Performance Evaluation of an Off-road Light Aerial Platform for Date Palm Cultivation

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Abstract

Date palm (*Phoenix dactylifera* L.) cultivation is characterized by several operations performed at the frond level. Fronds can be many meters above the ground, especially in older groves or plantations. Mechanization in date palm farms is still lacking or inadequate, especially in medium and small farms of non-industrialized countries, and operations at the frond level are still done manually by climbing up the tree. Working at height without specific equipment is difficult, tiring and risky and many accidents occur to workers when climbing on taller palms with the traditional belt-based climbing system. In large specialized plantations of valuable date varieties, aerial platforms are used, generally derived from the construction industry, with or without adaptations to the specific task. Nevertheless, the high purchase price and maintenance costs don't allow for their use in smaller farms.
However even medium sized groves, where high value varieties are cultivated such as the world renowned Medjool in the Jordan Valley (H.K. of Jordan), could benefit of specialized mechanized equipment if of adequate size and cost, but suitable solutions have been missing until now.
With the aim of proposing a versatile machine for aerial operations in date palm medium-sized farms, in 2016 the Italian manufacturers CO.ME.T. and ERREPPI marketed a compact aerial platform mounted on an off-road light carrier, specifically designed for use in palm plantations.
The objective of this study is the evaluation of this self-moving aerial platform, named Xiraffe, in terms of timing, effectiveness and general attitude to work along the date palm cultivation process. This analysis is based on observations done and data collected in 2017, during harvesting field trials on Medjool date palms in the Jordan Valley. These trials, carried out on palms of different height and characteristics, aimed at comparing mechanized and traditional manual harvesting, which is still the most common method in the study area. The results showed that this small sized and agile machine proves to be effective while capable of improving work safety and timing when used to harvest palms between 6.0 and 9.4 meters high. However, the manual harvest is still more effective for medium and small farms in the test environment, but some technical improvement to the platform, such as modifying the bucket shape or providing it with specific tools for other operations (e.g. pruning, bagging or pollination), can reduce the gap, opening a completely new scenario in date palm cultivation.

Keywords: Medjool dates, Jordan, agricultural mechanization, harvesting, lifting of operators.

1. Introduction

Date palm (*Phoenix dactylifera* L.) is considered one of the most valuable and important fruit crop in its main distribution area of the Middle East and North Africa. It is among the very few plants that can thrive in arid environments and can provide significant resources for local populations (Chao and Krueger, 2007). More recently, because of the characteristics of the fruits that are appreciated in all the world, it was introduced in new areas such as America, Australia, Namibia, etc. (Garbati Pegna, 2008). In the last few decades, date production has grown extraordinarily and is expected to continue to raise (Chao and Krueger, 2007). Worldwide it has increased from 6,440,583 t in 2000 to 8,460,443 t in 2016, while the harvested area has expanded from

1,051,482 ha in 2000 to 1,353,159 ha in 2016 (FAOSTAT, 2018). This positive trend is also forcing date cultivation to develop new solutions to face the modern production challenges: timeliness of agricultural practices, increasing labor costs, scarcity of skilled labor, fatigue and risks inherent in this work are part of the main issues to address. In fact, date palm cultivation is characterized by several operations performed at the frond level which is often at more than 6 m above the ground and can reach up to 20 m in old plantations. In most plantations access to the frond level is still performed in traditional ways, where workers have to climb up the trunk with the help of belts or straps or long ladders or of other people piled up on each other's shoulders (Opara, 2003 in Garbati Pegna, 2008, Nourani, 2016). This makes these operations, among which harvest is obviously the most important, very difficult and risky, especially when palm height is over 6-8 m, causing many victims yearly or the abandoning of the higher palms (Garbati Pegna, 2008).

A major change that has occurred in date cultivation in the United States has been the mechanization of some cultivation practices and in particular the timing and method of harvesting (Barreveld, 1993 in Akyurt, 2002). During 1940's and 1950's, under the impact of increasing labor costs and ever-increasing height of the palms, some growers in the U.S. built large tractor-pulled harvesting towers, to avoid the need for ladders (Akyurt, 2002); starting from 1960, the use of truck-mounted hydraulic crane-like man-positioning machines was experimented, in order to move workers from palm to palm (Akyurt, 2002). Even if none of these attempts provided a significant increase in workers' productivity, the scarcity of labor was such that by 1966, 80% of the date crop in the US was being harvested with the use of these mechanical devices (Brown, 1983 in Akyurt, 2002). Nowadays other machines, which can harvest dates by shaking the plant or that by a slider mechanism and a grip force on the stem can climb up the operator to the frond, have been developed but these devices are not suitable for most date varieties and they still need many improvements (Shamsi, 1998). One of the most important steps forward in mechanizing operators' access to the fronds, flowers and fruits of date palms has been a large "U" shaped aerial platform, hold by a hydraulically moved telescopic boom or forklift mounted on an off-road carrier, that can provide support and space to several workers allowing them to work on a palm at the same time. This system, which offers good levels of efficiency and safety for workers and allows a faster repayment of the investment, is widely used in large specialized plantations where valuable varieties are cultivated. However, the high purchase and maintenance costs of this equipment make it not affordable for the medium and small farms (Garbati, 2008 and Shamsi, 1998). Further limits may be identified in difficulties of maneuvering in tight spaces caused by irrigation systems, an irregular layout of palms, insufficient tree spacing and intercropping (Shamsi, 1998). In some of these cases, or where different equipment is used, operators have to jump out from the platform to reach the fruits if the bunches are hidden by the fronds hence nullifying the safety aspect. Smaller elevating devices have also been proposed by various manufacturers (Garbati Pegna *et al*, 2012) but none has succeeded in capturing farmers' confidence.

