

Article

# Results of Economic Tests and Technical and Economic Indicators of a Chisel-Cultivator Equipped With an Improved Plate Roller

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**Citation:** Abdumomin o'gli R. M. Results of Economic Tests and Technical and Economic Indicators of a Chisel-Cultivator Equipped With an Improved Plate Roller. American Journal Of Botany And Bioengineering 2026, 3(3), 112-120.

Received: 10<sup>th</sup> Dec 2025

Revised: 11<sup>th</sup> Jan 2026

Accepted: 23<sup>th</sup> Feb 2026

Published: 24<sup>th</sup> Mar 2026



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**Abstract:** The article presents the results of economic tests and technical and economic indicators of a chisel cultivator equipped with an improved slatted roller.

**Keywords:** Tractor, machine, frame, aggregate, roller, pawl, disk, pipe, slat, chisel cultivator, diameter, radial, soil, roller axis, roller bases, slat thickness.

## Introduction

In the course of theoretical and experimental studies, preliminary requirements and technical specifications for a chisel cultivator equipped with an improved plank roller with substantiated parameters were developed. Based on them, an experimental prototype of a chisel cultivator equipped with an improved plank roller was manufactured at Andijontexmash LLC. Field and farm tests of the developed chisel cultivator were conducted on the experimental farm of the Information and Consulting Center of the Andijan Institute of Agriculture and Agrotechnologies, on farms of the Andijan and Balykchi districts of the Andijan region.

## Materials and styles

Fig. 1 and 2 depict the general and working views of the chisel cultivator (hereinafter - chisel cultivator), equipped with the developed improved plank roller.



**Figure 1.** General view of the chisel cultivator equipped with the developed improved plank roller.



**Figure 2.** View of a chisel cultivator equipped with a developed improved plank roller during operation.

The developed chisel cultivator is used for preparing fields plowed in autumn for spring sowing of cotton seeds and seeds of other agricultural crops, as well as for sowing repeated crops on lands freed from winter wheat. The chisel cultivator consists of a frame equipped with a mounting mechanism, on which two rows of cultivator and arrow-shaped paws are installed in a staggered manner, and an improved plank roller. The working process of the chisel cultivator proceeds in the following order: the cultivator and arrow-shaped paws loosen the soil to a specified depth, the improved plank roller smooths the unevenness formed on the field surface from them, crushes clods, and compacts the soil.

Table 1 presents the recommended parameters of the roller, and Table 2 - the technical characteristics of the experimental sample of the chisel cultivator [1].

**Table 1.** Parameters of the developed improved plank roller.

No.	Parameter name	Mark-nishi	Value
1.	Diameter of the plank roller, mm	$D$	380.
2.	Number of bars, pcs.	$n_t$	10.
3.	Plank length, mm	$l_t$	270.
4.	Angle of installation of the plate relative to the radial of the roller disc, degrees	$\gamma_t$	55°
5.	Angle of installation of the planks relative to the axis of rotation of the roller, degrees	$\beta$	20.
6.	Plank height, mm	$H_t$	50.

7.	Height of the sections of the bars entering the base of the roller, mm	$h_a$	20.
8.	Plank thickness; mm	$b_p$	10.
9.	Diameter of the roller base; mm	$D_t$	350
10.	Thickness of the roller base; mm	$B$	6.
11.	Vertical load on the roller; N/m	$Q_t$	850

**Table 2.** Technical characteristics of the developed chisel cultivator equipped with an improved plank roller.

No.	Name of indicators	Indicator-larning unit of measure	Indicator value
1.	Type	-	suspension
2.	Combined tractor class (model)	-	2-3
3.	Operating speed	km/h	6.0-9.0
4.	Reach width	m	3.6.
5.	Processing depth	cm	10-20
6.	Width of loosening and arrow-shaped paw tracks	cm	20.
7.	Longitudinal distance between the cultivator and the arrow-shaped arms	cm	30.
8.	Longitudinal distance between the arrow-shaped blades and the roller	cm	35.
9.	Productivity over time	ha/hour	2.1-3.2
10.	Fuel consumption	kg/ha	16.
11.	Total weight	kg	850±50
12.	External dimensions, width height length	mm	3160 1180. 2010

## Results and their analysis

*Results of economic tests of a chisel-cultivator equipped with a plank roller.* Field tests of the chisel cultivator were conducted on an irrigated 13.44 hectares of the experimental field of the Information and Consulting Center at the Andijan Institute of Agriculture and Agrotechnologies for growing repeated crops after harvesting winter wheat.

