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# Consumption of Time and Fuel When Using Different Machines for Soil Preparation

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## Keywords

*Circular self-cleaning harrow  
Disk harrow  
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Time consumption*

## Ključne riječi

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Subject review

A field test was performed to compare the presowing soil cultivation formerly and today. Three agricultural implements (soil preparation machine, disk harrow and circular self-cleaning harrow) were used in four repetitions. The test was aimed at proving that time and fuel and, consequently, money can be saved, if new agricultural machinery is used. The surface area of the field was 19530 m<sup>2</sup> and it was divided into twelve plots of 1627,5 m<sup>2</sup> each. Statistical data processing showed that the most economical implement was the circular self-cleaning harrow.

## Trošenja vremena i goriva za korištenje raznih strojeva za pripremu zemljišta

Pregledni rad

Proveli smo eksperiment u kojem smo usporedili predsetveno obradu zemlje u prošlosti i sadašnjosti. U pokusu smo koristili tri različite priključke (predsetvenik, diskasta drljača i rotacijska drljača) sa četiri ponavljanja. Htjeli smo dokazati da je moguće uštedjeti vrijeme i gorivo, a time i novca, koristeći suvremene poljoprivredne mehanizacije. Površina polja je bila 19530 m<sup>2</sup>, polje je bilo podijeljeno na dvanaest parcela, područje svake parcele je imalo 1627,5 m<sup>2</sup>. Prema statističkim podacima, utvrdili smo da je najisplativija i najekonomičnija rotacijska drljača.

## 1. Introduction

The soil preparation machines are supposed to crush the furrow slices and to level and break up the soil in the smallest possible number of passages. Taking into account the soil structure and the weather conditions the soil must be best prepared for sowing and/or planting after cultivation with soil preparation machines [1-3].

In addition to conventional machines for soil preparation (disk harrows, soil preparation machines), lately the circular self-cleaning harrows, which are expensive and pose high demands on maintenance, have been frequently used [4-8].

This paper is aimed at finding which agricultural implement uses the least time and which of the three soil preparation implements (soil preparation machine, disk harrow and circular self-cleaning harrow) requires least fuel on the previously ploughed field. It was interesting to know whether newer agricultural machinery can contribute to time and money saving [9-15].

## 2. Material and methods

The field was measured by the internet application Gerkviewer on the pages of the Agency for agricultural markets and landscape and area development. After measuring the field was divided into 12 identical plots. The surface area of the field was 19530 m<sup>2</sup> and that of the individual plots 1627.5 m<sup>2</sup>.

The plots were divided by means of tape measure, marking stakes, rope and line (Figure 1). Staking out of the field started at the north. First, the outer edge was staked out in the clockwise direction. In order to verify the borders a rope stretched between the extreme points north-south and east-west was used in addition to the tape measure. At the connection points white marking stakes were driven, then the borders along the rope were additionally marked with lime [16].

The time was measured by a stop watch from the beginning of the plot marked with lime until the end of cultivation of the individual plot.



**Figure 1.** Plot marking

**Slika 1.** Etiketiranje parcela

The fuel consumption was measured by a laboratory measuring cylinder (Figure 2). For each plot the fuel was topped up in the tank prior to beginning of and at the end of cultivation of plot. The reading on the measuring cylinder gave the information about the fuel consumption.



**Figure 2.** Laboratory measuring cylinder

**Slika 2.** Laboratorijski mjerilni cilindar

#### Test plane

The test comprised three treatments with four repetitions.

<b>A</b>	<b>B</b>	<b>C</b>
<b>B</b>	<b>C</b>	<b>A</b>
<b>C</b>	<b>A</b>	<b>B</b>
<b>A</b>	<b>B</b>	<b>C</b>

A – circular self-cleaning harrow

B – soil preparation machine

C – disk harrow

#### Tractor and agricultural implements

The tractor New Holland 70-56 DT driven by a four-cylinder water-cooled Iveco engine was used for the test.

