

# Agri-food policy trends in Algeria: Selected explorations

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## Abstract

*This study addresses the urgent need to enhance food security in Algeria, exacerbated by nearby economic and geopolitical instabilities. It investigates six critical challenges, beginning with an overview of agricultural settings in Algeria. First, it questions the prioritization of strategic sectors, compelling a thorough reevaluation. Second, it highlights ongoing rural development issues, emphasizing insufficient investments in infrastructure. Third, it addresses price stability management by reconsidering the efficacy of different storage mechanisms. Fourth, the study examines agrarian structures, advocating for a meticulous evaluation to optimize land market efficiency. Fifth, it explores irrigation water management, questioning concerns of abundance and scarcity. Lastly, it confronts climate change challenges, emphasizing the need for more resilient agricultural practices. By analyzing these fundamental aspects, this study aspires to offer insights that can inform strategic policies and public interventions, ultimately contributing to the enhancement of Algerian food security in light of current and future challenges.*

**Keywords:** Food security, Food policy, Trends, Challenges, Agricultural development, Algeria.

## 1. Introduction

The geopolitical scene in the Mediterranean is undergoing instabilities that directly affect the agricultural sector in the region (Abis & Demurtas, 2023). Addressing food security in Algeria has become increasingly urgent, given the current alarming situation marked by economic deterioration and international political changes.

Although the government has prioritized food security in its public policy objectives since gaining independence in 1962, the academic discourse on this subject is gaining momentum. Traditionally, food security has been examined through historical analysis,<sup>1</sup> focusing on post-independence events and occasionally exploring further back into the colonial era. Recent studies, such as those by Bouzid *et al.* (2022), Bessaoud

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<sup>1</sup> In terms of historical and exploratory analysis, with a specific focus on underlying questions, noteworthy academic works include those by Henni (2009) and Bedrani (1982). These comprehensive studies extensively document various facets of Algerian agriculture.

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*et al.* (2019), Adair *et al.* (2022), and Sahali *et al.* (2016), contribute significantly to the evolving understanding of food security in this respect. Some studies adopt a sector-specific approach, as seen for example in the works of Makhoul *et al.* (2015) and Bekkis *et al.* (2022).

Primarily, it is imperative to acknowledge the well-established fact that the contemporary challenges a nation faces are strongly tied to its complex historical narrative. Disregarding this hinders comprehensive understanding. Secondly, honing in on a specific aspect of the broader issue proves to be the most effective approach for arriving at more accurate conclusions. Nevertheless, the current emphasis in this study diverges from comprehending the issue of food security in Algeria through these approaches. Instead, this study shifts the focus to the present, aiming to provide a concise summary of the predominant challenges today – a structured inventory resembling a to-do list. This pragmatic shift aims to stress the importance of providing a big picture of the prevailing major issues as formidable hurdles that must be addressed to enhance the country's food security situation.

Up until the tumultuous events of the bloody decade in the 1990s, successive governments prioritized food security as an objective within their developmental plans, subject to periodic evaluations. However, it is evident, based on Swearingen (1992) estimation, that the intended objective was not realized. Post this period, Algeria embarked on a policy initiative geared towards enhancing national food security, with a focus on the development of specific priority agricultural sectors and land utilization (Bessaoud *et al.*, 2019). What can we say again about the results in terms of food security dimensions? Assessing the outcomes in terms of food security, it is apparent that considerable work and effort are still required across various domains, as highlighted in studies by Bouzid *et al.* (2022), Daoudi & Bouzid (2020), particu-

larly concerning both quantitative and qualitative aspects.

This study aims to present, albeit not exhaustively or in exhaustive detail, some significant contemporary challenges facing Algerian agriculture nowadays with the goal of enhancing food security. The identified issues encompass rural development concern, strategic sectors priorities, farm prices stability, agrarian structures, irrigation water resources, and the climate change. The approach adopted here is straightforward, simple, and succinct. Each point directly addresses a specific problem, followed by a solution for consideration, at least at the conceptual level. This deliberately sidesteps the conventional complexities associated with a nation's food security, with the hope that these concise reflections will provide a foundational framework for more detailed elaborations on each covered aspect.

## 2. Algerian agriculture: An overview

At first, it seems useful to get the big picture on the Algerian agriculture in terms of some key aggregates. Table 1 displays the key aggregates of the Algerian agriculture in the last two decades, namely 2000 and 2022. These figures are obtained mainly from FAO (2023) statistics<sup>2</sup>.

Over the past two decades, there has been a significant shift in population distribution. The urban population has almost doubled, increasing by 79.6% from 18.68 million in 2000 to 33.57 million in 2022, while the rural population has decreased by 9.4% from 12.49 million to 11.32 million. However, the number of individuals employed<sup>3</sup> in agriculture has risen by 127.3% from 1.28 million in 2000 to 2.91 million in 2022. This indicates a growing reliance on agriculture for employment, driven by the need to sustain food production for a growing population despite urbanization trends.

