

FIELD TRIALS AND ECONOMIC EFFICIENCY OF THE POTATO DIGGING-LOADER HARVESTER

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Abstract. This study analyzes the field trials and technical-economic effectiveness of the KP-2 potato digging-loader harvester, which was developed based on the serial KST-1.4 potato-digging machine and equipped with a Centrifugal Lifting and Sieving Rod Elevator (CLSRE). The field trials were conducted in the Namangan region of Uzbekistan during 2024-2025. The results demonstrated that the KP-2 harvester achieved superior performance compared to the traditional KPK-2 (complex harvester): labor input was reduced by more than 3 times (from 20 man-hours/ha to 3.3 man-hours/ha), and the total mass was decreased by 3.5 times (from 6000 kg to 2000 kg). The new technical solution significantly reduced tuber damage to below the permissible agrotechnical standard (3.4%). The calculated annual economic benefit amounted to 25.041 million UZS (for 100 hectares).

Keywords: potato, potato harvester, separation, soil, lifting elevator, centrifugal separation, working unit, efficiency, mechanical damage, mathematical modeling, economic efficiency

Introduction

The potato is a crop that yields high harvests in loose soils. Modern intensive technologies, such as the Dutch technology [7], ensure the creation of loose soil conditions using active working organs. Under these conditions, it is recommended to harvest potatoes not with complex harvesters like the KPK-2 (weighing up to 5-7 tons), but with lighter digging-loaders (the simplest harvesters) weighing up to 2 tons, which simultaneously reduces the level of tuber damage.

Potato digging-loaders mechanize the most labor-intensive operations—harvesting the tubers and loading them onto transport—freeing up to 50 workers required for a 2-row potato digger. The purpose of this study was to determine the quality, productivity, and reliability of the KP-2 harvester, as well as to evaluate its economic effectiveness [3].

Methods

Description of the Machine and Technological Solution

The KP-2 potato digging-loader harvester was developed on the basis of the serial KST-1.4 potato-digging machine [6]. It is equipped with additional components that ensure the separation of potatoes from haulms and impurities, and their loading onto a transport vehicle. The total mass of the machine is 2000 kg.

The main view of the KP-2 (Figure 1) [1] consists of several parts, including the front support rollers, digging share, first rod elevator, second separating and lifting rod elevator, lifting drum with ribs, delivery belt conveyor, low-rod haulm separating conveyor, and cross-loading conveyor.



Figure 1. General view of the experimental testing device

The fundamental new technical solution is the lifting and separating unit, which includes the Centrifugal Lifting and Sieving Rod Elevator (CLSRE), the ribbed drum, and the delivery belt conveyor.

Operating Principle

The digging shares excavate potato tubers from two ridges and deliver them to the first rod elevator, where the soil is partially sieved. The mass then passes to the second separating and lifting rod elevator, which has a cylindrical surface. Here, the soil mass is intensively and completely sieved. The separated tubers are directed via the delivery conveyor to the haulm separating conveyor and the cross-loading conveyor. The haulm separating conveyor removes the haulms onto a grid chute for discharge into the field. Finally, the separated tubers are loaded onto the transport vehicle by the cross-loading conveyor.

Conditions of Field Trials

The field trials of the KP-2 harvester were conducted in 2024-2025 in the Yangiqo'rg'on and Chortoq districts of the Namangan region, according to the acceptance testing program [2]. The tests were evaluated in accordance with the O'z DSt 923:2019 standard [2].

Results

The results of the field trials demonstrated that the KP-2 harvester fully ensures the effective separation of potato tubers from soil and impurities, and their loading onto transport. The data shows significant advantages compared to the existing KPK-2 (base machine):

Indicator	Base Machine (KPK-2)	New Machine (KP-2)
Total Mass (kg)	6000	2000
Labor Input (man-hours/ha)	20	3.3
Total Costs (UZS/ha)	326450	69933

Key Performance Advantages

- **Tuber Quality:** The level of tuber damage was reduced to 3.4%, which is lower than the permissible agrotechnical standard (4.0%) [4].
- **Labor Savings:** Labor input was reduced from 20 to 3.3 man-hours/ha, resulting in a reduction in manual labor costs by approximately 3.03 times [6].
- **Economic Effect:** The reduction in the machine's total mass (from 6000 kg to 2000 kg) led to a 25% decrease in specific material consumption and a 10-15% decrease in energy consumption. Total costs were reduced by approximately 4.5 times.
- **Annual Economic Benefit:** The calculated annual economic benefit for harvesting 100 hectares amounted to 25,041,700 UZS [3].

Discussion

The conducted field trials [1] confirm that the use of the Centrifugal Lifting and Sieving Rod Elevator in the KP-2 harvester is technically and economically effective. The new technical solution serves to eliminate tuber damage by preventing the rod elevator screen from shaking, thereby reducing collisions between the potato tubers and metal rods [4].

The KP-2 harvester's mass (2000 kg) is significantly lighter (3.5 times) than the KPK-2 (6000 kg), leading to lower manufacturing and operating costs. The sharp reduction in labor input is a crucial socio-economic achievement, as it enables the release of up to 50 potato pickers [6]. The technical solution of the harvester is protected by Patent No. 2048726 of the Russian Federation [5].

Conclusion

1. The KP-2 digging-loader harvester with the Centrifugal Lifting and Sieving Rod Elevator demonstrated high productivity, reliability, and efficiency even in complex soil and climatic conditions [1].
2. The new technological scheme ensures the effective separation of tubers from soil and a reduction in damage to 3.4% [4].
3. The implementation of the KP-2 reduces labor input from 20 to 3.3 man-hours/ha, increasing operational efficiency by more than 3 times [6].
4. The overall economic effectiveness analysis shows that using the KP-2 reduces total costs by up to 4.5 times, with a total economic benefit of 25,041,700 UZS per 100 hectares [3].

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