

DEVELOPMENT AND TESTING OF A CENTRIFUGAL LIFTING-SCREENING WORKING ELEMENT FOR ENHANCED POTATO HARVESTING EFFICIENCY**Salokhiddinov Nurmukhammad Sotimboyevich**

Senior Lecturer of the Department of “Technological Machines and Equipment”

Namangan State Technical University

Abstract: This study focuses on developing and testing a novel working element—a centrifugal lifting-screening screw elevator—to enhance potato harvesting efficiency and drastically reduce manual labor input. Conventional harvesters struggle with adequate soil separation, leading to high labor costs. Experimental trials were conducted using a modified KP-2 potato harvester-loader. The operational results confirmed the effectiveness of the new design. Key findings include a boost in potato purity to 99.4% and a reduction in tuber damage to 3.4%, which is well below the agrotechnical norm of 4.0%. Most notably, labor costs were cut by more than three times, falling from 20 person-hours/ha to just 3.3 person-hours/ha. The lighter and simpler machine design also yielded an annual economic effect of 25.041 million Sums per 100 ha. The centrifugal elevator is confirmed as a reliable and highly efficient solution for modern potato harvesting

Keywords: Potato harvester, Centrifugal separator, Lifting-screening element, Separation completeness, Tuber damage, Labor costs, Kinematic factor, KP-2, Efficiency.

Introduction

The efficiency of potato harvesting remains a critical factor in agricultural productivity, significantly impacting labor costs and overall yield quality. Conventional potato harvesting equipment often struggles with adequate separation of soil and debris from the tubers, leading to high labor requirements for manual sorting and increased damage to the crop. A primary challenge is the effective and gentle separation of a high volume of soil and haulm mass during the harvesting process. This inefficiency necessitates the development of new mechanical solutions that can achieve superior separation while minimizing operational complexity and tuber damage[1-4].

This study addresses these limitations by focusing on the design and creation of a novel lifting-screening working element for a potato harvester. The goal is to develop a robust and effective structure—specifically a centrifugal lifting-screening screw elevator—that can enhance labor productivity and significantly reduce manual labor input during potato harvesting. The research aims to achieve superior soil separation and confirm the optimal structural and kinematic parameters through rigorous experimental investigation [5-8].

Methods**Experimental Setup.**

The investigation focused on the design and testing of a centrifugal lifting-screening screw elevator. Experimental research was conducted in both a stationary laboratory setting and using a mobile device based on the KST-1.4 potato digger [9-11].

The mobile equipment was modified to feature a centrifugal lifting-sorting drum instead of a flexible drum. This design creates a centrifugal separation zone by directing the incoming mass along a circular arc.



a)



b)

Figure 1 a) and b). General view of the experimental combine and view of the compression grinder cylinder.

Stationary Field Experiments.

Field experiments were conducted using a stationary setup. The experiments were performed in five-fold replication. In each replication, the mass of soil was 300 kg, and the product feed rate was 100 kg/s.

Machine Comparison.

For comparing different centrifugal separators, the structural and kinematic factor (Z) was introduced:

$$Z = V^{2K} R^{1-K}$$

This factor allows for the comparison of centrifugal separators of different diameters.

Regression Analysis.

To evaluate the influence of three main factors—elevator speed (X_1), wrapping angle (X_2), and radius of curvature (X_3)—on the separation efficiency and tuber damage, regression coefficients were calculated using an experimental planning matrix. The following regression equations were derived after excluding insignificant coefficients:

1. Separation Efficiency (Y , %):

$$Y = 89,375 + 2,025 X_1 + 2,297 X_2 + 1,075 X_3$$

2. Tuber Damage (Y_t , %):

$$Y_t = 3,2 + 0,265 X_1 + 0,025 X_2 - 0,05 X_1 X_2$$

Results

Operational Trial Results.

Operational trials of the KP-2 potato harvester-loader, equipped with the centrifugal lifting-screening elevator, were conducted in 2024–2025 in the Yangikurgan and Chartok districts of Namangan region.

The application of the new centrifugal elevator resulted in several key advantages over older models, such as the KPK-2 combine:

- **Purity and Quality:** The overall purity of the potatoes increased to 99.4%. Simultaneously, the tuber damage level decreased to 3.4%, which is significantly lower than the permissible agrotechnical norm of 4.0%.
- **Labor Savings:** Labor costs were drastically reduced from 20 person-hours/ha (for KPK-2) to just 3.3 person-hours/ha (for KP-2), representing a reduction of more than 3 times.
- **Financial and Energy Savings:** Due to the simpler and lighter design (total mass reduced from 6000 kg to 2000 kg), the following savings were achieved:
 - Specific material consumption: 25 % reduction
 - Energy consumption: 10-15 % reduction
 - Fuel consumption: 5-8 % reduction
- **Economic Effect:** Based on the reduction in losses, labor, and costs, the estimated annual economic effect for harvesting 100 ha is 25.041 million Sums (at 2025 prices).