The agrifood trade figures reveal a concerning trend: agrifood exports as a percentage of

<sup>2</sup> Official website <https://fao.org/faostat/en/#data>.

<sup>3</sup> Data on employment in agriculture are provided from The Arab Organization for Agricultural Development (AOAD, 2023).

Table 1 - Some key aggregates of the Algerian agriculture in 2000 and 2022

<i>Aggregates</i>		<i>2000</i>	<i>2022</i>
Population	Urban	18.68 millions	33.57 millions
	Rural	12.49 millions	11.32 millions
	Agricultural Labor	1.28 millions	2.91 millions
Agrifood exports (%) of total exports		1.14%	0.82%
Agrifood imports (%) of total imports		21.07%	28.90%
Agricultural Lands (ha)	Arable land	7.66 millions	7.53 millions
	Land equipped for irrigation	0.60 millions	1.38 millions
Crop share in agricultural production value (%)		48.33%	68.38%
Livestock share in agricultural production value (%)		51.67%	31.62%
Value added (agriculture, forestry and fishing)		4.6 million USD	24.4 million USD

total exports have decreased by 0.82%, while agrifood imports have risen by 28.90%, highlighting a growing dependency on imported food and posing challenges for food security. Additionally, the area of arable land has slightly decreased by 1.7%, but the land equipped for irrigation has more than doubled, reflecting efforts to improve productivity through better water management. The composition of agricultural production value has shifted significantly, with the crop share increasing by 41.5% and the livestock share decreasing by 38.8%, indicating a strategic focus on crop cultivation.

From this analysis, the big picture can display these major challenges and concerns: the dramatic increase in the urban population, coupled with the decrease in the rural population, underscores a strong urbanization trend. This presents a challenge for maintaining agricultural productivity in rural areas, as it may result in a shrinking rural workforce. Despite this trend, there has been a substantial increase in the number of individuals employed in agriculture. This suggests that agriculture remains a vital source of employment for a significant portion of the population, highlighting its importance in sustaining food production for the growing population (45.6 million in 2023). The agrifood trade figures indicate also a concerning trend. The percentage of agrifood exports relative to total exports has decreased by 28.1%,

while agrifood imports as a percentage of total imports have risen by 37.1%. This growing dependency on imported food products poses a significant challenge for food security and self-sufficiency.

### 3. Strategic sectors choice: Reevaluating priorities

The strategic sectors chosen in Algerian public policies have consistently reflected the prevailing patterns of large-scale food consumption. It is noteworthy that, despite the absence of a comprehensive list of these products or sectors within regulatory frameworks, the selection has consistently prioritized public support for fundamental sectors. Among these, the primary focus has been on durum wheat, soft wheat, potatoes, and milk. This strategic choice is underpinned by the substantial influence these particular products exert on the daily dietary preferences of the typical Algerian consumer. The decision to prioritize these sectors aligns with the recognition of their significant weight in the typical Algerian daily basket of goods. These sectors are heavily subsidized, reflecting a policy orientation towards output support to ensure these essential goods are affordable for the population (Makhlouf *et al.*, 2015).

The objective here is not to challenge the existing choices, which are indeed legitimate given

the strategic importance of the selected sectors. Rather, the focus is on reevaluating priorities and considering an alternative perspective. This involves incorporating sectors based on their alignment with production potential and local heritage. In essence, the aim is to emphasize, as a priority, sectors that exhibit high production potential, align with the country's inherent vocation, and are naturally and historically adapted to Algeria's diverse bioclimatic conditions. Particularly when considering the Northern region of the country, priority sectors should include the vineyard, dates, orange, olive, fig, and apricot for fruit cultivation. Likewise, for vegetable production, emphasis should be placed on crops such as artichoke and garlic. In terms of livestock breeding, sheep meat emerges as another sector deserving high priority. Moreover, the ongoing conversion toward Saharan agriculture will pose other options. This shift in perspective recognizes the importance of aligning agricultural priorities not just with current large-scale consumption patterns but also with the innate potential of the land and the preservation of local heritage. By focusing on sectors that inherently thrive in Algeria's bioclimatic conditions, this approach aims to optimize production efficiency while respecting the historical and environmental contexts of the country. It signifies a different approach that considers the natural strengths of the region and seeks to harmonize agricultural priorities with the rich heritage and ecological characteristics of the country.

Compiling a pertinent, comprehensive, and inclusive list of strategic sectors by the government is key factor for addressing the population's food requirements at a reduced cost. The solution lies not in downstream price support but, more effectively, in upstream support for producers. The overarching goal of this strategic choice should be the preservation of the national heritage and ensuring the food sovereignty of the country. Central to this objective is the preservation of gene banks, which can serve as a lever for the sustainable development of Algerian agriculture.

