The role of steppe and desert agriculture in enhancing food security in Algeria

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Received: 21/12/2025 **Accepted: 13/02/2026** **Published:20/10/2026**

Abstract

This study aims to analyze the role of agriculture in steppe and desert regions in enhancing food security, focusing on the Algerian context, with the goal of understanding the challenges and opportunities available in these areas. Desert agriculture demonstrates its capacity to transform arid environments into platforms for sustainable food production by effectively utilizing limited resources: water, soil, energy, and innovation in the face of climate change and water scarcity. This type of agriculture is a key contributor to food security by increasing and diversifying local production and providing more stable livelihoods for desert populations and the general population of Algeria.

This study was conducted using a combination of research methods, including statistical data and expert opinions in agriculture and rural development in Algeria.

The study's findings point to multiple challenges facing agricultural development in steppe and desert regions, but also reveal new opportunities to enhance agricultural productivity and promote sustainability in these harsh environments.

This study highlights the importance of understanding and analyzing the challenges and opportunities in agricultural development in steppe and desert regions, which will contribute to guiding agricultural policies and programs to achieve food security in Algeria.

Keywords: Agricultural, Arid areas, Desert areas, Algeria, Food security.

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1. Introduction

Steppe and desert agriculture is a cornerstone of Algeria's national strategy for enhancing food security, given the significant natural and human potential of these areas despite harsh climatic challenges. The steppe and desert regions have become promising areas for agricultural expansion thanks to the fertility of some of their basins, the availability of vast arable lands, and the government's adoption of support programs aimed at developing large-scale farming and livestock breeding. With the development of modern irrigation and plant protection technologies, desert agriculture has emerged as a strategic alternative for achieving food self-sufficiency in the production of cereals, vegetables, fruits, and even fodder. Steppe agriculture also contributes to supporting livestock and providing essential products such as milk and meat, making it a pivotal element in the national food security system. Thus, these agricultural regions represent a promising future, capable of strengthening Algeria's ability to guarantee its food supply and achieve sustainable agricultural development.

One of the vital issues facing Algeria is agricultural development in the steppe and desert regions. These areas are of great strategic importance to the national economy, as agricultural practices and food production are key contributors to economic growth and food security. However, these regions face significant challenges that hinder the achievement of sustainable agricultural development. The agricultural sector is a unique instrument of development, which is defined as the structural evolution or change of society in its economic, social, intellectual, and organizational dimensions to provide a decent life for its people (Al-Quraishi, 2007). These regions are characterized by harsh natural conditions and a scarcity of resources, making the improvement of agricultural conditions and farming practices to achieve sustainable development an urgent and essential matter. Algeria is among the countries facing this challenge particularly, as the steppe and desert regions constitute a large percentage of Algerian territory.

Therefore, this study aims to examine and analyze the role of agricultural development in the steppe and desert regions in enhancing food security in Algeria, to understand the challenges and obstacles it faces, and to offer recommendations for achieving sustainable development in this sector. The objectives of this study are to examine the challenges and opportunities facing agricultural development in steppe and desert regions, and to offer practical recommendations for improving the agricultural situation in these areas. It also aims to highlight the role of desert agriculture as a strategic option for enhancing self-sufficiency and diversifying production sources.

The importance of this study stems from the fact that agricultural development in steppe and desert regions is of paramount importance, as it contributes to improving the standard of living of the population, enhancing food security, and achieving sustainable development in the country. It also contributes to strengthening economic and social stability in these regions and reducing rural-to-urban migration.

Therefore, we have employed a descriptive-analytical approach in this study, given its significant relevance to understanding agricultural development in steppe and desert regions.

Based on the above, we can pose the general problem of this research paper, which is:

What is the role of agricultural development in steppe and desert regions in enhancing food security in Algeria?

To answer this problem, we tried to present some sub-questions: which are part of our study and analysis, represented by what is the reality of the agricultural sector in the steppe and desert regions? Has agricultural development succeeded in promoting self-sufficiency? How can the role of farmers and agricultural workers be strengthened in achieving agricultural development in these regions? How can support programs and preventive measures ensure better preservation of agriculture in these regions?