Table 3 presents data on the moisture content, hardness, and density of the tested field soil, and Table 4 presents the test results. In the tests, the chisel cultivator DONGFENG 904 E was used in aggregate with the tractor. The working speed is set at 6 and 9 km/h, and the processing depth is 16 cm.

During the tests, the following indicators of the developed chisel cultivator were determined:

- processing depth;
- quality of soil crumbling in the 0-10 cm layer;
- soil density below the 0-5 cm layer;
- total tractive resistance of the machine;
- labor productivity;
- fuel consumption.

**Table 3.** Soil moisture, hardness, and density before testing.

Soil layer, cm	Humidity, %	Hardness, MPa	Density, g/cm <sup>3</sup>
0-10	15.7	0.55	0.96
10-20	16.3	0.84	1.05
20-30	15.5	1.11	1.08
0-30	15.9	0.82	1.03

**Table 4.** Results of the recommended chisel cultivator tests.

No	Name of indicators	Value of indicators		
		According to preliminary requirements	Based on test results	
1.	Speed of movement, km/h	6-9	6.02	8.82
2.	Processing depth, cm: M <sub>Middle</sub> $\pm\sigma$	10-20 2.	15.	16.
2.	Amount of soil fractions of the following size, % >50 mm 50-25 mm <25 mm	<5 - >80	3.23 11.6 85.17	2.2 10.2 87.6
3.	Soil density in the 0-10 cm layer, g/cm <sup>3</sup> :	1.1-1.2	1.16	1.12
4.	Tractive resistance: - total, kN - specific, kN/m	<30	11.7 3.9	12.3 4.1
6.	Fuel consumption, kg/ha	-	8.1	8.5
7.	Productivity, ha/h: - main time - during operation	1.9-2.5 1.17-1.56	1.76 1.18	2.37. 1.62

The crumbling quality and density of the treated soil and the draft resistance of the machine were determined by the methods described in Chapter 2 of the dissertation.

The machine's productivity and fuel consumption were determined based on chronometric observations. In this case, the area processed and the amount of fuel consumed during one hour of operational time were determined.

The data presented in Table 4 show that the performance indicators of the chisel cultivator, equipped with an improved plank roller, meet the agrotechnical requirements for it at both speeds of movement.

According to the results obtained during the tests, with the recommended chisel cultivator at a speed of 6.02 km/h, the content of fractions larger than 50 mm was 3.23%, fractions smaller than 25 mm - 85.17%, and at a speed of 8.82 km/h - 2.2 and 87.6%, respectively. According to the initial requirements, these indicators should be less than 5 percent and more than 80 percent, respectively.

Soil density at a speed of 6.02 and 8.82 km/h was 1.16 and 1.12 g/cm<sup>3</sup>, respectively. According to the initial requirements, this indicator should be in the range of 1.1-1.2 g/cm<sup>3</sup>.

During the tests, the developed machine reliably performed the specified technological process, and no serious shortcomings were observed.

*Economic indicators of the use of a chisel cultivator equipped with a plank roller.* Economic indicators of a chisel cultivator equipped with an improved plank roller with the recommended parameters O'zDSt 3193:2017. "Testing of agricultural machinery. "Method of Energy Evaluation of Machines" [2] and other regulatory documents. In this case, the developed machine was compared with the currently used combined machine (KM-3.0) (Table 5) [3].