#### **4. Rural development issue: Still insufficient infrastructure**

The Algerian government's expenditure on agricultural development for rural areas has significantly increased from 17.1 million USD in 2001 to 60.6 million USD in 2022. While this level of investment is comparable to neighboring countries such as Morocco, Tunisia, and Egypt, it remains substantially lower than in countries like France (725.1 million USD in 2021), Spain (359.3 million USD in 2021), and Turkey (220 million USD in 2022)<sup>4</sup>. This disparity highlights primarily the ongoing challenges of underinvestment in rural infrastructure in Algeria.

In the early 2000s, with the return of social peace, increased oil revenues, and the end of structural adjustment programs, the Algerian government initiated several agricultural policies that took into consideration the rural sphere. The National Agricultural Development Plan (PNDA) was launched, and in 2002, it was expanded to include the rural dimension, becoming the National Plan for Agricultural and Rural Development (PNDAR). A National Strategy for Sustainable Rural Development (SNDRD) was developed by the government for the period 2005-2015, aiming to promote economic activities and develop natural and human resources to reduce rural exodus, especially from mountainous areas, by involving local communities in regional projects (Bessaoud, 2006; Souidi & Bessaoud, 2011).

Several actions have been taken for the benefit of a rural population approaching 11 million inhabitants (FAO, 2023), characterized by low agricultural income and high unemployment rate. Key actions focused on improving food security for rural households, particularly in deprived areas, and promoting rural professions to support development activities. The PNDAR relied on implementing a participatory policy and an investment support mechanism to generate and supervise demand from farmers and investors. A concrete example of this approach is the Integrated Rural Development Proxim-

<sup>4</sup> According to FAO (2023) statistics.

ity Project (PPDRI), which was strengthened by the Agricultural and Rural Renewal Policy (PRAR) in 2008. Financial resources, supported by multiple funds (FNDA<sup>5</sup>, FNRPA<sup>6</sup>, FLDDPS<sup>7</sup>, FDRMVT<sup>8</sup> and FPZPP<sup>9</sup>), over the period 2000 to 2021.

Adair *et al.* (2022) emphasize that public spending was distributed as follows: 46% for investment in agricultural businesses, 31% for regulation, and 16% for rural development, desertification, small farms, and livestock. Additional financial resources, supported by the Ministry of Agriculture and Rural Development (MADR) operating and equipment budget. It is also important to point out that the Algerian government has decided to close the support funds (FNDA and FNDR<sup>10</sup>) agriculture<sup>11</sup>, and has been committed to budgetary programming from January 2023, which is focused on results in order to have more transparency in public finances.

All agricultural support measures have been oriented towards expanding and conserving soils, acquiring livestock, transportation logistics, specialized livestock equipment, irrigation equipment, and equipment for rural artisanal production linked to agricultural activity. Ambitious public programs such as the National Reforestation Plan (PNR) aimed at promoting viable rural livelihoods, enabling rural populations to improve their income and living conditions. By the end of 2021, the Ministry of Agriculture reported achieving over 840,000 hectares of reforestation, targeting over 1 million hectares.

In the last decade, there has been a growing trend toward Saharan agriculture. Recognizing the potential of these vast, arid regions, the government has intensified its efforts to develop this sector. In 2024, the Ministry of Agriculture and

Rural Development identified a real estate basin with a total area of 163,999 hectares across thirty Saharan perimeters to attract investors to the Saharan regions. This initiative underscores the strategic shift toward harnessing the agricultural potential of the Sahara.

Several persistent challenges in rural development persist. The first major challenge is insufficient infrastructure, which hampers efficient agricultural production and distribution. Inadequate roads, irrigation systems, and storage facilities limit the ability to bring products to market and reduce overall productivity. Secondly, there is a need for increased investment in modern agricultural technologies. Many rural areas still rely on traditional, less efficient farming methods. Introducing advanced technologies can significantly boost productivity and sustainability. Thirdly, access to finance remains a significant barrier for many rural farmers. Without adequate financial resources, farmers cannot invest in necessary inputs, equipment, or infrastructure improvements. Improving access to credit and financial services is crucial for empowering rural farmers and supporting their development (Ibrahim, 2023; Capone *et al.*, 2021).

## 5. Price stability: It would be better to manage instability

The stability of food prices is a critical dimension of a country's food security, directly impacting accessibility and occasionally precipitating social and political unrest (Grafton *et al.*, 2015; Bellemare, 2015). Raising food prices, particularly, adversely affect households, disproportionately affecting the economically vulnerable (Swinnen & Squicciarini, 2012). Notably,

<sup>5</sup> *Fonds National de Développement Agricole* (Ex. FNDIA), in english: National Agricultural Development Fund.

<sup>6</sup> *Fonds National de Régulation de la Production Nationale* (National Fund for the Regulation of National Production).

<sup>7</sup> *Fonds de Lutte contre la Désertification et de Développement Pastoral de la Steppe* (Fund for Combating Desertification and Pastoral Development of the Steppe).

