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Water resources and their role in food security in Algeria: Analytical Study

Hanene Amrouci

Research Lab on Economic Intelligence and Sustainable Development LRIEDD,
Faculty of Economic, Commerce and Management Sciences, University of Chadli
Ben Jedid, Taref, Algeria
Email: amrouci-hanene@univ-eltarf.dz

Aissa Rehim

Laboratory of Sustainable Local Development: Agriculture, Rural Development,
and Ecotourism, Faculty of Economic, Commerce and Management Sciences,
University of Chadli Ben Jedid, Taref, Algeria
Email: rehimi-aissa@univ-eltarf.dz

Abstract---This study aimed to identify the status of water resources in Algeria and their uses, as well as to diagnose the reality of food security in light of global food security indicators during (2019-2022), employing the descriptive and analytical approaches. The study concluded that: agricultural reforms contributed to improving agricultural productivity (cereals, oil, sugar, milk); however, Algeria has not yet achieved self-sufficiency in terms of the widely consumed substances. Besides, the effects of climate change on agriculture require Algeria to continuously develop appropriate.

Keywords---Water resources, food security, agriculture, self-sufficiency.

JEL classification code: O13, Q15, Q18, Q25

1- Introduction

The issue of water and food is a major global concern, with increasing world population, economic progress, depletion of land resources and climate change. While the previous trend is tending to address water security independently of food security, the new outlook is based on understanding the close link and the mutual effects between them, the realization that it is practically impossible to address one in isolation from the other, and that water security policies must be integrated with food security policies.

Algeria, like other countries in the arid and semi-arid regions, is experiencing a nearly acute water crisis today, falling into the category of countries with limited and irregular water resources, considering the scarcity threshold established by the United Nations Development Program (UNDP) or by the World Bank, i.e. 1,000 m³ per year per population, while Algeria has only 600 m³. International organizations have classified it among the countries that will suffer in the medium term from a real water scarcity problem due to mismanagement and use of water resources, and the absence of a rational policy to manage the growing demand for water, particularly in the agricultural sector, significantly impacting its agriculture.

Problematic

Food is a strong tool to exert pressure on the sovereignty of States, and food security has therefore become a major priority in States' strategies, since it cannot be achieved without the adoption of an agricultural development strategy based on the conservation and sustainable management of water resources. Based on the above, the problematic of the research is as follows:

How can water resources contribute to food security in Algeria?

Sub-questions

1. What does water security have to do with food security?
2. What policies has the Algerian State taken to strengthen its water resources?
3. What is the role of efficient use of water resources in agriculture to enhance food security in Algeria?

Hypotheses

1. Drought and water scarcity are the main threats to food security in the world in general and Algeria in particular.
2. Algeria's water crisis is not only rare and limited, but also poor administration and management have contributed to the crisis and worsening of the situation.
3. Water is not used efficiently in the Algerian agricultural sector, which has affected food security, particularly in strategic crops.

Research objectives

1. Identification of the status of water resources in Algeria and their uses by sector;
2. Diagnosis of the reality of food security in Algeria under the World Food Security Indicators (2019-2022);
3. Presentation of the Algerian State's efforts in rationalizing and efficient use of water resources in agriculture.

Research Methodology

The study applied the analytical and descriptive approaches, by describing the reality of water and food security, under the indicators of food security in Algeria (2019-2022), as well as the contribution of the agricultural sector to such

field. Besides, the analytical approach helped in carefully analysing the data after their organization.

2- Water Security in Algeria

Algeria's water resources are strategic in the overall development of the country because they are closely linked to sustainable development. The country's water supply is a rare and precious resource that requires rational use to meet the needs of the population and the national economy without making the demands of future generations at stake. Algeria is one of the poorest countries in the world in terms of means. It is ranked below the theoretical minimum of scarcity set by the World Bank at 1000 m³/year, since Algeria's theoretical water salary in 1962 was estimated at 1500 m³/year, falling in 1999 to 500 m³/year. The problem of water in Algeria is exacerbated by climatic characteristics ranging from arid to semi-arid on most Algerian territory, which are therefore inexhaustible, threatening to decrease resources at a time when the demand for this resource is growing as a result of demographic growth, and by growing consumer sectors such as industry, farming and tourism (**Zahrawi, 2021, p. 76**).

2-1- Status of water resources in Algeria

The wide spread of national territory from the Mediterranean to the desert, and hence from the Mediterranean to the arid field, has led to a clear natural disparity between the north, centre and south of the country. This is evidenced by rainfall and humidity, thermal rates and extreme variation of water resources in terms of spatial and temporal distribution. Water sources in the coastal zone and atlases cover most of the surface water available in Algeria, while desert areas hardly know a surface cooling, but have significant non-renewable groundwater resources.