Aiming at addressing the mechanization problems of smaller or difficult farms, by providing a flexible and light machine for operator's access to the high parts of the palms, two Italian companies ERREPPI and CO.ME.T. developed Xiraffe, an off-road light aerial platform, easily adaptable to diverse operating conditions, ensuring safety and easiness for working even at considerable heights. This machine constitutes a novelty in this sector for its characteristics and its suitability to work in harsh conditions and could represent a rentable solution, also susceptible of further developments, for field operations at frond level, offering suitable and affordable specialized mechanization solution even to the medium and small sized farms.

This study analyses the performances of Xiraffe focusing on the harvesting operations; the investigation is based on data collected in 2017, during field trials in Medjool plantations in Jordan Valley (H.K. of Jordan); these trials, carried out on palms of different height and characteristics, aimed at comparing mechanized and traditional manual harvesting, which is still the most common method in the study area.

2. Equipment

Xiraffe is a compact aerial platform, consisting of an articulated hydraulic boom lift mounted on a 4 wheel drive power unit, produced by a joint venture between ERREPPI, an Italian agro-transport vehicles producer, and CO.ME.T., an Italian lifting machines manufacturer.

2.1 The platform

The aerial part is composed of a basket held by an articulated boom lift, supported by four hydraulic outriggers. The platform lifting system is hydraulic and is activated by an always running hydraulic pump, moved by the power unit engine through a transmission belt. A main valve controls the hydraulic circuit, allowing fluid flow towards the lifting system only when the outriggers are well opened and the pressure on each one of them is between 5 and 295 kPa; at the same time, this valve doesn't allow the fluid to activate the outriggers when the boom has been moved from the initial position, in order to maintain the previously achieved stability. This system can only be interrupted by special emergency levers. The outriggers have a supporting surface of 314 cm² each and are controlled by a micro-switch based system and a warning signal is emitted when one of them is losing pressure on the ground and stability could be affected; furthermore, if the platform is subject to an excessive force further extension of the boom is disabled. The outriggers are positioned manually by the operator and the machine's attitude is checked on the control panel; the outriggers can be adjusted to a maximum difference in height of 0.78 m, allowing the placing of the machine even on a very uneven terrain.
The aerial system can be guided by two fully hydraulic controls, one in the basket and the other at the base of the unit. The basket has a rectangular base of 1 m x 0.7 m and a height of 1.1 m with a rated maximum loading capacity of 150 kg, though no specific sensor controls this limit. The basket can be raised in 40 s at its maximum height of 9.8 m (basket floor) that means an average reach of 11.8 m, considering operator's height; the maximum outreach is 4.5 m from the boom's pivot vertical axis, that can be accomplished at a height of 7 m (Figure 2.1). The turret rotation range is 360° which makes it possible to access all the surrounding area. If safety limitations are respected the platform is rated for working up to a maximum wind speed of 15 m/s. The basket is provided with a 230 V electric outlet and a compressed air outlet for connecting different tools such as secateurs, chainsaw, sprayers etc. At the moment either electricity or compressed air have to be provided by an external source. External canisters can be also hung on the basket's railing to collect the harvested dates.
Figure 2.2 shows the main dimensions of Xiraffe and its platform components.

