Bulletin of the Transilvania University of Brașov

SERIES II

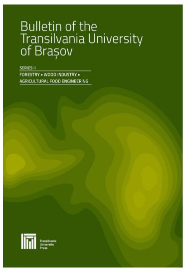
FORESTRY • WOOD INDUSTRY • AGRICULTURAL FOOD ENGINEERING

Transilvania University Press

Universitatea Transilvania din Brașov

BULLETIN OF THE TRANSILVANIA UNIVERSITY OF BRASOV
SERIES II - FORESTRY. WOOD INDUSTRY. AGRICULTURAL FOOD ENGINEERING

Published by Transilvania University Press, Brasov, Romania



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BULLETIN OF THE TRANSILVANIA UNIVERSITY OF BRASOV • VOL. 14(63) No. 1 - 2021
SERIES II - FORESTRY • WOOD INDUSTRY • AGRICULTURAL FOOD ENGINEERING, ISSN 2065-2135 (Print), ISSN 2065-2143 (CD-ROM)

FORESTRY

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WOOD INDUSTRY

BULLETIN OF THE TRANSILVANIA UNIVERSITY OF BRASOV • VOL. 14(63) No. 1 - 2021
SERIES II - FORESTRY • WOOD INDUSTRY • AGRICULTURAL FOOD ENGINEERING, ISSN 2065-2135 (Print), ISSN 2065-2143 (CD-ROM)

AGRICULTURAL FOOD ENGINEERING

Bulletin of the *Transilvania* University of Braşov
Series II: Forestry • Wood Industry • Agricultural Food Engineering • Vol. 14(63) No. 1 – 2021
https://doi.org/10.31926/but.fwiafe.2021.14.63.1.12

THE HEAP PARTS MOVEMENT ON THE SHARE-BOARD SURFACE OF THE POTATO HARVESTING MACHINE

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Ihor KUPCHUK[2] Ruslana SEMENYSHENA[1]

Abstract: *The article is devoted to the problem of the reduction of tubers mechanical damages while providing qualitative indicators of the potato heap separation process. Theoretical and experimental dependences of the influence of design and kinematic parameters of the machine operation on the quality performance are obtained. Within the field of experimental studies, a field installation was made to investigate the potato harvester as a whole on the efficiency of separation, the degree of damage, the magnitude of losses and the total capacity for aggregation. Comparison of the results of theoretical and experimental studies showed that the developed mathematical model of the process of separation of potato heap is adequate.*

Key words: *potato heap, potato tuber, underground working bodies, model, separation, potato harvesting machines.*

1. Introduction

The Government of Ukraine has chosen a strategic course for development in the agrarian and industrial direction [8]. However, in order to successfully enter the western markets, it is necessary to ensure, first of all, the competitiveness of our products, which is achieved by the complex mechanization of technological processes, reducing labor costs, increasing the yield and quality of the obtained products [2], [11].

Potato cultivation in our country is

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carried out according to the technologies of the last century, and if earlier the cultivation of potatoes was mechanized, nowadays in most farms it is grown manually [1], [7].

The machines for potato cultivation in Ukraine were imported mainly from Belarus and Germany. It is well known that the equipment is 70-80% outdated and it is not in the best condition and needs significant updating [5], [8].

The techno park of potato growing in Ukraine, however, is being updated. The problem arises for improving the existing technologies and inventing new promising technologies and working bodies for the potato harvesting machinery, substantiating the optimal modes of their operation and, ultimately, providing this field of crop production with modern, highly productive and reliable harvesting equipment [4],[6].

2. Materials and Methods

For the first time in the most general form, the theory of activated separation was proposed in [12]. This theory is based on the analysis of the evolution of the distribution function of soil fractions in size as they pass through the separating device. It is clear that the initial condition of the distribution function depends on the type and condition of the soil, as well as on the excavating working bodies [5]. The final condition is mainly determined by the separation devices. Introduction to the distribution function assumes that the heap is a set of almost unconnected soil aggregates [7], [15]. Such a soil model allows differential equations to be used to analyze the dynamics [1], [5] and to obtain a zero mathematical model of the process of activated separation [13] by a specific separation device.

Therefore, improving the existing methods and inventing new methods of undermining working bodies and separating piles for these purposes is an important task.

The purpose of the study of the motion of heap particles on the share-board surface of the potato harvesting machine [7] was to condition the study of the rotation of the formation at a certain angle under the action of applied forces.

