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Costs Update of Olive Trunk Shaker Mechanical Systems

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Abstract Results of work rates and costs from field trials performed in Portugal over more than five years in olive orchards averaging 150 trees per hectare, was published by Almeida, A. *et al* (2001) and Almeida, A. *et al* (2007).
Olives were harvested using two main harvesting systems, both with the same trunk shaker, but in one (System I) olives detached were collected by canvas manually moved and in the other (System II) olives detached were collected with an inverted umbrella.
Results showed that the time spent in the displacement between trees is very important for the work rate value. Labour based manual collecting was found to reach the higher working rates, whereas in terms of costs the inverted umbrella scored the best results.
More than one decade after the publication of those results, equipment and labour costs are substantial different as well as olive production value. Costs are updated and analyzed the consequences for referred olive mechanical harvesting systems.
Key words: Olives, mechanical harvesting, costs.

INTRODUCTION

Olive crop is in a critical situation due to low product price and high production costs.

In order to face the problem it is mandatory to increase competitiveness in the global market, reducing costs and improving fruit quality. Low mechanization level penalizes the sector.

Olive harvesting mechanization systems allow achieving these goals: costs – reducing manpower needs and quality – better work rates make possible to harvest in the optimal harvest timing (Amirante, Tamborino, 2012).

In this paper we will focus on traditional rain feed olive orchards with up to 150 trees per hectare, presenting work rate results (trees/hour) and costs of two mechanical harvesting systems.

MATERIALS and METHODS

Field trials carried out in Portugal in eleven traditional olive orchards (sites) over three years. Traditional olive orchards vary from 100 to 150 trees per hectare. Six of the olive orchards are in Trás-os-Montes region and five are in Alentejo region. A total of 2535 trees were used in the field trials.

In Trás-os-Montes there are three main cultivars: Cobrançosa, Verdeal and Madural, whereas in Alentejo, Galega is the main cultivar.

The mechanical harvesting systems studied are based on a trunk shaker mounted on the front loader of a 60 kW four wheel drive tractor. Two different systems were used to collect olives detached:

In system I (Figure 1) the olives detached are collected on a 10m × 10m canvas placed under the canopy projection, and moved by four labourers. In a parallel row, a second group was placing another canvas under the next tree to be shacked. A second tractor and trailer was standing by to collect the olives when canvas became too heavy, as well as to provide transport to the processing unit.

In system II (Figure 2) the olives detached are collected by a 9 m diameter inverted umbrella linked to the tractor front-end-loader under the trunk shaker frame. The inverted umbrella can store temporarily 200/250 kg of olives in a collecting tray. Under the

collecting tray a lead may be hydraulically open to allow discharge of the olives.

Figure 1. System I

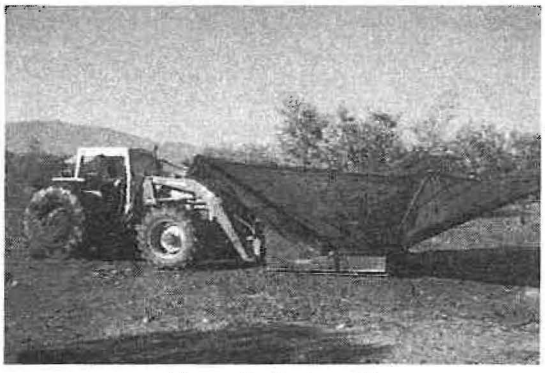

Figure 2. System II

The following time in seconds were taken to evaluate work rates:

Tvt - medium value of time per tree for trunk shaking (in systems I, and II);

TDV - medium value of time to move the tractor/shaker unit, from one tree to next (in systems I, and II);

Tdaz - medium value of discharging time of the inverted umbrella (in system II).

Na -Number of trees between discharges (in system II).

Work rates (WR) were computed from the following expressions:

$$\text{System I} \rightarrow WR = \frac{3600}{TVt + TDV} \qquad (1)$$

$$\text{System III} \rightarrow WR = \frac{3600}{TVt + TDV + \frac{Tdaz}{Na}} \qquad (2)$$

The following assumptions were taken to evaluate costs:

An average of 50 days at 7 hours/day of work is assumed to be the average within the harvesting season, which spreads from October till December.