2-1-1- Traditional water resources

Algeria is endowed with a variety of surface and groundwater resources, mainly due to its geographical and natural diversity, which distinguishes it from other Arab and African States and territories. The real total volume of water resources is estimated at only 19.4 billion m³, of which only 75% are renewable (60 % for surface water and 15 % for groundwater), of which 13.8 billion m³ on the north and 5.6 billion m³ on the south (**Drouiche, Ghaffour, Mohamed Naceur, & Lounici, 2012, p273**). They are distributed according to the resource type and regions according to the following table:

Table 1: Real water resources in Algeria (billion M³)

Resource Type	Regions			
	Coastal areas	Upper plains	South	Total
Surface water	11.1	0.7	0.6	12.4
Groundwater	02*		05*	07
Total	13.8		5.6	19.4

(*) Exploitable annual volume

Source: Prepared by the researchers using:

- Rachid Farrah (2010), p171.
- Nadjib Drouicheet al, (2012), p273.

Based on the table, the distribution of water potential in the country is uneven, with the coastal area occupying the largest share of surface water at 89.51%, while the highlands (5.64%) are decreasing, and the desert (4.83%) has significant groundwater resources. In other words, traditional sources of water can be divided into three sections: rainwater, surface water and groundwater.

2-1-2- Non-traditional water resources

In the face of increasing demand for this strategic biological resource, rapid population growth, industrial development, low rainfall caused by drought, natural difficulties (such as the difficult terrain in our country) and economic obstacles (high financial costs) in the investment and exploitation of natural water sources from rain, surface or groundwater, it is essential to seek alternatives and ways to diversify and develop water supply sources, particularly by desalinating sea water and treating wastewater.

a. Seawater desalinization

Algerian authorities have recently been engaged in pushing the drought and thirst nightmare away, to ensure their water security, owing to the continuing scarcity of rain, which has witnessed in the last decade, as in the case of the States of the region. Soufiane ZAMICHE, the manager of the Algerian Energy Company in its latest output, revealed that the number of seawater desalination plants had been increased to 19 in 2024, with 11 plants on the coastal area having been completed with a production capacity of 2.11 million m³/day. Under the emergency plan, the Government has also completed another 3 plants with a capacity of 70.000 m³/day, in parallel with the completion of 5 additional plants within the Supplementary Program, which will provide 1.5 million m³/day in 5 counties in 2024. The national water strategy 2021-2030 is aimed at meeting the need of Algerians for drinking water by desalinizing sea water by up to 60%. 17 % of the needs are now covered according to the official figures, and it will gradually rise to 22% in 2022, 42% in 2024 and 60% in 2030 (**Hadaka, 2023**).

b. Waste water treatment

Algeria's potential for this resource remains very weak, so that water is discharged at sea for coastal populations, and in valleys and groves for the rest of

the communities. The total volume of wastewater drained in the natural environment was 600 million m³/year and could reach 700 and 800 million m³/year, of which only 10% are cleared and treated. 50% of such plants are found at the level of the hill basins, the purpose of which is to achieve a continuous and tangible improvement of public hygiene and the protection of water resources **(Mohcen, 2019, p547, 548)**.

Algeria has 177 disinfectant plants with a capacity of 805 million m³/year equivalent to an estimated population of 13.8 million, of which 49 are equivalent to an estimated population of 6 million in metropolises (the capital, Oran, Ain Timouchent, Skikda, Annaba, Jijel and Boumerdes). In addition to the operational plants, water resources sector has 69 clearing plants in the process of completion with an estimated capacity of 6 million equivalent to the population of 244 million m³/year. It is expected that the number of clearing plants will reach more than 270 units with an estimated capacity of about 1300 million m³/year **(sanitation)**.

c. Saltwater purification (bitter water)

This process is different from the desalinization of seawater, which is intended to clear saline groundwater in some areas where salt water has been mixed with fresh water, especially in the southern regions of the country. This process began in 1980, and there are in Algeria 22 mining plants in salt water with a capacity of 0.22 million m³/day, meeting the needs of some 949033 people **(Non-traditional water resources)**.

d. Water transfer

In addition to the above-mentioned sources of water, in order to meet the need for drinking water, and to mitigate the effects of water shortages, Algeria has resorted to other projects to achieve this end by transferring water from the more abundant to the less abundant areas, namely, the system of water diversion from Taksebt to Algiers, KoudiaAcerdoune- High Plains system, Moustaganem - Arzio-Oran system, Ain Saleh -Tamanraset transfer system, andTichiHaf-Bejaia transfer.