The basis of our research is based on the theory of a share-board surface [7, 8] under the following assumptions:

1. The movement of the center of gravity of the intersection of the potato bed layer relatively to the share-board surface is uneven [3], [7];
2. The undermined layer of potato bed when moving on a share-board surface adjoins it with all its points [4], [6, 7];
3. A layer is a deformable body and has the ability to resist deformation [7], [14, 15].

Figure 1 shows: *I)* is the relative trajectory of the motion of the particle in the first case (the heap roof immediately after leaving the share); *II)* trajectory of motion in the other case (division of heap into parts at the top of the trajectory); *III*) is a solid heap of turf.

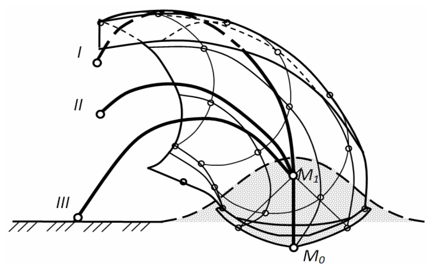


Fig. 1. *Scheme of relative trajectory of motion heap particles along the share corresponding to curve I*

The advantages of the proposed design are that the separation of tubers from the soil is due to: reducing the flow of the soil layer during its motion at an angle on cylindrical blades; crumbling the formation during its movement along the screw-right board and turning it to a certain angle; crush layer during its entry into the rod-separating device; stretching the formation material inside the working surface of the rod-separating device [6].

As a result of the analysis of the separation process and the design of the share-board potato harvester, their main structural and technological parameters were identified, and the relationships between them were identified (Table 1) [7, 8].

The main parameters of the potato harvester Table 1

Parameter	Marking
The parameters of the excavation part:	
-depth of tubers digging [m]	h_d
- share width [m]	B
- angles of the share inclination, [degree]	α_s
- the angle of rising of the plant residues [degree]	γ
- length: share, blades [m]	l_s, l
- the angle of inclination of the working surface of the wedge to the horizon [degree]	ε_0
Potato Heap Feeder Parameters:	
- the angle of lifting, crumbling and loosening of a potato heap [degree]	β
- the angle of inclination of the potato layer [degree]	γ_0
- the displacement angle of the potato heap [degree]	R_{cal}
- the calculated value of the radius of the share-board surface of the body [m]	B
- the width of the concavity and the length of the board surface [m]	L
- angle of the board surface to the direction of movement [degree]	β
Modes of the digger operation as a whole:	
- technological throughput [kg·s^{-1}]	Q
- traction resistance of the digger [kN]	R_a
- power costs for aggregation [kW]	N_a

To substantiate such a mathematical model, we must first consider all components independently of each other, and then move from partial to general, that is, to combine individual influences into a finite model of the process of moving particles on a share-board surface.

3. Results

3.1. Forces Analysis of Blade Movement in a Potato Heap

The study of the movement of the blade in the potato heap (Figure 2) will be based on the following assumptions:

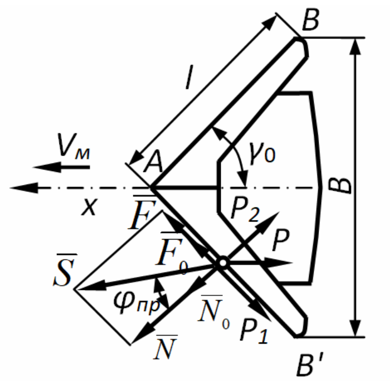


Fig. 2. *Scheme of the passive cylindrical share*

a) The relative velocities of the particle before and after collision with the blade lie in the same plane with the normal to the surface, the impact of the particle on the surface is considered absolutely inelastic (the coefficient of recovery is zero) [7];
b) The force of resistance to the movement of the particle in the space between the surrounding fixed particles is opposite in the direction of the vector of its absolute velocity;
c) The reaction of the surface applied to the particle coincides in the direction with the absolute speed of the particle;
d) The displacement resistance of the group of particles that fill the playground *dF* is proportional to the size of the playground [10].

Integrating the obtained expressions from ε_1 до $\pi/2$ and doubling (for two symmetrical halves of the blade), we find the numerical values $\overline{N}$ (1) and $\overline{F}$ (2) of the components and the total cutting force $\overline{S}$ (Figure 2).