The working volume of engine is 3613 cm<sup>3</sup> and its output 51,5 kW or 70 HP. It has the four-wheel drive. The mass of the empty tractor is 2950 kg.



**Figure 3.** Tractor New Holland 70-56 DT

**Slika 3.** Traktor New Holland 70-56 DT

Figure 4 shows the circular self-cleaning harrow Emy CL 25 used for the test. This is a harrow of 2,5 m working width, 824 kg mass, with 10 pairs of teeth. It is equipped with a Paker roll and is driven through a cardan shaft. During the test the soil was prepared for sowing in one passage at the anticipated speed 6 km/h.



**Figure 4.** Circular self-cleaning harrow

**Slika 4.** Rotacijska drljača

Figure 5 shows the soil preparation machine by Kovastvo Prelog and used for the test. Its working width is 3 m and it is equipped with 20 spring cutters and 4 crushing rolls. The soil was prepared for sowing in two passages at anticipated speed 8 km/h.



Figure 5. Soil preparation machine

Slika 5. Predsetvenik

Figure 6 shows the disk harrow made by Vogel & Noot and used for the test. Its working width is 2 m.

This harrow has 20 disks distributed on four movable axles of five disks each. For crumbly earth three passages were necessary at anticipated speed 5 km/h.



Figure 6. Disk harrow

Slika 6. Diskasta drljača

#### Statistical data processing

The data were collected and edited in the Excell program. The originally obtained results were converted from values for plots into values per hectare, which allows greater transparency. The statistical package SPSS 17.0 for Windows was used for the statistical analysis. The mean values of the calculated average parameters were compared among the individual treatments by the variance analysis (ANOVA). In order to find out the statistical differences among individual treatments the Tukey HSD test was performed.

The statistically significant differences of the individual parameters among different treatments were in case of  $p \leq 0,05$  and statistically insignificant differences were in case of  $p \geq 0,05$ . Further, statistical differences among individual agricultural implements in the time consumption per unit of surface were determined.

### 3. Results with discussion

#### Time consumption

Concerning the time consumption it was statistically confirmed that the soil was fastest prepared by the circular self-cleaning harrow. The most modern agricultural implement prepared the soil within the shortest time. The oldest agricultural implement used most time. The time sequence was: circular self-cleaning harrow, soil preparation machine and, last, the disk harrow. The data were processed according to the Tukey test ( $p \leq 0,05$ ).

The target of the test was crumbly soil structure. In order to reach such one passage with the circular self-cleaning harrow, two passages with the soil preparation machine and three passages with the disk harrow were necessary. As a result, this had an effect on the longer time of cultivation with the soil preparation machine and disk harrow.

Table 1 shows time consumptions used for cultivation of plots and those converted into values per hectare. Statistically significant differences occurred in the time consumption among individual agricultural implements. It was anticipated that most time would be used for cultivation with disk harrow, almost one half less time is used for work with the soil preparation machine; the work is performed fastest with circular self-cleaning harrow ( $p \leq 0,05$ ).

Table 1. Average time consumption

Tablica 1. Prosječno vrijeme

Treatment / Tretiranje	Time consumption / Trošenje vremena, min. / plot	Time consumption / Trošenje vremena, min. / ha
Circular self cleaning harrow / Rotacijska drljača	15,16	93,16
Soil preparation machine / Predsetvenik	19,16	117,77
Disk harrow / Diskasta drljača	33,86	208,07

Figure 7 shows the values from Table 1, where it can be clearly seen how much time is used for soil preparation with disk harrow in comparison with the soil preparation machine and circular self cleaning harrow.

