРСКИХ ХОЗЯЙСТВ. Universum: технические науки, (6-1 (87)), 55-58.

4. Отаханов, Б. С. (2013). Расчет длины пути резания. Europaische Fachhochschule.,(4), 126.

5. 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.

6. Байметов Р.И. О крошении почвы комбинированными орудиями предпосевной обработки // Механизация хлопководства. 1972, № 10. с. 4-5.

7. 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.

8. Otahanov, B., Qidirov, A., & Nuriddinov, B. (2021). MILLING SPEED OPTIMIZATION. Innovative Technologica: Methodical Research Journal, 2(08), 15-27.

9. Тухтакузиев, А. Т., & Отаханов, Б. С. (2005). Траектория движения гибких рабочих органов. Фарғона политехника институти илмий-техника журнали, (2), 132.

10. Otakhanov, B. S. (2013). Opredelenie skorostnogo rezhima. Nauchnoe obozrenie, 2, 61-62.

11. Никифоров М.В., Голубев В.В. Определение критерия качества предпосевной обработки почвы при использовании различных почвообрабатывающих машин // Вестник ФГОУ ВПО «МГАУ имени В.П. Горячкина». 2018. N 6(88). С. 11-16. DOI 10.26897/1728-7936-2018-6-11-16.

12. ГОСТ 10650-2013 Торф. Методы определения степени разложения. М.: Стандартинформ, 2014. 13 с.

13. Otahanov, B. S., Pajziev, G. K., Fajziev, S. G., & Toshpulatov, B. B. (2018). Determination of the thickness of the beater blade when interacting with the rods of topremoving conveyor. Интерактивная наука, (6), 50-53.

14. Вадюнина А.Ф., Корчагина З.А. Методы исследования физических свойств почв. М.: Агропромиздат, 1986. 416 с.

15. Вадюнина А.Ф., Корчагина З.А. Методы определения физических свойств почв и грунтов (в поле и лаборатории). М.: Высшая школа, 1961. 344 с.

16. Голубев В.В. Обоснование коэффициента структурности почвы при возделывании мелкосеменных культур // Проблемы аграрной науки и образования: Сб. науч. тр. Тверь: Тверская ГСХА, 2008. С. 63-65.

17. Otahanov, B. S., Paiziev, G. K., & Khozhiev, B. R. (2014). Varianty vozdeistviia rabochego organa rotatsionnoi mashiny na pochvennye glyby i komki., 2, 75-78. M.: Nauchnaia zhizn.

18. Отаханов, Б. С., & Киргизов, Х. Т. (2014). Обоснование диаметра ротора бесприводного ротационного рыхлителя с гибким рабочим органом. Вестник развития науки и образования, (4), 8-10.

19. Отаханов, Б. С. (2014). ОБЪЕМ СВОБОДНОЙ ВЫГРУЗКИ ПОЧВЕННОЙ ФРЕЗЫ. Вестник развития науки и образования, (4), 11-13.

20. Никифоров М.В., Туманов И.В., Черненко Я.В. Методика и результаты лабораторных исследований выравнивателя почвы // Сб. тр. студентов и молодых ученых «Проблемы и направления развития предприятий АПК: взгляд молодых ученых». Тверь: ТГСХА, 2018. С. 148-150.

21. Отаханов, Б. С., Киргизов, Х. Т., Ашурбеков, Ж. К. У., & Мамажонов, Э. Х. У. (2018). Машина для обмолачивания створок маш ручной сборки. Интерактивная наука, (6 (28)), 50-53.

22. Отаханов Б.С. Обоснование параметров ведомого ротора ротационного бесприводного рыхлителя: дис. ...канд. техн. наук. - Ташкент, 2007. - с. 38-58.

23. Sadirdinovich, O. B., Kadyrovich, P. G., & Bahromjonovna, O. M. (2021). DEVELOPMENT OF STUDENTS'TECHNICAL THINKING ON THE BASIS OF INTERDISCIPLINARY INTEGRATION. Academicia Globe: Inderscience Research, 2(08), 43-47.

24. Otahanov, B. S., Kirgizov, H. T., Ashurbekov, Z. K., & Mamazhonov, E. H. (2018). The machine for trashing flaps of mung bean. Интерактивная наука, (6), 50-53.