From formulas (1, 2) it can be seen that the forces F_1 and N_1 depend on the blade parameters: angle ε_1 and γ_1; grip width B; shape and size of the curve of the orthogonal cross section of the blade (the form of the equation $\rho = \rho(\varepsilon)$); from soil friction coefficient to steel f [14]; soil properties k.

$$N_{s1} = k_s B \frac{\sin^2\varphi}{\cos\gamma_1} \int_{s_1}^{\frac{\pi}{2}} \left(\cos\varepsilon + f\cos\gamma_1 \frac{\sin^2\varepsilon}{\sqrt{1-\cos^2\gamma_1\cos^2\varepsilon}} \right) \rho(\varepsilon)\, d\varepsilon;$$
$$N_{b1} = k_b B \frac{\cos^2\varphi}{\sin\gamma_1} \int_{s_1}^{\frac{\pi}{2}} \left(\sin\varepsilon + f\sin\gamma_1 \frac{\cos^2\varepsilon}{\sqrt{1-\sin^2\gamma_1\sin s^2\varepsilon}} \right) \rho(\varepsilon)\, d\varepsilon; \tag{1}$$

$$F_{s1} = k_s B \frac{\cos\varphi}{tg\gamma_1} \int_{\varepsilon_1}^{\frac{\pi}{2}} \frac{\rho(\varepsilon)}{\sqrt{1-\cos^2\gamma_1\cos^2\varepsilon}} d\varepsilon;$$
$$F_{b1} = k_b B \frac{\sin\varphi}{tg\gamma_1} \int_{\varepsilon_1}^{\frac{\pi}{2}} \frac{\rho(\varepsilon)}{\sqrt{1-\sin^2\gamma_1\sin^2\varepsilon}} d\varepsilon. \tag{2}$$

The components of the total effort S of cutting along the coordinate axis for a symmetric blade are equal to:

$$\left.\begin{aligned} S_x &= 2\left[(F_{s1}+F_{s2})\sin\gamma_1 + (N_{s1}+N_{s2})\cos\gamma_1\ \right]; \\ S_y &= 2\left[(F_{s1}+F_{s2})\cos\gamma_1 - (N_{s1}+N_{s2})\sin\gamma_1\right]; \\ S_z &= 0. \end{aligned}\right\} \tag{3}$$

The theory of cutting a heap with a blade allows us to approach (in the first approximation) a number of sides of the work of the blade [7], [9].

Upon penetration of the share into the soil, the mass of the heap under the pressure of the P_h in front of the lying undamaged layers moves up the inclined plane upwards [15], compacted, collapsing into small fractions, which leads to a decrease in the pressure and the collapse of the heap on the share. To determine the relationship of these parameters, we consider the equilibrium condition of the forces acting on the share (Figure 3) [8], [15].

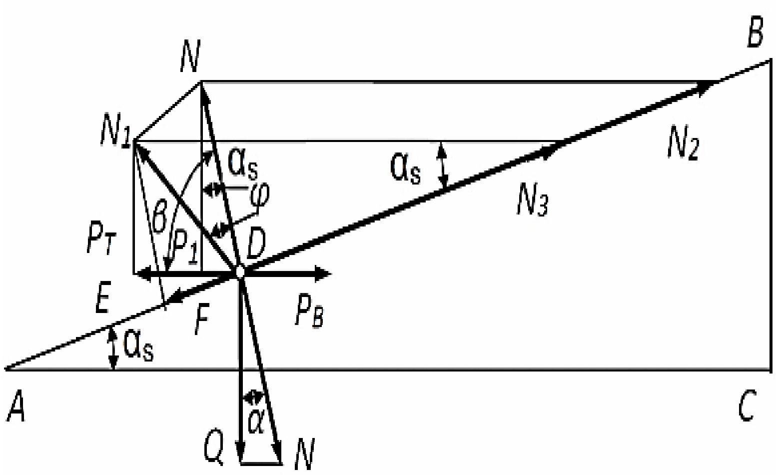


Fig. 3. *Forces arising in the process of cutting, moving and transferring a broken heap to a board surface*

The force P_T, moving the blades at the speed V_M^{max}, is actually traction and in magnitude equal to the force P_h resistance heap:

$$P_h = P_0 + I = h_d \cdot B \cdot \left(K + \xi \cdot V_M^2\right) \quad (4)$$

where:

- P_o is the resistance of the formation layer to the heap [kN];
- I – inertia force [kN];
- h_d – the depth of digging of the share; h_d = 0.140… 0.250 m;
- B – the width of the excavation; B = 0.300… 0.410 m;
- K – the coefficient of resistance of the heap of the deformation layer; K = 10 kPa;
- ξ – coefficient depends on the shape of the share and the physico-mechanical properties of the heap; ξ = 64.22 kg·s^2·m^{-4} [7, 8].

