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Improving the date production chain in the Moroccan oases through small mechanization inputs to support the governmental development strategies

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Moroccan oases as other Saharan oases are a highly artificial ecosystem that have proved to be capable of sustaining agriculture under arid climatic conditions for centuries, though it has suffered a strong degradation process during the last decades. This is due to a complex phenomenon linked to socio-economic, political and climate changes, that has brought traditional oasis agriculture to lose its relevance, consequently putting its complex environment in serious danger. The most important factors of degradation of the agricultural system are: land and water scarcity, salinity, silting and the negative impact of various pests and diseases (the most dangerous of which is Bayoud). Small farmers are the most important resource for the surviving of the oasis ecosystem but, on a socio-economic point of view, oasis dwellers, especially the younger ones, tend to search for better livelihood opportunities elsewhere, with consequent loss of traditional knowledge and availability of labour for all agricultural operations.

Date palm cultivation is the most important crop in this environment but date production faces several problems along the whole chain (field operations, storage, processing and marketing phases) and the oldest groves are abandoned for new intensive plantations with consequent endangering of biodiversity and genetic heritage.

In the last years, the Moroccan Government launched development programs such as the Programme Oasis Sud and the Plan Maroc Vert, with the goal to restore a sustainable oasis ecosystem. The main focus of these interventions is on date post-harvesting operations, improving storage, transformation and marketing capability of farmers and cooperatives, sustaining rural development through market improvement, but most constraints of field operations are still unsolved.

This work reports an analysis that has been carried out on Moroccan oases farming system and outlines the main constraints, proposing some possible mitigation interventions, based on the introduction of small mechanization inputs along the production chain, especially for the most dangerous aerial operations such as pollination, harvesting and pruning. Interventions are designed to support and integrate the implementation of the governmental strategies as well as other interventions (e.g., of the international cooperation agencies), allowing to create a network of practice and to build partnerships.

Introduction

Date palm is the pillar of the oasis structure in the environment under examination: it assures a favourable microclimate for the crops of the two lower layers, provides an important feed integration for livestock and is the only crop still able to provide, in some cases, an attractive income. Traditional knowledge of ancient farming techniques is a fundamental heritage of centuries of date palm cultivation. It preserves an important source of biodiversity and genetic material, with a high resilience potential against future threats. The action of climate change, advancing of sand dunes and desertification can be mitigated also by maintaining oasis environment safeguarded and healthy.

As a matter of fact, a degraded palm grove, that can be a consequence of environmental factors such as water scarcity, salinization, diseases, or anthropic ones such as labour scarcity, loss of attractiveness for landowners, land fragmentation etc. causes capital losses, agricultural crisis, rural exodus and other problems that create a vicious circle.

This situation is well known in Morocco and various Governmental or local administrations have been engaged in addressing the problem, together with international organizations, NGOs, Cooperation agencies of other Countries etc. but most of the actions have focused on marketing and economic aspects and technological interventions have concerned only the post-harvest phase and, in a lesser form, the date processing industry.

This work describes the attempt done by the authors to propose a technological intervention also in the field cultivation phase, in order to make rehabilitation of degraded palm groves possible by making work less hard and hazardous and more productive, hence more attractive for workers and in particular for young people.

The objective has been pursued through a diagnosis of the major constraints phase, based on a review of what has been previously produced by other investigations and a field survey carried out in almost 20 oases of south-eastern Morocco and a proposal for mechanizing date palm cultivation field operations, in a way that could result appropriate and possibly sustainable for the specific environment.

Material and Methods

The work has proceeded across a first phase of analysis, to individuate weak points and inefficiencies, based on data collection on traditional production and marketing system, through revision of previous public or private actions taken in this field, identification of stakeholders and field surveys. A proposal for an appropriate technological intervention has then been formulated based on the study of available technology at local and international level and will be validated by means of a cost/benefits analysis, an evaluation together with local stakeholders and field trials of pilot mechanization modules.

Results and Discussion

Low profitability and high work requirement have made traditional palm groves in oasis uninteresting for new generations who prefer living in town and doing different kind of works. Land fragmentation caused by successive share outs has also contributed in making farming in this environment not convenient or sufficient for earning a living and the spreading of *Bayoud* disease has impoverished the ancient date palm heritage. For this reason, land owners are seldom interested in taking care of their plots and investing in them.

Mixed cultivation, together with presence of many poor value varieties and need for climbing up tall trees, make planting new plots with regular layout, efficient irrigation and valuable varieties more attractive and convenient for investing than farming old groves. Moreover, working in traditional groves is hard and needs skills that nowadays are getting lost.

Other problems concern the usual difficulties for farmers in exploiting the product, in this case due to poor logistic for transport and marketing, inadequate or insufficient equipment availability, poor marketing capacities, difficulty in relations with cooperatives and other collective bodies and difficulty in matching quality standards and in obtaining health and quality certificates for farm products.

All these problems bring to careless tending of plants, missing of renovation and drift towards an interest in palm grove that is only opportunistic: minimum management for productive palms, while neglecting the rest of the grove.

