

Some agricultural techniques to cope with the fluctuation of the groundwater level in arid environments: Case of the Souf Oasis (Algerian Sahara)

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ABSTRACT

In arid lands, the unique characteristics of the date palm are the privilege of the main axis of oases ecosystems. In the Souf oasis, the palm trees are planted as form *Ghout* where these trees directly benefit from groundwater. The *Ghout* is a model for sustainable agricultural systems, saving water, soil, and adapted to harsh conditions in arid lands. However, because it is completely dependent on the groundwater level, it is considered precarious, by raising or lowering this slick threatens the palm trees, or by flooding, or by drought. In this research paper, we showed two agricultural techniques that used by farmers to cope with the fluctuation of the water table, and in spite of its simplicity, they contributed for a long time to the preservation of the traditional irrigation system from disappearing.

KEY WORDS: Palm date, *Ghout*, groundwater level, Souf oasis, Arid lands

INTRODUCTION

Date palm (*Phoenix dactylifera* L.), or as it is called the tree of life (Nixon, 1951), is a perennial tree domesticated for at least 5000 years (Sané *et al.*, 2005) and is the axis of oases ecosystems. Date palm groves create a microclimate suitable for the cultivation of fruit trees, cereal crops, and different vegetables (Bouguedoura *et al.*, 2015; Khalef *et al.*, 2010). In addition, date palm is a drought resistant and salt tolerant plant. It can tolerate soil salinity up to 4 dS/m without a reduction in yield (Ai-Amoud *et al.*, 2000).

In several tropical countries, date palm plays an important social, environmental and economic role, because it constitutes the principal financial and food sources of oasis cultivators and contributes to the development of subjacent cultures (Sané *et al.*, 2005). In the south of the Algerian Sahara, the palm cultivation is concentrated in many oases such as *El-Oued*, *Tamenrasset*, *Adrar*, *Ouaregla*,

Ghardaia, and *Biskra*. The Souf oasis in *El-Oued* province is among the most important of them, where old palm trees planting in the form of *Ghout*.

The purpose of this research is try to shed light on some agricultural techniques related to the palm trees and used by the farmers to cope with the fluctuation of groundwater level in the Souf oasis.

Study Area

Souf oasis is one of the dozens of oases Scattered in the Algerian Sahara located in the central part of *El-Oued* province (Figure 1), characterized by a hot and drought climate (Khezzani and Bouchemal, 2016). The rainfall is oscillatory and rare, with an annual average not exceeding a value of 70 mm, evaporation characterized by high value while the annual value exceeding 2200 mm. Temperature up to record levels during the summer with the registration of a large thermal difference between night and day. The

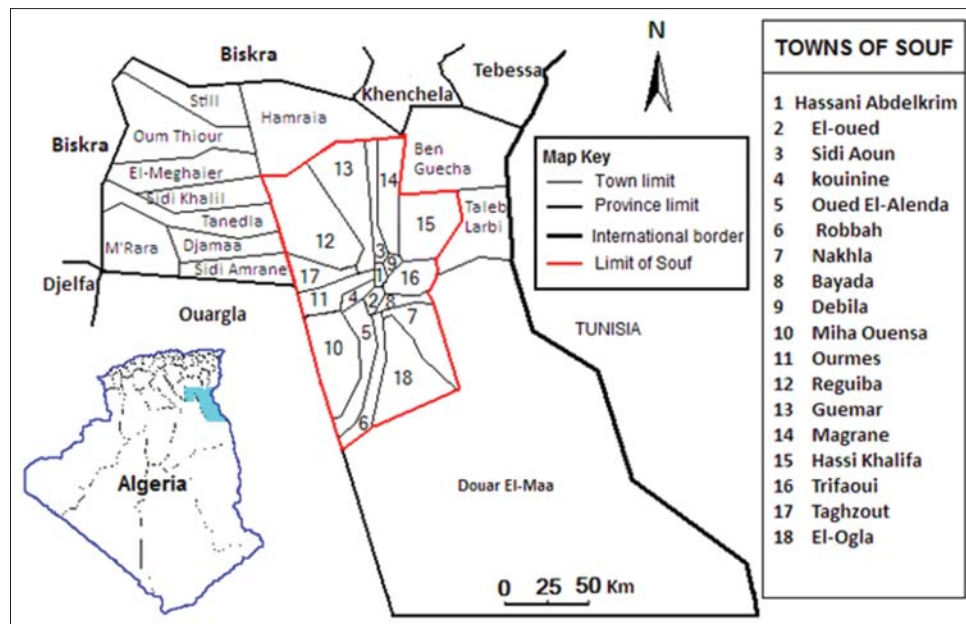


Figure 1: Location of the study area

Souf region is famous for its abundant wind, especially in spring. All of these indicators are a clear evidence of the cruelty of climate.