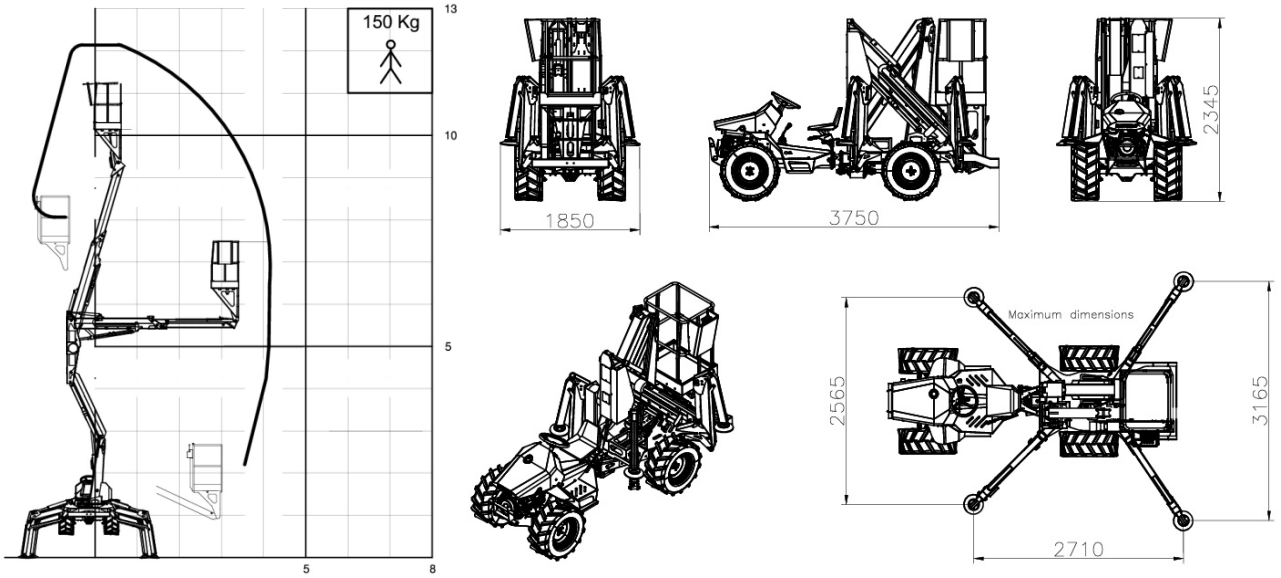

Figure 2.1 and 2.2. Platform aerial movements, on the left, and Xiraffe dimensions, on the right.

2.2 The vehicle

The power unit is a compact all-terrain tractor powered by a Yanmar L100N single cylinder, 435 cc air cooled Diesel engine, with a maximum power output of 8.3 kW. The engine is equipped with electric start and a battery of 50 Ah. The unit is 3.75 m long and 1.85 m wide (Figure 2.2) with a front and rear wheel track of 1 m and 1.17 m respectively and a wheelbase of 1.975 m; the steering angle reaches 27.5° for each side; the ground clearance is 0.27 m and the total weight is 1,680 kg including the platform.
A synchromesh five gear plus reverse transmission allows Xiraffe to reach a maximum speed of 18.9 km/h while the average fuel consumption is about 0.7 l/h at an engine speed of 3,000 rpm. Disk brakes are mounted on each wheel. Transmission is part-time type, allowing to select traction of 2 or 4 wheels depending on the situation.
Being the platform load mainly concentrated on the back wheels, the total maximum weight per wheel reaches 565 kg, so low pressure flotation tires (82 kPa) have been adopted in order to allow moving also on soft or sandy soils without damaging the irrigation systems or the grove environment. The vehicle is also provided with a rear hitch for towing a 500 kg trailer.
These characteristics make the unit very versatile and well suited for operating also in tight and rugged environments.

3. Evaluation method

The evaluation was conducted by comparing manual and mechanically assisted harvesting in terms of time, productivity and out-of-pocket costs (fuel).
The tests were carried out in three different farms, all located within 1 km along the Middle Jordan Valley, in the municipality of Ma'addi, Al-Balqa governorate. In all farms, the main product was represented by Medjool dates with some secondary production such as Barhi dates, citrus and grapes. All farms were characterized by medium texture sandy/loamy, deep soils. All the cultivation practices carried out at the frond level, from pruning to harvesting, were still done manually, in the traditional way, while some mechanized equipment was used for the post-harvest processes. Tending of the palms was mainly managed by Egyptian workers, which are employed for the harvesting season or all year round.
Since most of the palms in the farms were less than 15 years old, it was difficult to find plants that were sufficiently tall to make trials significative.

The farms were:

- *Al-Sughaiyer Co.* plantation, a 5.2 ha farm leased with a 5-year contract; the grove was constituted by 717 palms (700 Medjool and 17 Barhi) with an 8 x 8 m plant spacing. Pruning is done every second year, with a consequent presence of a high amount of leaves.
- *Jeneidi* farm, a family-run grove of 3.7 ha with 470 palms (455 Medjool and 15 Barhi) with a 9 x 9 m plant spacing. Secondary production is based on grapes and a nursery of ornamental palms is also part of the business. In this farm it has not been possible to find plants higher than 5.4 m because of the young age of the plantation, that was less than 12 years old.
- *Arar* farm owned by an entrepreneur with a 30 ha total area and 2,700 Medjool palms with an 8 x 8 m pattern. Other cultivations are Barhi (1,100 palms), citrus and grapes. In this farm there is a wide variety of palm sizes and shapes which allowed to carry out trials in many different situations.

