

Estimation of the Production Cost of Date Fruits of Cultivar Majhoul (*Phoenix dactylifera* L.) and Evaluation of the Moroccan Competitiveness towards the Major Exporting Regions in the World

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Abstract

The aim of the present study was to estimate the production cost of dates of cv. Majhoul (*Phoenix dactylifera* L.) as part of the Moroccan strategy to develop the date palm sector, and to compare it to that reported in the main exporting regions. Data were collected through surveys of farmers and farm owners carried out in the “Meski Boudnib” extension zone during 2018 and 2019, as well as from studies performed by some governmental organizations. The surveys were conducted on 30 modern and productive date palm farms, managed in monoculture and equipped with localized irrigation systems. All fixed and variable costs were calculated. It was found, through our calculations, that the subsidies from the Moroccan government reduce the average investment cost of a modern date palm farm by 56%. It was also shown that the production cost of one ton of date fruits of cv. Majhoul in the extension zone “Meski Boudnib” (Morocco) is estimated at about 6060 MAD (US\$ 634.5), out of which 28% represents the labor cost and 23% represents mineral and organic fertilization costs. The findings of the present study revealed that the production cost of one ton of cv. Majhoul dates in “Meski Boudnib” is lower than

those reported in the Coachella Valley (20,189 MAD/ton; US\$ 2114) and the Jordan Valley (10,536 MAD/ton; US\$ 1103).

Keywords

Coachella Valley, Cultivar Majhoul, Date Palm Industry, Jordan Valley, Morocco, Production Cost

1. Introduction

Date palm (*Phoenix dactylifera* L.) is a fruit species that plays important socio-economic and ecological roles in the Middle East and North Africa (MENA) region, and is highly valued throughout the world. In fact, date palm is cultivated in more than 30 different countries, with more than 150 million plants belonging to 5000 cultivars [1] and an annual global production of dates exceeding 8 million tons [2]. In Morocco, date palm contributes to the valorization of marginal and degraded soils, and contributes with up to 60% of the income of 1 million inhabitants of the arid and semi-arid regions [3]. Besides, date palm generates more than 3 million working days per year [4]. These working days concern the work in the palm groves, the date processing and storage units as well as the date palm by-products recovery units. The date palm fruit (*i.e.* date) is delicious and highly nutritious. It provides many essential nutrients such as carbohydrates, dietary fibers, minerals and vitamins. In addition, dates have health-promoting properties such as anticancer, antioxidant, antimicrobial, antidiarrheal and anti-inflammatory activities, among others [5].

Majhoul cv. is a Moroccan date palm cultivar also known as Mejhoul, Medjool, Medjehuel, Medjhool, and Mejhul [6]. It is the most famous and most sought after date palm cultivar in the world [7]. In addition, the commercial value of the fruits of cv. Majhoul exceeds those of the other date palm cultivars available on the international market. Majhoul cv. is native to Morocco. It was introduced to California in the 1930s [8], and since then it was considered as the most economically important date palm cultivar [9]. Today, and due to their adaptation to different climatic and environmental conditions, plants of date palm cv. Majhoul can be found in many parts of the world. The Majhoul dates, which are known worldwide for their large size, pleasing taste and high quality, are currently exported by Morocco in very limited quantities. In fact, the production of Majhoul dates has decreased considerably because of the bayoud disease, a very dangerous wilt disease caused by the fungus *Fusarium oxysporum* f. sp. *albedinis* and that threatens Majhoul plantations in Morocco [10]. Thus, the current production in Majhoul dates barely satisfies the Moroccan consumers [11].

The worldwide exports of the fruits of cv. Majhoul are around 67,000 tons with an economic growth of 5% to 10% per year [12]. Around 25% of this quan-

tity is intended for the European market [13]. To date, the international market of cv. Majhoul fruits is dominated by the Israeli and American (Californian) dates [14]. It is worth noting that the international market of cv. Majhoul dates holds a great potential. In fact, due to the 67,000 tons exported, the turnover achieved is around US\$ 469 million. Despite the increasing demand from consumers, the dates of cv. Majhoul represents only 4% to 5% of the total date exported [15].

