RESULTS OF RESEARCH ON THE BASIS OF COMBINED UNIT SOFTWARE PARAMETERS

Khudoiberdiev Tolib Solievich[1], Khudoyarov Anvarjon Nazirjonovich[2], Abdullaev Dilmurodjon Asadullaevich[3], Tursunov Bokhodirjon Nasibovich[4], Yuldasheva Matluba Ashuralievna[5], Nazirjonov Ibrokhimjon Anvarjon Ogli[6]

[1]Doctor of Technical Sciences, Professor, Andijan Branch of Tashkent State Agrarian University, Department of "Organization of Agricultural Machinery and Maintenance". E-mail: agai_info@edu.uz
[2]Candidate of Technical Sciences, Professor, Andijan Branch of Tashkent State Agrarian University, Department of "Organization of Agricultural Machinery and Maintenance". E-mail: agai_info@edu.uz
[3]Candidate of Sciences, Associate Professor, Andijan Branch of Tashkent State Agrarian University, Department of "Organization of Agricultural Machinery and Maintenance". E-mail: agai_info@edu.uz
[4]Candidate of Technical Sciences, Associate Professor, Andijan Branch of Tashkent State Agrarian University, Department of "Organization of Agricultural Machinery and Maintenance". E-mail: agai_info@edu.uz
[5]Independent Researcher, Andijan Branch of Tashkent State Agrarian University, Department of "Organization of Agricultural Machinery and Maintenance". E-mail: agai_info@edu.uz
[6]Andijan Branch of Tashkent State Agrarian University, Master's Degree in "Organization of Agricultural Machinery and Maintenance". E-mail: agai_info@edu.uz

Received: 23.04.2020 Revised: 24.05.2020 Accepted: 21.06.2020

ABSTRACT: Extensive work is being done to increase cotton yields at low energy and cost costs in the cotton sector, which is one of the main sectors of agriculture. One of the important ways to increase the yield of cotton is the technology of its cultivation in the field. Studies have shown that after sowing in the fall, the seeds sown in the pile create favorable conditions for germination and development, as well as increase productivity.

KEYWORDS: Minimal tillage technology, Combined aggregate, Deep softener, Road softener, Fertilizer, Mulch, Plowing, Harrowing, Mulching energy consumption, Fuel and lubricant consumption, Softener working surface geometry, Soil penetration angle, Working surface length, Width, Analytical expressions, Bubble shape of the working surface of the softener, Soil erosion.

 DOI: http://dx.doi.org/10.31838/jcr.07.14.209

I. RESEARCH METHODS AND MATERIALS

In the analysis and research, a technology focused on minimal tillage in cotton cultivation and the combined aggregate that implements it were developed and theoretical mechanics, higher mathematics and mathematical statistics and pona theories were used to theoretically substantiate the size of the deep softening working body.

Research results

When using a combined aggregate, the road is loosened without overturning, fertilization and germination, fertilizing, plowing, harrowing, consumption of labor, energy and fuel and lubricants is significantly reduced as a result of the absence of the need for mulching and weeding, due to the sharp reduction in the number of crossings of aggregates in the field, it was found that favorable conditions for the development of the root system of cotton without excessive compaction of the soil. Based on the study of the process of interaction of the softener with the soil, the geometric shape of its working surface was substantiated, analytical expressions were obtained that allow to determine the angle of penetration into the soil, the length and width of the working surface.

The combined unit, designed to implement a new technology focused on minimal tillage, loosens the soil used in last season's irrigation in one pass, fertilizes the softened area in two layers in a ribbon-like manner, and creates new buds and furrows by pushing old buds on the loosened and fertilized road. It was found that the working surface of the softener should be in the form of a bubble, its penetration angle into the soil should be in the range of 30-350, length and width should be at least 125 and 140 mm, respectively, to ensure quality crushing of the soil with low energy consumption.

II. INTRODUCTION

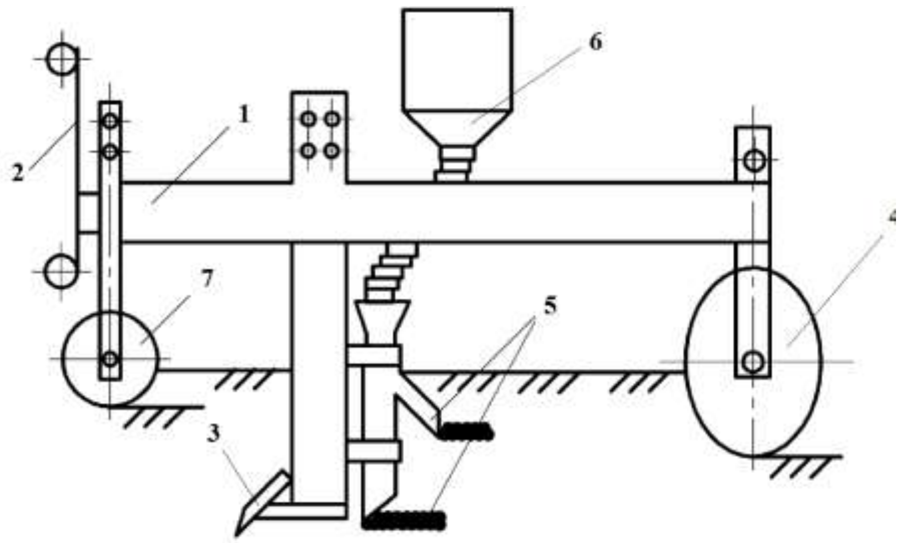
Extensive work is being done to increase cotton yields at low energy and cost costs in the cotton sector, which is one of the main sectors of agriculture [1]. One of the important ways to increase the yield of cotton is the technology of growing it in the garden bed. Studies have shown that after the autumn plowing, the seeds sown in the pile can create favorable conditions for germination and development, as well as increase productivity [2].

