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The Water Use in Agriculture in the Algerian Central Sahara: What Future?

Bouchemal S*

Department of GTU, RNAMS Laboratory, University of Oum El Bouaghi, Algeria

***Corresponding author:**

Salah Bouchemal,
Department of GTU, RNAMS Laboratory, University of Oum El Bouaghi, Algeria,
E-mail: s_bouchemal@yahoo.fr

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1. Abstract

The study on the use of water in the Algerian Central Sahara shows that this resource has given much hope to the development of agriculture in this part of Algeria, thanks to a law that has allowed the granting of concessions to the farmers in different parts of the country. This has given rise to several forms of agricultural development, each with its own particularities, but everywhere the problem of the use of groundwater, whose repercussions are numerous, particularly because of its overexploitation, is a source of great concern, especially for the future of traditional agriculture, which is based on the foggara irrigation system, an ingenious system dating back several centuries.

2. Introduction

Human organizations in the Sahara have taken shape through a socio-hydraulic system that for centuries has always been able to adapt to the difficult conditions of the environment. Today, more than in the past, the problem of groundwater exploitation is acutely present. We have identified it thanks to a study of agriculture in the Algerian Central Sahara, which encompasses three regions, the Gourara, the Touat and the Tidikelt. The study is the report of a mission carried out in these three regions. It was carried out by means of surveys of administrative services and farmers, which made it possible to establish a typology of the different forms of agriculture and to understand the problems they face.

2.1. The Water Use in Central Sahara

In the Central Sahara, agriculture is one of the main sources of income. It obeys two types of water exploitation system, a traditional system, which is based on irrigation by foggara, and another called modern, based on the techniques of sinking wells or boreholes but whose charges are very important and therefore do not allow an appreciable extension of the cultivated areas.

2.2. The Foggaras System

It is a centuries old and ingenious irrigation technique. The foggara is made up of several wells of varying depths, joined at their base by an underground gallery that is very slightly inclined and which brings water to the surface of the ground under the effect of gravity (Figure 1). It extends over a length of sometimes up to ten kilometers. There are 926 living foggaras in the central Sahara, which were delivering an annual volume of water of about 80 million m3 per year at the beginning of the years 2000.

A study carried out by S.A. Bellal indicates that the total flow by natural region of the Central Sahara in 1998 is significantly lower than in 1960. The deficit is 812 l/s, it is especially important in the Touat and Tidikelt with 463 l/s, on the other hand it is almost nil in the Gourara[1]. The deficit in flow is a consequence of the overexploitation of the albian aquifer by drillings and lack of maintenance. This causes the lowering of the water level and the drying up of 452 foggaras, the highest number of which is in the Timimoun sector, in Gourara (Figure 1).

Figure 1: Foggara distributor in the Amekid palm grove (Touat)

2.3. The Drillings

A survey carried out in 2012 in Central Sahara indicates that the drillings is spread over all three regions (Table 1). The total number of drillings was 714, of which 306 are in service. Equipped with motor pumps and delivering an annual water volume of 7474 l/s, nearly 236 million m3 per year, they provide drinking water and enable the development of the agriculture.

Table 1: Breakdown of drillings by region in Central Sahara in 2012

	Drilling for drinkings water	Industrial drillings	Irrigation drillings	Exploited drillings	Non-operated drillings	throughput in l/s
Gourara	50	9	43	36	70	938
Touat	78	15	432	246	279	6235
Tidikelt	20	3	60	24	59	301
Total	148	27	535	306	408	7474

In the central Sahara, the first drilling was carried out in 1952 in the commune of Ksar Aoulef, in the Tidikelt. The development of the drilling technique was slowed down until the years 1980 with the law on the accession of agricultural land ownership (APFA) which saw an intensification of water withdrawal from geological reserves. Thus, there were 535 drillings for irrigation throughout the Central Sahara in year 2012, compared to 148 for domestic water and only 27 for industry.

While irrigation has the largest number of drillings, it is also worth noting the inequality in their distribution across the communes of the central Sahara. The commune of Zaouiet Kounta has the largest number of boreholes, 118 with a flow rate of 1355 l/s, while those of Timmi and Akabli both have only 3 and 4.