To evaluate the annual total costs it was assumed a purchasing price of 25000 € for the trunk shaker and 8000 € for the inverted umbrella. An expected life of 10 years for both equipments.

The annual costs of other equipment and labour were also assumed as follows:

- 10 canvas (10 m×10) — 80 €/year;
- 3,5 ton trailer — 3 €/hour (300 hours of total annual use);
- Tractor 1 (60 kW) to support the trunk shaker — 35 €/hour (800 hours/year);
- Tractor 2 (40 kW) for trailer work — 28 €/hour (800 hours of total annual use);
- 8 men — 40 €/day/man;

Costs were evaluated, according the following equations:

For System I (3)

$$C = \left(\frac{CT1 + FLC + CT2 + TC}{WR} + \frac{SC + CC}{TNT} + \frac{8 \times LC}{WR \times HWD} \right) \times \frac{1}{OPT}$$

For System II (4)

$$C = \left(\frac{CT1 + FLC + CT2 + TC}{WR} + \frac{SC + IUC}{TNT} \right) \times \frac{1}{OPT}$$

C - cost/kg of olives harvested
CT1 – Cost/hour of Tractor 1
CT2 - Cost/hour of Tractor 2
TC – Trailer cost/hour
FLC – Front loader cost/hour
SC – Trunk shaker cost/year
IUC – Inverted umbrella cost/year
CC – Canvas cost/year
LC – Labour cost/day
HWD – Hours of field work/day
WR – Trunk shaker work rate
TNT – Total number of trees harvested/year
OPT – Olive production/tree

RESULTS and DISCUSSION

Figure 3 show the work rate results, considering the assumptions mentioned in the previous section. Some factors are responsible for the great interval in both systems between minimum and maximum values: the traditional olive orchard heterogeneity, and the different soil conditions. Soils with good

capacity to sustain the harvesting equipment allow a useful time reduction in the displacement between trees improving work rates.

System I show a better performance than system II, but system I has a great dependence of hand labour (8 men to move canvas).

Figures 4 to 7 show the cost per kg of olive harvested, considering the three main representative work rates values (in bold the medium value), the total number of trees harvested per year and the production level per tree. For olive orchards with lower production the work rate improvement assumes a great importance. In this case, better work rates allow increasing the number of trees harvested and the reduction of harvesting costs is more significant than in olive orchards with better production.

Figures 8 and 9 compare costs of systems I and II obtained with medium work rates, considering olive orchards with lower production (10/tree) and higher production (20kg/tree). Costs are lower in system II than in system I in both production levels, despite system I better work rates.

CONCLUSIONS

It is possible to get excellent work rates with system I, but the dependence of labour put this system in disadvantage.

Costs per kg of olives harvested are lower in system II. This system has not a great dependence of labour. These two factors make system II recommendable for the referred kind of olive orchard.

These costs compared with costs computed in same conditions published in 2001 (Almeida et al, 2001) show an increase of 40% to 49%, mainly due to higher equipment cost (all items, including fuel) and higher labour cost.

This considerable increase of harvesting costs makes mandatory to improve the efficiency of olive orchards production and the efficiency of olive orchards systems.

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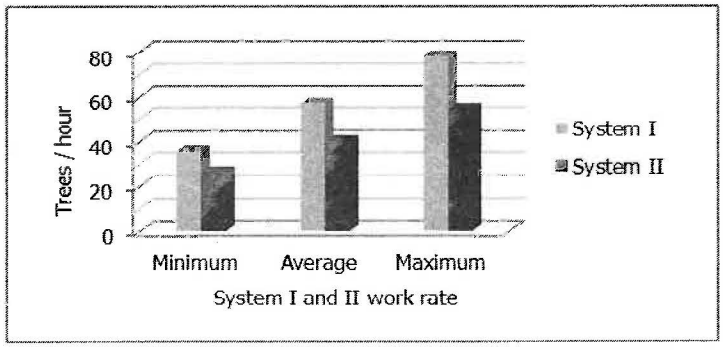