We find the force of the R_h resistance of the heap, taking into account its movement up the inclined plane. For this purpose, the angle α_s of the share unit on the side of its surface *AB* will be artificially increased by the friction angle ϕ. For a ploughshare with a total installation angle α_s + ϕ we find:

$$P_B = \left(\frac{N}{\cos\varphi}\right)\sin\left(\alpha_s + \varphi\right) = \left(\frac{\pi\, h_d B l_s \gamma_g \cos\alpha_s}{4\cos\varphi}\right)\sin\left(\alpha_s + \varphi\right), \quad (5)$$

where $\pi h_d B l_s \gamma_g / 4 = Q$ is the weight of the heap [N].

3.2. Kinematic Analysis of Blade Movement in a Potato Heap

It is known that the rotation of the rod is not a circular cross-section between the twisting moment, acts in the intersection, the stiffness and the relative torsion angle, but there is a dependence (Figure 4) by the transformation of which we get:

$$M_{кр} = GI_{кр}\frac{d\varphi}{dS} = GI_{кр}\frac{\omega}{V_м}, \qquad (6)$$

where:

- $\psi = \frac{d\varphi}{dS} = \frac{\omega}{V_M}$ is the relative angle of twist of the potato beds *dS*;
- *dφ* – the intersection of the intersection *a'c'b* 'with respect to the intersection of *acb* around the axis $\overline{t}$;
- $\omega = \frac{d\varphi}{dt}$ – the angular velocity of layer formation;
- $V_м = \frac{dS}{dt}$ – the relative velocity of the layer (machine).

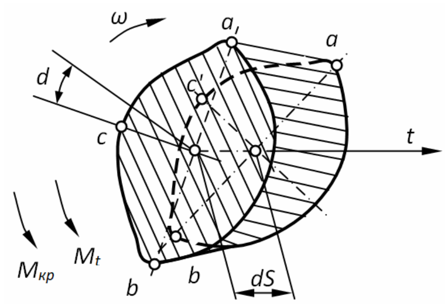


Fig. 4. *Scheme of rotation of the potato bed as a rotational motion around the axis* $\overline{t}$

At the moment of detachment of the element *dS* from the share-board surface, the moment of the equivalent forces of normal pressure*d N'* relative to point *C* is zero. Then the condition of equilibrium of an element (Figure 5) under the action of forces and moments applied to it with respect to the point *C* will be:

$$\sum M_c = \left(d\,Q_b + d\,F_b + d\,Q_{(1)b} + d\,P_b\right)l - \left(d\,M_{kp} + d\,M_t\right) = 0. \qquad (7)$$

Substituting into equation (7) the values of the inputs to it, we get equation (8):

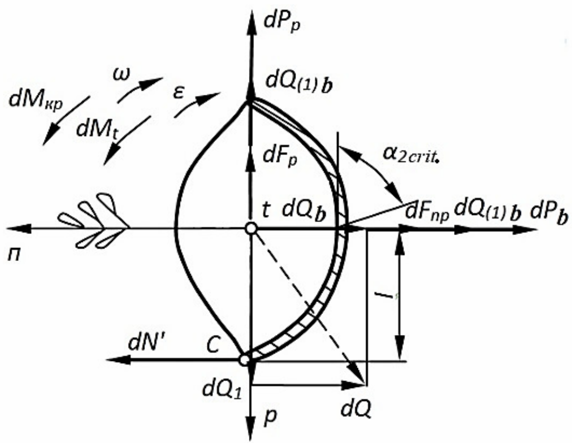


Fig. 5. *Diagram of separation of the dS element from the share-board surface relative to point C*

$$S_b^{\min}\gamma_g dSl\cos\alpha_2+\left(\frac{S_b^{\min}\gamma_g}{2g}\cdot V_M^2\,k_n d\,S+E\,I_p\frac{d^2k_n}{d\,S^2}d\,S+P\,k_n dS\right)l-$$
$$-\left[G\,I_{kp}\frac{d^2\varphi}{dS^2}dS+I_t\left(\omega_t\frac{d\varphi}{dS}+V_M^2\frac{d^2\varphi}{dS^2}\right)\right]=0. \tag{8}$$

From equation (8) we determine the critical value of the angle α_2 at which the separation of the element of the *dS* layer from the share-board surface begins:

$$\alpha_2 crit.=\arccos\left[\frac{G\,I_{kp}\frac{d^2\varphi}{dS^2}dS+I_t\left(\omega_t\frac{d\varphi}{dS}+V_M^2\frac{d^2\varphi}{dS^2}\right)}{S_b^{\min}\gamma_g l\,d\,s}-\left(\frac{V_M^2k_n}{2g}+\frac{E\,I_p\frac{d^2k_n}{dS^2}+Pk_n}{S_b^{\min}\gamma_g}\right)\right]. \tag{9}$$

It can be seen from equation (9) that the value of α_{2crit} decreases with increasing torsional stiffness GI_{kp} and depends on the velocity of formation V_m relative to the torsion angle *dφ / dS,* the stiffness of the *EI* layer bending in the plane of the axes $\bar{n}$ and $\bar{t}$, and, the normal curvature of the trajectory k_n, the friction coefficient *f* of the layer against the board and the size of the layer.