Although the indicators of drought prevail on the surface, it is completely different under the land; the region sleeps on the biggest stocks of groundwater located in three different levels; the most important for agriculture sector is the first level which called phreatic table. This water was used by the first farmers in creating the oasis through the technique of *Ghout*.

Technique of *Ghout*

The system of *Ghout* is one of the most fascinating agricultural techniques in the world that could first sedentary through which to defy nature and adapt to the harsh conditions in Saharan and arid lands (Figure 2).

In this oasis, irrigation is from groundwater; the traditional cropping system involves the planting of palm trees to fund large craters, called, in the vernacular term *Ghouts*, water is drawn directly from the water table. This method allows farmers to avoid all irrigation loads, which one faces in other arid regions (Cauvet, 1914; Despois, 1958; Zella and Smadhi, 2006). According to Khezzani and Bouchemal (2013), a total number of *Ghouts* in the Souf oasis will be about 9792 unites.

This original and unique irrigation system are adapted to the harsh conditions of the natural environment of



Figure 2: System of *Ghout*

Souf (Bataillon, 1955; Brunhes, 1902). However, and because it is completely dependent on the groundwater level, it is considered precarious. By raising or lowering this slick threatens the palm trees, or by flooding or by drought. This raises the probability of agro-ecological disaster.

Because the *Ghout* is a model for sustainable agricultural systems, saving water, soil and adapted to harsh conditions in arid lands, the FAO classed this agriculture system among agricultural word heritage in 2005.

METHOD OF DESCENDING AN ADULT DATE PALM

This method is practiced by old farmers when the palm tree threatened by drought stress resulting from the perceived decline in the level of the groundwater table.

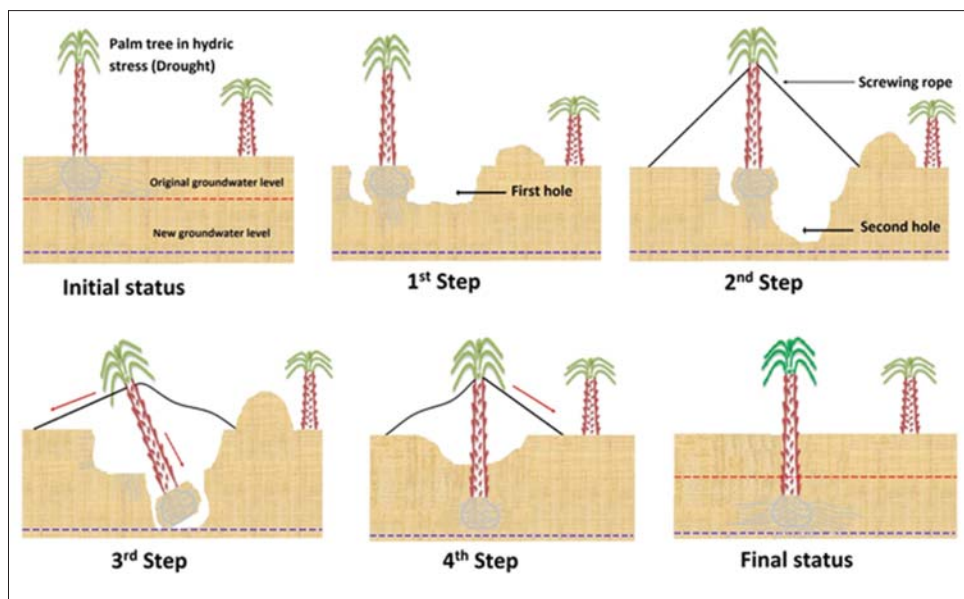


Figure 3: Different steps of descending an adult date palm

This operation is done in late winter and early spring, because the roots in this period begin to grow and activity.

Initially, the farmer excavates a circular hole around the palm tree until baring all roots which are located mostly at a depth of no more than 2.5 m. Then, the palm tree is linked to the top by ropes at least three sides to prevent it from falling and to facilitate the process treading (Figures 3 and 4).

