World Wide Journal of Multidisciplinary Research and Development

WWJMRD 2018; 4(2): 361-363
www.wwjmrd.com
International Journal
Peer Reviewed Journal
Refereed Journal
Indexed Journal
UGC Approved Journal
Impact Factor MJIF: 4.25
E-ISSN: 2454-6615

Cost Analysis of Olive Harvesting By Hand-Held Machine

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Abstract
Field experiments were carried out in the Experimental Farm of Agricultural Production and Research Station (APRS), National Research Centre (NRC), Nubaria Province, El-Behaira Governorate, Egypt. The effect of the use of different speeds in (rpm) and operating period in (min) on harvest productivity and damage percent were evaluated. The main objective of this research is to economical evaluated of hand-held machine harvester for olive. This work describes the complete design of an olive harvesting machine especially conceived for secular olive plants with the purpose of increasing the mechanization level of the harvest operation and permitting the production of high quality fruits. It could be concluded that using of the machine resulted in declining in operating cost by 37.1% compared to using the manual method. The harvesting by using machine costs about 0.39 L.E/kg while the manual about 0.5 – 0.75 L.E/ kg. This meaning that the hand-held machine designed saved about 37.1% of manual cost.

Keywords: Hand-Held, Machine, Olive varieties, Evaluation, Cost analysis, Egypt

1. Introduction

Olives and olive oil played a key role in ancient Mediterranean economies. Today, olives contribute billions of dollars to the global economy which gives a strong motive to develop and facilitate harvest techniques. Olives and their oil now sustain an industry producing about $10 billion annually. Therefore, it is extremely important for all growers to try maximizing this product efficiency and to lower harvesting costs in spite of this value, in many regions of the Mediterranean and most parts of the world, olives are still picked by hand, using wooden tools, or beaten from the tree with poles and caught in canvases or net placed under the tree to collect the fallen fruits. This type of harvesting is time consuming and involves intensive labor. In addition, it results in elevated level of fruit damage, **(**Kauraba et al., 2004). The manual harvesting is more over an operation with low productivity and with costs which reach the 50 % - 70 % of the cultivation revenue **(**Hegazi, 2009; Vieri and Sarri, 2010**)** An optimal harvesting operation can be defined as the ability to harvest more than90 % of the olives on a tree – in the shortest period and with the lowest number of workers – with minimum mechanical damage to the olives and trees and minimum risk for workers safety and health. The continuous evolution of harvesting systems, which has been taking place at an accelerated pace since the 1970s, is driven by the need to increase harvesting efficiency by increasing labor productivity to decrease harvesting cost (Gil Ribes et al., 2010 and Tous, 2012)

The manual harvesting is more over an operation with low productivity and The Egyptian olive production was about 563,070 tons produced from acreage 202,743 feddans, most of which are processed mainly as table olive and the rest is extracted to olive oil, (Ministry of Agriculture and Land Reclamation, 2013).50 – 60 % of total production cost issued for harvesting operations (Özarslan et al., 2001) with higher than $300 per ton (Costa et al.2013)
With costs which reach the 50 % - 70 % of the cultivation revenue (Vieri and Sarri, 2010).
Luigi Solazzi et al. (2014) reported that there are cultivations with trees not older than 30 years and an average trunk diameter of 20-30 cm; these sizes allow the mechanical the mechanical harvesting using a shaker acting on the trunk and able to detach the olives due to

Vibrations transmitted to the branches. This kind of cultivation permits an elevated level of mechanization, but lowers than the super intensive one, leading to an increase of production costs. Another type of cultivation with secular olive trees is characterized by an average trunk diameter of 50-60 cm, up to 1 m and more in some cases; with this size the olive cannot be detached with a trunk shaker due to the high stiffness of olive wood. The harvesting operation on these trees is made sometimes in a complete manual way, sometimes with the help of vibrating pneumatic or electric rakes carried by hand. The objective of this research is to cost analysis of hand-held machine harvester for olive.

Materials and Methods

The details of the mechanical prototype of the machine and design procedures that followed to reach the goal of the study are to cost analysis and evaluate of hand-held machine harvester for olive. The design was taken the following criteria:

Using local raw materials in the manufacture of the equipment

1. Improving the first prototype and testing it in field under different operating conditions (three different working speeds, three different duration of time and three varieties of olive.
2. Technical, ergonomically and economical evaluation for the final prototype of the machine

Physical properties of olive fruits

Manzanillo variety is the most important Spanish varieties grown in most countries of the world, medium-sized fruit tend to rotate and weighs 4-6 grams, the kernel smooth bulk, the meat constitutes 11% of the weight of the fruit and the oil content of 16-20%, using fruits in green and black pickling (Wikipedia,2017). Krotina variety is Italian varieties that have proven successful in Egypt in terms of production and quality of the oil quantity and quality. Small-sized fruit tend to rotate and weighs 3-4 grams, oil content ranging from 18-22% **(Wikipedia, 2017).** Kornaky variety is Greek varieties - small fruit long swollen from the middle, weighing 1-1.5 g. Kernel smooth bulk meat make up 18% of the fruit weight, oil content of 16-24% of the world's best varieties to extract the oil, fruits ripen from November to December **(Wikipedia, 2017).** Some physical properties of studied variety of olive (Manzanillo, Krotina and Kornaki) were measured as shown in table (1).

Table 1: Average values for certain physical properties show for three varieties of olives.