For the loosely connected layer of the potato bed, equation (9) takes the form:

$$\alpha_2 crit.=\arccos\left[\frac{I_t\left(\omega_t\frac{d\varphi}{dS}+V_M^2\frac{d^2\varphi}{dS^2}\right)}{S_b^{\min}\gamma_g ldS}-\left(\frac{V_M^2k_n}{2g}+\frac{Pk_n}{S_b^{\min}\gamma_g}\right)\right]. \tag{10}$$

For the rotation of the bed of the potato bed by a potato harvester, the share-board surface must have an angle α_2 that is constant or increases from the chest of the board to its wings. The value of α_{2crit} of the wing of the share-board surface should be determined empirically for the specific operating conditions of the potato digger.

When moving in the first and second cases (Figure 1), the heap is like a cantilever beam; the cutting force and the bending moment at the end point of the trajectory are zero:

$$M_{bm}=E\ell\frac{d\eta}{ds}=0;\quad Q_{cf}=E\ell\frac{d^2\eta}{ds^2}=0. \tag{11}$$

Therefore, for s = s^2 (the length of the cantilever heap) we have:

$$\left(\frac{d\eta}{ds}\right)_2=0;\ \left(\frac{d^2\eta}{ds^2}\right)_2=0. \tag{12}$$

This determines the values of constants when integrating the differential equation of the trajectory. Consider the relative trajectory of the motion of the particle in the first case (the heap collapse immediately after leaving the board) (Figure 1), and the second and third case will not be considered. Determine the absolute velocity of the heap particles coming off the shelf; this will allow us to consider the next movement of the heap layer.

If the direction tangent to the relative trajectory is determined by the angles α_2 (Figure 6) and β_2 (Figure 7), then we can write:

$$V_2 = V_e\sqrt{1+\psi^2 - 2\psi\cos\alpha_2}; \tag{13}$$

$$\left.\begin{aligned} V_{x2} &= V_e(1-\psi\cos\alpha_2) \\ V_{y2} &= -\psi V_e \sin\beta_2 \sin\alpha_2; \\ V_{z2} &= \psi V_e \cos\beta_2 \sin\alpha_2. \end{aligned}\right\} \tag{14}$$

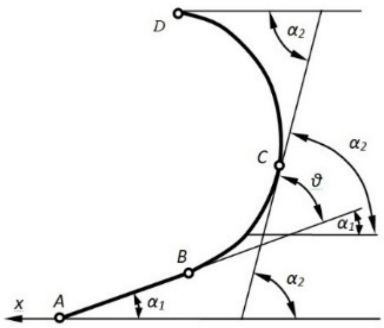


Fig. 6. *Dependence of the trajectory of the potato heap particle motion on a share-board surface from angle α_2*

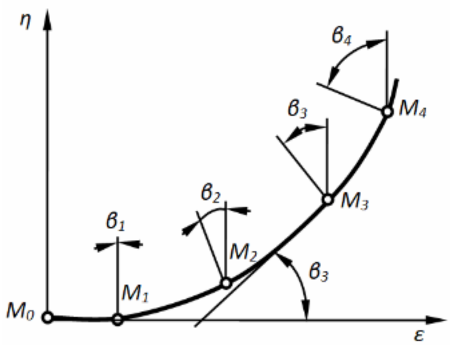


Fig. 7. *Dependence of the trajectory of the potato heap particle motion along the share-board surface from the angle β_2 and angles ε, η*

If the trajectory of the potato heap particle was a flat curve, then, as shown in (Figure 6), the exact equality would be $\alpha_2 = \alpha_1 + \vartheta$. Since the particle trajectory is not a flat curve, this equality is breached.

The greater α_2 (respectively, α_1 and ϑ), the more evenly the crushing energy is equal.

3.3. Dynamic Analysis of Blade Movement in a Potato Heap

The position of the moving point M_0 corresponds to the beginning of the free fall (the moment of the rise of the heap layer from the board) (Figure 8); velocity is the initial velocity of free fall.