However, the already existing plants yield without need for major investments and some varieties such as Medjoul, Bou-feggous and Bouskri are valuable while others are appreciated by local

consumers and the many shoots produced by adult plants can provide an interesting revenue if adequately valorised.

Table 1 shows what are the recommended operations for correctly tending a palm grove and how they are performed in the observed groves. It emerges that operations are mainly manual and often neglected, hence contributing to palm grove degradation.

In modern agriculture mechanization has allowed to increase noticeably work outputs, reducing drudgery and, when correctly applied, protecting worker's health and increasing safety. However, one of the main limitations of mechanization remains the relatively high investment costs and the need for scale economy, which make it difficult to access by many farmers and particularly by smallholders. Increased power availability for farm work in most cases has some positive effect on productivity but its efficiency and consequently its convenience can be dramatically undermined by wrong or inappropriate choices that lead to poor agronomic results and higher costs due to underutilization, increased energy needs, premature wear-out and breakages.

Operation	Performing
Collection of off-shoots	Seldom
Plantation	Yes
Pollination	No
Pruning / dethroning	No
Thinning	No
Cleaning of the trunk	No
Arrangement of fronds/bunches	No
Coverage (bagging)	No
Harvesting	Yes, for valuable varieties seldom for others
Tillage	Seldom
Spraying	No
Fertilizing	Seldom, mainly with manure
Transport	Yes
Waste management	No

Table 1: Recommended operations for date palm cultivation and how are carried out in Moroccan oasis

Mechanization interventions should be carefully designed taking in account adequacy, appropriateness of technological level, correct sizing, local infrastructure and, in case the action proceeds from outside, its acceptability by the farmers and their willingness to change the usual system. Adequate specific training is essential in both cases.

Following these considerations, a proposal for mechanizing farming operations in traditional palm groves has been drafted and is reported in table 2, where the machines that could be used for each operation are listed; it is small power light equipment, capable of moving in tight space and under low canopies and performing all the operations done by larger and more expensive machines though in smaller scale.

Conclusions and Outlook

Introducing mechanization may reduce drudgery, encourage youths and increase labor productivity and safety, but it should be economically and technically sustainable and adequate in the environment where it is proposed. The proposed equipment seems to respond to the requirements but should be object of a deeper analysis, in coordination with private and public stakeholders, in order to evaluate costs, performances, acceptability and overall suitability for the task. This analysis should be carried out through pilot units to be implemented in a few oases representative of the general situation. An effectual and efficient way of management should also

be defined, possibly involving specialized service entities such as mechanization contractors, cooperatives or NGOs.

Operation	Machine/equipment
Earth moving (removal of sand)	Compact self-propelled excavator with bucket Compact skid steer loader Compact tractor with trailer Motocultivator with trailer Compact transporter
Collection of shoots	Compact self-propelled excavator with bucket or chisel Compact tractor with mounted backhoe with special bucket or chisel
Plantation	Compact excavator Compact tractor with mounted backhoe with bucket Compact tractor with mounted post hole digger
Tillage	Compact tractor with plow/rotary hoe Motocultivator with plow/rotary plow/rotary hoe Motorhoe
Digging of furrows and channels	Compact tractor dicher/rotary dicher Compact self-propelled excavator with bucket or special bucket Motocultivator with dicher/rotary plough
Pruning (i.e. cutting of leafs and other vegetative parts)	Compact self-propelled off-road aerial platform Metal ladder (adapted to date palm) Power scissors (pneumatic or electric) Chain saw (pneumatic, electric, heat engine) Motorized static mulcher Motocultivator with flail mower or static mulcher
Cleaning of the trunk	Power chisel, (pneumatic or electric)
Fertilizing	Compact tractor with mounted spreader (broadcaster/localizer) Motocultivator with spreader
Dethroning	Compact self-propelled off-road aerial platform Metal ladder (adapted to date palm) Power scissors (pneumatic or electric)
Collection of pollen	Compact self-propelled off-road aerial platform Metal ladder (adapted to date palm) Power scissors (pneumatic or electric)
Pollination	Compact self-propelled off-road aerial platform Metal ladder (adapted to date palm) Pollen blower (pneumatic or electric)
Pest control	Compact tractor with mounted sprayer Motocultivator with traile sprayer Compact transporter with sprayer Knapsack motorized sprayer
Weed control	Motocultivator with traile sprayer Compact transporter with sprayer Knapsack motorized sprayer Motocultivator with flail mower or vertical axle mower
Bunch thinning	Compact self-propelled off-road aerial platform Metal ladder (adapted to date palm)
Arranging of fronds and bunches	Compact self-propelled off-road aerial platform Metal ladder (adapted to date palm)
Bunch bagging	Compact self-propelled off-road aerial platform Metal ladder (adapted to date palm)
Harvesting	Compact self-propelled off-road aerial platform Metal ladder (adapted to date palm)
Transport	Compact tractor with trailer Motocultivator with trailer Compact transporter

Table 2: Possible mechanization scheme

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