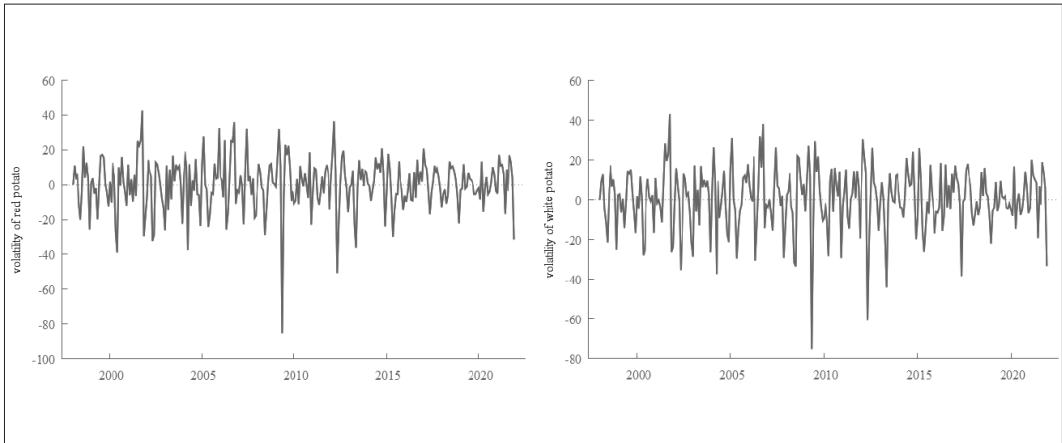
<sup>8</sup> *Fonds de Développement Rural et de Mise en Valeur des Terres par Concession* (Rural Development and Land Development Fund by Concession).

<sup>9</sup> *Fonds de Promotion de la Santé Animale et de la Protection Phytosanitaire* (Fund for the Promotion of Animal Health and Phytosanitary Protection).

<sup>10</sup> *Fonds National de Développement Rural* (National Fund for Rural Development).

<sup>11</sup> Article 167 of Law No. 20-16 of December 31, 2020 relating to the finance law for 2021.

Figure 1 - Prices volatility of red and white potatoes in Algeria.



it is revealed that the instability of agricultural prices represents a fundamental characteristic inherent in agricultural markets, as elucidated by Gérard *et al.* (2008) and Boussard (2010). Comprehensive documentation exists regarding research into the causes and implications of agricultural price instability. The monumental studies conducted by Gérard *et al.* (2008, 2013) and Boussard (2017) significantly contribute to the understanding of this subject. Nevertheless, effectively managing this inherent instability remains a major challenge for public policy, particularly for less developed countries. The mechanisms employed for addressing this challenge involve both public and private storage systems.

The Algerian government has implemented subsidy and support programs for farmers, primarily aimed at enhancing productivity. Notably, some of these programs are specifically designed to alleviate consumer prices. Since gaining independence, consumer price support has been directly provided and has impacted various food products considered strategically important. Presently, consumer price support primarily centers around wheat and milk. Government intervention maintains a direct upstream presence in these two sectors, but its influence extends indirectly down-

stream to impact consumer prices. Direct intervention by public authorities in agri-food prices is notably constrained, primarily facilitated through the public storage mechanism for large-scale consumed products, predominantly potatoes and garlic.

To examine the effectiveness of the public storage mechanism in terms of price stabilization, consider the case of potatoes. Monthly prices for both red and white varieties were obtained<sup>12</sup> to eliminate nuances. The simplest measure of price volatility was then calculated using the following formula:

$$p_t = 100 \times [\ln(P_t) - \ln(P_{t-1})]$$

This formula<sup>13</sup> provides a straightforward assessment of price volatility over time, allowing an analysis of the effectiveness of the public storage mechanism in mitigating price fluctuations. The graphical representation of the outcomes in both instances is depicted in the Figure 1. Knowing that the initiation of public storage regulation mechanisms in 2010, it is discernible that the magnitude of price fluctuations has remained nearly constant, with minimal mitigation observed. This raises concerns about the efficacy of public storage mechanisms, warranting a

<sup>12</sup> Data on monthly prices of both varieties are obtained from CEIC data (<https://www.ceicdata.com/>).

<sup>13</sup> Where  $p_t$  is for price volatility index at time  $t$ ,  $P_t$  for price at  $t$ , and  $P_{t-1}$  for price in last period  $t - 1$ .

Table 2 - The evolution of farm landholdings by sizes.

Decades	% <10 ha	% [10-50 ha]	% [50-100 ha]	% >100 ha
1970s	79,21	18,93	1,37	0,48
1980s	88,02	11,31	0,59	0,09
1990s	79,21	18,93	1,37	0,48
2000s	59,26	30,63	8,07	2,04

more precise quantification through the application of more sophisticated analytical methods.

The prevailing challenge in managing agricultural prices, as is the case with the majority of agricultural commodities, lies in mitigating the impact of seasonality on these prices. In the context of this country, a comprehensive investigation into the volatility of agricultural prices is notably absent. However, a preliminary examination of the price series for most agricultural products unveils existing regularities in the overall price behavior. Consequently, conducting thorough studies on the behavioral patterns of agricultural prices becomes imperative, aiming to assess their controllability and address seasonality on an annual basis, among other timeframes. Moreover, a detailed comparative analysis between public and private storage efficiency is essential to gauge the effectiveness of these storage mechanisms.