2-2- Uses of water resources in Algeria

Algeria has embarked on a large-scale program of investments, which cost the public treasury approximately 55 billion US dollars. This has enabled the water resources sector to meet the demand for water. In 2018, Algeria was able to mobilize 10.4 billion m³ of water, including agricultural (6.8 billion m³), domestic (3.3 billion m³) and industrial (0.3 billion m³) oriented use, equivalent to 65.38%, 31.73% and 2.88%, respectively, of Algeria's total available water resources. The country's annual water needs are expected to increase to 12.9 billion m³ in 2030. The projected annual needs in 2030 are distributed to 4 billion m³ for drinking (31%), 8.3 billion m³ for farming (64.34%) and 0.6 billion m³ for industry (4.65%).

For the purpose of covering the country's needs in 2030, a national water plan has been developed that is based on the continuation and strengthening of the mobilization of traditional and non-traditional water resources, focusing on areas

with water shortages, by exploiting all the opportunities available to intensify and expand the network of connections and diversions between the country's major water systems.

In this regard, the former Minister of Water Resources highlighted that 45% of the projected requirements in 2030 would be secured by dams as opposed to 35% by mobilization and water production structures, which are not affected by climatic fluctuations such as the seawater and groundwater desalination plants in the south, while the remaining 20% would be provided through groundwaters in the north and the upper plains, the rate of renewal of which would be determined by climatic conditions. **(Participation of Minister of Water Resources Houcine NECIB on a Parliamentary Day Organized by the Committee of Housing, Equipment, Irrigation and Urbanization, on the Future of Water Resources in Algeria, 2019).**

2-3- Per capita renewable water resources in Algeria

Through the Falkenmark index, Algeria is a water-scarce country where per capita water consumption did not exceed the threshold of 500 m³/year. The following table shows the evolution of per capita water resources during the time period (2001-2019):

Table 2: Per capita renewable water resources in Algeria (2001-2019)

Year	2001	2005	2010	2015	2019
Per capita M ³ /year	360	341	314	284	263

Source: Prepared by researchers using:

FAO, Water Statistics Data AQUASTAT, World Bank, 2023.

Based on the table, Algeria's freshwater per capita has not exceeded the threshold of 500 m³/year to its lowest value in 2019 (263 m³/year), which means Algeria's entry into a state of absolute scarcity of water. The serious decline in Algeria's annual freshwater per capita compared to the ever-increasing population shows that Algeria is classified as a country below the water safety line.

3- Reality of Food Security in Algeria Under The World Food Security Indicators During The Period (2019-2022)

According to the World Food Security Index, Algeria is ranked at the top of the list of African countries and 54 out of 113 countries worldwide in 2021, significantly improving its 2019 ranking. Economist Impact indicated that this improvement in Algeria's ranking in the World Food Security Index 2021 was the result of an estimated overall point of 63.9 out of 100, i.e. 77.9 points for food affordability, 58 points for abundance, 62 points for food quality and safety, and finally 50.7 points for natural resources and adaptation.

Algeria has, according to the same source, recorded an upward trend in food security since 2012, thus improving its ranking from 70th in 2019 to 58th in 2020 and 54th in 2021, as shown in the following table:

Table 4: Food security indicators in Algeria during the period (2019-2022)

Year	Ranking /113 States	General indicator/100 points	Affordability of food	Availability of food	Food quality and safety	Natural resources and adaptation
2019	70	59.8	66.9	55.8	53	52.1
2020	58	61.8	78.7	55.7	62	42
2021	54	63.9	77.9	58	62	50.7
2022	68	58.9	66.8	57.3	54.7	54.2

Source: Prepared by researchers using:

Regional Report: Middle East and Africa, Global Food Security Index 2019, 2020, 2021, 2022.

The table shows that the value of Algeria's food security index for 2020 was 61.8 on a scale of (0-100 points) with an estimated improvement (+3.34%) over 2019, while 63.9% in 2021 with an estimated improvement (+3.39%) compared to 2020. In 2022 the food security index showed an estimated significant decline (-7.82%) compared to 2021.

