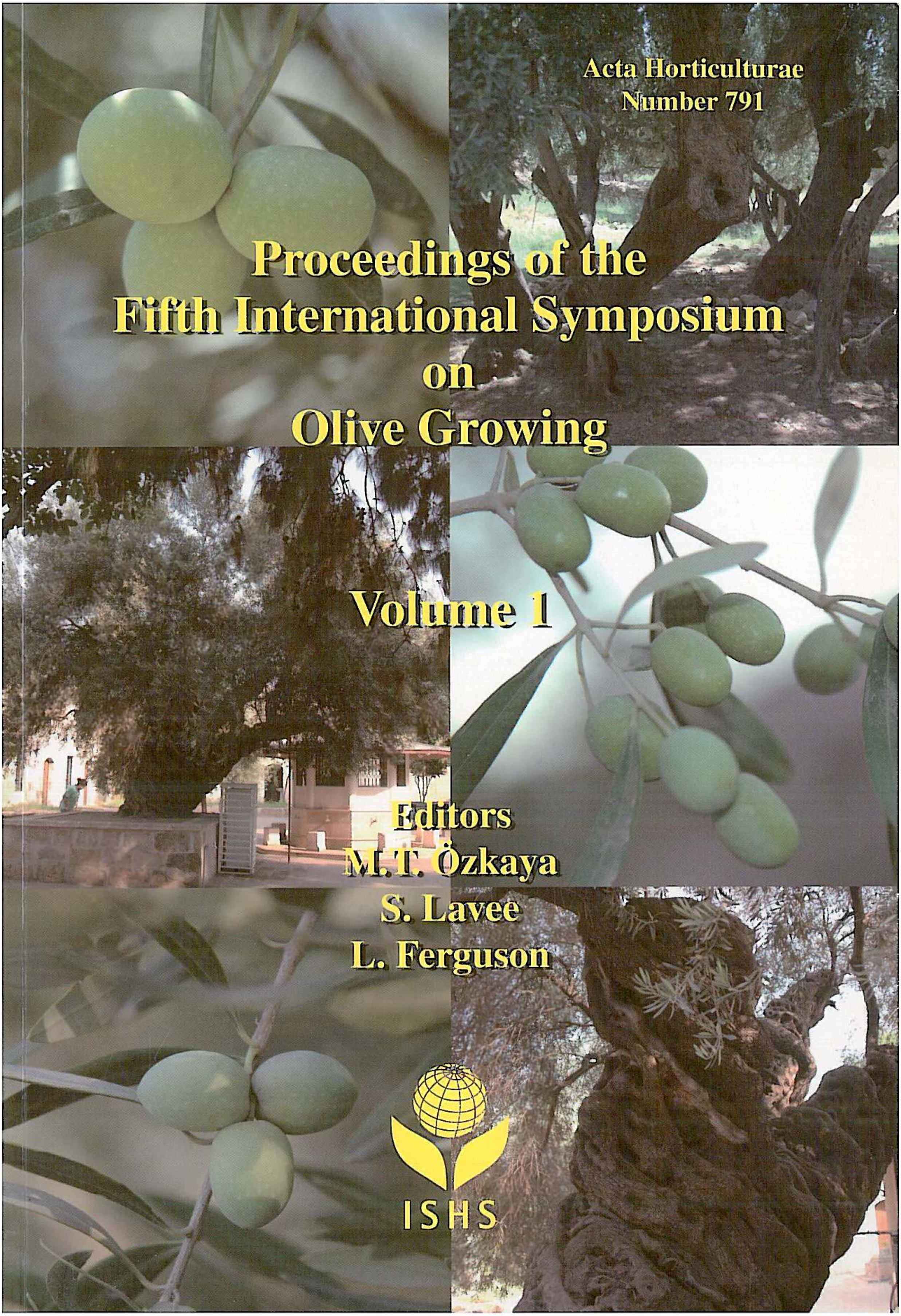

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Mechanical Harvesting of 400 Trees per Hectare Olive Orchards Based on a Rolling Canvas Prototype

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Abstract

As the world's olive industries move towards higher densities of trees per hectare, different alternatives are required to collect olives harvested by trunk shakers. This paper puts forward a revised concept of the traingli cart with a rolling canvas system.

The equipment consists on a 6 m long box welded to a wheeled chassis, with a rolling canvas system placed over its full length. Olives are stored until the box is full, and then discharged through the back by a conveyor belt placed at the bottom of the box. Steering axle and low pressure tires increase performance. All components are hydraulic powered from the pulling tractor.

Real scale tests were carried out in two 400 trees per hectare olive orchards: (a) a trunk shaker, and one trailed cart harvesting a single row of trees at a time; (b) a trunk shaker, and two trailed carts for two-row harvesting.

Results show working rates of around 40 and 50 trees / hour, respectively, for a single-row and two-row harvesting. Discussion of the results reveals that higher working rates are possible.

INTRODUCTION

In Portugal the most common plantation densities found in olive orchards vary from 90 to 240 trees per hectare. In these traditional olive orchards, harvesting is usually based on a tractor mounted trunk shaker and 4 workers employed to collect the olives using canvas manually placed on the ground under the tree. Other solution is based on an inverted umbrella linked to the tractor mounted trunk shaker (Almeida et al., 2003).

Recently modern olive orchards have been planted, adopting irrigation and therefore with higher tree densities.

New harvesting solutions are required to cope with densities of 300 to 400 trees per hectare, since the frequency of operations put a higher level of strain on workers and equipment and in many cases, there is not enough space to open the inverted umbrella.