## 6. Agrarian structures: Efficiency in question

The impact of agrarian institutions on agricultural sector performance, particularly in terms of productivity, is direct and significant, posing a fundamental concern for food security. Certainly, the issue of agricultural land in Algeria is intimately connected to its historical and political context. As highlighted by Tatar (2013), discussing land ownership and accessibility invokes a comprehensive historical process wherein land has been a central concern, subject to political and ideological choices during key periods in Algerian history. However, amidst the challeng-

es facing Algerian agriculture nowadays, the current imperative is to embark on an investigation into existing agrarian structures, placing a central focus on their economic efficiency. Table 2 shows the evolution of farm landholdings in Algeria over several decades<sup>14</sup>. In the 1970s, small farms (<10 ha) made up 79.21% of all farms, but this increased dramatically to 88.02% in the 1980s due to land redistribution policies. By the 1990s, the distribution returned to the 1970s levels. However, in the 2000s, there was a significant shift: small farms decreased to 59.26%, while medium-sized and larger farms increased.

The evolution of farm sizes highlights several challenges. The fluctuating policies have led to instability in landholding patterns, making it difficult for farmers to plan long-term investments. Also, the increasing concentration of land in medium and larger farms raise issues related to access to land for small farmers and new entrants, exacerbating inequalities in the agricultural sector. Integrating these landholdings into a functional land market remains persistent public policy challenge, as legal and bureaucratic hurdles often hinder efficient land transactions and consolidation efforts.

However, economic theory asserts that there is no universally optimal structure applicable to all contexts when it comes to agrarian institutions. Beyond direct forms of farmland exploitation, it is crucial and pressing to judiciously inspect what is referred to as “*Faire valoir indirect.*” The studies conducted by Bessaoud (2020) and Colin & Daoudi (2020) meticulously detail the insights into this aspect within the context of Al-

<sup>14</sup> The figures included in this table came from secondary data provided by Bedrani (1982), Henni (2009) and Benachenhou (2009).

Table 3 - Distribution of farmland area by type

<i>Types of farmlands</i>	<i>Area (ha)</i>	<i>(%) SAT*</i>
EAC and EAI	2.33 millions	5.30%
Pilot Farms**	146,000	0.33%
Private Farms	6 millions	13.64%
Private Farms (APFA)	167,000	0.38%
Concession Farms	150,000	0.34%
Private Agro-pastoral Farms ( <i>Arch Rangelands</i> )	More than 30 millions	More than 68%

Source: MADR (2022).

\* It represents the total agricultural used area. It is estimated at more than 43 million hectares (MADR, 2022).

\*\* The total number of pilot farms is 174 farms. The name of the pilot farm was changed to Agricultural Production Unit (UAP) and they were attached to a new Strategic Crop Development Company (EPE / Spa DCAS) in accordance with the guidelines of the high authorities of the State. The new company EPE / Spa DCAS will include in its portfolio, 4 subsidiaries: EPE / Spa Perennial Crops, EPE / Spa Oilseeds, EPE / Spa Seeds and EPE / Spa Dried Vegetables.

gerian farmlands. On the other hand, an in-depth examination of the size-productivity relationship of farms should be conducted using more sophisticated methodologies, as demonstrated by the study conducted by Benmehaia (2022). Additionally, the flexibility of such structures concerning the responsiveness for prices, as explored by Benmehaia (2021), warrants more careful attention. Given the limited number of studies on these aspects, the initiation of investigations into the efficiency of agrarian structures in Algeria will be beneficial for informing public policy and implementing regulations that effectively enhance productivity.

As agricultural land in Algeria has undergone significant upheaval, particularly since the economic liberalization of the early 1990s, the government has implemented several legal and regulatory mechanisms to address land tenure issues. Several successive regulation laws have been adopted by, including: *Access to Land Ownership*<sup>15</sup> (1983): Encourages the development of

agricultural land and sets conditions for transferring ownership of private agricultural land and land intended for agriculture. *1989 Constitution*: Provided a new framework for agricultural land issues, encouraging private ownership of land and limiting government intervention in land matters, differing from the frameworks of 1963 and 1976. *Land Orientation Law*<sup>16</sup> (1990): Subdivides land assets by class: forest land, alfa lands, rangeland, agricultural land, Saharan land, and urbanized and urbanizable land. *Agricultural Orientation Law*<sup>17</sup> (2008): Establishes legal provisions for better exploitation of agricultural land and facilitates the transfer of usage rights. *Law on the Exploitation of State-Owned Private Agricultural Land*<sup>18</sup> (2010): Converts the right of perpetual enjoyment into the right of concession for the exploitation of State-owned private agricultural land and introduces a new type of private-private partnership to encourage investment in the agricultural sector. Table 3 displays the current distribution of farmland area by type in Algeria.