The table also shows that there has been a decline in the affordability of food from (+17.63%) to (-14.24%) during the period (2019-2022), while the availability of food declined by (-0.1%) between 2019 and 2020, rising by (+4.1%) during the period (2020-2021), again by (-1.2%) during the period (2021-2022). The quality and safety of food declined significantly from (+17%) to (-11.7%) during the period (2019-2022), but the natural resource and adaptation dimension has improved significantly despite the decline of other indicators, from (-19.38%) to (+7%) during the period (2019-2022).

In general, there has been a tangible improvement in Algeria's overall food security index for the period (2019-2021), reflecting an improvement in Algeria's food security level. However, in 2022 there was a marked decline due to the spread of the Covid 19 pandemic. The latter has disrupted global supplies, food production, transport and distribution. This situation has led to a decline in food exports owing to the excessive storage of food products by food-producing countries, which has affected food security in many Arab countries, including Algeria, because of their heavy dependence on food imports, particularly basic food.

The hunger crisis is also one of the main threats to Africa and Algeria in the current Russian-Ukrainian war, because Ukraine is one of the world's most important exporters of wheat, barley, and primary agricultural materials. The Russian invasion of Ukraine is a direct threat to global food security, as food prices have risen, and productivity has decreased in Ukraine.

Climate change in Algeria has affected the agricultural sector in general and has become increasingly visible and disturbing, particularly through decreased rainfall, increased temperature fluctuations, deteriorating soil quality and rising sea levels. As the effects of climate change on agriculture intensify, growing crops,

taming animals, managing forests and fishing in the same ways and in the same places as in the past.

3-1- Contribution of the agricultural sector to food security in Algeria

The former Minister of Agriculture and Rural Development, Mr. Abdelhafid HENNI, stressed that the Program of Action for Agriculture and Rural Development Sector was aimed at promoting a modern, competitive, and efficient agriculture that would contribute to the diversification of the national economy and strengthen the foundations of sustainable food security. Within the framework of the new vision of promoting agricultural production in its various branches, particularly the strategic divisions, the Ministry has taken a series of actions that would allow our country to cover its national needs in the medium term, with the possibility of exporting and preparing for accessing foreign markets. In this regard, the new plan for agricultural development has been prepared after careful analysis of the situation, capacities, and the use of necessary tools for the period from 2025/2030/2035, which will bring about a real leap in agriculture through the integration of knowledge, techniques, and operational intelligence.

He also stated that agriculture is a privileged economic and social sector. Today, it contributes more than 14.4% to the gross domestic product (PIB). It accounts for more than a quarter of the working labour force, equivalent to 2.7 million. The value of agricultural production in 2022 (as a primary product) was 4.5 billion, compared with 3.5 billion in 2021, say an increase of 31%. The coverage of food needs (available) from national production was at 75%.

A significant abundance of basic products has also been recorded at the national market level, with most of the agricultural branches registering an increase in production in 2022, as follows: cereal production registered 41 million Quintal, say an increase of 48% compared to 2021, dry pulse production of 1.2 million Quintal, say an increase of 20% compared to 2021, potato production of more than 44.2 million Quintal in 2022, say an increase of 30% compared to 2021, industrial tomato production with a stable production of more than 23 million Quintal, olives (table olives and oil-oriented olives) produced more than 9.5 million bottles in 2022, say an increase of 34% over 2021, red meat produced 5.7 million Quintal in 2022, say an increase of 6%, white meat produced 4.8 million Quintal in 2022, say an increase of 11%, and fresh milk produced 3.4 billion litres in 2022, say an increase of 2%. **(Hearing by Minister of Agriculture and Rural Development Abdelhafid HENNI on the Finance and Budget Committee of the National People's Assembly, 2022).**

The following table shows the extent to which Algeria can provide its food commodity needs through local production:

Table 5: Main food available for consumption in Algeria (2015-2020) Unit:
(Agricultural production: 1000 tons, fresh milk: 1000 litres)

