pISSN:2349-5707 Volume:13,Issue 4, April -2026 eISSN:2349-5715

OPTIMIZATION OF TECHNICAL INDICATORS OF A POTATO HARVESTING MACHINE USING THE METHOD OF MATHEMATICAL PLANNING

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Abstract. In the article from the Centrifugal Lifting Rod Elevator (CLRE) equipped potato backhoe loader worker parameters mathematician planning method using optimization results. The experiments are based on the Hartley-4 plan. Based on held, four incoming factor (drum) rotations number, elastic drum width, elevator speed, worker (of) soil communication rate (Y1, %) and of the nodes damage (Y2, %) impact learned. Obtained second level regression the equations are Fisher and Student criteria based on checked. Optimization as a result of the car high efficiency provider acceptable values detected: drum rotations number of 120 rpm, elevator speed 0.94 m/s, working slot 0.010 m. Field tests as a result soil 81.62% penetration, nodes damage by 5.74% reached. These indicators to the traditional KKS-1.4 combine 10-12% higher than efficiency provides.

Key words: from the center escape elevator, excavator, mathematician planning, regression equation, soil termination, termination damage, optimization.

1. Introduction

Potato in cultivation the harvest collection on time the soil from root vegetables separation important technological process is considered. Traditional potato excavator in combines applicable with bars elevators heavy and wet in soils stuck stay, soil communication level low (72-75%) and of the nodes mechanic injury problems brought releases [1].

This problems solution to do for from the center escape to the forces based new lifting - separating working body – Centrifugal Lifting Rod Elevator (CLRE) offer This is done of the device work principle drum rotation on account of to the surface coming from the center escape power under the influence soil mass lines from the range fast to transfer based on [2-4].

The research purpose – CLRE (Centrifugal Lifting Rod Elevator) with equipped optimal parameters of the excavator mathematician planning method using determination and agrotechnician efficiency assessment [5-8].

2. Materials and methods

In the study four factorial many factorial experiments Hartley-4 plan based on held. Incoming factors and their change the levels are listed in Table 1.

Table 1

Factors, their conditional determination, variation range and level

No.	Factors name and to be determined	Change levels	Change range		
			-1	0	+1
1	X1 – Drum rotations number , rpm	80	100	120	20
2	X2 – Elastic drum width, m	1.2	1.3	1.4	0.1
3	X3 – Elevator speed, m/s	0.4	0.8	1.2	0.4
4	X4 – Worker slot, m	0.06	0.07	0.08	0.01

In experiments assessment criterion as following indicators acceptance done:
Y1 – soil communication level (%);
Y2 – nodes damage (%).
Experience results of the “PLANEX” software in the complex Cochrane, Student and Fisher's criteria based on processing was given. As a result second level regression equations received.

3. Results

pISSN:2349-5707 Volume:13,Issue 4, April -2026 eISSN:2349-5715

Experimental information based on following regression equations received:

Soil communication rate (Y1, %):

$Y1 = 81.6209 + 1.580X1 – 1.317X2 – 2.333X3 – 1.333X4 + 4.819X1^2 – 1.512X1X2 + 2.919X2^2 – 2.296X2X3 + 3.454X2X4 + 3.013X3X4 – 3,031X4^2$

Of the nodes damage (Y2, %):

$Y2 = 5.7459 – 0.214X1 – 0.413X2 + 0.117X3 + 0.737X4 – 1.423X1^2 + 0.194X1X2 + 0.318X1X3 – 0.376X1X4 – 0.688X2^2 – 0.383X2X3 – 0.429X2X4 + + 0.695X3^2 + 0.177X3X4 + 0.138X4^2$