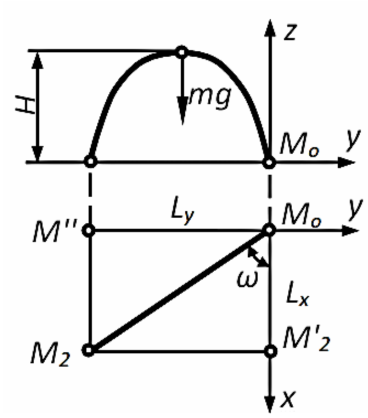


Fig. 8. *Scheme of movement of point M_0, corresponds to the beginning free fall*

The free-fall differential equations of the particle with respect to these axes are:

$$\left.\begin{aligned} m\frac{d^2x}{dt^2} &= 0; \\ m\frac{d^2y}{dt^2} &= 0; \\ m\frac{d^2z}{dt^2} &= -mg. \end{aligned}\right\} \quad (15)$$

When integrating these equations, the constant integrations are found from the initial conditions: at $t = 0$, the point is at the origin and has an initial velocity whose projections on the coordinate axis V_x, V_y, and V_z are defined by formulas (16).

As a result of integration, we obtain equations of motion, which are parametric equations of the absolute trajectory of a particle.

Excluding time from the first two equations of motion, we obtain the equation of projection of the trajectory on the *XOY* plane:

$$\left.\begin{aligned} x &= V_e\left(1-\psi\cos\alpha_2\right)\cdot t; \\ y &= -\psi V_e\sin\beta_2\sin\alpha_2\cdot t; \\ z &= \psi V_e\cos\beta_2\cos\alpha_2\cdot t-\frac{1}{2}gt^2 \end{aligned}\right\} \quad (16)$$

The equation found can be regarded as the equation of the plane in which the absolute trajectory is located, or as the equation of the direct - projection of the trajectory on the *XOY* plane.

$$y=\frac{\psi\sin\beta_2\sin\alpha_2}{1-\psi\cos\alpha_2}\cdot x\,. \quad (17)$$

From equation (17) it follows that the plane of the absolute trajectory is with the plane *zMox* a two-sided angle ω whose tangent is equal to the angular coefficient of the line (17):

$$tg\omega=-\frac{\psi\sin\beta_2\sin\alpha_2}{1-\psi\cos\alpha_2}. \quad (18)$$

A minus sign in this case indicates that the angle ω is calculated from the *OXy* axis in the negative (clockwise) direction. To determine the projection of the trajectory on the *yMoz* plane, we exclude time from the last two equations of motion:

$$z=-\frac{y}{tg\beta_2}-\frac{gy^2}{2\psi^2V_t^2\sin^2\beta_2\sin^2\alpha_2} \quad (19)$$

Thus, the projection of the trajectory on the *yMoz* plane is a parabola. From equations (17) and (19) it is easy to find the maximum lifting height *H* and the flight range of the particles L_x and L_y in the projections on the *Mo* and *Moy* axes (Figure 6). Under the range of the deflection we will understand the coordinates $x_2 = L_x$ and $y_2 = -L_y$ of the point M_2 of the intersection of the absolute trajectory with the plane *xMoy*, thus we obtain:

$$\left.\begin{aligned} H &= \frac{V_r^2}{2g}\sin^2\alpha_2\cos^2\beta_2; \\ L_y &= \frac{V_r^2}{g}\sin^2\alpha_2\sin^2 2\beta_2 \end{aligned}\right\} \quad (20)$$

$$L_x=\frac{2V_r^2}{g}\sin\alpha_2\cos\beta_2\left(V_e-V_r\cos\alpha_2\right). \quad (21)$$

The distance $M_0M_2 = L$, on which the particle in absolute motion is rejected from its initial position (Figure 7), is equal to:

$$L = \sqrt{L_x^2 + L_y^2} = \frac{L_y}{\sin\omega}, \qquad (22)$$

or, substituting the notions of values, we find:

$$L = \frac{V_r^2}{g\sin\omega}\sin^2\alpha_2\sin 2\beta_2 \qquad (23)$$

3.4. Parameters of Potato Heap Separation Process

The technological throughput of the potato digger was determined by the performance of the drum separator in kg·s^{-1} [7]:

$$Q = \tau\gamma_n V_L S, \qquad (24)$$

where:

τ is the ground mass crumble coefficient, if $\tau = 1$, then $W_0 = W'$ and the soil crunch will be rational;

γ_n – the density of the subsoil, $\gamma_n = 1260$ kg·m^{-3} [6];

V_L – speed of axial movement of the particle;

S – the cross-sectional area of the soil in the drum [m^2].

$$Q = \tau\gamma_n\omega R_i tg\delta \cdot 1{,}9\sqrt{R_i \cdot H^3}. \qquad (25)$$