		Cereals	Potatoes	Pulses	Vegetables	Fruits	Sugar	Oils	Meat	Milk
2015	Production	3760.95	4539.58	87.39	12469.33	4323.11	00	1.90	769	3895
	Imports-exports	13821.1	152.92	228.2	27.20	412.12	1439.1	801.4	67.20	3372.6
	Available for consumption	17582.1	4692.48	315.6	12496.53	4735.24	1439.1	803.3	836.2	7267.6
	Self-sufficiency %	21.39	96.74	27.69	99.78	91.30	00	0.24	91.96	53.59
2016	Production	2942.3	4759.7	88.5	14563.8	4802.4	00	99.5	840.4	3719
	Imports-exports	13436.9	84.6	197.3	63.1	264.7	1357.8	1047.6	65.8	897.5
	Available for consumption	16379.2	4844.2	285.8	14626.9	5067.1	1357.8	1147.2	906.2	4616.5
	Self-sufficiency %	18	98.3	31	99.6	94.8	00	8.7	92.7	80.6
2017	Production	3478.1	4606.4	107.2	8882.5	4942.7	00	99.4	1073.7	3521.2
	Imports-exports	12892.2	140.9	105.1	1.8	35.6	1595.5	830.3	49.6	403.7
	Available for consumption	16370.3	4747.3	212.3	8884.3	4978.3	1595.5	977.8	1123.3	3924.9
	Self-sufficiency %	21.2	97	50.5	100	99.3	00	10.2	95.6	89.7
2018	Production	6065.9	4653.3	146.3	17351.2	4779.8	00	101.4	1069	3280
	Imports-exports	16722.2	109.6	238.4	29.6	- 9.7	1692	876.8	51.6	756.3
	Available for consumption	22788.1	4733.7	405.5	17385.1	4740.8	1692	978.2	1255.6	3913.1
	Self-sufficiency %	26.6	98.3	36.1	99.8	100.8	00	10.4	85.1	83.8
2019	Production	5633.5	5020.2	146.6	8620	5006.1	00	115.8	803.6	3189.2
	Imports-exports	17177.8	85.9	- 323.8	- 6.4	- 120.8	1298.5	922.1	56.2	630.2
	Available for consumption	22811.2	5106.2	- 177.3	8613.6	4885.3	1298.5	1038	859.9	4278.9
	Self-sufficiency %	24.7	98.3	- 82.7	100.1	102.5	00	11.2	93.5	74.5
2020	Production	4339.1	4659.5	115	10287.2	4552	00	249.9	798.5	3354.7
	Imports-exports	13085.1	60	191.4	24.7	184.6	1318.5	1002.2	33.2	1270.7
	Available for consumption	17478.2	4719.5	306.5	10311.9	4736.5	1318.5	1252.1	831.8	4625.4
	Self-sufficiency %	25.1	98.7	37.5	99.8	96.1	00	20	96	72.5

Source: Prepared by researchers using:

Arab Agricultural Statistics Annual Book, Arab Organization for Agricultural Development, 2017, 2019, 2021, vol. 37, 39, 41.

Reading the table shows that the contribution of agricultural production to food demand coverage for staple foods varies from substance to substance. It is weak in cereals and pulses, which in turn have witnessed significantly rising prices at the local market level, and very weak in sugar and oil. This has further widened the food gap between supply and demand in these substances, resulting in an increase in the volume of imports. This means that domestic production has been unable to keep pace with the growing national demand for these substances.

All cereals are at the top of the list as a primary source of food and a major consumer for the Algerian individual. However, self-sufficiency rates for this substance are low over the period (2015-2019), reaching a maximum of 26.6% in 2018. That is a very low proportion for a country where this food is an essential component of its people.

Since sugar requires a special climate for cultivation (tropical and semi-tropical climate) that is not available in Algeria, this means that the sufficiency rate is 0% and therefore the dependence rate on imports is 100%. The same applies to vegetable oils, but they are relatively better than sugar, with an improvement in the sufficiency ratios from 0.24% in 2015 to 11.2% in 2019, which naturally increases dependence abroad and exacerbates the import bill.

As far as the vegetable and fruit group is concerned, it is contrary to the previous groups. Based on the table's data, there have been high rates of self-sufficiency for the period (2015-2019) of at least 90%, while in 2019 they reached more than 100%. According to our study of this food group, Algeria does not seem to have a major problem in securing vegetables and fruits, since the national production system is satisfactory, but rather seeks to achieve a significant export ratio similar to the recent surge in potato production.

The meat has also known high self-sufficiency rates that have not fallen below 85%, which explains the abundance of animal output relative to meat. However, the productivity of meat group does not necessarily mean that it is easily accessible to the individual or Algerian consumer due to high prices, which, although essential to the consumer, affects its consumption, in the sense that the weak purchasing power of the consumer affects its consumption and makes the substance foody for the simple individual with limited income, despite the availability of production in terms of volume and quality.

Milk comes in second grade after cereals in terms of nutritional importance. It is also a strategic substance on which the State has focused so much attempting to achieve self-sufficiency. For years, efforts have been exerted in this domain through the increase in the rates of self-sufficiency of milk, as in 2017, where the rate reached 89.7%. In general, the rates at the milk level are acceptable, but not sufficient to meet the needs of the population and the reduction of the import bill.