Taking into account the competitive market price of cv. Majhoul dates as well as the large and significant profit margin (90%) [14], the Moroccan date palm plantation program in the extension zones (new date palm groves that are free of bayoud) consists of planting 67% of cv. Majhoul plants of the total number of date palm plants to be planted [16]. Thus, by 2028, the additional Moroccan production of the dates of cv. Majhoul is estimated to be 70,000 tons [14].

Bearing in mind the recognized importance of the dates of cv. Majhoul, and due to the absence of an economic study on its production cost in Morocco, the aim of the present investigation was to calculate the production cost of cv. Majhoul dates in Morocco, and to compare it with that of the main exporting regions, to assess its ability to compete in the international market.

2. Materials and Methods

2.1. Data Collection

All data were collected through surveys of farmers and farm owners carried out during 2018 and 2019, as well as from studies carried out by two governmental organizations: the Office for Agricultural Development of Tafilalet (ORMVATF) and the Department of Development of Oasis Areas (DDZO).

The farmers and farm owners with whom the surveys were conducted are located in the “Meski Boudnib” extension zone (31°56'05.9"N 3°57'31.4"W, Drâa-Tafilalet region, Morocco). This area was once used for pastoralism, but currently contains hundreds of modern date palm farms over an area of 3400 ha [3]. Thus, more than 90% of the total extension area established for date palm cultivation since the launch of the Moroccan strategy for the development of date palm sector. The Moroccan date palm extension area is growing continuously and will exceed 20,000 ha by 2030 [17].

Our surveys were carried out on 30 modern and productive date palm farms, managed in monoculture and equipped with localized irrigation systems.

2.2. Production Cost Calculation

Variable costs are the operating costs that include the costs of energy, fertilizers and phytosanitary treatments as well as the costs of temporary workers. The fixed costs include the depreciation of equipment and buildings, the acquisition cost of plants, the wage of permanent workers and the cost of land rent in the case of tenant farms. In the extension zones, date palm cultivation is undertaken

on collective lands granted to investors through rental contracts. The rental price is set at 800 MAD (US\$ 83.76) per ha per year. All the fixed costs related to the acquisition of equipment and plant material are computed with and without subsidy in order to assess the importance of the government incentives.

The costs are presented in Moroccan Dirham (MAD) and US dollars (US\$) per hectare, per date palm plant and per ton of date produced (US\$ 1 \approx 9.55 MAD). Calculations were made based on an average planting density of 123 plants/ha and an average yield estimated at 70 kg/plant.

2.3. Comparison of the Production Cost of Dates of cv. Majhoul with the Main Producing Regions

Determining and comparing the production costs at the international level constitute the fundamental basis for the assessment of the economic competitiveness of any sector [18]. In this experiment, we aimed to compare the production cost of Majhoul dates between the main producing regions in the world. These regions are the Coachella valley in California, USA [9] and the Jordan Valley in the Middle East [19].

3. Results and Discussion

3.1. Estimation of the Production Cost of Dates of cv. Majhoul

Table 1 revealed that the production cost of dates of cv. Majhoul is estimated at 50,477 MAD/ha (US\$ 5285.5/ha). The average cost per a date palm plant is about 410 MAD (US\$ 43), while the cost of production of one ton of cv. Majhoul dates is estimated at 6060 MAD (US\$ 634.55). These results are obtained by analyzing the fixed and variable costs as follows:

3.1.1. Variable Costs

The variable costs include all expenses directly related to production operations such as energy costs, all agricultural production factors as well as the costs of temporary workers. Based on our analysis, the variable costs are estimated at 33,734 MAD/ha (US\$ 3532.35), the equivalent of 274 MAD/plant (US\$ 28.7) and of 4050 MAD/ton of date produced (US\$ 424). This represents 67% of the total cost of production of cv. Majhoul dates. These costs are distributed as follows:

Irrigation costs

The irrigation system used in all the date palm farms surveyed in the present study is the drip irrigation. This irrigation system was chosen since it allows a rational water management and prevents the propagation of the bayoud disease [20].

The variable costs related to drip irrigation mainly concern the maintenance costs of the irrigation system that are estimated at 333 MAD/ha (US\$ 35), which is the equivalent of 3 MAD/plant (US\$ 0.3) and of 40 MAD/ton of date produced (US\$ 4). This represents 1% of the total production cost.