Power N_a required for potato aggregator:

$$N_a = R_a V_p / 3.6, \qquad (26)$$

where:

R_a is the traction resistance of the potato digger [kN];

V_p – the maximum permissible working speed of the potato harvester with the capacity of the drum separator [km·h^{-1}].

$$R_a = S_x + Q_{nx} + P_T + R_x + P_c, \qquad (27)$$

where:

S_x is the cutting of the soil with a share blade [kN];

Q_{nx} – deformation of the soil by the share and chest of the board [kN];

R_h – overcoming resistance from the forces of weight of the heap and forces of friction distributed on the surface of contact of the heap with the board [kN];

R_x – velocity transfer to heap particles;

P_c – the working resistance created during the process of separation of the drum separator [kN].

Within the field of experimental studies, the greatest interest is the study of the reciprocating speed of the machine V_m, the angle of the share, the angle of the board surface to the direction of movement. All these figures were expressed in %.

After the experimental data were obtained, they were processed using the Microsoft Excel application for PC. The regression equations (20-24) in decoded form are shown in Table 2.

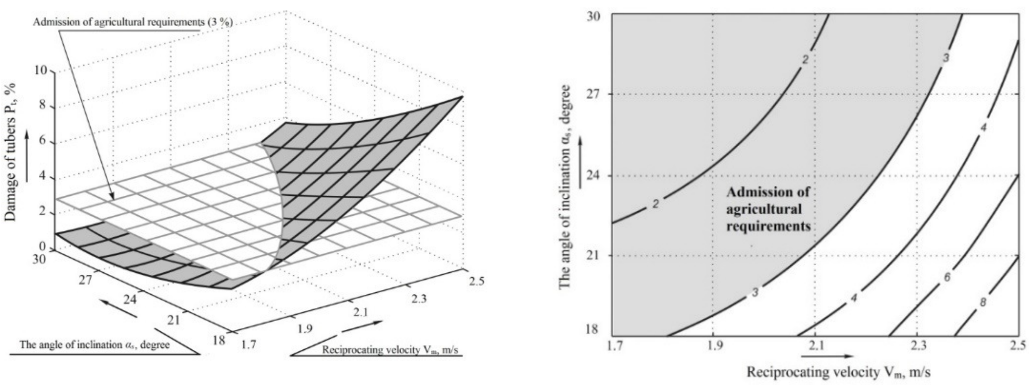
Table 2

Regression equations for the main parameters of the potato heap separation process

Parameter	Equation
Purity of the tubers (20)	$C' = -72{,}6044 + 2{,}614795\cdot\beta + 80{,}2356\cdot V_m + 2{,}0970\cdot\alpha_n - 0{,}3739\cdot\beta\cdot V_m - 0{,}0855\cdot\beta\cdot\alpha_s + 0{,}9323\cdot V_m\cdot\alpha_s - 19{,}5156\cdot V_m^2 - 0{,}0498\cdot\alpha_s^2$;
Separation efficiency (21)	$E = -46{,}6239 - 1{,}7266\cdot\beta + 91{,}6089\cdot V_m + 5{,}5439\cdot\alpha_s + 1{,}3833\cdot\beta\cdot V_m - 0{,}0285\cdot\beta^2 - 28{,}0231\cdot V_m^2 - 0{,}1229\cdot\alpha_s^2$;
Tubers damage (22)	$P_t = 18{,}2441 - 0{,}2181\cdot\beta - 10{,}5132\cdot V_m - 0{,}4179\cdot\alpha_s - 0{,}1164\cdot\beta\cdot V_m - 0{,}5835\cdot V_m\cdot\alpha_s + 0{,}0083\cdot\beta^2 + 8{,}2238\cdot V_m^2 + 0{,}0272\cdot\alpha_s^2$;
The loss of tubers (23)	$B_t = 3{,}9366 - 4{,}6970\cdot V_m - 0{,}1999\cdot\alpha_s - 0{,}0386\cdot\beta\cdot V_m + 0{,}2718\cdot\beta - 0{,}0643\cdot V_m\cdot\alpha_s - 0{,}0032\cdot\beta^2 + 1{,}8200\cdot V_m^2 + 0{,}0075\cdot\alpha_s^2$;
Total aggregate capacity (24)	$N_a = 13{,}8143 - 0{,}4772\ \beta - 15{,}1027\cdot V_m + 0{,}9582\cdot\alpha + 0{,}0092\ \beta^2 + 4{,}27\cdot V^2 - 0{,}0180\cdot\alpha^2$.