It is known that today the preparation of fields for sowing of cotton consists of agro-technical measures, such as fertilization, plowing, leveling, chiseling, harrowing, mulching and mulching of lands, which are carried out with separate units, including chiseling, harrowing and mulching. performed two to three times. Such repeated tillage of the soil from the field leads to an increase in labor, energy and fuel consumption, disruption of its structure and over-compaction.

III.THE MAIN FINDINGS AND RUSULTS

Based on the analysis of the literature and the results of research [3,4,5,6] in cotton growing developed a technology aimed at minimal tillage and a combined unit that implements it. According to the proposed technology, the fields cleared of cotton will not be plowed in the fall, only the inside of last season's irrigated plots is loosened and fertilized to a depth of 30-40 cm without overturning, and in these loosened and fertilized areas new buds with a height of 25-30 cm are formed for sowing seeds next year, that is, softened and fertilized buds are formed in place of last season's branches, and agates are formed in place of garden-beds.

When comparing the existing and proposed technologies of field preparation for sowing, the proposed technology significantly reduces labor, energy and fuel consumption due to loosening of roads without tillage and lack of harrowing, mulching and chiseling, a sharp reduction in the number of units passing through the field (6-7 times) 2 times). In addition, because the seeds are softened, fertilized and germinated and planted in areas not covered by tractor motors, they create favorable conditions for even germination, good plant growth and high yields. The combined unit (Fig. 1) designed to implement this technology is a frame 1 on which the working bodies are mounted, device for hanging the unit on the tractor 2, softener 3, garden bed maker 4, fertilizer bunker 5, consists of a fertilizer spreader 6 and a support wheel 7.



1- Rama; 2- Installer; 3- Softener; 4- Garden Bed Maker; 5- Fertilizer Bunker; 6- Fertilizer Spreader; 7- Base Wheel

Figure 1: Schematic of a Combined Unit

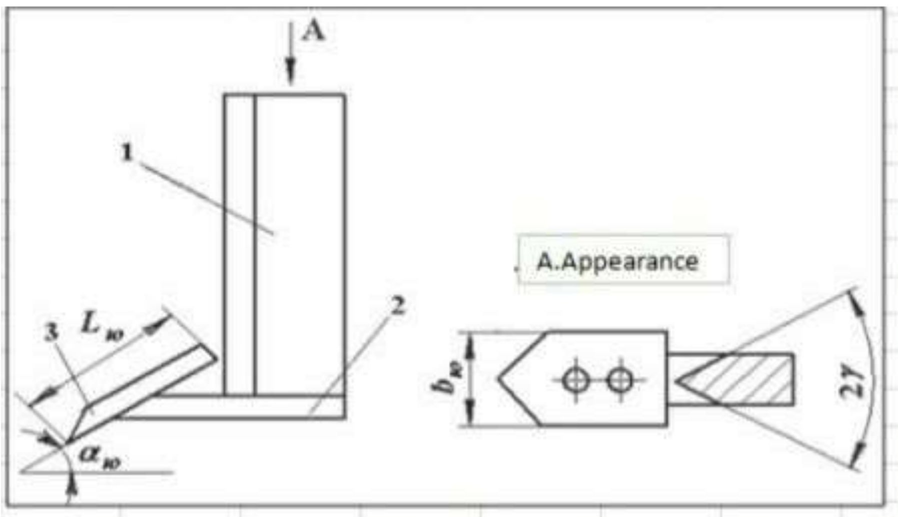
The main working bodies of the combined unit are the road softener, which softens the road without overturning the soil, fertilizer device for tape application to the softened layer, and garden bed receivers that form a garden bed on top of a loosened and fertilized layer.

According to the results of preliminary studies, the softening working body was the spindle softener, and the spherical discs were the working body.

Deep softeners ramas are placed on the inside with a spacing of 1800 mm. Softeners soften the inside of the furrow, which was opened last season, to a depth of 30-40 cm to irrigate between rows of cotton.According to the number of deep softeners in the unit, two insulators are softened in one pass. They are mounted on the front of the unit frame by pushing the support wheels 200-250 mm to the rear.

The softener of the combined aggregate (Fig. 2) consists of a column 1, a shoe 2 and a scraper softener, which serves to soften the inside of the remaining inlet from the previous innocence to a depth of 30-40 cm.