2.4. The Situation of Agriculture in Central Sahara

In the Central Sahara, as everywhere in the Algerian Sahara, the oases originated mainly with the development of the caravan trade or thanks to the settlement of former nomads near a spring. The palm grove provided them with an additional source of subsistence, but with the development of the technique of drilling, for a little over a century, agriculture has taken off significantly, first ensuring an export of the date products, then developing other types of culture. But it is especially from the years 1980 that this agriculture could know the most profound transformations, they are sometimes encouraging, sometimes marked by disillusionment especially when we measure the effects due to the exploitation of the acquifers. Such an evolution is linked to the conjunction of two fundamental elements:

- the local hydraulic resources which are now known and which conceal considerable potentialities, they amount to 60.000 billion m3 for the Continental intercalary nappe alone (known as albian), this one is closer to the surface in the Gourara, Touat and Tidikelt than in the bordering zones;
- the 1983 law on land ownership, stimulated by the crucial problem of importing food products. It stipulates that any land in the public domain that is likely to be developed in the Saharan region may be the subject of a concession accompanied by a title deed, by payment of a symbolic dinar, after notification of the agriculture and hydraulics departments. For all development work, the purchaser can benefit from bank assistance.

The land acquisitions first concerned small scale farming (PMEV), for the benefit of the peasantry in place. Lots were allocated individually or to groups of cooperatives, mainly family-based. The beneficiaries use a public drilling or dig their own wells. Some are running their old farm at the same time as the new one, while others have never owned any plots before.

The experience, rich in lessons learned, encouraged the government to move on to a different type of development by drilling deeper boreholes, such as those that reached the Continental Intercalary, but also by expanding the areas granted. Thus, from an allocation of 1 to 10 hectares, concessions ranging from 50 to 100 hectares or more, and even 1500 hectares, are reached. This large scale development (GMEV) is the one that set in motion the efforts of the public authorities to develop cereal growing under pivot.

One can deduce from this the particular interest in agriculture in the central Sahara, by individuals of various origins, because land allocations have subsequently interested not only the local inhabitants, but also those living in the north of the country. However, this enthusiasm has not always matched the ambitions of the initiators of the development project, as many setbacks have occurred, for several reasons, such as parsimony in the allocation of funds, delay in the completion of drilling or lack of water.

In any case, the result is not negligible, even if it seems less than hoped for. Thus, traditional agriculture, that of the ksars[2], whose principles were based on the right of community use, with narrow and cramped plots of land, is increasingly giving way to a system of individual production, reinforced by marquetry where

1. Sid Ahmed Bellal: collective work under the direction of Bernard Kabaora and Ahmed Moroti: Le désert : de l'écologie du divin au développement durable, éditions l'Harmattan, 2006, 266 pages.

each farm is often far removed from the other. This has also had repercussions on the method of irrigation of the foggara, which is largely giving way to motor pumps or drilling by the state. It is also the transition from a subsistence economy, marked mainly by the sale of dates, to a much more diversified production, mainly oriented towards marketing for enrichment. For, apart from date palms, most of the range of crops in northern Algeria finds its existence, but it is mainly tomatoes that are grown, and this is not at all a new fact, mainly in Touat where this type of culture had been encouraged very early on by the local administration, just before the years 1970. Its success was such that production was flown to the north of the country.

Vegetable products have appreciable yields and sometimes allow their export abroad. Cereals, irrigated by pivot, reach up to 70 quintals per hectare. However, in spite of this diversification and performance achieved by this evolution of agriculture, the traditional sector continues to occupy the largest agricultural area in Central Sahara with nearly 64% of the total, during the 2011-2012 crop year (Table 2).

Table 2: Distribution of agricultural land in Central Sahara (2011-2012 crop year)

Sector traditional		GMEV		PMEV		The entire agriculture sector	
Area per hectare	%	Area per hectare	%	Area per hectare	%	Area per hectare	%
13.973	63,53	4.148	18,86	3.871	17,10	21.992	100

The other two types of farms (GMEV and PMEV), which are almost equal in terms of agricultural area, take the rest of the land allocated to agriculture. But in terms of distribution by commune, the communes of the daira[3] of Zaouiet Kounta, in Touat, have the largest agricultural area, 22.92% of the total, and this is also where the different types of farms are best represented. In this secteur, in the direction of the chief town, from Stah Azzi, on about fifteen kilometers, we were able to draw up, in 2003, during a mission, a typology where we identified the following forms of enhancement agricultural, each one being governed by its own mode of irrigation (Figure below and images 2, 3, 4, 5 and 6):

- large hancement module of 150 to 1500 hectares with pivot irrigation (2 to 3) ;
- large scale hancement in the module from 50 to less than 150 hectares with pivot irrigation (only one) and motor-pump wells ;
- small hancement in the module from one to 5 hectares per recipient;
- the traditional oasis.