The working procedure was the following:

Mechanically assisted harvesting

The first operation to be done, once the machine has reached the palm, is the positioning of the four outriggers; after this, the platform can be lifted by the operator itself or by a ground

assistant. Once reached the cluster, the dates are collected and placed in plastic boxes and subsequently stored inside the canister. As common in Medjool plantations, only the ripe fruits are harvested and not the whole bunch: this is done by covering the bunch with a net bag and lightly shaking it, collecting only the dates that fall. Then, when the canister is full or all of the planned bunches have been harvested, the platform is lowered and the boxes manually passed by the operator on the basket to the one on the ground, which makes a first check and selection of the harvested dates. Once completed the task, the operator gets off from the basket, the outriggers are lifted and the machine is moved to the next position. At the end of each day, the fuel tank is filled up to monitor the daily fuel consumption.
Servicing date palms with a platform can be done in two different ways: the first is harvesting with the "360°" method, that means servicing a whole palm with just one positioning of the machine which is done near to the palm base (Figure 3.1). The second one is called "180°+180°" method that means servicing two half palms at a time and is done by placing the machine between two palms, in the middle of the row, and reaching only the half frond facing the machine (Figure 3.2).
In the Al-Sughaiyer Co. plantation, the selected palms were 15 years old and a total of 3 trials were done in the same day, using two times the "360°" method and one time the "180°+180°".
In the Jeneidi farm, 5 palms were harvested with the use of the Xiraffe; only the "360°" method was adopted, but the number of operators varied: the first three times employing only one skilled operator for all the activities, while the other two times two operators were engaged.
In the Arar farm, a total of 15 trials were done, 5 per day. In the first day the "180°+180°" method was used, while in the second and third days the "360°" technique was applied.

Changing servicing method and number of operators was a consequence of the novelty constituted by the kind of operation that needed to be gradually adjusted, since neither the Xiraffe nor the mechanically assisted harvest had been experimented before in these farms, and of the need to adapt to different situations that arise in the various locations.


Figure 3.1 and 3.2. Placing for the two different methods: "360°", on the left, and "180°+180°" on the right.

Manual harvesting

The traditional manual harvesting was done by skilled operators climbing up the palms with or without the use of a belt, sometimes with the help of a ladder, and by placing the collected fruits in a small bucket, with a capacity of about 5 kg of Medjool dates, and lowering it to the ground with the use of a rope.

Data collected

The positioning of each harvested tree was detected by the use of the I-Phone 6 inbuilt GPS and the "GPS & UTM" application for I-Phone.
The distances from the trunk and the height of the dates bunches from the ground were measured with a Stanley TLM 99 laser telemeter, while the trunk circumferences with the use of a tape measure. The weight of harvested dates was measured by a farm's field spring scale, provided with a tray with a maximum capacity of about 3 kg of Medjool dates. These measurements were randomly verified in the warehouse by the use of a lager, 10 kg capacity, spring scale which evidenced an approximation of 10% in the field weighting system. The number of leaves of each palm was counted in order to assess the density and three density classes were defined: 120 leaves (high density, clusters completely covered by the frond), 100 leaves (medium density, clusters are still inside the frond but is much easier to reach them) and 90 leaves (low density, few clusters are out from the frond and all of them are easily reachable).
The daily volume of Diesel fuel consumption was quantified with a 2 l graduated container with a 0.25 l accuracy.
The time for carrying out the different operations in the manual and mechanically assisted harvesting was measured by the use of a chronometer.

- *Transfer*: in mechanically assisted harvesting the time needed to move the machine from palm to palm, from when the operator sits on the driver's seat to when he first touches the controls for the positioning of the outriggers. In manual harvesting, transfer is the time used for moving the equipment from one palm to the other. This was not always possible to measure so, after the first measurements, an average value of 30 s was considered for all the methods.
- *Placing*: the period from the end of transfer to the moment the operator is in the basket and ready for lifting. In this time also a 40 s period for loading the empty boxes into the basket is considered. In manual harvesting, placement is the preparation phase before climbing, during which the operator checks the palm and connects the rope to his arms or trousers' buckle. After the first measurements, it has been estimated in 30 s for the manual method.
- *Lifting*: from the first touching of the aerial platform control panel to the reaching of the date clusters. In manual harvesting, it is the period between the first touching of the ladder or of the plant to the touching of the clusters.
- *Harvesting*: the whole time used for harvesting, from the first touching of the cluster to the closing of the last cluster net bag. This is the same in both manual and mechanical one.
- *Descending:* from the completion of the harvesting to the positioning of the basket at the initial resting position. In manual harvesting is the time from the end of harvesting to the touching of the soil by the operator.
- *Unloading*: the time needed by the operator on the basket to hand over the boxes to the ground operator. In a few cases, because of the high amount of dates harvested, lifting, harvesting and descending operations had to be repeated twice.
- *Disengaging*: from when the operator steps out of the basket to when he sits again on the driver's seat after lifting the outriggers, ready for the transfer to the next palm.