3-2- Per capita of Agricultural Gross Domestic Product (GDP) in Algeria

The increase in per capita agricultural productivity is closely linked to the increase in the value of agricultural gross domestic product (GDP) as well as changes in the total population. At the Arab level, the average per capita

agricultural productivity was about \$310 per capita in 2021 compared with \$424 per capita worldwide (**Arab food security conditions 2021, 2022, p. 33**). The evolution of per capita agricultural productivity in Algeria can be shown in the following table:

Table 6: Evolution of per capita agricultural GDP in Algeria (2008-2021)
Unit: \$US

Year	2008	2009	2010	2011	2012	2013	2014
Agricultural per capita GDP	321.7	365.24	382.6	442.43	433.28	537.21	556.12
Year	2015	2016	2017	2018	2019	2020	2021
Agricultural per capita GDP	493.4	478.8	492.9	487.55	477.1	475.5	480.1

Source: Prepared by researchers using:

- *Arab Agricultural Statistics Annual Book, Arab Organization for Agricultural Development, 2011, 2013, 2015, vol. 31, 33, 35.*
- *Report of the Arab Organization for Agricultural Development, 2022, p. 34.*

The evolution of per capita agricultural gross product from year to year is clear on the table, recording in 2008 about US \$321.7, while in 2021 it was about US \$1,480, say an increase of 49.23%, yet, with its maximum value of US \$12,556 in 2014, due to the rise in agricultural gross product in recent years because of reforms.

However, per capita agricultural productivity remains weak when compared with other countries such as Saudi Arabia, for example, with US \$578 in 2021 (**Arab food security conditions 2021, 2022, p. 34**). Algeria is a country that relies on fuel rents. Most of the products it imports are intended for consumption or food products. Therefore, solutions must be sought to promote the agricultural sector in order to bring it into line with the constant increase in the population and thus eliminate food dependence abroad.

4- Irrigated Areas in Algeria

Algeria relies mainly on water from rainfall, which is particularly rare in the last two decades as a result of drought, and irregular distribution during the periods and seasons of the year, on the one hand, and uneven across the national territory, on the other hand. This is, of course, linked to climatic, natural, and geographical fluctuations. Algeria's agriculture is therefore of a rain-fed nature, depending on the amount of annual rainfall in irrigation, which benefits the country's most northern regions only. In 2014, it reached 4,252 million hectares, i.e. 50% of the area under cultivation (forest and pasture areas not accounted for). In view of the lack of some food crops, the State has been developing the area since independence. The implementation of the National Plan for Agricultural Development has witnessed a significant leap in irrigated areas, as shown in the following table:

Table 7: Evolution of irrigated areas in Algeria from 2000 to 2021 (Unit: 1 million hectares)

Year	2000	2002	2004	2007	2010	2012	2015	2016	2020	2021
Irrigated area	0.350	0.645	0.793	0.905	0.981	1.053	1.260	1.301	1.4	1.47

Source: Prepared by researchers using:

– O. Bessaoud, J.-P. Pellissier, J.-P. Rolland, W. Khechimi, 2019, p73.

The table shows the evolution of irrigated areas from 350000 hectares in 2000 to a total of 1.47 million hectares in 2021. The irrigated areas in Algeria are divided into two categories: large irrigated areas, medium and small irrigated areas.

5- Rationalization and Efficiency of The Use of Water Resources in Algerian Agriculture

The agricultural sector is one of the most water-consuming sectors as it is a pillar of food security. The sector alone consumes about 65.38% of Algeria's total available water resources, mainly because of low irrigation water prices and the dominance of traditional irrigation methods, such as traditional surface irrigation, which was being applied in more than 63% of the irrigated area in 2011. In addition to the unrestricted withdrawal of groundwater, the poor pricing applied to irrigation water that is not commensurate with its economic value in improving cost recovery and in alleviating the burden on the State's general budget. All these factors have led to the absence of incentive to conserve water and rationalize its use, and farmers' use of crops that consume large amounts of water, or to draw water for irrigation at rates far exceeding those required for crop cultivation, as well as the amount of water lost before reaching their users due to poor irrigation systems.

For a long time, Algerian agriculture has been using all surface irrigation methods, from a way that covers the entire surface of the earth, i.e., the immersion. Another way that water covers a part of the surface of the earth, as in the case of line irrigation. Surface irrigation is applied to all irrigated crops. This system has been inherited by the farmer for a long time since independence until the end of the 1990s. It has been spread by an estimated 80% to 90%, with an efficiency of only 40%.