MATERIALS AND METHODS

The two olive orchards used in this study are located in Alto Alentejo, which is one of the most important olive growing provinces of Portugal. They are both privately owned and reveal high husbandry standards. Both are olive orchards of the variety Picual, with drop irrigation, planted in a 7.0 m×3.5 m array, that came into full production in 2000 (site 1) and in 1999 (site 2).

In both sites trees were trunk shaken using an orbital shaker-head mounted on a 45 kW articulated tractor with hydrostatic transmission (Fig. 1).

Falling olives were intercepted by a canvas unrolled from a purposely built trailed cart with a rolling canvas system (Fig. 2). This equipment (Peça et al., 2003) consists on a 6 m long box welded to a wheeled chassis, with a rolling canvas system placed over its full length (Fig. 3). Two workers per cart are employed to support the free side of the canvas, placing it under the trees. Olives are stored until full capacity of the box, and then discharged trough the back by a conveyor belt placed at the bottom of the box, onto small storage canvas, that are left on the ground for later loading (Fig. 4).

Steering axle and low pressure tyres increase performance (Fig. 5). All components are hydraulic powered from the pulling tractor.

Two trailed carts were used, pulled, respectively, by a 44 kW and by a 56.5 kW four-wheel-drive agricultural tractor.

At the end of the day, the storage canvas were loaded into a trailer, using the same tractors, one with a rear mounted hydraulic crane and the other pulling a farm trailer. Loads were weighed using a digital dynamometer (Fig. 6).

At each site, two harvesting methods were tested:

- One shaker/ one cart, harvesting one row of trees at a time. In this method, the shaker progressed along a line of trees with the trailed cart progressing along the same line of trees, at the opposite side (Fig. 7).
- One shaker/ two carts, harvesting two rows of trees at a time. In this method, each one of the carts is moving along its own line of trees. The tractor/shaker unit progresses between the two rows, harvesting alternatively trees from each row (Fig. 8).

Table 1 shows the number of trees involved in each test.

RESULTS

Table 2 reports the mass of olives harvested per tree.

Table 3 and Table 4 show the average time spent in the successive operations of the harvest routine.

The work rates are shown on Tables 5 and 6.

DISCUSSION AND CONCLUSIONS

From the results it can be seen that the average time of actual manoeuvring of the tractor/shaker unit between two consecutive trees (T3) is similar, regardless test site or method used. This is explained by the fact that all the tests were carried out by the same tractor/shaker unit and operator in two olive orchards, which are not different concerning the relevant features of terrain and distance between trees.

However, the average time between the vibrations of two consecutive trees (T2) is, in every site and method used, always higher than T3. This means that the tractor/shaker unit has non-productive periods of time, in which it is waiting for the routine of the cart(s) to be finished. Furthermore, the differences in each site between the average results of T2 and T3, are very small when one shaker/two carts method was tested, which means that, in average, the two carts were able to progress from one tree to the next without any delay for the tractor/shaker unit. That was impossible to accomplish when a single cart was used.

From Tables 5 and 6, it is clear that unless there is an improvement in the work rate of the method based on one shaker/ two carts, this method will not be able to justify the extra investment on second tractor and cart unit.

It is a well known fact that work rates are influenced by the type of contract established with labour: payment by the hour or payment according to the kilograms harvested.

The team of workers employed to assist in these tests were paid by the hour. A further test with workers paid according to the work produced should reveal much higher and realistic work rates. This assumption was confirmed and reported in a second paper also submitted by the same authors, in this volume (Almeida et al., 2004).

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Tables

Table 1. Number of trees involved in each test.

Method	Site 1	Site 2
One shaker/one cart	69	84
One shaker/two carts	188	132

Table 2. Mass of olives harvested per tree (kg).

Method	Site 1	Site 2
One shaker/one cart	9.97	19.93
One shaker/two carts	7.48	19.10

Table 3. Results obtained with one shaker/one cart.

Average time (s)	Site 1	Site 2
T1	7.9	8.9
T2	79.6	68.2
T3	57.5	55.1
T4	233.7	113.0

T1 - Average vibrating time per tree; T2 - average time between the vibration of two consecutive trees; T3 - average time of actual manoeuvre of the tractor/shaker between to consecutive trees; T4 - average time of discharge.

Table 4. Results obtained with one shaker/two carts.

Average time (s)	Site 1	Site 2
T1	7.7	11.0
T2	61.4	56.4
T3	59.2	55.4
T4	190.0	158.2

T1 - Average vibrating time per tree; T2 - average time between the vibration of two consecutive trees; T3 - average time of actual manoeuvre of the tractor/shaker between to consecutive trees; T4 - average time of discharge.

Table 5. Work rate in trees per hour.

Method	Site 1	Site 2
One shaker/one cart	38.7	42.0
One shaker/two carts	50.1	49.3

Table 6. Work rate in trees per man hour.

Method	Site 1	Site 2
One shaker/one cart	9.7	10.5
One shaker/two carts	7.2	7.0

Figures

Fig. 1. Tractor/shaker unit used in the tests.

Fig. 2. Canvas fully extended.

Fig. 3. Full length storage box.

Fig. 4. Operation of discharge of a full load.

Fig. 5. Detail of the steering axle with low pressure tyres.

Fig. 6. Loading and weighing storage canvas.

Fig. 7. Single row harvesting.

Fig. 8. Two row harvesting.