<sup>15</sup> *Accession à la propriété foncière agricole* (Access to Agricultural Land Ownership) via the Law 83-18 of 08/13/1983.

<sup>16</sup> Law No. 90-25 of November 18, 1990 on land orientation.

<sup>17</sup> Law No. 08-16 of August 3, 2008 on agricultural orientation.

<sup>18</sup> Law No. 10-03 of August 15, 2010 establishing the conditions and methods of exploitation of agricultural land in the private domain of the State.



The distribution of farmland area in Algeria, as shown in Table 3, reveals significant disparities among different types of farmlands. Private agro-pastoral farms, particularly those in Arch Rangelands, dominate with over 30 million hectares, accounting for more than 68% of the total agricultural area. This is followed by private farms, which cover 6 million hectares (13.64%). EAC (agricultural collective farms) and EAI (agricultural individual farms) occupy 2.33 million hectares, representing 5.30% of the total. Pilot farms, private farms under the APFA program, and concession farms collectively cover a much smaller portion, with 146,000 hectares (0.33%), 167,000 hectares (0.38%), and 150,000 hectares (0.34%), respectively.

It is important to note that a significant number of farms are untitled and unregistered, constituting a serious obstacle to agricultural development. This includes issues like lack of equipment and limited access to agricultural loans and credits. To address this, the government issued a circular<sup>19</sup> in 2018 to conduct a census of farmers without titles. The usable agricultural area (UAA) has been limited to over 8 million hectares since the 2000s. The UAA increased from 8.22 million ha in 2000 to 8.6 million ha in 2021, a minor increase of +4.55%. This increase is attributed to the development policies initiated by the government. Among these 8 million ha, over 4 million are herbaceous crops, including more than 3 million ha of cereals and over 3 million ha of fallow land, mainly in arid and semi-arid regions. This represents 0.19 ha per inhabitant, one of the lowest ratios in the Mediterranean (0.45 in Tunisia and 0.24 in Morocco). The irrigated area continues to increase, from 350,000 ha in 2000 to 1,489,988 ha in 2022, now representing 17% of the UAA. This quantitative evolution of 1.13

million ha of irrigated land, averaging 52 000 ha per year, was accompanied by efforts to develop water-saving irrigation systems (MADR, 2022).

## 7. Water resources: Saving water issue

The abundance of water resources in Algeria, particularly designated for the irrigation sector, have been comprehensively documented, as evidenced by the works of Hammani *et al.* (2009), Kherbache (2020), Zwartveen *et al.* (2021), and Oulmane *et al.* (2022), which illuminate the extensive nature of this subject. However, it is somewhat perplexing to encounter academic expressions of concern regarding the scarcity of irrigation water, especially at the aggregate level, when fundamental facts challenge these notions of rationalization in a specific context. While such concerns may be valid for isolated regions with limited water resources, an analysis at the aggregate level could offer a different perspective.

The simple demonstration begins by providing key factual data related to Algeria's agricultural landscape. The total agricultural used area is quantified at 43 million hectares, with the cultivated area covering 8.5 million hectares, and the irrigated area specifically amounting to 1.3 million hectares<sup>20</sup>. Additionally, the analysis will then focus only on the Albien Nappe, a significant underground (nonrenewable) water reservoir, which is estimated to contain 50,000 billion cubic meters<sup>21</sup>. Algeria's share of this resource is approximately 70%<sup>22</sup>, translating to roughly 35,000 billion cubic meters. To further contextualize these figures, the demonstration assumes an average annual water consumption of 7 billion cubic meters within the agricultural sector<sup>23</sup>. Utilizing this approximation, it is calculated that to irrigate the 1.3 million hectares,

<sup>19</sup> Interministerial Circular No. 750 of July 18, 2018.

<sup>20</sup> Figures provided by FAO (2023).

<sup>21</sup> These Albien estimates are sourced from UNESCO (1972). It is essential to note that while the specific reservoir example used here pertains to Albien, the cumulative water resources in Algeria can be substituted without substantially affecting the drawn conclusions.

<sup>22</sup> Estimation of the UNESCO (1972).

<sup>23</sup> Estimation provided by Boudjadja *et al.* (2003). It is crucial to acknowledge that, specifically, the estimation of natural irrigation water potentialities in Algeria was reported at 18 billion m<sup>3</sup> per year in 2013, as per Mozas & Ghosn (2013). Importantly, substituting this particular estimation with alternative figures for irrigation water quantities would not significantly alter the conclusions.

a consumption of 7 billion cubic meters is necessary. Extrapolating this requirement to cover the entire cultivated area of 8.5 million hectares, the total consumption would escalate to almost 43 billion cubic meters. The ensuing revelation is rather surprising: relying solely on groundwater from the Albién aquifer, without factoring in other water sources like surface water, other aquifers regeneration, and additional irrigation water types<sup>24</sup>, would necessitate a staggering 814 years to irrigate the entire cultivated land, constituting 20.5% of the used agricultural area.