As for modern irrigation systems, after the drought of the 1980s, serious thinking began to develop modern irrigation techniques (drip irrigation, spray irrigation, tank irrigation...). Drip irrigation is one of the most efficient and positive methods, helping to increase yields by up to 100% and saving water by 40% to 80%, in addition to the associated savings in fertilizers, pesticides and labour. The efficiency of modern irrigation in the large area is estimated at 65%, while its efficiency in the medium and small areas is estimated at 62% (**Kedouda, 2018, p. 205**).

With the beginning of the implementation of the national program for development, there has been a radical and major shift in the use of modern irrigation techniques. All the material resources necessary for the development of

irrigation techniques of all kinds have been made available. All agricultural and organizations and farmers have been encouraged to fully integrate into the success of this plan, which enables the country to expand the area of irrigation and to make rational use of water resources using sophisticated irrigation methods. Even at the level of surface irrigation, it has been improved through the renovation and rehabilitation of water transfer and distribution channels within fields to reduce water losses, since it has been difficult to persuade farmers to change traditional irrigation systems, which are less costly comparing to modern irrigation systems. The following figure shows the evolution of irrigated areas from 2000 to 2021 according to the irrigation pattern:

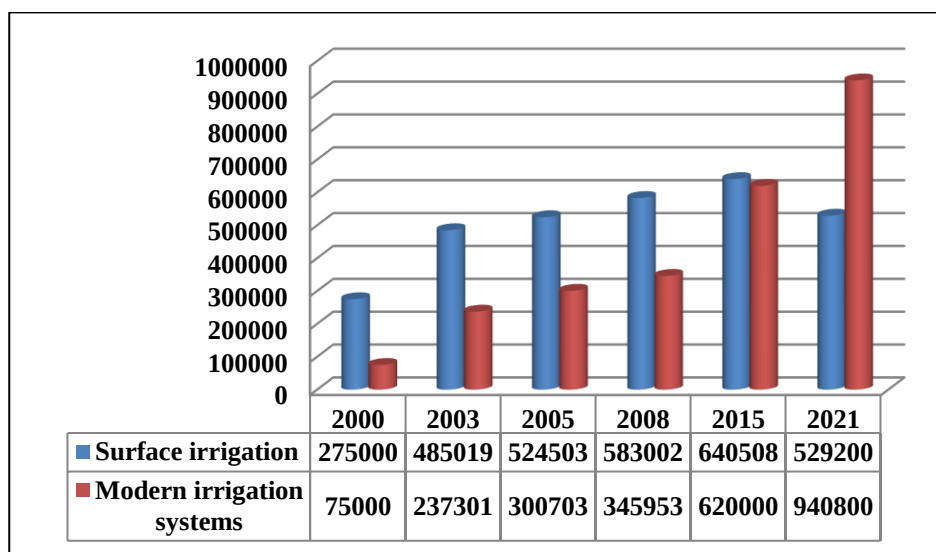


Figure 01: Evolution of Irrigation Systems in Algeria for the Period (2000-2021)

Source: Prepared by researchers using:

- Adel Kedouda, 2018, p. 194.
- *Hearing of the Minister of Agriculture and Rural Development of the Finance and Budget Committee of the National People's Assembly, 2022, accessed on: 10/07/2024.*

The figure shows that the proportion of irrigated land by water-saving methods has increased, while the proportion of traditionally irrigated land has declined from year to year, with areas dependent on modern irrigation prior to the National Program for the Development of Rural Agriculture (PNDP) amounting to 75000 hectares. In 2021 there were approximately 940800 hectares, or 21.42% and 64%, respectively, of the total irrigated land. This confirms that Algeria is changing its efforts to modernize irrigation techniques in order to increase the efficiency of water use in the irrigation sector, which presents the highest demand for water. The development in the use of modern techniques has therefore contributed to improving the efficiency of irrigation water use.

6- Conclusion

Algeria has made substantial investments and has mobilized substantial financial resources. It has coordinated large programs and projects to mobilize traditional and non-traditional water resources in order to meet current water needs and meet future water requirements. Nevertheless, the per capita freshwater level reached 263 m³ in 2019 and reflects absolute scarcity. It is a sign of a crisis in the water resources that Algeria is trying to address before they occur, not only to achieve water security but also to achieve food security, since they are priorities for security in Algeria and cannot be separated. Indeed, they are two sides of the same coin.