Figure 3. Work rates

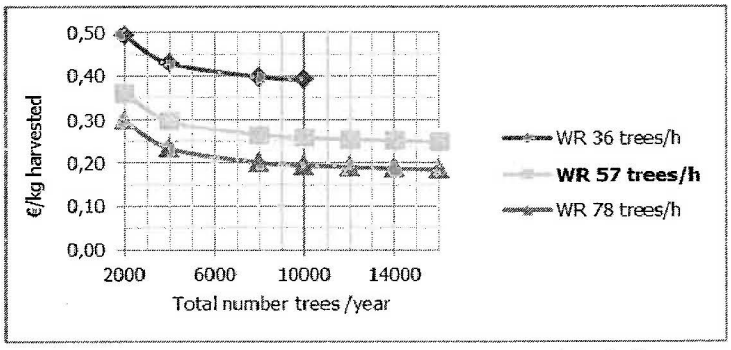

Figure 4. System I - Costs per kg of olive harvested – 10 kg of olives per tree.

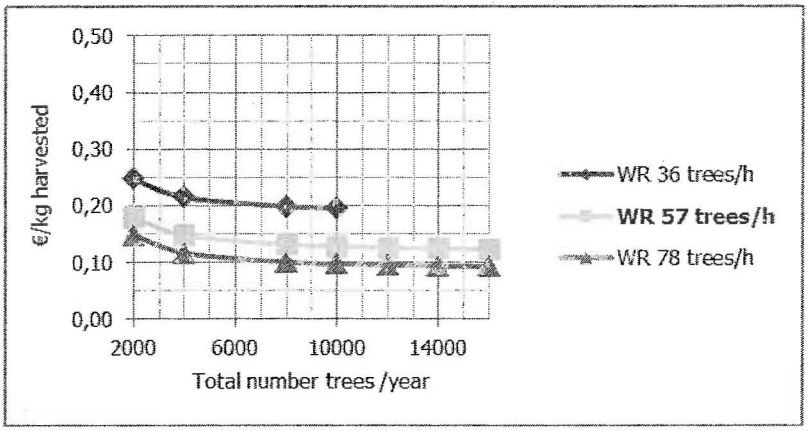

Figure 5. System I - Costs per kg of olive harvested – 20 kg of olives per tree.

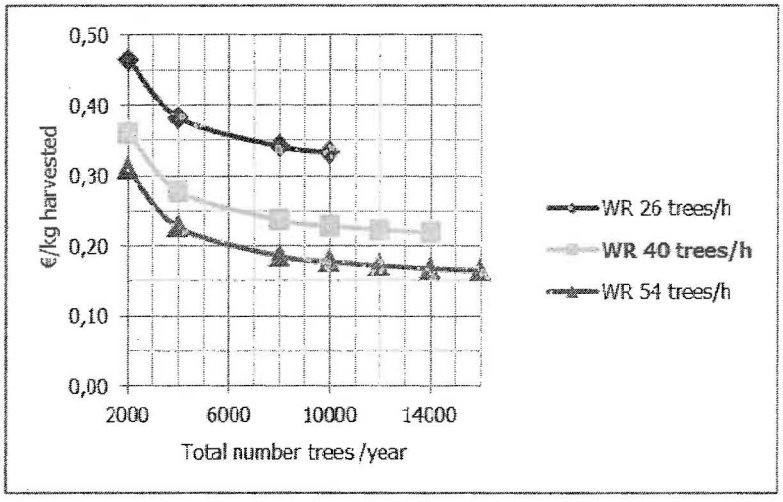

Figure 6. System II - Costs per kg of olive harvested – 10 kg of olives per tree.