The main parameters that affect the quality and energy performance of the softener are the geometric shape of the working surface, width, -$b_{ю}$, angle of entry into the soil (crushing) -$\alpha_{ю}$, height-$L_{ю}$ and the sharpening angle of the column -2γ (Figure 2).



1-Column; Shoe 2; Pin Softener 3
Figure 2: Combined Aggregator Softener

The main criteria for selecting the optimal values of aggregate softener are quality crushing of the soil with minimal energy consumption, the formation of compacted furrows under the softening layer and the width of the softening zone by the softener (this distance should not exceed the distance between rows).

Theoretical studies studied the processes of deformation and disintegration under the influence of soil softener, which obtained analytical expressions that allow to determine the geometric shape of the working surface, width, angle of entry (crushing) into the soil.

Research results. Deformation and decomposition processes under the influence of soil softener

It is known from the literature and previous research [7,8] that the process of soil decomposition under the influence of working bodies consists mainly of two stages: when the working body passes from state I to state II (Fig. 3), the soil is compressed and when the stresses generated in it reach the critical limit, the ground breaks down in the plane ABB_1A_1 at an angle ψ to the direction of motion. As a result, a prism-shaped lump separates from the soil.

At the next displacement of the working body, this process is repeated sequentially, i.e. the soil is compacted and then the lump is separated from it again (Fig. 4). Correspondingly, the gravitational resistance of the working body also changes periodically, i.e. it increases when the soil is compacted and decreases after disintegration [8].

If we consider that the experimental voltage generated in the plane ABB_1A_1 under the influence of the soil working body (Fig. 3) exceeds the critical value, that is, it breaks down due to displacement [8], the value of the angle ψ is as follows

$$\psi = \frac{\pi}{2} - \frac{1}{2}\left(\alpha_{ю} + \varphi_1 + \varphi_2\right), \quad (1)$$

where $\alpha_{ю}$ is the angle of entry of the working body into the soil;

φ_1, φ_2 are the external and internal friction angles of the soil.

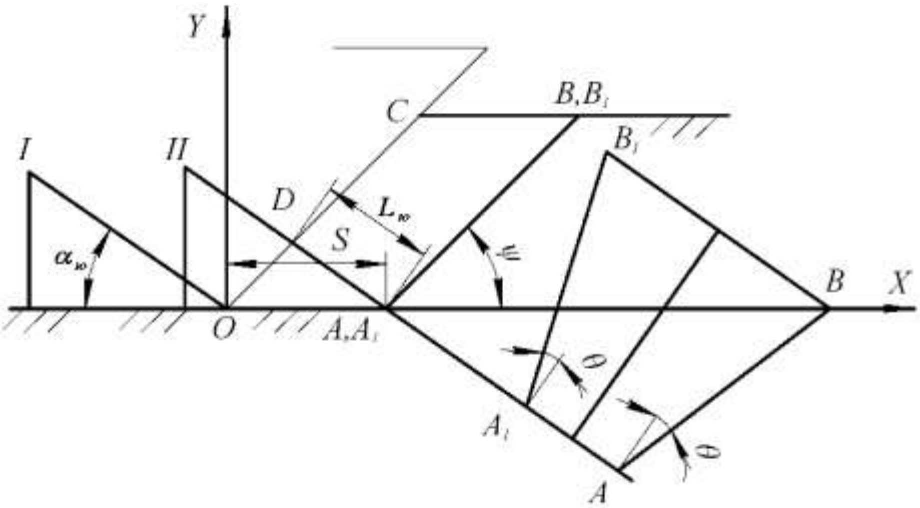


Figure 3: Deformation of the Soil Under the Influence of the Working Body and Decomposition Processes

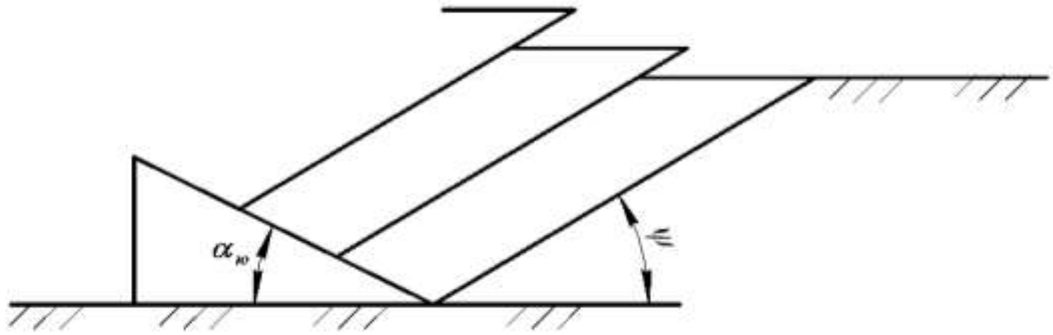


Figure 4: In Series Under the Influence of the Working Body of the Soil Deformation Process

The agrotechnical and energetic performance of a working body depends in many respects on the distance *S* (see Figure 3) from the compaction of the soil to its disintegration. The smaller this distance, the higher the crushing quality of the soil, and the lower the gravitational resistance, and conversely, when *S* is large, large lumps move from the soil and the gravitational resistance of the ponaish organ increases. Therefore, the distance *S* can be considered as an important criterion for evaluating the performance of the working body.