The various strategic products in Algeria, such as cereals in various forms, depend on rainfall. Since Algeria is part of global warming, climate change, drought and desertification, the rate of rainfall is declining from year to year. This affects the productivity of cereal agriculture. We therefore note that most food imports consist of this component. **This confirms the first hypothesis.**

Despite the efforts made by the Algerian State to improve and rationalize the use of water in the agricultural sector, through the construction of dams and the attempt to provide water-saving irrigation methods, Algeria continues to be dependent on food from abroad, particularly for the main foodstuffs (cereals, pulses, sugar, oils). etc., even classified as one of the six most imported countries for global wheat.

What is actually lacking is not the necessary water resources or tyres or even water under completed dams, but rather the lack of good management, the inefficient use of water resources and the lack of seriousness in dealing with the situation. What we notedaily are those leaks of water pipes on public roads during times of water delivery to homes and farms. Moreover, farmers do not treat water as a valuable resource, especially with little water pricing, and with no control over drilling wells and individual exploration of groundwater sources. **This affirms the second hypothesis.**

Water is not used efficiently in Algeria's agricultural sector, which has affected food security, particularly in strategic crops. In 2021, irrigation areas reached 1.47 million hectares. The efficiency of surface irrigation, which is 36% of the total irrigated area, is only 40%. The main reason for the use of traditional irrigation methods by farmers, such as immersion, is the loss of large amounts of water from irrigation systems due to their deteriorating status and the lack of periodic maintenance. Even the efficiency of modern irrigation remains somewhat weak, estimated at 65% in the large areas and 62% in the medium and small areas, due to the farmer's lack of awareness of the proper use of modern irrigation systems and their lack of commitment to the water supply of agricultural crops. **This validates the third hypothesis.**

Attempting to answer the problematic and test the hypotheses, the following conclusions were drawn:

- ❖ Algeria is moving rapidly towards absolute scarcity. After 1985, Algeria's freshwater per capita reached a threshold of only 500 m³/year to reach its lowest value in 2019 (263 m³/year), which means Algeria's entry into a state of absolute scarcity of water. The serious decline in Algeria's annual freshwater per capita compared to the ever-increasing population shows that Algeria is classified as a country below the water safety line;
- ❖ Algeria, among the water-poor countries due to prolonged recurrent droughts and a shortage of rainfall, has experienced severe water shortages in the last two years due to lack of rainfall. This has resulted in the cutting off of water from the population and the re-distribution of water programs, which are now set every two to three days by region and by source of supply. It resorted as well to water desalinization plants as a supplementary source of drinkable water in the north after the drought of most dams.
- ❖ The State's agricultural reforms have made some gains in terms of production. The agricultural support policy adopted by the State, particularly at the beginning of the third millennium, has contributed to the development of agricultural activities and increased investment in the agricultural sector. This has contributed to the improvement of agricultural productivity in both fauna and flora, but this has not met the basic objective of food security.
- ❖ Large-scale and essential food substances have not yet achieved self-sufficiency in Algeria, notably cereals, oil, sugar, and milk, given that food security inevitably passes through full self-sufficiency in basic substances.
- ❖ There has been a marked improvement in Algeria's overall food security index for the period (2019-2021), reflecting an improvement in Algeria's food security. Yet in 2022 there was a marked decline due to the spread of the Corona pandemic (Covid 19);
- ❖ Algeria has made significant progress in expanding its water supply in recent years, despite the country's lack of rainfall, from 350000 hectares in 2000 to a total of 1.47 million hectares in 2021.
- ❖ The effects of climate change on farming require Algeria to continuously develop appropriate irrigation systems in order to ensure national production, particularly strategic agriculture.

In the light of these findings, a number of recommendations can be suggested as follows:

- ❖ The need to promote a smart agriculture that reduces the consumption of water resources and optimizes the use of available ones, particularly rainwater harvesting and wastewater recycling.
- ❖ To continue reforms in the water resources sector, through institutional and legislative frameworks, and to open the way for domestic and foreign investors, particularly in the pipeline industry and water-saving instruments.
- ❖ Rationalizing water consumption in agriculture by establishing appropriate water pricing as an economic resource.
- ❖ Technical and financial support for farmers to use pumping and water-saving equipment, including sprinklers, rollers, pivot sprayers and drip water systems, for the proper use of these devices and the non-waste of

water resources, which will accelerate the pace of production and ensure the proper functioning of the food security.

- ❖ Reliance on desert farming following positive results, particularly in the south-eastern part of the country, where vast unused land and water are in the ground that can be exploited.
- ❖ Attention to scientific research to develop varieties of low-water-consuming plants and crops that can withstand drought, water salinization and soil.

7- References

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