

Self-moved ladder for date palm cultivation

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Abstract

Difficulty in accessing the productive zone is one of the common characteristics of adult palms that are cultivated for their fruits (*Elaeis guineensis*, *Cocos nucifera*, *Phoenix dactilifera* etc.); in most Countries where palms are grown, especially where cultivation is carried out with traditional techniques, workers have to apply tiring and risky techniques to reach the top of the trunks.

A self-moved ladder, consisting of 15 m extendable sliding ladder mounted on a mini tracked dumper has been developed to make access to the top of palm trees easier: positioning and transport of the ladder is controlled by the hydraulic system of the dumper, while the extension is done with a manual winch. Operating this equipment is simple and requires no effort for the worker who can then climb the trunk up to a height of 15 m tacking advantage of all the security accessories developed for ladder borne operations. Setting and extending the ladder to its maximum length takes about 60 s.

Keywords: mechanization, palm tree, harvesting, climbing, mini dumper.

Introduction

Date palm (*Phoenix dactilifera* L.) cultivation is widespread in North Africa, Near and Middle East where it has historically constituted a precious source of food and protection for desert dwellers. More recently, because of the qualities of the fruits that are appreciated worldwide, the cultivation of dates has become more rational and intensive and has expanded to new geographical areas (i.e. America, Australia, India, etc.).

Date palm cultivation requires several interventions during the year, among these the most important ones are carried out at the stem level (Figure 1) that in older plants can be 10 m and more above the ground. In some cases productive palm trees can reach up to 20 m, although in most cases more than 15 m is considered a discouraging height (Ali et al, 1998).

These operations, among which harvesting is obviously the major one, require that the worker reaches the stem of the plant and carries out his task holding himself at the trunk at the same time. Difficulty in accessing the productive zone is, as a matter of fact, one of the common characteristics of adult palms that are cultivated for their fruits (*Elaeis guineensis*, *Cocos nucifera*, *Phoenix dactilifera* etc.); this makes harvesting and other operations very difficult if carried out with ladders or poles or other manual aids, specially when palm height is over 8-10 m. In most Countries where palms are cultivated, especially where cultivation is carried on with traditional techniques (Abounajmi, 2004), workers have to climb up the trunk alone or with the help of belts or straps (Figure 2) or of other people piled up on each other's shoulders. These techniques are tiring and risky (Opara et al., 2003) and cause yearly many victims and only a small number of people, mostly elders, are still available for practicing it, making it difficult to harvest within the ideal period and causing the higher palms to be abandoned.

In most industrialized Countries and where date palm cultivation provides high revenues, self-moved aerial platforms are used to access to higher palms: these can rise one or two operators up to 20 m or more in only a few seconds but are very expensive. Even smaller elevating platforms, such as those mounted on tracked mini dumpers, are too expensive for those areas where date cultivation doesn't provide high incomes to farmers.

Where these machines are not affordable manual climbing is the most common technique, but rarely this is done with the use of adequate devices such as solid leather boots with steel shank, crampons, belt and gloves, and indeed sometimes worker climb the trunks without any aid at all (Figure 3).

Portable ladders are seldom used (Figure 4), mainly because of their limited length and because the longer ones are heavy to transport and to set and allow to reach only one side of the fruit bearing area. In some cases these aids are used to reach the top of the palm while the subsequent work is done in the traditional way, with the use of belts or other devices (Figure 5). In other cases ladders can be used to speed up the first part of the climbing.

In European Countries portable ladders are built according to specific regulations that limit height to about 15 m, however this is a considerable height and these ladders are built in 3 parts that can slide one into the other to form a shorter piece for handling and transportation. When the ladders are very long their mass can reach 80 and more kg so the extension is done with the help of a winch. All this makes it difficult to transport, set, open and close these ladders in a repetitive way, as required during field operations in specialized plantations.

Aiming to contribute to the improvement of safety, productivity and ergonomics of the operations that are carried on at the stem level of date palms, the author has developed a self-moved ladder where the heaviest operations are automatized.

This work therefore analyses the possibility of using long extendable aluminum ladders for climbing up the palm trunks since they are inexpensive, if compared to elevating platforms, and very reliable. However longer ones are heavy and difficult to handle so the possibility of mounting a ladder on a low cost mini dumper has been thoroughly examined in order to allow the carrier to bear the effort of moving and placing the ladder and to provide a reliable anchorage without the use of extendable stabilizers.