We find that the distance *S* depends on what factors. To do this, we consider the forces acting on the soil by the working body. The soil is normal by the working body *N* and friction $F = N\,tg\varphi_1$ forces (Figure 5).

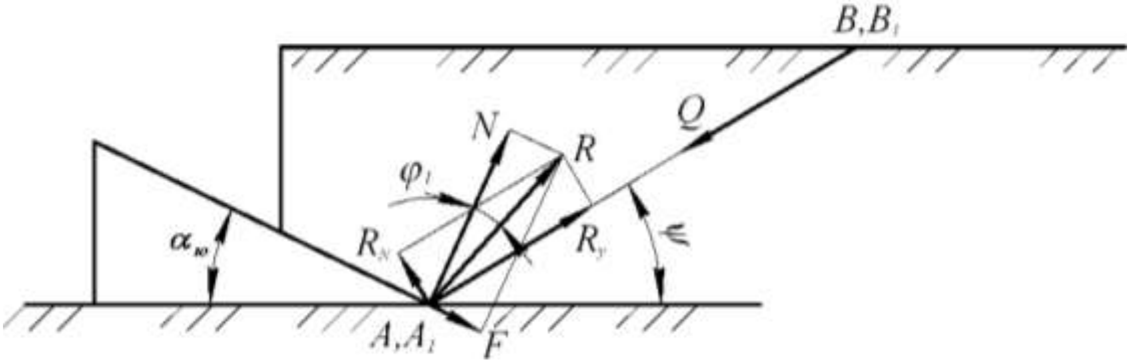


Figure 5: Impact on the Soil by the Working Body Driving Forces

These forces were equally influential $R = N / cos\varphi_1$ power ABB_1A_1 affecting the plane $R_y = N\sin(\alpha_{ю} + \varphi_1 + \psi)/ cos\varphi_1$ and directed perpendicular to it $R_N = N\sin(\alpha_{ю} + \varphi_1 + \psi)/ cos\varphi_1$ dividing by the forces, we find the stress τ generated in this plane.

$$\tau = \frac{R_y}{F_{ABB_1A_1}} = \frac{N\sin(\alpha_{ю} + \varphi_1 + \psi)\sin^2\psi}{(b_{ю}\sin\psi + htg\theta)h\cos\varphi_1} . \quad (2)$$

in this $F_{ABB_1A_1}$ - the surface of the soil decomposition plane (Figure 2.2);

$b_{ю}$ – the width of the pony;

h – the depth to which the pona sinks into the ground;

θ - Mor corner.

(2)) instead of τ in the expression $[\tau_{к}]$ (here $[\tau_{к}]$ – By determining the critical (boundary) resistance of the soil to displacement and solving the obtained expression with respect to N, we determine the normal force acting on it by the working body during the decomposition of the soil.

$$N = \frac{[\tau_{к}](b_{ю}\sin\psi + h\,tg\theta)h\cos\varphi_1}{\sin(\alpha_{ю} + \varphi_1 + \psi)\sin^2\psi} . \quad (3)$$

(1) Given that the expression $\theta = \frac{\pi}{4} - \frac{\varphi_2}{2}$ and [8] and making a number of changes, we make expression (3) as follows.

$$N = \frac{2[\tau_{к}]\left[b_{ю}\cos\frac{1}{2}(\alpha_{ю} + \varphi_1 + \varphi_2) + h\,tg\left(\frac{\pi}{4} - \frac{\varphi_2}{2}\right)\right]h\cos\varphi_1}{[\cos(\alpha_{ю} + \varphi_1) + \cos\varphi_2]\cos\frac{1}{2}(\alpha_{ю} + \varphi_1 + \varphi_2)} . \quad (3,a)$$

Depending on the resistance of the soil to compression before compaction (compression) is proportional to the size of its deformed part [9], the normal force exerted by the soil on the working body can also be found by the following formula.

$$N = q_0 F_{ADO} b_{ю}, \quad (4)$$

in this q_0- coefficient of volumetric compaction of soil;

F_{ADO}- the cross-sectional surface of the soil crushed by the working body, i.e. the surface of the *ADO* triangle in Fig. 3;

$$q_0 = mh^n\left(1 + K_V V\right), \quad (5)$$

m- proportionality coefficient;

n – coefficient depending on the physical and mechanical properties of the soil;

K_V- a coefficient that takes into account the velocity-dependent variation of the coefficient of soil compaction. From the diagram shown in Figure 3

$$F_{ADO} = \frac{S^2 \sin\left[\frac{\pi}{2} - \frac{1}{2}\left(\alpha_{ю} + \varphi_1 + \varphi_2\right)\right]\sin\alpha_{ю}}{2\sin\left[\alpha_{ю} + \frac{\pi}{2} - \frac{1}{2}\left(\alpha_{ю} + \varphi_1 + \varphi_2\right)\right]}. \quad (6)$$

or $$F_{ADO} = \frac{S^2 \sin\psi \sin\alpha_{ю}}{2\sin\left(\alpha_{ю} + \psi\right)}. \quad (7)$$