Energy costs

The energy required both for pumping irrigation water and for the operation

Table 1. Cost of production of dates of date palm cv. Majhoul.

Component	Cost MAD/ha	Cost MAD/plant	Cost MAD/ton	Percentage
Variable costs	33,734.33	274.26	4049.74	67%
Energy	6960.00	56.59	835.53	14%
Irrigation	333.33	2.71	40.02	1%
Fertilization	11,685.00	95.00	1402.76	23%
Phytosanitary treatments	800.00	6.50	96.04	2%
Temporary workers	5016.00	40.78	602.16	10%
Extra production costs	8380.00	68.13	1006.00	17%
Other costs	500.00	4.07	60.02	1%
Fixed costs	16,742.94	136.12	2009.96	32%
Land rent	800.00	6.50	96.04	2%
Construction	383.33	3.12	46.02	1%
Equipment	3632.50	29.53	436.07	7%
Drip irrigation system	1230.17	10.00	147.68	2%
Permanent workers	9126.00	74.20	1095.56	18%
<i>In vitro</i> plants	1570.94	12.77	188.59	3%
Total cost	50,477.27	410.38	6059.70	100%

of agricultural equipment has an estimated cost of 6960 MAD/ ha (US\$ 729), which is the equivalent of 57 MAD/plant (US\$ 6) and 835MAD/ton of date produced (US\$ 87.5).

Fertilization costs

The fertilization costs of a modern date palm farm cover the mineral and organic fertilizers. These fertilizers are applied to improve the yield and fruit quality and the protection against pests and diseases [21].

The costs of mineral and organic fertilizers are estimated at 11685 MAD/ha (US\$ 1223.56), which is the equivalent of 95 MAD/plant (US\$ 10) and 1402 MAD/ton of date produced (US\$ 147). This represents 23% of the total production cost, and showed that fertilization is the most expensive cultural practice in the production process of dates of date palm cv. Majhoul.

Phytosanitary treatment costs

The costs of phytosanitary treatments cover the costs of purchasing fungicides, insecticides and herbicides. According to our analysis, these costs are estimated at 800 MAD/ha (US\$ 84), which is the equivalent of 6.5 DH/plant (US\$ 0.7) and 96 DH/ton of date produced (US\$ 10). This represents only 2% of the total production cost.

Temporary worker costs

In date palm cultivation, temporary workers are widely hired to support the

permanent ones in carrying out seasonal agricultural practices that require several working days. These agricultural practices are pruning, fertilization, pollination, thinning, bunch protection and harvesting. It is worth noting that cv. Majhoul is a very demanding cultivar in terms of labor.

The cost of temporary workers is estimated at 5016 MAD/ha (US\$ 525.2), which is the equivalent of 41 MAD/plant (US\$ 4.3) and 602 MAD/ton of date produced (US\$ 63). This represents 10% of the total production cost. Harvesting is the major agricultural practice since it represents 38% of the temporary worker costs.

Extra production costs

These costs include the bags used to protect fruit bunches from monsoon rains and the ropes used to fix them [22]. The cost of these products is estimated at 8380 MAD/ha (US\$ 877.5), which is the equivalent of 68 MAD/plant (US\$ 7) and 1006 MAD/ton of date produced (US\$ 105.3). This represents 17% of the total production cost.

3.1.2. Fixed Costs

The fixed costs include the cost of land rent, the depreciation of equipment and buildings (construction, equipment and installation of the drip irrigation system), acquisition and planting of date palm plants as well as the wage and social costs of permanent workers. The fixed costs are estimated at 16742 MAD/ha (US\$ 1753), which corresponds to 136 MAD/plant (US\$ 14.2) and 2010 MAD/ton date produced (US\$ 210.5). The fixed costs represent 33% of the total production cost.

Our analysis showed that the cost of permanent workers is the largest expense, with 18% of the total production cost, followed by depreciation costs which represent 10% of the total production cost. The cost of land rent represents only 2% of the total production cost, while that of plant acquisition and plantation does not exceed 3% of the total production cost.