When new equipment has to be used operators must be trained to learn how to manage and operate the machine properly and safely. In this case, due to lack of workers, only one operator from Jabaly Agricultural Co., a local Company which gave an important sustain to this study, could be trained and therefore was in charge of operating the machine during all trials. In this situation a 4-hour course, given by expert technicians of the manufacturing Companies, was enough to demonstrate and analyze all the different functionalities of Xiraffe, allowing the operator to experiment the different situations that may occur when using this kind of machine.

After this, the operator practiced for 3 days in order to acquire the necessary experience and skills.

During field trials, the operator was supported by a worker from the hosting farms. As a matter of fact, two workers are needed for the most efficient use of the platform: one in the basket for harvesting and one on the ground for assistance. Normally only the operator in the basket drives the machine and therefore needs specialized skills but, during the trials, the farm owners insisted to have their man harvesting the dates so the trained operator had to drive the machine from the ground panel, leaving to the other worker the task of harvesting and managing the dates. This system poses some hazard and should not be normally adopted, being even forbidden in many Countries. The weight of the operator in the basket was about 65 kg.

4. Results and discussion

The easiness of access to the date clusters depends mainly on their position, being frond coverage and height from the ground the most important factors.

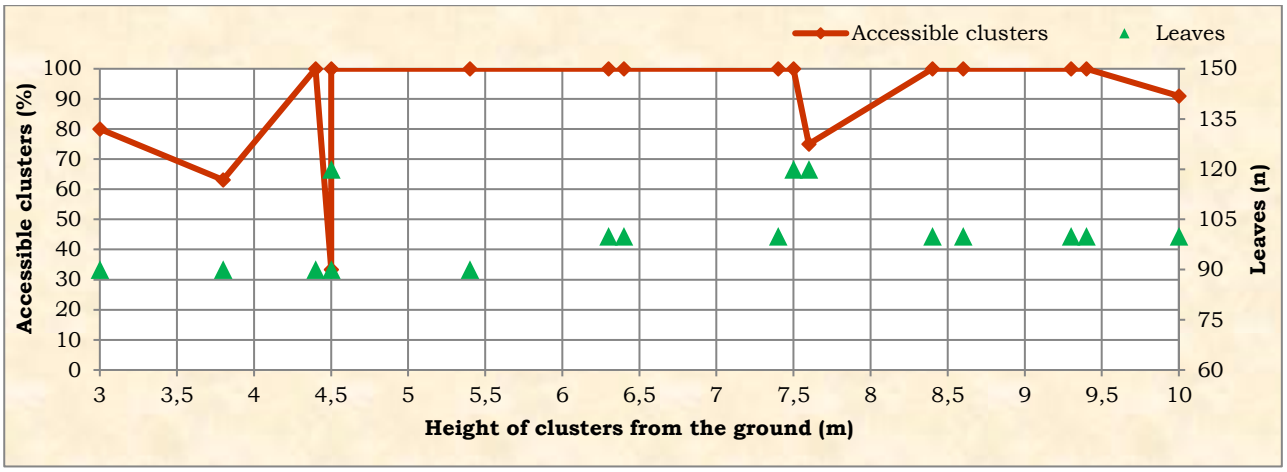

Figure 4.1. Main factors limiting access to the clusters in the 16 more significant trials.

Figure 4.1 shows how the machine proved to be fully efficient in reaching clusters in a range between 4.4 and 9.4 m height with a normal frond density of about 100 leaves per plant.
In these conditions, Xiraffe allows harvesting all the palm's bunches with only one positioning ("360°" method). However, when cluster height is lower than 6 m, the boom geometry makes the platform progressively more difficult to manage because of the projection of the lower sections and the possibility of contact with the outriggers or other parts of the machine. On the other hand, when height is above 9.4 m, the accessible area decreases not allowing a 360° access around of the stem (Figure 2.1).
Figure 4.1 also shows how high leaf density negatively affects the access to the bunches; this is because the volume of the basket, hinders its capacity to penetrate through the canopy and the operator has to open his way between the leaves or crouch down in the basket, hence losing the full control of the platform. This problem is worsened by the canister that increase the volume of the basket and consequently its capacity to move across the fronds.
Concerning the stem's size, the results were not influenced by different diameters which ranged from 0.42 to 0.62 m, though keeping the stem trimmed is still recommended.

Out of 23 trials, only the last 8 were in the ideal height range and the team had reached complete confidence in operating the Xiraffe: figure 4.2 shows the total harvesting time spent during these 8 trials.