Properties	Varieties of olives		
	kornaky	Manzanillo	krotina
Length (L), cm	2.00	2.03	1.55
Diameter (d), cm	1.54	1.62	1.34
Volume (v)	2.95	3.06	2.11
Mass(g)	3	4	1.5

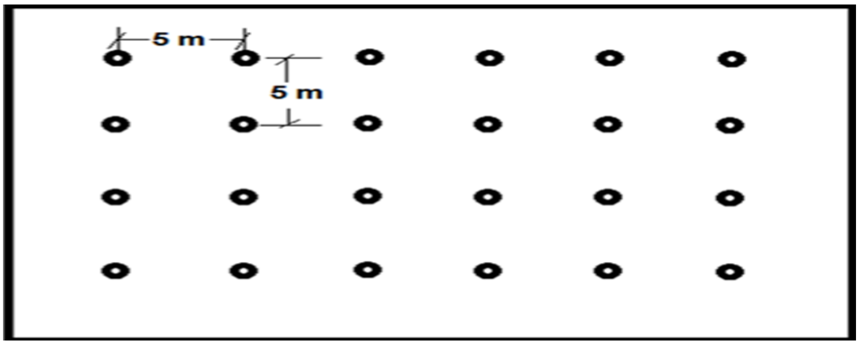

Fig.1: Layout of harvesting experiments for olive trees at farm of NRC, Nubaria, Elbuhaira, Egypt

Cost analysis

(1) **Fixed costs**

- Depreciation cost
- Interest
- IST (Insurance, Shelter, Taxes)

Total fixed cost= Depreciation cost + Interest + IST (Insurance, Shelter, Taxes)

(2) **Variable costs**

- RM (Repair and maintenance)
- Labor cost

Total operation costs = Total fixed costs + variable costs

a. Cost/Benefit ratio
b. Cost/Benefit ratio
c. Cost of production

All the experiments were conducted at Randomized Complete Blok design with three replications. The experimental data were analyzed using an analysis of variance (ANOVA). The means and the interactions between treatments were compared with LSD at 5% significance level for all studied parameters.

Results and Discussion

Economical evaluation of the machine, according the procedure of calculating the costs and estimating economical evaluation, the costs and economical parameters are presented as follows;

d. Operating costs

The total operation costs of the machine were calculated according to the machine list price. The machine list price was 1100 L.E. and the annual use was 800 h. The results showed that:

(3) **Fixed costs**

- Depreciation cost = 123.75 L.E./year
- Interest = 60.5 L.E./ year.
- IST (Insurance, Shelter, Taxes) = 44 L.E./year

Total fixed cost = 123.75+60.5+44 = 228.25 L.E / year
= 0.24 L.E/h.

(4) **Variable costs**

- RM (Repair and maintenance) = 12 L.E./ h.
- Labor cost = 15 L.E/ h.

Total operation costs = Total fixed costs + variable costs
= 0.24+12+15= 27.24 L.E/h

e. Cost/Benefit ratio

The benefit was considered and calculated. Machine productivity was 70 kg/h equivalent 27.27 L.E/h. The current price of olive 0.22 L.E/kg The results showed that the ratio value equals 0.11<1. So the machine satisfied to user.

f. Cost of production

The results showed that using machine in harvesting operation decreased the cost of productivity compared to the manual harvesting (Fig.2). The previous related studies indicated that manual harvesting operation costs in Egypt about 0.5 – 0.75 L.E/ kg. The costs of harvesting olive by using the hand-held machine were found to be 0.39 L.E/kg. The designed hand-held machine decreased the cost of operation by 37.1%.

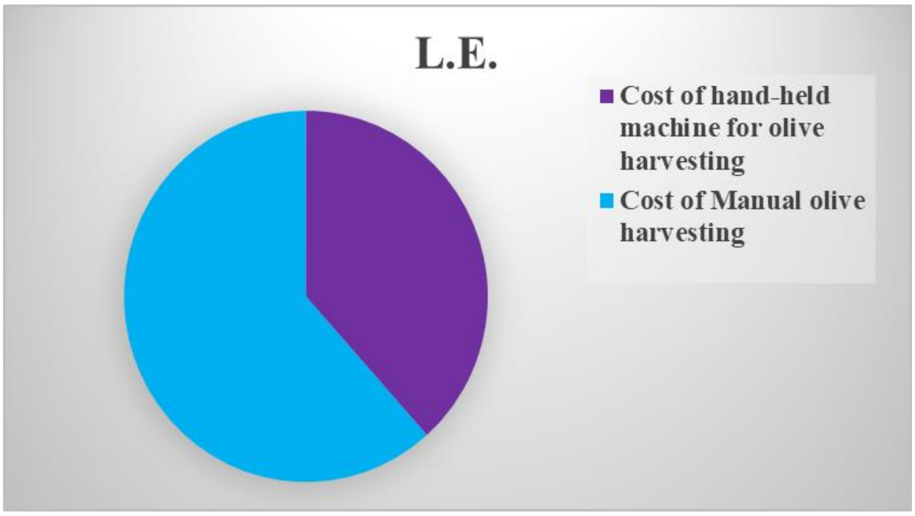

Fig. 2: Comparison of between olive harvesting costs (L.E.) by hand-held machine and manual method

The use of the machine resulted in declining in operating cost by 37.1% compared to using the manual method. The harvesting by using machine costs about 0.39 L.E/kg while the manual about 0.5 – 0.75 L.E/ kg.

Conclusion

This work describes the complete design of an olive harvesting machine especially conceived for secular olive plants with the purpose of increasing the mechanization level of the harvest operation and permitting the production of high quality fruits. It could be concluded that using of the machine resulted in declining in operating cost by 37.1% compared to using the manual method. The harvesting by using machine costs about 0.39 L.E/kg while the manual about 0.5 – 0.75 L.E/ kg. This meaning that the hand-held machine designed saved about 37.1%. of manual cost.

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