Substituting its value for expression (1) instead of ψ in this expression, we obtain the following

$$F_{ADO} = \frac{S^2 \cos\frac{1}{2}\left(\alpha_{ю} + \varphi_1 + \varphi_2\right)\sin\alpha_{ю}}{2\cos\frac{1}{2}\left(\varphi_1 + \varphi_2 - \alpha_{ю}\right)}. \quad (8)$$

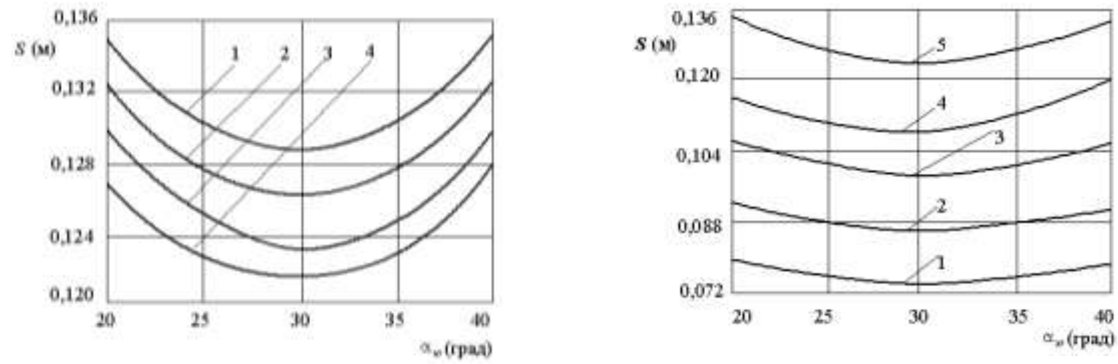
Substituting this value of F_{ADO} and the value of q_0 in expression (5) into (4) gives the following expression.

$$N = \frac{mh^n\left(1 + K_V V\right)b_{ю}S^2 \cos\frac{1}{2}\left(\alpha_{ю} + \varphi_1 + \varphi_2\right)\sin\alpha_{ю}}{2\cos\frac{1}{2}\left(\varphi_1 + \varphi_2 - \alpha_{ю}\right)}. \quad (9)$$

We equate the right sides of the expressions (4) and (9) to each other and solve the obtained expression with respect to *S* to obtain

$$S = 2\left\{[\tau_к]\left[b_ю \cos\frac{1}{2}(\alpha_ю + \varphi_1 + \varphi_2) + htg\left(\frac{\pi}{4} - \frac{\varphi_2}{2}\right)\right]\times\right.$$
$$\left.\times h\cos\frac{1}{2}(\varphi_1 + \varphi_2 - \alpha_ю)\cos\varphi_1\right\}^{\frac{1}{2}} \times \left\{mh^n\left(1 + K_V V_a \sin\frac{\alpha_ю}{2}\right)\times\right. \quad (10)$$
$$\left.\times b_ю \cos^2\frac{1}{2}(\alpha_ю + \varphi_1 + \varphi_2)[\cos(\alpha_ю + \varphi_1) + \cos\varphi_2]\sin\alpha_ю\right\}^{-\frac{1}{2}},$$

It can be seen from this expression that the distance *S* traveled by the working body before the soil disintegrates depends on the crushing quality of the soil, its resistance to the working body and its physical and mechanical properties, working depth, working body parameters and working speed. Since the value of *S* for a given working condition, depth and speed of cultivation depends mainly on the angle of entry of the working body into the soil. $[\tau_к] = 2 \cdot 10^4$ Па; $\varphi_1 = 30^o$; $\varphi_2 = 40^o$; $n=1$; $m = 2{,}5 \cdot 10^7$ Н/м^3 ва $K_V = 0{,}1$ accepted [10,11] (10) at different values of velocity and machining depth according to the expression, the graphs of change depending on the $\alpha_ю$ angle of the distance *S* were constructed (Fig. 6).



1-*V*=1,5 м/с; 2-*V*=2,0 м/с; 3-*V*=2,5 м/с; 4-*V*=3,0 м/с;

A

1-*h*=20 см; 2- *h*=25 см; 3- *h*=30 см; 4- *h*=35 см *ва* 5- *h*=40 см.

B

Figure 6: Work Speed (a) and Graphs of Change of S at different Values of Tillage Depth(b) Depending on α.

It can be seen from the graphs that in both cases the distance *S* varies in the form of a sunken parabola depending on the angle $\alpha_ю$ and when the $\alpha_ю = 30\text{-}35^0$ it has a minimum value.As the speed increases, *S* decreases**,** as *h* increases, it increases. This means that in order to grind the soil with high quality and low energy consumption, the angle of entry of the working body into it should be in the range of 30-35º.