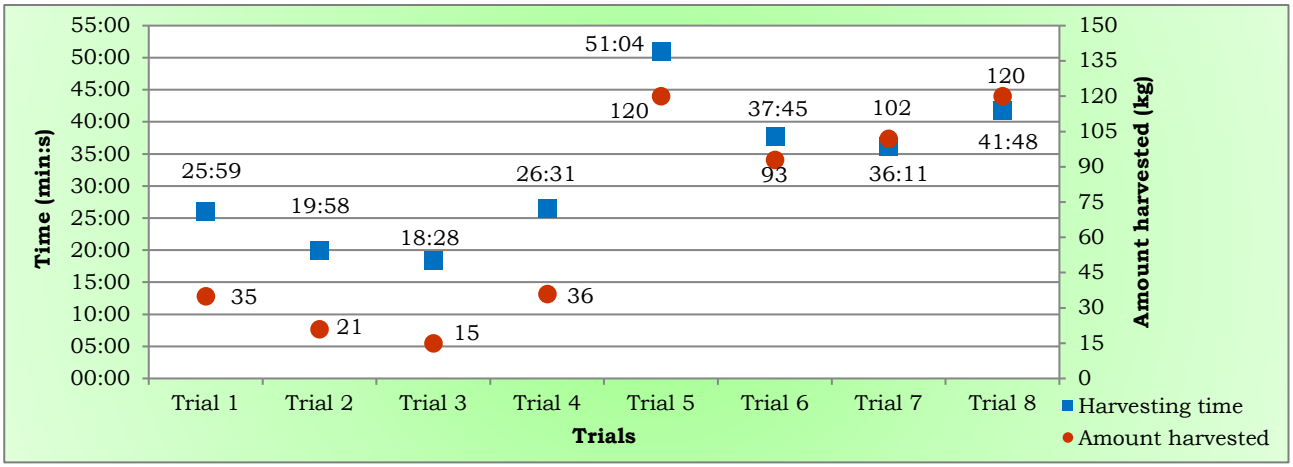

Figure 4.2. Harvesting time and quantity in 8 different trials.

The average time for harvesting one palm was of 1,933 s (32'13") with two operators involved. However, harvesting time varied greatly from one palm to another being influenced by the different frond characteristics and amount of dates to be harvested. This is because when the total amount of dates per palm exceeds 60 kg, which is the maximum storage capacity of the basket and the canister together, an intermediate unloading is necessary, increasing the total time of the session. As a matter of fact, this extra operation nullifies the gain in productivity (quantity harvested/time), due to the high amount harvested in one single session, and builds up extra time losses.

Given that, during the 8 trials time increased with the amount harvested, a considerable difference can be noted between sessions where the total harvested amount was below or above 60 kg. In particular, sessions 5 was the slowest one because of the high amount of leaves on the palm that forced to remove the canister, hence reducing the storage capacity and making 2 extra unloading operations necessary.

This shows that, apart from the previously mentioned usefulness of pruning the older and less productive leaves, the size and shape of the basket are very important and solutions should be thought of for increasing its' loading capacity. In particular, the canisters didn't turn out to be a satisfying solution and should be redesigned. Also unloading of dates from the basket should be better organized since this was the slowest operation besides harvesting, taking 13.19% of the total time as shown in figure 4.3.

Among the other operations, lifting and descending were mainly related to the height of the palm and the ease of reaching the clusters or penetrating into the canopy. Disengaging was simple and fast as the transfer, which was mainly influenced by the distance between the plants that were not always near to each other. The placing was influenced by the terrain conditions and not always fast, but sped up with the operator's experience.

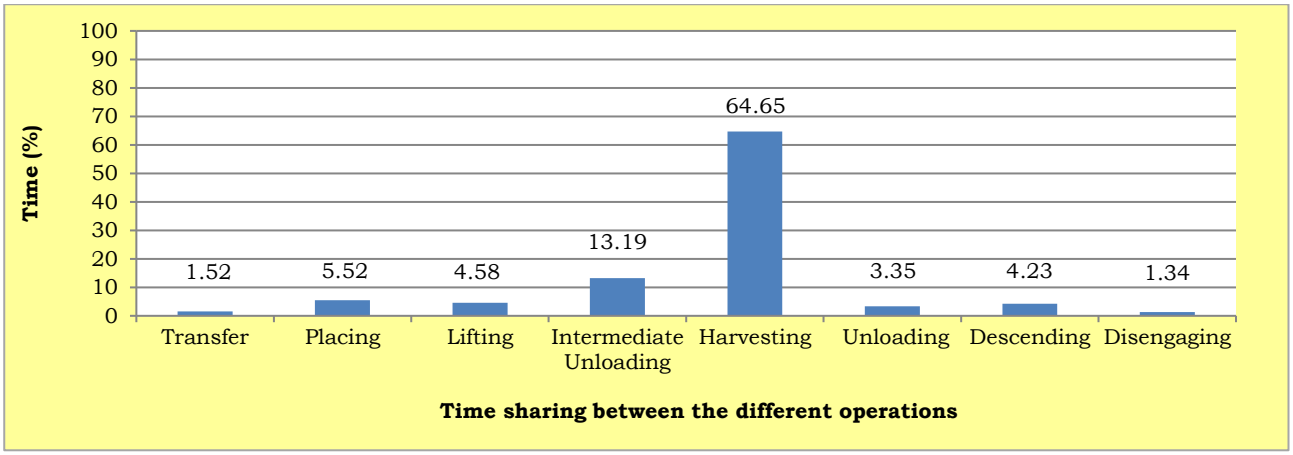

Figure 4.3. Time for single operations. Only trials where one intermediate unloading was needed have been considered.