Figure 2: GMEV Benabdelmoumene in Stah Azzi : pivot in activity (Touat)

Figure 3: GMEV Moulaye Nejm in Stah Azzi : sorghum field irrigated at the pivot (Touat)

Figure 4: GMEV Moulaye Nejm in Stah Azzi: lemon trees in the shade of the palm tree (Touat)

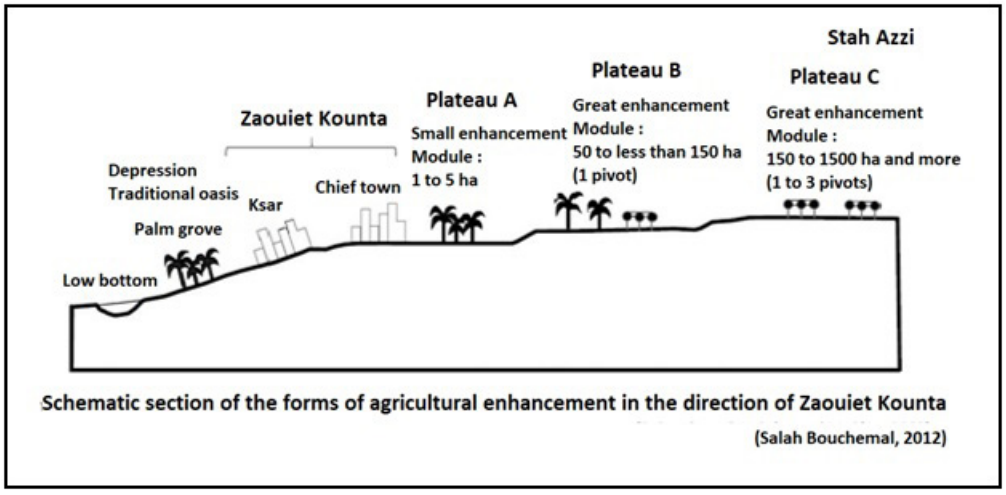
Figure 5: Small enhancement in Stah Azzi: irrigation by the skate (seguia) (Touat)

Figure 6: Small enhancement in Stah Azzi (Touat)

2. The ksars constitute the traditional cities in the Sahara.

3. The daïra is an administrative district that includes a group of communes

At the eastern end of Stah Azzi are concentrated the large scale enhancement, those exceeding 100 hectares. The GMEV, chaired by MN[4], is one of these, and has the largest area in the entire sector.



Schematic section of the forms of agricultural enhancement in the direction of Zaouiet Kounta

(Salah Bouchemal, 2012)

The GMEV was first formed by an unit of 170 hectares and then another by 1500 hectares, 500 hectares of which are awaiting development. The members of the association are the father, MN, and his 5 children. They employ 70 permanent staff members, all living in the neighboring villages; among them, 3 are of Malian nationality. The group combines the most sophisticated techniques: irrigation by drip and by pivot. It calls upon a researcher from the National Institute of Agronomy in Algiers and does not hesitate to send one of its members to Saudi Arabia for training on new techniques for sheep breeding in the Saharan environment. The unit has 650 head, mainly of Malian breed, and intends to develop this herd.

The crops are varied and allow high yields, such as cereals, which are between 60 and 70 quintals per hectare and which range from durum and soft wheat, to millet and corn, a speculation that takes place twice a year. The group, which is experimenting with sugar cane, is also interested in growing soybeans and to all kinds of vegetables, while various fruit trees grow in the shade of the palm tree.

This GMEV, dynamic and well maintained, always achieves the expected results and can boast of being among the most efficient farms in Algeria. Thus the market garden products are always harvested several dozen days before those of Biskra, which is a city in the North-East of the Sahara and which is very famous for market garden crops, or other regions of the country. But unfortunately, there is the problem of their marketing, especially when it comes to transporting them to the port of Annaba for export, when we know that transport by truck of 7 tons, for example, costs 90000 dinars[5] and freight costs to France estimated at 40000 dinars per ton, because 3 departures to this country have already taken place. Tomatoes are difficult to find a buyer, and when they are not sold, the production is dried and then sold at low prices. However, to avoid this difficulty, a project to build a 1500 m3 cold room will soon have to materialize. But there is also another problem to report, the GMEV suffers from the high cost of the energy bill, which is about 700000 dinars, which is not without effect on irrigation possibilities. In the past, irrigation was done from four boreholes, now reduced to two. Moreover, this is why MM sounded the alarm to draw the attention of the public authorities and say: "what future for Saharan agriculture?"