Discussion

The experimental and operational results unequivocally validate the effectiveness of the centrifugal lifting-screening screw elevator design, particularly when integrated into the KP-2 potato harvester-loader.

Perhaps the most compelling outcome of the operational trials is the dramatic reduction in labor input—from 20 person-hours/ha to 3.3 person-hours/ha. This over three-fold decrease in labor intensity, coupled with the improved potato purity (99.4 %) and reduced tuber damage (3.4 %), underscores the significant economic and practical benefits of the new design. Furthermore, the substantial reduction in machine mass and corresponding savings in material, energy, and fuel consumption contribute to a high annual economic effect.

The high performance, reliability, and efficiency of the KP-2, even in challenging soil and climatic conditions, suggest that the centrifugal lifting-screening elevator is a viable and advantageous alternative to older separation technologies. The results are protected by Russian Federation Patent No. 2048726.

Conclusion

The objective of developing a high-performance lifting-screening working element for a potato harvester has been successfully met. The centrifugal lifting-screening screw elevator, as implemented in the KP-2 potato harvester-loader, achieved outstanding results:

- Superior Quality: Potato purity was boosted to 99.4%, and tuber damage was reduced to 3.4%, well within agrotechnical limits.
- Economic Efficiency: Labor costs were reduced by more than three times (from 20 person-hours/ha to 3.3 person-hours/ha), resulting in a calculated annual economic effect of 25.041 million Sums per 100 ha.

The research confirms that the structural and kinematic factor (Z) provides an effective criterion for comparing the performance of centrifugal separators of different diameters. The KP-2 machine, equipped with this centrifugal elevator, has demonstrated high productivity, reliability, and overall efficiency, providing a clear path for reducing the manual labor burden and increasing profitability in potato harvesting.

References:

1. Saloxiddinov Nurmuxammad Sotimboyevich. WAYS TO IMPROVE THE EFFICIENCY OF A POTATO HARVESTING MACHINE. "ILM-FAN VA INNOVATSION RIVOJLANISH" xalqaro ilmiy-texnikaviy jurnal. VOLUME 8, ISSUE 5, SEPTEMBER – OCTOBER 2025. 110-117 b.
2. Нишонов, Ф. А. (2022). Кидиров Атхамжон Рустамович, Салохиддинов Нурмухаммад Сатимбоевич, & Хожиев Бахромхон Рахматуллаевич (2022). Проблемы и решения сбора урожая арахиса. Вестник Науки и Творчества, (1 (73)), 22-27.
3. Нишонов, Ф. А., Кидиров, А. Р., Салохиддинов, Н. С., & Хожиев, Б. Р. (2022). Проблемы и решения сбора урожая арахиса. Вестник науки и творчества, (1 (73)), 22-27.
4. Nishonov, F. A., & Saloxiddinov, N. (2023). Mashina detallarining yeyilishini rayvandlash va mustahkamlash texnologiyalari. Scientific Impulse, 1(10), 1782-1788.
5. Салохиддинов, Н. С. (2023). Обоснование технологической схемы картофелекопателя-погрузчика кп-2. Scientific Impulse, 2(16), 770-786.
6. Рустамов, Р. М., & Салохиддинов, Н. С. (2021). Влияние размера клубня на движение его в подъёмном центробежно-сепарирующем прутковом элеваторе. Механика ва технология илмий журнали, (1), 53.
7. Muradovich, R. R., & Satimbaevich, N. (2020). Basic Equations Of Motion Of A Material Particle In A Lifting Centrifugal-Separating Bar Elevator. Solid State Technology, 63(5), 3129-3133.
8. Нишонов, Ф. А., Кидиров, А. Р., Салохиддинов, Н. С., & Хожиев, Б. Р. (2022). Проблемы и решения сбора урожая арахиса. Вестник науки и творчества, (1 (73)), 22-27.
9. Nishonov, F. A., Saloxiddinov, N., Qidirov, A., & Tursunboyeva, M. (2023). Detal yuzalariga bardoshli qoplamalarni yotqizish texnologik jarayoni. Pedagog, 6(6), 394-399.
10. Qidirov, A., Nishonov, F., Saloxiddinov, N., Yoqubjonov, F. V., Rashidxo'jayev, M. M., & Tursunboyeva, M. (2023). Detallarning ishqalanuvchi yuzalarini yeyilishga chidamliligini oshirish texnologiyasi ishlab chiqish: detallarning ishqalanuvchi yuzalarini yeyilishga chidamliligini oshirish texnologiyasi ishlab chiqish.
11. Kadirovich, P. G., Muradovich, R. R., & Satimbaevich, S. N. (2021). Application Of Oscillating Shares In Machines For Harvesting Potatoes And Table Root Crops. Nveo-natural volatiles & essential oils journal| nveo, 2664-2672.