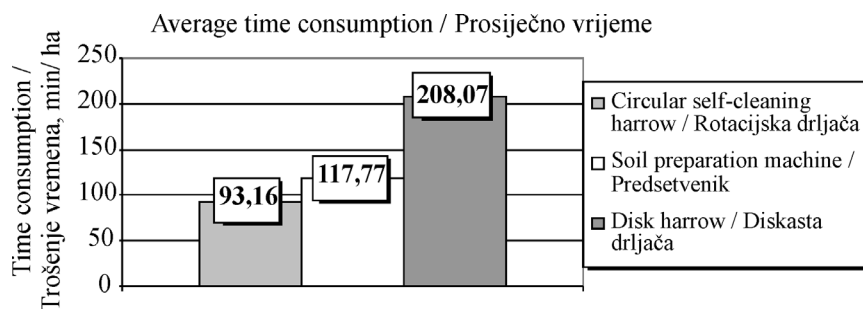


Figure 7. Average time consumption

Slika 7. Prosječno vrijeme

Table 2 shows that the circular self-cleaning harrow and the soil preparation machine do not statistically differ in the fuel consumption, whereas the fuel consumption of the disk harrow in comparison with the soil preparation machine and circular self-cleaning harrow does. This proves that the disk harrow as the oldest agricultural implement is most uneconomical in fuel consumption. The other two, more modern, implements consumed less fuel, but it could not be statistically confirmed that the circular self-cleaning harrow used less fuel than the soil preparation machine.

Table 2 shows the differences in fuel consumption among individual implements. First, the values of fuel consumption on plots are indicated, then those values are converted into values per hectare for greater transparency.

Table 2. Average fuel consumption

Tablica 2. Prosječna potrošnja goriva

Treatment / Tretiranje	Fuel consumption / Potrošnja goriva, l / plot	Fuel consumption / Potrošnja goriva, l / ha
Circular self cleaning harrow /Rotacijska drljača	1,8	11,05
Soil preparation machine / Predsetvenik	1,9	12,13
Disk harrow / Diskasta drljača	3,27	20,12

Picture 8 shows average fuel consumptions, where a considerable difference is obvious between the disk harrow and the other two implements, how much fuel is consumed for cultivation in the older way, which is a piece of information very much in favour of circular self-cleaning harrow and soil preparation machine which were far more economical. It was not statistically confirmed in case of  $p \leq 0,05$  that the circular self-cleaning harrow was more economical, while working with it was more comfortable for the driver, since tractor driving is smoother.

#### 4. Conclusion

During the test various soil preparation machines were compared. Three different agricultural implements (soil preparation machine, disk harrow and circular self cleaning harrow) were used in four repetitions. It was proved that newer agricultural machinery can help save time and fuel and, consequently money.

Among individual treatments statistically demonstrated differences occurred in the time required for cultivation of one hectare of soil, where all three implements used different values of time. Least time was used with modern circular self-cleaning harrow (93,16 min. / ha) and most with disk harrow (208,07 min. / ha). In the fuel consumption statistically significant differences occurred between the disk harrow and the soil preparation machine and between disk harrow and circular self-cleaning harrow; there were no statistical differences between circular self-cleaning harrow and

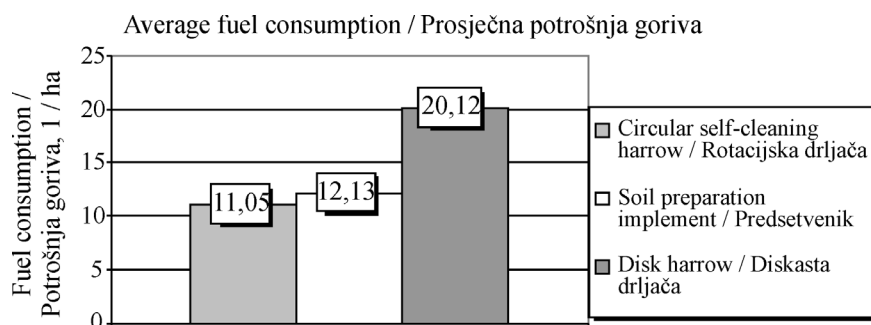


Figure 8. Average fuel consumption

Slika 8. Prosječna potrošnja goriva

soil preparation machine. It was proved that the highest consumption occurs when using disk harrow (20,15 l/ha) and the least fuel consumption when using circular self-cleaning harrow (11,05 l/ha).

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