A System to Simplify the Use of Mounted Shakers for Harvesting Olives and Dry Fruits

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Summary

The shakers for harvesting olives and dry fruits have reached a high standard and their use is increasing rapidly.
In order to satisfy the different demand, manufacturers offer a wide range of shakers, from the more expensive self-propelled ones to those to be mounted on the tractor's power lift, with shaking headers of different mass and size, suitable for the different orchard characteristics.
Self-propelled shakers have high steering capacity and optimum visual field for the operator, so their working capacity is very high with respect to that of mounted shakers, which are less expensive but have lower steering capacity and a limited view on the header. Therefore the approaching of mounted shakers to the plant and the fastening of the header to the trunk or branch of the tree is more difficult, and a second operator to pilot the tractor driver is needed, in order to increase the machine working capacity and to avoid plant and/or shaker damages.
This paper proposes to use a system composed of a CCD video camera, installed on the frame of a mounted shaker and connected to a TFT monitor, fitted in the tractor cab.
Comparative tests with and without the above system were carried out. The video camera was mounted on the shaker frame.
The system is relatively cheap, user-friendly and can be mounted on any shaker. It provides the driver with an easy view of the lower dead angle and increases the working capacity and productivity of the machine.

Key words: *mounted shakers, CCD video camera, TFT monitor, working capacity.*

Introduction

The shakers for harvesting olives and dry fruits have reached a high standard and their use is increasing rapidly.
In order to satisfy the different demand, manufacturers offer a wide range of shakers, from the more expensive self-propelled ones to those to be mounted on the tractor's power lift, with shaking headers of different mass and size, suitable for the different orchard characteristics.
Self-propelled shakers have high steering capacity and optimum visual field for the operator, so their working capacity is very high with respect to that of mounted shakers, which are less expensive but have lower steering capacity and a limited view on the header. Therefore the approaching of mounted shakers to the plant and the fastening of the header to the trunk or branch of the tree is more difficult, and a second operator to pilot the tractor driver is needed, in order to increase the machine working capacity and productivity, and to avoid plant and/or shaker damages (Piraino, 2004).

Material and methods

This paper proposes to use a system composed of a CCD video camera, installed on the frame of a mounted shaker and connected to a TFT monitor, fitted in the tractor cab. The technical specifications of this system are shown in Table 1.
A mounted shaker of the manufacturer Sicma, Mythos 80, having a front orienting shank, ending with a multi-directional header, and equipped with an umbrella, was experimented (Fig. 1). The video camera was mounted on the shaker frame, located above the hopper and below the header, in order to provide the driver with an easy view of the lower dead angle, during the approaching of the header to the plant. It provides the driver with an easy view of both the trunk base and the machine header and hopper and, therefore, it allows to avoid damages to both the plant and the shaker.

Table 1. Technical specifications of the system equipping the tested shaker and composed of a CCD video camera and a TFT monitor.

Camera	Monitor
Manufacturer: Pulnix	Manufacturer: Shenzhen Timeless-Long Industrial Co.
Model: TM-7EG	Model: HR-970
Imager: 1/2 inch interline transfer CCD	Screen size: 7 inches
Pixels : 768 (H) x 494 (V)	Display mode: 16: 9
Scanning: 525 lines EIA	Format: PAL or NTSC
TV resolution: 570 (H) x 350 (V)	Pixels: 480 (H) x 234 (V)
Minimum illumination: 0.5 lux (F = 1.4)	Power supply: 12 V DC
Video output: 1 V p-p composite video, 75 Ω	Power consumption: 8.5 W
Gamma: 0.45 or 1	Operating temperature: -10 ÷ 50 °C
Lens mount: M14 x 0.5, C/CS-mount	Shape size: 189 x 149 x 37 mm
Power requirement: DC 12V, 2.5 W	Input: 2 video/1 audio
Operating temperature: -10 ÷ 50 °C	Display screen view angle ± 15° manual adjustment
Random Vibration: 7 Grms @ 10÷2000 Hz	Size: 189 x 149 x 37 mm
Shock: 70 G	
Size: 17 mm (diameter) x 101.9 mm (Length)	
Lens specification	
Focus length: 2.1 mm	
Diaphragm opening: F = 1.2	
Visual angle: 127° (fisheye)	
Mass: 18 g	
Size: 22 x 30 mm	