**Table 5.** Calculation of initial data and economic indicators.

No	Indicators	Designation	Indicator value	
			Available cars	Proposed car
1.	2.	3.	4.	7.
<b>A. Initial data</b>				
1.	Aggregate composition: tractor  machine		DONGFENG 904 E  Combination- lashgan mashina (KM-3.0)	DONGFENG 904 E  Improved planar roller (TPG-3.6)
2.	Weight, kg: Tractor machine	$G_t$ $G_0$	5524 760.	5524 850
3.	Retail price, sum tractor machine	$Shorse$ $S_{00}$	1148000000 55000000	1148000000 60000000
4.	Productivity during main working hours, ha/h	$W_0$	2.70	3.24
5.	Time utilization factor: shift operational	$K_{cm}$ $K_{ek}$	0.72 0.69	0.76 0.72
7.	Annual load, hours: A) standard tractor machine	$T_{mt}$ $T_{mJ}$	1380.00 150.00	1380.00 150.00
	B) territorial tractor machine	$T_{xt}$ $T_{xj}$	1380.00 150.00	1380.00 150.00
8.	Service personnel, people tractor driver worker	$K_t$ $K_i$	1.00	1.00
9.	hourly tariff rate, sum/hour to the tractor driver worker	$T_{bt}$ $T_{bi}$	8208.74	8208.74
10.	Fuel and lubricants consumption, kg/ha	$He$	11.40	10.50

11.	Cost of 1 kg of complex fuel, sum	$S$	13,000.00	13,000.00
12.	Renovation allocation factor: for a tractor for the car	$a_t$ $a_j$	0.170 0.142	0.170 0.142
13.	Deduction coefficient for maintenance and repair: for a tractor for the car	$Ch_t$ $Ch_j$	0.115 0.100	0.115 0.100
14.	Coefficient of transfer of retail price to the balance price	$C$	1.10	1.10
<b>B. Calculation of economic indicators</b>				
1.	Balance price, sum tractor $BT=KShorse$ Car $Bj=KSoj$	$B$ $B_T$ $B_c$	126,280,000 60500000	126,280,000 66000000
2.	Total salary, sum/ha $Z= (T_{bt}+T_{bi}) /W_{cm}$	$Z$	4222.60	3333.63
3.	Productivity per 1 hour, ha/hour in shift: $W_{cm}=K_{cm}W_0$ during operation: $W_{ek}=K_{ek}W_0$	$W_{cm}$ $W_{ek}$	1.94 1.86	2.4624 2.33
4.	Annual territorial load, ha $W_x=W_{ek}T_{xj}$	$W_{xm}$ $W_{xya}$	279.45	349.92
5.	Renovation costs, sum/ha $A=(B \times a) / (T_z \times W_{ek})$ tractor machine	$A_t$ $A_o$	83500.98 30742.53	66684.81 26783.26
6.	Capital, current repairs and planned maintenance costs, sum/ha $R= (B \times Ch) / (T_z \times W_{ek})$ tractor machine	$R_t$ $R_o$	56,485.95 21649.67	45110.31 18861.45
7.	Fuel and lubricants consumption, sum/ha $G=U \times S$	$G$	148,200,00	136,500,00
8.	Costs per 1 ha, sum/ha $I_{ud}=Z+A_t+A_o+R_t+R_o+G$	$I_{ud \times j}$ $I_{ud \times ya}$	344801.73	297,273.47
9.	Total costs per 1 ha, sum/ha		344801.73	297,273.47

10.	Labor intensity, man-hours/ha $Z_i=L/W_{ek}$	$Z_j$	0.537	0.429
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Annual economic effect from the use of a single chisel cultivator equipped with the recommended plank rollers

$$E_y = ((I_{ud \times j} - I_{ud \times ya}) W_x = (344801.73 - 297273.47) 349.92 = 47528.26 349.92 = 16631089.3 \text{ sum}$$

Savings from total labor input

$$E_{y,m} = (Z_j - Z_{ya}) W_x = (0.537 - 0.429) 349.92 = 38 \text{ people.hours.}$$

### Conclusion

The performance indicators of the machine, equipped with a plank roller with substantiated parameters, fully met the requirements for it. According to the calculations, the use of a machine equipped with a plank roller with the recommended parameters for preparing plowed land for sowing reduces labor costs by 20.14% and operating costs per hectare of cultivated land by 13.78%. The annual economic effect will be 1,663,1089.3 soums.

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