This striking result challenges the conventional narrative of water scarcity, particularly at an aggregate level. The demonstration highlights that, given the abundance of the Albién aquifer, the issue of saving water becomes inconsequential in this specific scenario. The longevity of available water resources is emphasized by the estimation that, assuming a century encompasses three generations, Algeria's water reserves would be sufficient for the next 25 generations. While acknowledging the theoretical nature of this result, it provides an insightful approximation of the immense potential within Algeria's irrigation water resources. This demonstration prompts a reconsideration of water management policies, suggesting that the focus should be on efficient utilization rather than strict conservation in a context where the availability of water resources far exceeds current consumption demands.

The efficiency of irrigation water utilization poses a crucial inquiry for both public authorities and academics when considered on a broader scale. However, at a more granular level, such as individual farms or oases, the primary concern shifts towards the expenses associated with implementing water-saving technologies. Notable studies by Belaidi *et al.* (2022) and Oulmane *et al.* (2019) serve as recent contributions to this aspect. In the context of enhancing the sustainability of Algerian agriculture, the central challenge revolves around intervention strategies addressing extraction and distribution costs.

The recommended solution advocates directing support primarily towards mitigating extraction expenses, with secondary attention given to the costs associated with adopting water-saving technologies. The inherent abundance of water resources in the region underscores the importance of public policy orientation towards managing extraction costs and the necessary infrastructural facilities. This strategic approach aims to maximize the effectiveness of water resource utilization while maintaining economic viability for agricultural stakeholders.

## 8. Climate change policies: Challenges towards resilience

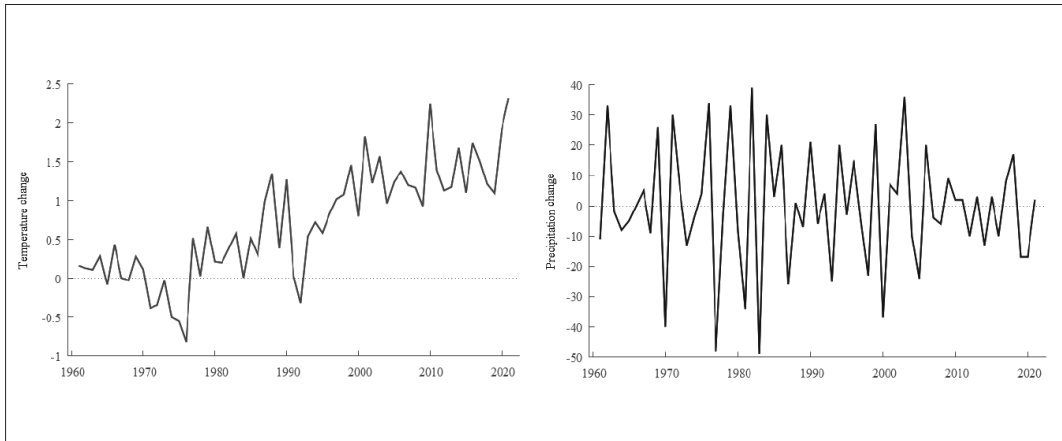
Climate change poses challenges worldwide, with agriculture standing out as a primary concern. In the context of Algeria, a straightforward examination of basic climate indicators, such as changes in temperature and precipitation<sup>25</sup> (as indicated by the two plots in Figure 2), reveals a discernible shift over the past two decades. The climate has exhibited a trend toward increased heat and reduced precipitation, contributing to an overall pattern of heightened aridity and greater climatic variability and uncertainty. Extensive documentation by various researchers, including studies by Boudiaf *et al.* (2020), Benmehaia *et al.* (2020), Bouabdelli *et al.* (2022), Shehzad *et al.* (2022), Chaouachi & Balsalobre-Lorente (2022), Bouregaa (2023), and Benmehaia (2023), has provided broad insights into the evolution and impact of the two primary components of climate – temperature and precipitation – on Algerian agriculture.

Effective mitigation of the challenges posed by climate change necessitates global-scale interventions. However, at the regional level, individuals are compelled to acknowledge this prevailing trend, albeit with the fervent hope that its consequences will not escalate into catastrophic scenarios. In the face of this inevitability, local efforts become centered on proactive adaptation

<sup>24</sup> These factors are of utmost importance for other practical and realistic considerations.

<sup>25</sup> Data provided from Trading Economics website (<https://tradingeconomics.com/algeria>). The two variables are expressed in terms of first differences to capture the annual changes in the data.

Figure 2 - Evolution of changes in temperature and precipitation in Algeria.



strategies, emphasizing the urgent need for communities to develop and implement measures that enhance resilience in the wake of evolving climatic conditions. Recent studies investigating the climate-agriculture interactions in Algeria have yielded valuable conceptual and practical recommendations. These findings, articulated by Bessaoud *et al.* (2019), Adair *et al.* (2022), Bouzid *et al.* (2022), Bouznit *et al.* (2022), Bouznit & Aïssaoui (2023), Benmehaia (2023), offer pertinent guidance for policymakers and stakeholders grappling with the impacts of climate change on the agricultural landscape.