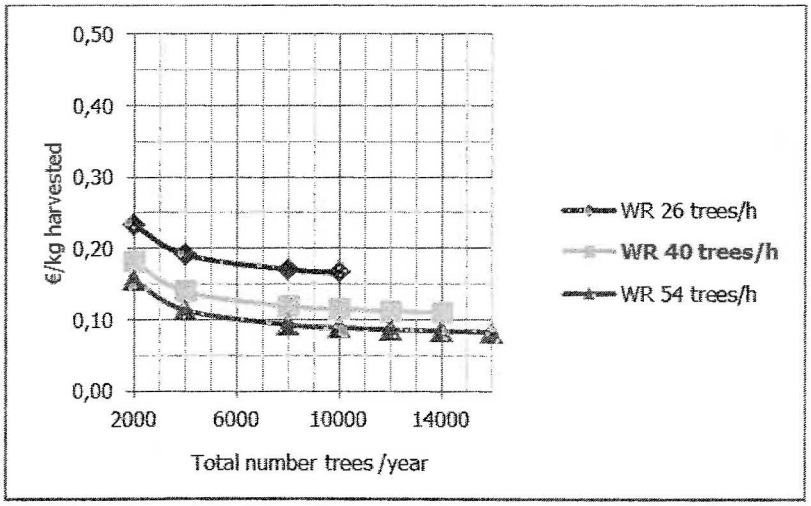

Figure 7. System II - Costs per kg of olive harvested – 20 kg of olives per tree.

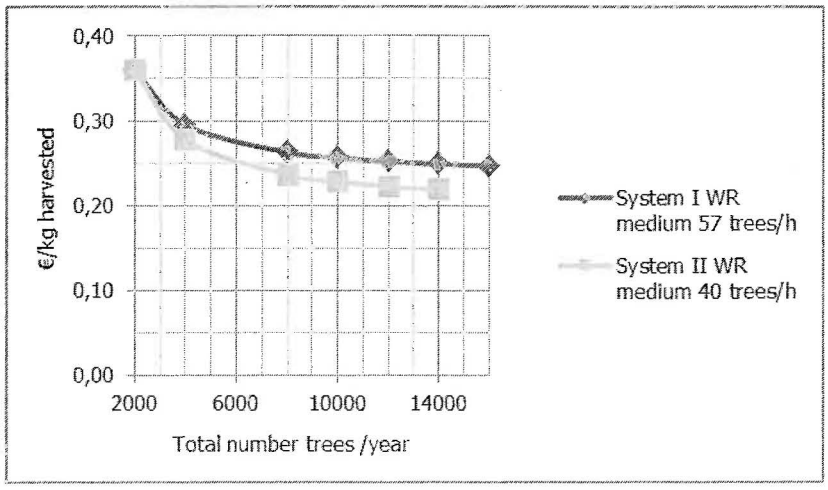

Figure 8. System I and System II comparison - Costs per kg of olive harvested – 10 kg of olives per tree.

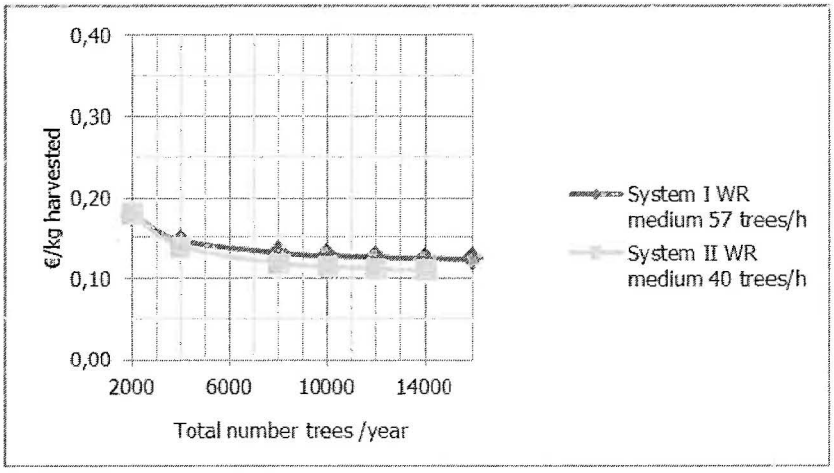

Figure 9. System I and System II comparison - Costs per kg of olive harvested – 20 kg of olives per tree.

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