During the first decade of November 2008 comparative tests with and without the above system were carried out at "Fusco" farm, located in the territory of Caccamo (Palermo), in an olive orchard of about 7 ha, on a flat soil. This orchard is constituted by trees of Biancolilla cultivar, transplanted in 1992 with spacing of 6 x 6 m, having central axis training system and about 5 m high during the testing period.
Both using the camera-equipped shaker and the same machine without the camera itself, two operators were employed: the first for driving the 61 kW tractor mounting the shaker, the second for driving the tractor connected with the trailer carrying the bins, where the olives were discharged. Moreover, using the shaker without the camera, the second operator must help the first one, staying on the ground and using gestures, for approaching the machine to the plant.
The following times for carrying out the various harvest operations were measured: shaker movement from a plant to the next one; machine approaching to the plant, header fastening to the plant trunk and umbrella opening; shaking; header opening and umbrella closing, olive discharge into the bins (Gucci et al., 2004).
Therefore the working capacity and productivity were determined in the two tests performed.
Moreover, all the results of this work were compared with those previously obtained by Tombesi et al. (2004), during two tests (reference tests 1 and 2) carried out in testing conditions very similar to ours (i.e. same kind of shaker, similar spacing, same training system, same number of operators).

Figure 1: The tested camera-equipped shaker during the movement from a plant to the next one.

Results

A mean olive production of about 38 kg per plant was recorded in both the tests performed.

The times of the various harvest operations and the working capacity and productivity, determined using both the camera-equipped shaker and the same machine without the camera, are shown in Table 2.
No damage to the shaker was recorded and only negligible damages to the base of some plant trunks were observed, because the position of the video camera, located above the hopper and below the header, provided the driver with an easy view of the trunk base.

Table 2. Times of the various harvest operations and working capacity and productivity, determined for the two tests and compared with the results obtained by Tombesi et al. (2004).

Shakers / **Parameters**	**Camera-equipped**	**Without camera**	**Reference test 1**	**Reference test 2**
Spacing (m)	6 x 6	6 x 6	5 x 6	5 x 6
Training system	Central axis	Central axis	Central axis	Central axis
Cultivar	Biancolilla	Biancolilla	Frantoio	Moraiolo
Operators	2	2	2	2
Time per plant (s)	109	174	150	120
Shaker movement time (s)	41	42	44	29
Shaker approaching, header fastening and umbrella opening time (s)	16	79	93	78
Shaking time (s)	19	18	14	13
Header opening and umbrella closing time (s)	15	14	-	-
Discharge time (s)	18	21	-	-
Working capacity (plants/h)	33	21	24	30
Working capacity (kg/h)	1254	798	450	450
Working productivity (plants/h/operator)	16.5	10.5	12	15
Working productivity (kg/h/operator)	627	399	225	225

Discussion

The time per plant recorded using the camera-equipped shaker resulted 37% lower than the value obtained using the same machine without the camera (time saving of 65 s).
The shaker approaching time resulted 80% lower, using the camera-equipped shaker. In fact, during the approaching of the equipped-camera shaker to the plant, the driver could benefit from an easy view of the trunk and, therefore, drive at a higher forward speed, without causing any damage to the machine and only negligible damages to the base of some plant trunks.

The discharge time resulted 14% lower, using the camera-equipped shaker. In fact, using the camera-equipped machine, the driver of the tractor connected with the trailer had only to drive it along the inter-row parallel to that where the shaker was moving. Instead, using the shaker without the camera, this operator had to help the other one during the harvest. Therefore, when the olives had to be discharged from the hopper to the bins, he had to reach his tractor and, then, drive it, in order to place the trailer in the next discharge point.
Similar differences for the time per plant and, within this one, for both the shaker approaching and discharge times, were recorded between the tested camera-equipped shaker and the same kind of shaker (without camera) used during the reference tests 1 and 2.
As a consequence of the above lower time per plant, the working capacity (plants/h and kg/h) and productivity (plants/h/operator and kg/h/operator) obtained using the camera-equipped shaker resulted 36% higher than those obtained using the same machine without the camera.
The working capacity (plants/h) and productivity (plants/h/operator) obtained using the tested camera-equipped shaker resulted, respectively, 27% and 9% higher than those of the reference tests 1 and 2.
Moreover, the working capacity (kg/h) and productivity (kg/h/operator) obtained using the tested camera-equipped shaker resulted 64% higher than those of the reference tests 1 and 2, because the mean olive production had resulted of only 17.1 and 15 kg per plant, respectively, and, therefore, much lower than the production recorded in our farm (of about 38 kg per plant).

Conclusion

The experimented system provides the driver of the tractor mounting the shaker with an easy view of the lower dead angle. It sensibly decreases the time per plant and, therefore, increases the working capacity and productivity, with reference to both the same tested machine without the camera and the two comparison reference tests.
The usefulness of the camera-equipped system would be even higher in working conditions different to the testing ones, e.g. in case of sloping ground and/or when the plant trunks are very twisted and/or very gnarled.
Moreover, using the camera-equipped machine, the driver of the tractor connected with the trailer has to perform only the driving task and not to help the other driver during the harvest, leaving his own tractor. Therefore the discharge of olives from the shaker hopper to the trailer bins can be rapidly carried out.
The tested system is relatively cheap, user-friendly and can be mounted on any shaker.

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