An additional test concerned also the placing technique were the “360°” and the “180°+180°” were compared. The “180°+180°” method, however, was viable only in groves where the layout didn’t exceed 8 x 8 m and even in this case it was necessary to place the machine exactly at the same distance from the two palms to be able to properly accomplish the task.
The results show that, in terms of productivity, the “360°” technique proved to be the most effective for the harvesting within the optimum height range. Figure 4.4 shows the hourly average productivity with the two placing methods and with manual harvesting.

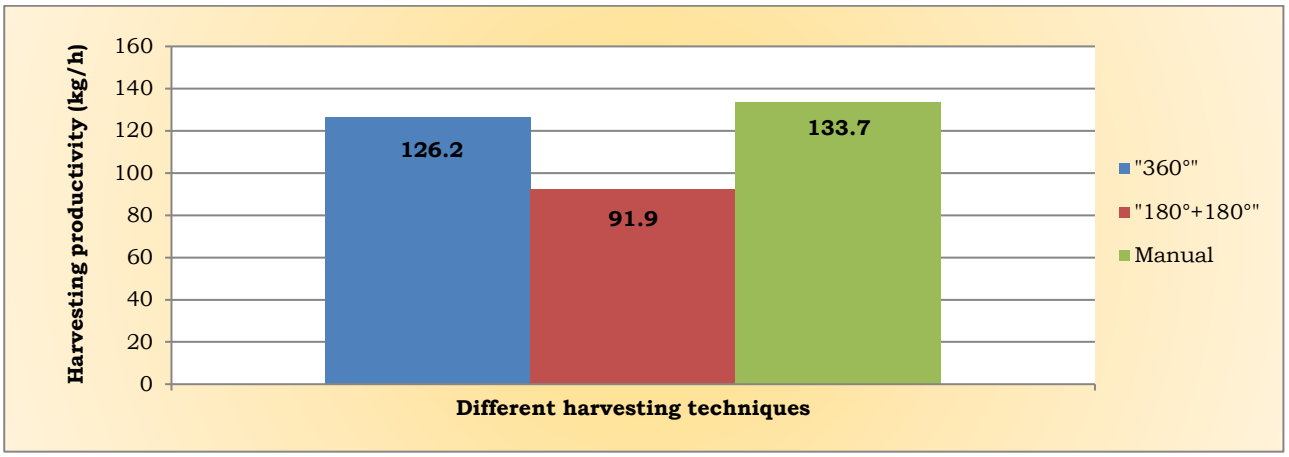

Figure 4.4. Harvesting productivity for each technique analyzed.

Moreover, in the “180°+180°” placing the distance from the plant affects the attainable height, as shown in the graph of figure 2.1, there is some time loss for the aerial moving from one palm to the other and the bordering plants of the plots need two placings anyway. The horizontally extended position of the boom also affects the stability of the machine when the load is high and in one case one of the outriggers sent a loss of pressure alarm.
All this witnesses the importance of a good placing of the machine; the best distance from the rear wheel of the vehicle and the plant is in the range of 1.5-2 m since if the machine is too close or too far from the plant it’s difficult or even impossible to carry out a complete 360° harvesting. If palms are inclined instead placement is easier and a single one under the frond is always enough for reaching all the clusters.
Figure 4.4 also shows that manual harvesting is faster than using Xiraffe. More detail is provided in figure 4.5 where the time needed for each single operation with manual harvesting and with the use of Xiraffe is reported; it can be seen that the machine is slower in the placing, descending and disengaging phases, but it’s faster in the harvesting and unloading operations even if the tests were in a manual harvesting friendly environment because of the high density of the fronds and the general low height of the plants.