3.2. Effects of the Government Incentives on the Production Cost of Dates of cv. Majhoul

In Morocco, date palm cultivation has benefited from government support within the framework of the agricultural development fund. The government subsidy supports the acquisition of agricultural equipment, installation of the drip irrigation system as well as the acquisition of *in vitro* plants. **Table 2** shows the effect of the government subsidy on the components of the overall investment.

The findings of the present study showed that the government subsidies reduced the total investment by 56%. Our findings revealed also that installing the drip irrigation system is the most expensive operation, with 42% of the total investment cost. However, the government subsidy covers 80% of this cost. The acquisition of date palm plants represents around 1/3 of the total investment cost, out of which 71% is covered by the government subsidy (**Table 2**). The

Table 2. Effects of the government incentives on the production cost of dates of cv. Majhoul.

Component	Cost without subsidy (MAD)	Percentage	Investment cost (MAD)	Percentage	Amortized value with subsidy (MAD/year /ha)	Amortized value without subsidy (MAD/year /ha)	% variation
Construction	337,400.00	9%	337,400.00	20%	383.33	383.33	0%
Equipment	834,000.00	22%	709,000.00	42%	3632.50	4170.00	13%
Drip irrigation system	1,594,000.00	42%	318,800.00	19%	1230.17	6150.83	80%
<i>In vitro</i> plants	1,033,200.00	27%	333,200.00	20%	1136.00	3936.00	71%
Total	3,838,600.00	100%	1,698,400.00	100%	6582.00	14,840.17	0.56

agricultural equipment represents 22% of the total investment cost, out of which 13% is covered by the government subsidy. Building construction is the least expense, thus representing only 9% of the total investment. This item does not benefit from subsidy.

3.3. Comparison of the Production Cost of Dates of cv. Majhoul with the Main Producing Regions

The findings of the present work showed that, in the “Meski Boudnib” extension zone in Morocco, the production cost of one ton of dates of cv. Majhoul is estimated at 6060 MAD (US\$ 634.5). This cost is relatively low when compared to the production costs reported in the main producing regions of the dates of cv. Majhoul. Indeed, the production cost of one ton of dates of cv. Majhoul in the Jordan valley was estimated at 10,536 MAD (US\$ 1103.2) [23], while it was estimated at 20,189 MAD (US\$ 2114) in the Coachella valley [24].

Three main factors can explain this difference in costs: 1) the temporary workers hired in California for the production of dates of cv. Majhoul cost almost ten times higher than the temporary workers in the extension zone of Morocco. In the Jordan valley, the temporary worker cost is almost the double of that estimated in Morocco [25]. 2) The cost of acquiring and planting date palm plants in Morocco (*in vitro* plants obtained through organogenesis) constitutes only 50% and 25% of the costs reported in the Jordan valley and the Coachella valley, respectively. It is worth noting that, in USA, date palm is propagated through offshoots due to the absence of the bayoud disease. 3) In Morocco, the cost of land rent represents only 2% of the total production cost of cv. Majhoul dates, while it represents 14% in the Jordan valley [26] and 20% in the Coachella valley [24]. Besides, our analysis revealed that the cost of land in the Coachella valley and the Jordan valley is 56 and 13 times higher than that of the “Meski Boudnib” extension zone, respectively [26].

4. Conclusion

The findings of the present investigation showed that the production of dates of cv. Majhoul in Morocco can be highly competitive in the international market.

This is due to several factors such as government subsidies, the low costs of permanent and temporary workers as well as the very low land rent cost. More studies will be carried out to evaluate the impact of other factors such as climate change on the production cost of dates of cv. Majhoul in Morocco, in order to assess the competitiveness of the Moroccan Majhoul dates in the international market under different potential scenarios.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Abbreviations

MAD	Moroccan Dirham
US\$	United States Dollars
MENA	Middle East and North Africa
MAPMDREF	Ministère de l'Agriculture, de la Pêche Maritime, du Développement Rural et des Eaux et Forêts
ANDZOA	Agence National pour le Développement des zones oasiennes et de l'Arganier
Cv	cultivar
CBI	Centre for the Promotion of Imports from developing countries
ITC	International Trade Center
DDZO	Department of Development of Oasis Areas
ORMVATF	Office for Agricultural Development of Tafilalet