Substantiate the geometric shape of the smoothing work surface

The chisel cultivator, deep softener and other machines currently used for tillage in the cultivation of cotton and other agricultural crops are mainly equipped with working bodies with the shape of a flat-surfaced plow.

As mentioned above, under the influence of such a pile (Fig. 7, a) the soil is compressed (crushed) in a direction perpendicular to its surface until it breaks, and when the compression reaches the limit of strength, the slab breaks (breaks) at an angle ψ to the direction of movement.

If the surface of the workpiece has a curved shape in the transverse-vertical plane, it will be under the influence of other deformations along with compression until the blade breaks.

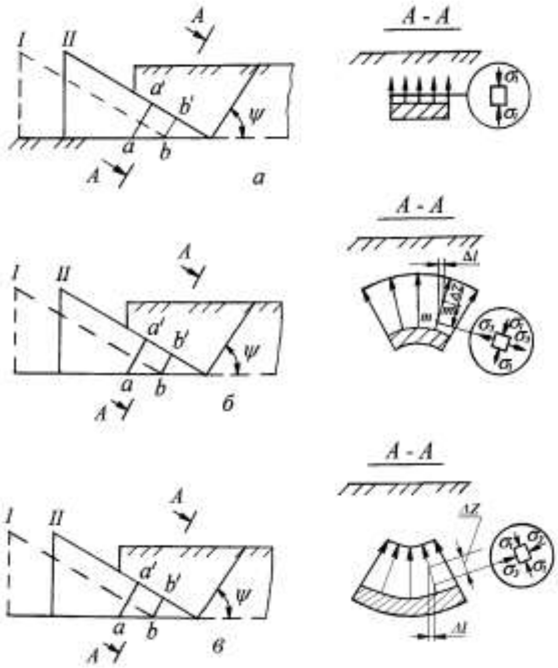


Figure 7: Palaxa has a Flat (a), Bubble (b) and Concave (s) Surface Deformation Under the Influence of Softener

For example, if the surface of the working body is in the form of a bubble (Fig. 7, b), the pelvis is stretched transversely with compression, that is, under the action of the working body, the point *m* of the shank is compressed to a distance Δz and extends to a distance Δl. This leads to poor soil compaction and low traction resistance of the working body.

If the surface of the working body has a concave shape (Fig. 7, v), the blade is perpendicular to the working surface, also compressed in the transverse direction (this compression is equal to Δz and Δl for point *m* of the plate, respectively). This, of course, leads to an increase in energy consumption in tillage.

Therefore, the working surface of the softener should be in the form of a bubble to ensure quality crushing of the soil with low energy consumption [12].

Substantiate the length of the softener working surface

We determine the length of the softener working surface using the diagram shown in Figure 3. It can be clearly stated that the length of the smoothing working surface $L_{ю}$ should be equal to or greater than *AD*, ie

$$L_{ю} \leq AD \,. \quad (11)$$

Otherwise, i.e. at $L_{ю} \leq AD$, the soil will not be sufficiently deformed under the influence of the working body and the soil will not be sufficiently softened and crushed as a result of the stresses generated in it not reaching the critical limit. Using the sine theorem, we obtain the following from the *AOD* triangle.

$$\frac{AD}{\sin\psi} = \frac{AO}{\sin\left[180^\circ - \left(\alpha_{ю} + \psi\right)\right]} \,. \qquad (12)$$

From this expression

$$AD = \frac{AO \sin\psi}{\sin\left(\alpha_{ю} + \psi\right)} \qquad (13)$$

It turns out that

Given that *AO* = *S* and expressions (1) and (11), we obtain the following expression to determine the length of the smoothing work surface.

$$L_{ю} \geq \frac{S\cos\frac{1}{2}\left(\alpha_{ю}+\varphi_1+\varphi_2\right)}{\cos\frac{1}{2}\left[\alpha-\left(\varphi_1+\varphi_2\right)\right]}. \quad (14)$$

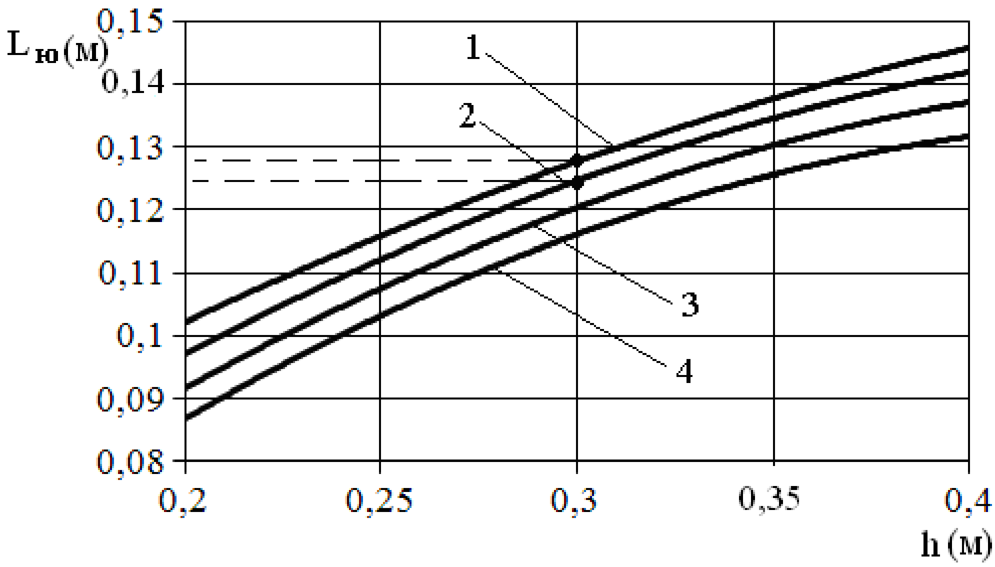
Given this expression (10), it has the following appearance