At the Algerian public policy level, since the 2000s, the government has strategically prioritized climate variations. Public institutions have been established as part of the national climate change strategy. The National Climate Change Agency, created in 2005, aims to integrate climate change considerations into all development plans and contribute to environmental protection<sup>26</sup>. This agency is supported by an orientation council<sup>27</sup> and a scientific council<sup>28</sup>, both comprising representatives from ministerial departments and experts in climate change.

Several government programs and action plans have been adopted in this context. The National Forestry Strategy for 2035 includes measures to conserve natural resources in forests, alfa lands, and other areas, restore affected ecosystems, and strengthen their resilience to climate change and drought (Safar-Zitoun, 2019). The National Climate Plan (PNC), developed in 2019 in cooperation with GIZ<sup>29</sup>, complements previous plans like the National Action Plan for the Environment and Sustainable Development (PNAEDD), the National Strategy and Action Plan for Biodiversity (SPANB), and the National Strategy for Integrated Waste Management (SNGID) by 2035. The PNC aims to develop future plans in the short (2020-2025) and medium term (2025-2035) to reduce climate change effects, including 155 measures to adapt to the climate situation, with 76 measures for mitigation (Prime Ministry, 2019).

Additionally, the Algeria National Drought Plan (2019), in collaboration with the UN through the Convention to Combat Desertification (UNCCD), aims to strengthen the resilience of communities and ecosystems to drought. The

<sup>26</sup> Art. 4 of Executive Decree No. 05-375 of September 26, 2005 establishing the National Climate Change Agency (ANCC), setting out its missions and defining the terms of its organization and operation.

<sup>27</sup> Order of December 5, 2023 appointing the members of the ANCC agency's steering committee.

<sup>28</sup> Order of April 18, 2019 designating the members of the scientific council of the ANCC agency.

<sup>29</sup> The *Deutsche Gesellschaft für Internationale Zusammenarbeit* (GIZ) GmbH is a German federal enterprise that promotes international cooperation for sustainable development.

National Action Plan to Combat Desertification<sup>30</sup> (PAN-LCD) initiated 12 actions, such as mitigating drought effects, adapting rangelands, protecting watersheds, promoting sustainable mountain development, eliminating poverty, and improving living conditions.

## 9. Conclusion

This study provided a selective examination of the pressing issues affecting the agricultural sector in Algeria, particularly on the aspect of food security. The geopolitical instabilities in the Mediterranean and internal economic challenges highlight the urgent need for effective strategies to enhance food security in Algeria. Despite the government's longstanding prioritization of this goal, significant gaps remain, necessitating a shift in focus towards current challenges and practical solutions.

The study identifies key areas of concern, starting with the strategic prioritization of agricultural sectors. Traditional staples like wheat and milk have dominated public support due to their importance in the Algerian diet. However, a reevaluation of these priorities to include crops and livestock better suited to the country's diverse bioclimatic conditions could enhance sustainability. Moreover, the rural development, a critical component of agricultural policy, remains hampered by insufficient infrastructure. Despite increased investment, the disparity in funding compared to other countries highlights ongoing challenges. Initiatives like the PNDAR and various participatory policies have aimed to address these issues, but the rural population continues to face significant obstacles. Enhancing infrastructure, modernizing farming techniques, and improving access to finance are essential steps to support rural farmers and boost agricultural productivity.

Price stability is another crucial aspect examined. The inherent volatility of agricultural prices poses a significant challenge, with current public storage mechanisms proving inadequate in mit-

igating fluctuations. Effective management of price instability, particularly through a detailed analysis of behavioral patterns and comparative studies of public versus private storage efficiency, is necessary. Addressing seasonality and implementing robust storage solutions can help stabilize food prices and ensure greater food security. Subsequently, the study addresses the efficiency of agrarian structures and water resource management. Legal reforms have been implemented to facilitate land ownership and use, but many farms remain untitled and unregistered, hindering development. On the water resources, it seems that the expansion of irrigated areas and the abundance of water resources, particularly from the national reserves, offer opportunities for improved water management. However, efficient utilization and addressing extraction costs are critical to maximizing these resources. Finally, the study highlights also the importance of climate change policies, with the government prioritizing resilience through various strategic plans, regulations and action programs.

It is important to note that the enumerated conclusions are not exhaustive or comprehensive. Instead, they serve as a concise foundation, intended to spark more in-depth investigations into each addressed aspect. The hope is that these succinct reflections will act as a catalyst for detailed analyses and, ultimately, contribute to comprehensive solutions for enhancing Algerian food security.

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<sup>30</sup> The development of the National Action Plan (PAN) and its validation on December 14, 2003 represent an important institutional measure for Algeria.

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