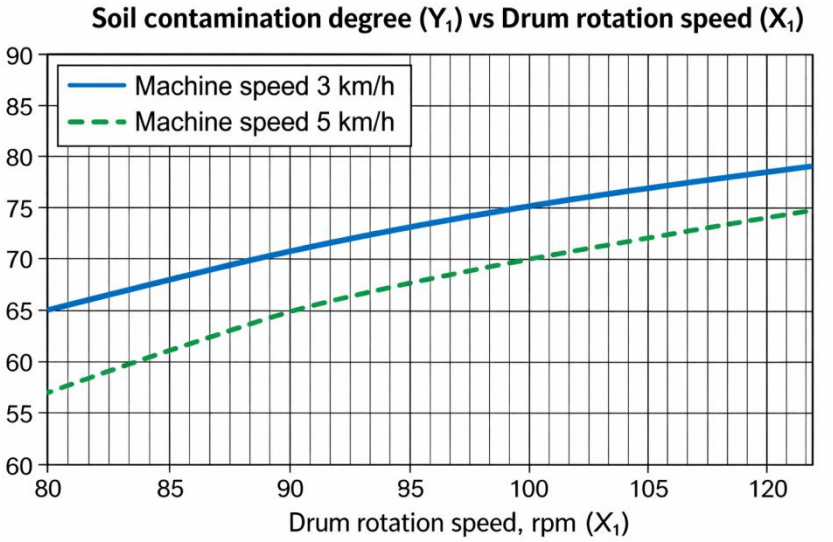

Figure 2. Soil communication level (Y1) of to factors dependency

This graphic drum rotations increase in number (X1) with soil spread how improvement shows. In the text to analysis according to , from 80 to 120 rpm communication level from 72% to 82% rises . Two line of the car various movement speeds (3 km/ h and 5 km/h) for cited .

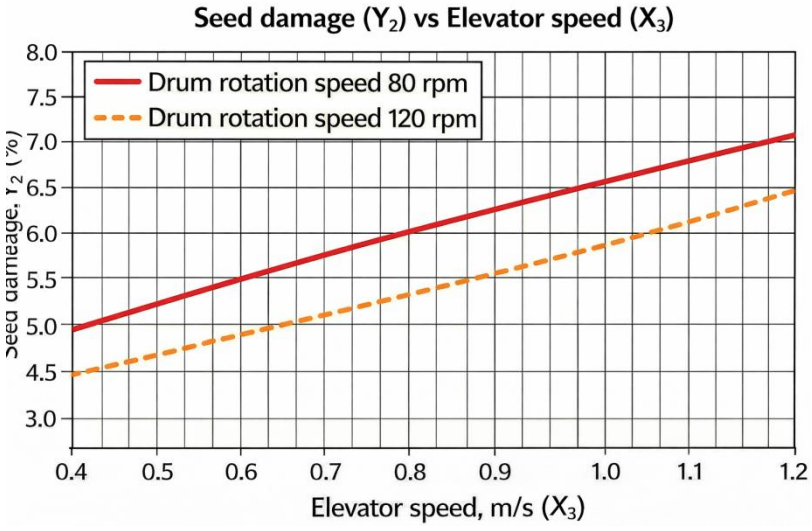

Figure 3. Of the nodes damage (Y2) to factors dependency

This graph shows the elevator speed (X3) nodes to injury the impact shows. To the text according to speed 0,4 from 1.2 m/s when increased injury From 4.2% to 6.8% increases . Also, the drum rotations increase injury the decrease is also on the graph own on the contrary found.