Next, inside the first hole has made the second hole up in the depth to groundwater level. After that, by loosen and tighten the three chords, the farmer makes palm tree in a position slanting, until the bulb rolled into a crater near groundwater. At the end, the farmer pulls the cord from the opposite side, even the trunk standing vertically and buried the roots to the desired level with the addition of some organic fertilizers presented by the excreta of camels.

In the *Ghout* contains between 50 and 200 palm trees, this operation is very difficult. For this reason, the operation of descending lasts a long time and the work is a collective because date palm is the only source for food and income.

Despite the success of this method in preserving the traditional way of irrigation, but now no longer used, because of the high rate of decline in the groundwater level between 1 year and other. The farmer digging a well in the yard of *Ghout* for extracting water by an electric pump and watering the palm trees from the surface like other crops.



Figure 4: Descending an adult date palm

METHOD OF BACKFILLING

The farmer is obliged to use this method when the palm trees are in danger of drowning and suffocation by excess water resulting from the rise of the groundwater level because the palm tree can give new roots from the lignified trunk, the farmer buried partially the palm by sand until reaching the required level. After this operation, progressively, palm tree disable suffocated old roots and adopting at new roots. In some areas where the water reaches record levels on the rise, the backfilling of *Ghout* was in whole (Figures 5 and 6).

Farmers in large scale use this method in the recent years, to save the palm trees threatened by drowning especially in urban zone such as *El-Oued*, *Kouinine*, *Bayada* and *Robbah* towns.

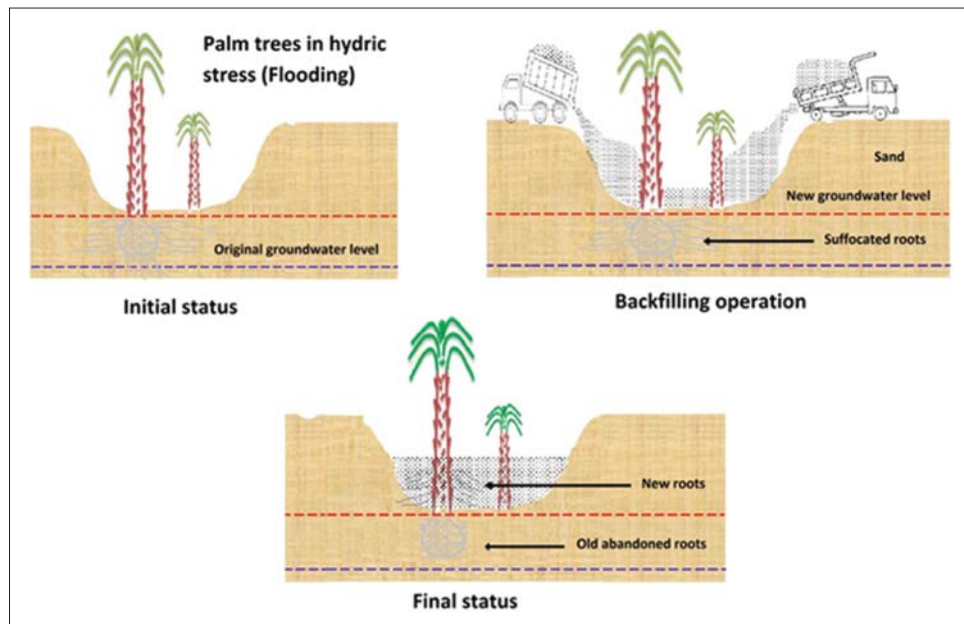


Figure 5: Method of backfilling a damaged Ghout



Figure 6: Backfilling a damaged Ghout

CONCLUSION

Phreatic water table, date palm trees and some agricultural techniques were the principal reasons to success of the settlement of populations in arid regions such as oases. In the Souf oasis, the *Ghout* is a model for sustainable agricultural systems, saving water and soil and adapted to harsh conditions in arid lands. Because the ground water level is variable and controlled by various factors, the farmer has used some of the traditional and simple techniques through which to control the level of planting palm tree by lifting or descending.

Despite the simplicity of these methods, it was a great effectiveness to cope with the fluctuation of groundwater

level and save palm trees; in addition, it represents an important part of our heritage not only for Souf but also for all worlds.

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