Materials and methods

A tracked mini dumper (Figure 6) of 300 kg with 500 kg of loading capacity, powered with a 4 stroke Honda GX200 4.5 kW petrol engine was used to hold an aluminum extensible ladder.

This ladder consists of 3 parts that can slide telescopically one in another. The ladder is 5.91 m long when closed and 15.15 m long when completely open. A professional hand winch with safety clutch is used to extend and shorten the ladder, an automatic safety catch assures stability as soon as winching is stopped. The mass is 76 kg. The ladder is provided with a special device for leaning on poles that assures improved stability and has been fitted with a banister on the last part. A pivoting hoisting pulley has also been installed at the end for raising and lowering tools and date bunches.

The dumper's tipping bed was removed by simply disconnecting it from the holding pins and from the hydraulic tipping ram and replaced with the ladder.

The ladder was connected to the same retaining system of the bed so it can pivot on the pins while the ram varies its inclination (Figure 7). For transport the ladder has an inclination of about 0.52 rad with the ground, while, when standing, the inclination can vary from 1.32 rad to 1.44 rad: this tolerance is allowed by the ladder's adjustable feet. The inclination of the ladder has been calculated according to the rule that for ladder heights up to 8 m the feet of

the ladder must be placed at a distance from the base of the vertical leaning plane of about 25% of the height, while for higher ladders the distance should be about 2 m. Figure 8 shows a draft of the equipment set in front of a palm tree.

Results

The machine takes all its movements from the tracked dumper so it is very easy to manoeuvre also in narrow or winding paths and to set it under a tree or a pole at a distance that varies from 1.5 and 2.5 m. Being the ladder much lighter than the maximum weight the mini dumper can transport no stress is set on it. Once the carrier has been positioned it takes about 10 s to place the ladder and regulate its feet and about 45 s to extend it comfortably to its maximum length. An operator can climb up to the top of the extended ladder in about 60 s while the bunch can be safely lowered to the ground in 15 s. The equipment can be moved to the next position in about 60 s after the operator has descended. Theoretically one operator is enough for operating the equipment and climbing the tree, but in some operations, such as harvesting, an assistant is needed for lowering the bunches.

The self-moved ladder, that cost altogether around 5.000 euro and consumes a maximum of 1.5 kg of petrol for 1 hour of continuous running of the engine, was tested on palm trees in Italy and then shipped to Iraq for in the field trials: there its performances will be compared to those of traditional harvesting techniques.

Conclusions

Safety and productivity can be improved in date palm cultivations with the use of an extensible self-moved ladder. The mini tracked dumper easily transports the ladder and sets it under the palm trees, improves its stability and allows operators to climb fast and safely up to 15 m height without the need for aids such as belt rigs or gaff hooks and without the help of other people. The mini dumper can also be used, once the bed has been reinstalled, for other transport operations even in different fields besides agriculture, so it has the potentialities for becoming an interesting tool for date palm cultivation.

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Figure 1. Cleaning the trunk is one of the operations that require climbing up to the top of the palm tree



Figure 2. Collection of dates in an uncomfortable position with the use of a simple belt (Scozzari, 2007)



Figure 3. Climbing with bear foot without straps or other safety devices (Scozzari, 2007)



Figure 4. Climbing up a palm about 7 m high with an extensible ladder (<http://www.jupiterimages.fr>)



Figure 5. Correct gear for working at the stem level of a tall palm tree
(<http://tour.airstreamlife.com/weblog/Tucson%20palm%20trim.jpg>)

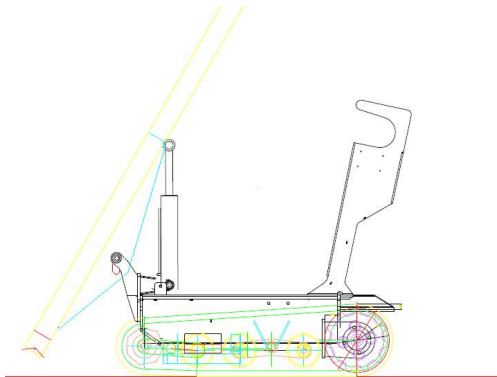


Figure 7. Scheme of the linkage between the dumper and the ladder



Figure 6. The minidumper used for mounting the ladder



Figure 8. Draft of the equipment positioned to service a date palm bearing fruits at a height of about 10 m. The figure shows the proportions within the sizes of the different components