ISSN 2349-7793 (online), Published by INTERNATIONAL JOURNAL OF RESEARCH IN COMMERCE, IT, ENGINEERING AND SOCIAL SCIENCES.,
under Volume: 16 Issue: 05 in May-2022
https://www.gejournal.net/index.php/IJRCIESS

25. 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.

26. Отаханов, Б. С. (2013). ОПРЕДЕЛЕНИЕ СКОРОСТНОГО РЕЖИМА ОБРАБОТКИ ПОЧВЫ РОТАЦИОННЫМИ МАШИНАМИ. Научное обозрение: теория и практика, (2), 61-62.

27. Отаханов, Б. С., Пайзиев, Г. К., & Хожиев, Б. Р. (2014). Варианты воздействия рабочего органа ротационной машины на почвенные глыбы и комки. Научная жизнь, (2), 75-78.

28. Отаханов, Б. С., Абдуманнопов, Н. А., Жураев, Ж. А. У., & Гиёсов, К. А. У. (2019). Работа на дробления почвенных глыб и комков. Интерактивная наука, (2 (36)), 43-45.

29. Rustamov, R., Xalimov, S., Otaxanov, B. S., Nishonov, F., & Xojiev, B. (2020). International scientific and scientific-technical conference" Collection of scientific works" on improving the machine for harvesting walnuts.

30. 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.

31. Мансуров, М.Т., Отаханов, Б.С., Хожиев, Б.Р., и Нишонов, Ф.А. (2021). Адаптивная конструкция стриппера для уборки арахиса. Международный журнал инновационных анализов и новых технологий , 1 (4), 140-146.

32. Мансуров, М. Т., Отаханов, Б. С., Хожиев, Б. Р., & Нишанов, Ф. А. (2021). *АДАПТИВНАЯ КОНСТРУКЦИЯ ОЧЕСЫВАТЕЛЯ АРАХИСОУБОРОЧНОГО КОМБАЙНА. МЕХАНИКА ВА ТЕХНОЛОГИЯ ИЛМИЙ ЖУРНАЛИ*, (3), 62-68

33. Tolanovich, E. S., Sadirdinovich, O. B., Rustamovich, K. A., & Abdulkhakimovich, A. N. (2021). New Technology for Drying Grain and Bulk Materials. Academic Journal of Digital Economics and Stability, 9, 85-90.

34. Рустамов, Р. М., Отаханов, Б. С., Хожиев, Б. Р., & Нишанов, Ф. А. (2021). УСОВЕРШЕНСТВОВАННАЯ ТЕХНОЛОГИЯ УБОРКИ АРАХИСА. МЕХАНИКА ВА ТЕХНОЛОГИЯ ИЛМИЙ ЖУРНАЛИ, (3), 57.

35. Отаханов, Б. С., П айзиев, Г. К., Файзиев, Ш. Г. У., & Тошпулатов, Б. Б. У. (2018). Определение толщины лопасти битера при взаимодействии с прутками ботвоудаляющего транспортера. Интерактивная наука, (6 (28)), 54-58.

36. Нишонов, Ф. А., Мелибоев, М. Х., & Кидиров, А. Р. (2017). Тягово-сцепные показатели машинно-тракторных агрегатов. Science Time, (1 (37)), 292-296.

37. Пайзиев, Г. К., Файзиев, Ш. Г. У., & Кидиров, А. Р. (2020). Определение толщины лопасти ботвоприжимного битера картофелеуборочных машин. Universum: технические науки, (5-1 (74)), 51-55.

38. Кидиров, А. Агротехнические показатели машинно-тракторного агрегатов. ББК-65.32 я43 И, 665.

39. Отаханов, Б. С., Абдуманнопов, Н. А., Ёкубжонов, Н. Н. У., & Гиёсов, К. А. У (2019). Оптимизация параметров ведомого ротора бесприводного ротационного рыхлителя. Интерактивная наука, (11 (45)), 49-51.

40. Отаханов, Б. С., Абдуманнопов, Н. А., Ёкубжонов, Н. Н., & Гиёсов, К. А. Engineering sciences. Интерактивная наука, 49.