$$L \geq AD = 2\left\{ \left[\tau_{к}\right]\left[b_{ю}\cos\frac{1}{2}\left(\alpha_{ю}+\varphi_1+\varphi_2\right)+htg\left(\frac{\pi}{4}-\frac{\varphi_2}{2}\right)\right]\times \right.$$
$$\left. \times h\cos\frac{1}{2}\left(\varphi_1+\varphi_2-\alpha_{ю}\right)\cos\varphi_1 \right\}^{\frac{1}{2}} \times \left\{ mh^n\left(1+K_V V_a \sin\frac{\alpha_{ю}}{2}\right)\times \right. \quad (15)$$
$$\left. \times b_{ю}\cos^2\frac{1}{2}\left(\alpha_{ю}-\left(\varphi_1+\varphi_2\right)\right)\left[\cos\left(\alpha_{ю}+\varphi_1\right)+\cos\varphi_2\right]\sin\alpha_{ю} \right\}^{-\frac{1}{2}}.$$

It can be seen from this expression that the length of the working surface of the softener depends on the physical and mechanical properties of the soil, the depth of tillage and the speed of work.

$[\tau_{к}]$, φ_1, φ_2, m,n and K_V by expressing the values of (15) and, $\alpha_{ю}=30^0$ the length of the working surface of the softener was calculated, based on the results obtained, variation graphs were constructed depending on the machining depth and speed of the softener working surface length (Fig. 8).

Analyzing these graphs, we determine that the length of the working surface of the softener should be at least 125 mm in order to soften the inside of the aggregate at a speed of 1.5-2.0 m / s to a depth of 30-40 cm [13,14].



1-V=1,5 м/с; 2-V=2,0 м/с; 3-V=2,5 м/с ва 4-V=3,0 м/с

Figure 8: The Length of the Softener Working Surface Depends on the Machining Depth (h) and the Aggregate Speed (V) as Change Graphs

Justify the width of the softener

Numerous studies [11,15] have found that the soil is loosened by the working body to a depth called “critical”. Below this depth, without loosening the soil, the walls form a compacted ridge, which leads to a violation of the water-air regime of the soil and wasted energy in its cultivation (Fig. 9). Hence, in order to qualitatively soften the soil with low energy consumption, the critical softening depth of the working body must be equal to or greater than its sinking depth, i.e. the working depth *h*, i.e.

$$h_{кр} \geq h. \quad (15)$$

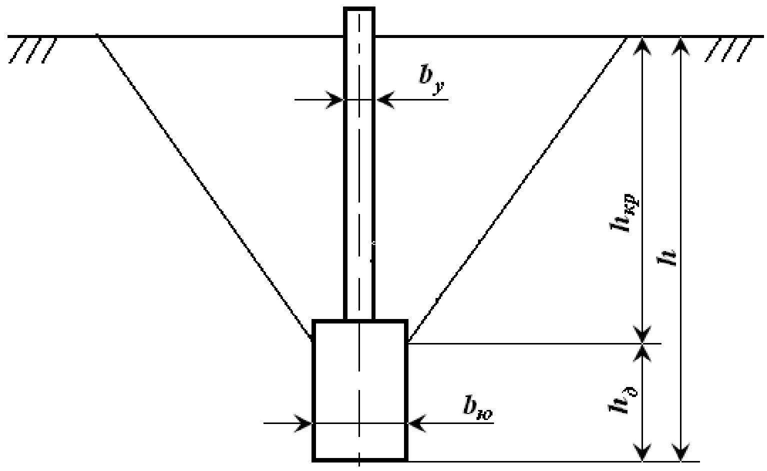


Figure 9: Of the Zone Softened by the Working Body Cross Section

The depth of critical loosening depends on the physical and mechanical properties of the soil, the shape and parameters of the working body, which can be found for the working body in the form of a two-sided pile by the following expression [11,15]

$$h_{кр} = \frac{b_ю \left[0{,}1 \frac{[\sigma_э]}{[\tau_к]} (1 + 3tg\xi) - n \right]}{m + ctg\alpha_ю}, \quad (16)$$

in this $[\sigma_э]$ – specific resistance to soil compaction;

ξ – the angle of deflection of the force acting on the ground relative to the horizon; *n, m* – coefficients without units of measurement depending on the physical and mechanical properties of the soil.