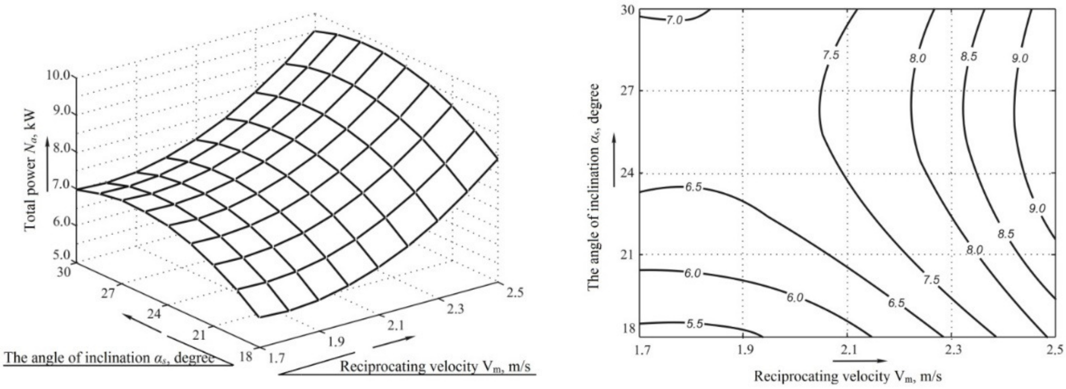
The obtained equations were investigated using the software package MATLAB 6.0.

Response surfaces and graphs of lines of the same values are shown in Figure 9 and 10.



a) b)

Fig. 9. *Feedback surface (a) and two-dimensional section (b)to damage the tubers P_t from reciprocating velocity V_m and the angle of inclination of the share α_s (at β = 30 deg., the soil is loam average, W = 16,5%)*



a) b)

Fig. 10. *Response surface (a) and two-dimensional section (b)for total power to aggregate N_a from translational velocity V_m and incline angle share α_s (at β = 30 deg., soil - loam average, W = 16.5%)*

The comparison of the results of the theoretical and experimental studies showed that the developed mathematical model of the process of separation of potato heap is adequate.

4. Conclusions

Having considered the existing prerequisites for the calculation of the structural and technological parameters of the potato harvester, we developed a mathematical model of the motion of heap particles on the share - board surface. It takes into account the change of the relative amount of soil of the passable fraction, large clumps of soil in the blasting pots in the top destruction of tubers, sifting of soil taking into account the self-destruction of tubers as they move through the separator, as well as damage to tubers, which makes it possible to analyze. This study allowed determining the dependence of the sifting ratio of potato heap and the degree of damage to the tubers on such indicators of the operation mode of the separator as the initial thickness of the heap layer, the intensity of impact on the heap and the time of separation.

As a result of the analysis of the mathematical model of the process of separation of potato heap, the rational parameters of the process of separation were determined: the time of movement on the share-board surface $T_r \approx 0.36$ s, the separation time $T_s \approx 0.86$ s, the initial rational thickness of the heap layer on the separator $h_d \approx 0.140 \ldots 0.250$ m. On the basis of these parameters the rational values of the parameters and the modes of operation of the share-board surface are determined: the permissible length of the share l_{rat}. = 0.330 … 0.460 m, the rational width of the share V_{opt}. = 0.300… 0.410m, the angle of inclination of the blades to the horizon G_{opt} = 16… 24° (at φ = 25… 40 ° and V_m^{max} = 2.22 m / s), the minimum and maximum cross-sectional area of the undermined row S_n^{min} = 0.033 m^2, C_n^{max} = 0.08 m^2, the angle of lift of the plant residues γ = 40… 45 deg. The angle of inclination of the wedge working surface to the horizon is ε_0 = 40…50 degrees. The angle of lifting, crumbling and loosening of the potato heap is α_2 = 55… 75 degrees. The angle of inclination of the potato layer is β = 0… 60 deg.. The angle of displacement of the potato heap is γ_0 = 40… 50 degrees, R_{max} = 0.232 m and R_{min} = 0,205 m. The width of the concavity of the board surface is B = 0.554 m. The angle of production of the share surface to the direction of movement is β = 0… 60 degrees. The feed heap to the separator is Q = 92.2 kg·s^{-1}. For these parameter values, the soil-sieving coefficient is v = 93.4% and the degree of damage to tubers P_h = 1.61%; determination of power costs for the potato harvester aggregation from its design parameters and rational operating modes is 6.5… 7.5 kW.

Comparison of the results of theoretical and experimental studies showed a deviation within 5%, which indicates the adequacy of the mathematical model of the process of separation of potato heaps.

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