Further downstream from this grouping, other farms appear. They are smaller in size and are also exposed to the constraints of very high groundwater exploitation. Irrigation is done by pivot and drip irrigation through the use of boreholes, but motor pump wells are also widespread. The range of crops is varied, but yields are low, either because of a lack of mastery of the techniques or because the equipment is damaged each time. In all cases, these are family businesses, with modest resources, but supported by development programs. This is the case of the Sid El Mokhtar cooperative, a farm of about 100 hectares, born from an association between 6 brothers, or the GMEV Djaballah, a farm of 140 hectares, managed by a family also composed of 6 brothers.

By taking a slope on the road leading to Zaouiet Kounta, we will reach the Benabdelmoumene cooperative, a unit with a smaller surface area, it is 70 hectares, divided between 25 hectares occupied by cereal crops and 45 hectares reserved for market gardening in the open field, and 3 greenhouses of 400 m2 each. Thus this diversification, which avoids possible risks, is associated with sheep breeding, with a herd of 200 head of mostly Ouled Djellal breed. Water is drawn from a borehole delivering 45 liters per second for

4. MN is named Moulaye Nejm
5. The Algerian dinar (DA) was worth 0.01 US dollar on September 20, 2020.

pivot and drip irrigation. The unit is held by 4 brothers who are not dissatisfied and are confident in the future. They intend to develop an additional 27 hectares and are thinking, thanks to the profits from the sale of their products, of investing in the construction of a cannery.

Beyond, a landscape dotted with small gardens announces the little enhancement. Here, a perimeter of 45 hectares has been granted to 15 farmers. The farms cover an area ranging from 1 to 5 hectares. Irrigation is done through two collective boreholes, and here too the use of drip irrigation has become essential for a large number of farmers, while the irrigation par seguia is also important. The crops are diversified (market gardening and arboriculture), but this is no longer the domain of cereals. Here, the workforce is exclusively family, except during peak periods when seasonal workers are used. Marketing the products, which are easily sold, allows farmers to earn a profit that protects them from want. This means that this type of development is less worrying, even if here too the electricity costs are as high, but the investments are less heavy.

On arriving in Zaouiet Kounta, below the ksar, stands the palm grove, which is the fundamental link between the members of the community. The property is of melk status, i.e. unwritten private law, but recognized by the community. It consists of small gardens, the boundaries of which are materialized by fences made of palm leaves and branches. The plots, concentrated and dense, are limited to a few ares, or even one are only or less, but in the shade of the palm tree grow vegetable crops and various fruit trees, just for consumption, while dates constitute the main part of the commercialization. Irrigation is done using a foggara whose flow rate is sharply declining, following the multiplication of boreholes or because it is poorly maintained due to a lack of human and financial resources, young people no longer being interested to taking over.

3. Conclusion

The typology relating to the forms of development reflects the conditions under which agriculture in the Zaouiet Kounta sector is evolving. Thus, it has been noted that each has its own problems, but what is described here is only a redundancy of situations found here and there in the Central Sahara. The general observation is simple: the use of water poses the problem of the exploitation technique implemented. Indeed, the multiplication of drillings has repercussions on the flow of the foggaras which weakens day by day and puts the small farmers in a difficult situation, whereas pivot irrigation leads to an additional cost of production and a great waste of water. Therefore, should the operating system in place not be reviewed?

It is therefore the entire development program agricultural of the Sahara that is called into question, the central Sahara being only an illustration. Indeed, in terms of agriculture, opinions agree that the Saharan Eldorado seems to be much more a decoy than a strategy to alleviate the difficulties faced by the agricultural sector in the north of the country. It was tempting to exploit the great hydraulic potential of the Saharan subsoil to develop strategic crops, especially cereals, which are the basis of the Algerian food system. The pivot irrigation system was the essential condition for this, an easily mastered technique, but in the Saharan environment its success seems questionable, inasmuch as some of its spin-offs should in no way be neglected.

In order to have good results, we know that the soils in the Sahara require much greater investment and water inputs than if one thought of installing irrigation pivots in the Sersou or the Setifois where yields would be higher, because as Mr. Cote said: ″the facts are stubborn: the agricultural potential of the country are located in the North, that's where we must revive agriculture, that's where we must produce the cereals needed by the country[6]. Today, water is abundant, but not renewable, so it seems more relevant to think about water development based on the cultivation systems that have succeeded in the past (date palm and market gardening), which means focusing efforts on the development of peasant agriculture to better fit with local ecological realities.

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