Given expression (16), we solve (17) for "$b_ю$" and obtain:

$$b_ю \geq \frac{h(m + ctg\alpha_ю)}{0{,}1 \frac{[\sigma_э]}{[\tau_к]} (1 + 3tg\xi) - n}. \quad (17)$$

It can be seen from this expression that the width of the softener depends primarily on the depth of tillage, the physical and mechanical properties of the soil and the angle of penetration of the working body into the soil. [11,15,16] based on sources m=4,2; $[\sigma_э]=1{,}44\cdot10^6$ Pa and $[\tau_к]=2\cdot10^4$ Па, n=2,5 accepted (17) It was determined that the width of the softener should not be less than 140 mm to ensure that the bottom of the ridge is softened to a depth of 30-40 cm without forming a dense ridge on the walls.

IV. CONCLUSION

1. The combined unit, designed to implement a new technology focused on minimal tillage, loosens the soil used in last season's irrigation in one pass, fertilizes the softened area in two layers in a ribbon-like manner, and creates new buds and furrows by pushing old buds on the loosened and fertilized road..
2. The combined unit, designed to implement a new technology focused on minimal tillage, loosens the soil used in last season's irrigation in one pass, fertilizes the softened area in two layers in a ribbon-like manner, and creates new buds and furrows by pushing old buds on the loosened and fertilized road.

3. Based on the study of the process of interaction of the softener with the soil, the geometric shape of its working surface was substantiated, analytical expressions were obtained that allow to determine the angle of penetration into the soil, the length and width of the working surface.
4. It was found that the working surface of the softener should be in the form of a bubble, its penetration angle into the soil should be in the range of 30-35^0, length and width should be at least 125 and 140 mm, respectively, to ensure quality crushing of the soil with low energy consumption.

V. REFERENCES

[1] The concept of development of mechanization of agricultural production until 2010. *–Tashkent: Fan, 2006. –22 p.*

[2] Dzhurakulov B., Kholmuratov N. (1980) Advantages of the comb method of sowing // *Agriculture of Uzbekistan. – Tashkent,* № 2. - P.24-25.

[3] Khudoyorov A.N. (2009). Combined unit for minimal processing // *Technique in agriculture.* M., No. 6. – P.56-57.

[4] Khudoiberdiev TS, Khudoyorov AN, Mamadaliev M.H. (2007) - Combined aggregate // *Agriculture of Uzbekistan. – Tashkent:* - №1. - P. 36.

[5] Xudoyorov A.N.(2011). Technology and combined aggregate and its technological work process aimed at minimal tillage // *Prospects for the development of private entrepreneurship in agriculture, Andijan,* P.176-179

[6] A.N. Khudoyorov, M.X. Mamadaliyev, M.A. Yuldasheva. R.Murodov. (2017). Power-efficient method of tillage and its technology model European science review Austria, *Vienna January-February.* №1-2, P.212-214.

[7] Klenin N.I., Sakun V.A.(1980). Selskoxozyaystvennые and meliorativnye mashiny. - M.: Kolos, P.617.

[8] Sineokov G.N., Panov I.M. (1977).Theory and calculation of tillage machines. - *Moscow: Engineering,* P.328.

[9] Baymetov R.I. (1990). Development of technologies and a set of machines for pre-sowing tillage in the cotton growing zone: Dis. *Doctor of technical science. - Yangiyul,* P.469.

[10] Baymetov R.I., Mirakhmatov M., Tukhtakuziev A. (1985). Tillage at elevated speeds in the cotton growing zone. - *Tashkent: Fan,* P.49.

[11] Abdirahmonov R.A. (2004). Substantiation of the parameters of a deep ripper for strip tillage: Diss.... cand. *those. sciences. - Yangiyul-Andijan,* P.131.

[12] Xudoyorov A.N., Mamadaliev M.X., Yuldasheva M.A.(2016). Motivation of the geometric form of looseners working surface of multifunction unit // *European science review Austria, Vienna* November-December №11-12, P.138-140

[13] Khudoyorov A.N, Mamadaliev M.H. (2015). Justification of the length of the working surface of the softener // *Bulletin of agrarian science of Uzbekistan,* №3, P.96-98

[14] Khudoyorov A.N, Yuldasheva M.A, Sobirov R.(2014). Determination of the length of the working surface of the combined unit // Collection of materials of the regional scientific-practical conference under the motto "XXI CENTURY - INTELLECTUAL GENERATION CENTURY". *Namangan June* 6-7, 3- book, P.503-506.

[15] Khudoyorov A.N, Mamadaliev M.H.(2012). Substantiation of the width of the combined aggregate softener // *Collection of materials of the international scientific-practical conference on the topic: "Modern materials, equipment and technology in engineering" Andijan:* P.258-260

[16] Tukhtakuziev A. (1998).Mechanical and technological foundations of increasing the efficiency of the tillage machines of the cotton-barn complex: Dis.... *Doctor of Technical Science – Yangiyul:* P.336.