pISSN:2349-5707 Volume:13,Issue 4, April -2026 eISSN:2349-5715

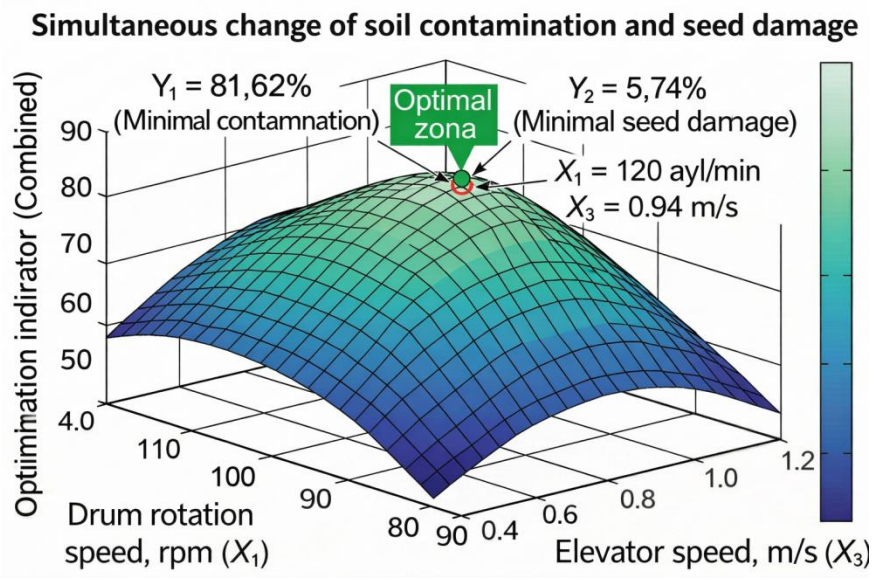

Figure 4. Soil spread and end of injury joint change

This is a 3D diagram of the research final result – ***optimization zone*** shows. At the point on the graph X_1 =120 rpm , X_3 = 0.94 m/s soil spread maximum (81.62%) and end with minimal damage (5.74%) acceptable area specified .

Regression equations using the Excel program "solution" "search" function using together solution as a result CLRE (CENTRIFUGAL LIFTING ROD ELEVATOR) of acceptable parameters was determined (Table 2).

Table 2
From the center escape lift striped elevator acceptable parameters

Parameter	Marking	Acceptable value
Drum rotations number	X1	120 rpm
Elastic drum width	X2	1.3 m
Elevator speed	X3	0.94 m/s
Worker slot	X4	0.010 m
Soil communication level	Y1	81.62 %
Nodes injury	Y2	5.74 %

4. Discussion

As can be seen from Figure 2 It's like a drum . rotations increase in number (X1) with of the soil communication level noticeable at the level improves. This the reason is from the center escape of power increase on account of soil of mass lines from the range transition speed increase. Drum rotations from 80 rpm to 120 rpm when increased , spread level from 72% to 82% rises .

Elevator speed (X3) increase and communication to the level reverse impact shows. Speed from 0.94 m/s When it increases, the soil on the surface of the separator to be time shrinks and to announce before I had time out goes. That's why acceptable speed was set to 0.94 m/s.

Figure 3 Analysis this shows that the nodes elevator speed damage increase with increases. Speed from 0.4 m/s to 1.2 m/s when increased, damage from 4.2% to 6.8% increases. Drum rotations number increase and injury reduces, because soil faster separates and nodes less mechanic to the effect occurs.

Worker slot (X4) expansion (up to 0.010 m) of the nodes lines between squeezed to stay reduces and mechanic injury reduces.

pISSN:2349-5707 Volume:13,Issue 4, April -2026 eISSN:2349-5715

Namangan region Yangikurgan and Attic in the districts farmer on their farms held field tests following the results gave:

Table 3
Field tests results

Indicator	KKS-1.4 combine harvester	MQKEChE (new)	Difference
Soil spread , %	72-75	81.62	+10-12%
Nodes damage , %	7.2	5.74	-1.46%
Work productivity , t/ h	3.2	3.6	+12.5%

New CLRE (Centrifugal Lifting Rod Elevator) device heavy and wet traditional in soils as well with bars to elevators than more efficient worked, the separator surface stuck to remain not observed.

5. Conclusion

1. Mathematician models adequacy in the "PLANEX" program by Fisher and Student criteria based on approved. Received second level regression equations the process reliable represents.
2. CLRE (Centrifugal Lifting Rod Elevator) optimal parameters of determined :
   - Drum rotations number – 120 rpm ;
   - Elevator speed – 0.94 m/s;
   - Worker slot – 0.010 m.
3. optimal parameters soil 81.62 %, nodes damage by 5.74% This is a conventional KKS-1.4 combine harvester. Relatively soil separation quality by 10-12% increase opportunity gives.
4. Field tests new of the structure working release under the circumstances reliable performance, heavy and wet separator surface even in soils stuck not to remain showed.
5. New worker organ current to grow potato in cultivation the cost reduces the yield preservation the deadline extends and product waste reduces.

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