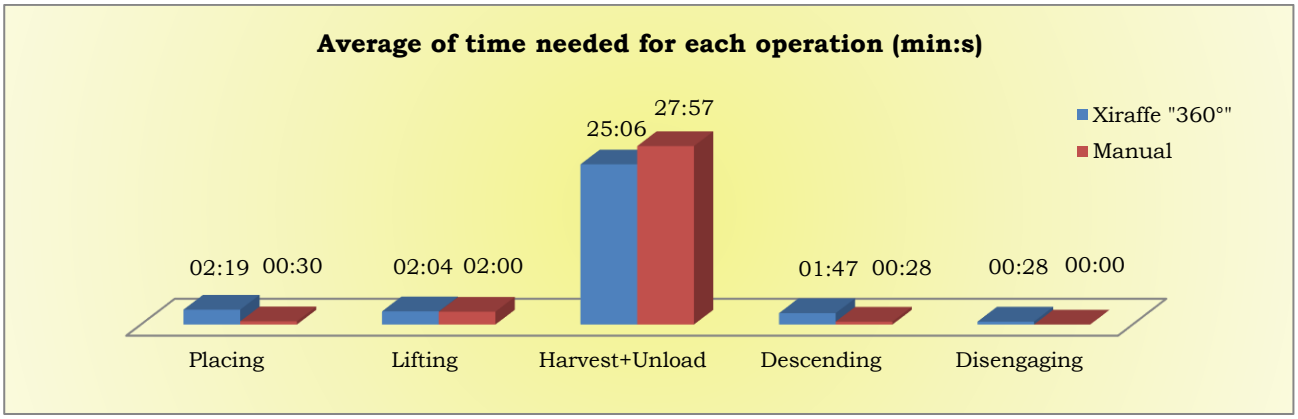

Figure 4.5. Time required for single operation with manual harvesting and with the use of “360°” method.

Of course, time for harvesting largely depends on the amount to be collected and Xiraffe proved to be more efficient where a huge amount of dates had to be harvested.
The collected data also show that productivity ratio between mechanically assisted and manual harvesting increases with palm height and harvested amount: when palms were above 7 m and more than 60 kg of dates had to be harvested, the continuous lowering and hoisting of the climber's small bucket can take long time and be quite tiring, making up for the extra time required for the intermediate unloading operation of the mechanically assisted harvesting. In table 1 manual and mechanically assisted harvesting productivity is compared to different heights and collected quantities.

Method	Manual		Xiraffe "360°"	
Height(m)	8	7.6	8.4	7.5
Quantity (kg)	35	90	36	96
Time (h:mm:ss)	0:20:30	1:01:37	0:26:31	0:40:24
Total (kg/min)	**1.71**	**1.48**	**1.36**	**2.38**

Table 1. Effectiveness of different harvesting methods where palm height and harvested quantity are considered.

It should be also noted that:

On two occasions farmers asked for machine assistance in order to be able to harvest safely palms that were dangerous to climb because of rotten parts in the stem or leaves. In these cases, Xiraffe was the only alternative for performing this and any other operation at the fronds level.

In order to evaluate also other functions and potentialities, the use of pneumatics tools was tested apart from harvesting trials. A small chainsaw and pruning shears were connected to the compressed air outlet in the basket and used for pruning and removing the leaves or for cutting the whole clusters when needed. This was to verify that Xiraffe doesn't work just as an operator lifting machine but that has multifunctioning characteristics extending its usefulness to many others cultural operations.

The variability of the farms' conditions concerning types of terrain and slopes didn't influence the capacity of Xiraffe to access the desired area. No damages to the PVC pipes for drip irrigation due to the passage of the machine have been noted and only minimal disturbances to the small furrows around the palms were observed.

The second worker, the one attending to the platform from the ground, was not fully involved in the operations becoming necessary only for the unloading and could be employed for other activities while idle (i.e. cleaning and arranging of harvested dates, attending other workings, etc.).

Fuel consumption was in the range of 0.75 l/h.

5. Conclusions

The performances recorded during the trials show that Xiraffe is able to reach and easily work in areas where access for larger machines would not be possible, without upsetting the grove structure and environment, and to allow an operator to reach up to the frond level of medium height to moderately tall palms, in a safe and effective way.
These characteristics can lead to interesting results and implications since this machine can fill the gap between expensive heavy and high productivity equipment and basic, ineffective and sometimes dangerous manual operations. The capacity of better performing, where palms are taller and bear high yield, makes it a possible option for established and well-tended medium sized farms, where the value of the product allows for investing in mechanization, possibly by pooling, or for contractors, which can better exploit this kind of equipment. This is particularly true when the labor force is scarce or expensive.

On the other hand, this machine is susceptible to improvements, many of which have been glimpsed in this first study, in order to reduce timing of operations and productivity; this is also because the platform component of Xiraffe is at the present derived almost completely from another area, that is the construction sector. Some of the most important modifications would concern the basket capacity and the possibility of unloading the harvested dates without descending.
As normal when mechanization is introduced in agriculture, also the crop should be adapted to the machines, making their action easier, so some modification can be studied also for the plantations, especially for the new ones, taking in consideration that when they will be productive, probably importance of mechanizing will be more evident. At the present, the most evident need for improvement that has emerged is the pruning of the leaves and possibly arranging of the bunches, which make much easier the access to the clusters.

In conclusion it is possible to foresee the opening a new scenario in commercial date palm cultivation, though further tests should be carried out, after reviewing some of its' characteristics, possibly on larger scale, where also the effect of fatigue of operators could be considered, either with manual or mechanically assisted harvesting, and, in case of using the platform, also of their gain in experience in placing and operating the machine.

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