Through the sub-questions, we can formulate initial hypotheses to guide our study. The agricultural situation in steppe and desert regions can be improved by adopting advanced agricultural techniques suited to harsh environmental conditions. Furthermore, the success of agricultural development in these regions requires concerted efforts from numerous supporting stakeholders, including strategic policies and substantial funding. Strengthening agricultural infrastructure and providing financial and technical support to farmers can also contribute to boosting agricultural development in these areas. Support programs and preventative measures are crucial for the preservation, development, and growth of agriculture in these regions, which have recently received particular attention.

This research paper is divided into three main elements: highlighting the current state and statistics of the agricultural sector and agricultural development in steppe and desert regions; presenting some preventative measures for preserving agriculture in steppe regions and strategic support programs (such as the agricultural electrification program) in desert regions; and finally, highlighting the role of desert agriculture in enhancing food security in Algeria

2. The reality of the agricultural sector in steppe and desert regions:

The agricultural sector in steppe and desert regions presents a significant challenge due to harsh environmental conditions, water scarcity, and arid terrain. While agriculture can be defined as the cultivation or tilling of the land, this definition is too narrow. Modern agriculture encompasses a broader range of activities (Hussein Abdel Aziz, 2006). Farming in these regions is particularly difficult due to low rainfall and high temperatures, which limit the cultivation of diverse crops. Among the most important branches of agriculture are forestry, fish farming, and animal husbandry. Generally, agriculture includes all productive activities (Sayed Mohamed Ahmed, 2011). Farmers in these regions typically rely on advanced agricultural techniques such as drip irrigation and the use of pesticides and fertilizers to achieve desired productivity. However, these techniques can be expensive and unsustainable due to the heavy reliance on limited natural resources.

Furthermore, steppe and desert regions suffer from desertification and soil loss due to climate variability and poor environmental management, further complicating agriculture in these areas and reducing the potential for achieving environmental and economic sustainability.

Therefore, the current state of the agricultural sector in steppe and desert regions necessitates comprehensive strategies to promote agricultural sustainability and provide financial and technical support to farmers to address the environmental and economic challenges they face.

2.1 The state of the agricultural sector in steppe regions:

2.1.1. Area of steppe lands in Algeria:

Algeria possesses approximately 20 million hectares of plains, 9 million hectares of fishing grounds, and 4.2 million hectares of forests. Arable land constitutes about 3.1% of Algeria's total area, while irrigated land accounts for only 2.6%, a low percentage indicating that most of the land relies on rainfall (Machine, 2017).

Meanwhile, the Algerian steppe lands, covering 25 provinces (8 steppe provinces, 13 agro-pastoral provinces, and 4 semi-desert pastoral provinces), extend over an estimated total area of 32 million hectares, representing about 14% of the country's total area (Machine, 2017).

2.1.2. Steppe regions in Algeria

The steppe is a geographical region located between northern Algeria and the Sahara Desert. It comprises a vast area between the 100-400 mm/year rainfall lines, stretching from the Tell Atlas to the Saharan Atlas. The Algerian steppe encompasses 25 provinces (8 steppe, 13 agricultural steppe, and 4 semi-desert) and covers an area of 36 million hectares, equivalent to 15% of the country's total area. It consists primarily of pastures and esparto grass patches, characterized by a dynamic livestock system dominated by animal husbandry. According to the official census announced in November 2023, the number of sheep in Algeria exceeds 17 million head out of a total of 36 million head, as stated by the former Algerian Minister of Agriculture, Abdelhafid Henni. There are also 4 million goats and 400,000 camels. These grazing areas represent 42% of the added value of the agricultural sector, thus ensuring permanent employment and income. For the inhabitants of these regions, 80% of them, equivalent to 09 million people, benefit from livestock farming activity" (Ministry of Agriculture and Rural Development, 2024) (Tahami and Jaafoura, 2019).

Table (1): Steppe and semi-desert regions

Pastoral steppe states	Agricultural steppe states	Semi-desert states
Djelfa, Laghouat, M'Sila, Biskra, Tebessa, Khenchela, Naâma, El Bayadh.	Tiaret, Medea, Bouira, Setif, Bordj Bou Arreridj, Souk Ahras, Oum El Bouaghi, Batna, Saida, Sidi Bel Abbes, Tissemsilt, Mascara.	Ghardaïa, Ouargla, El Oued, Béchar.

Source: Tahami M., Jaafoura M., Steppe Environment Problems in Algeria, Social Empowerment Journal, Volume 1, Issue 4, Laghouat, December 2019, p. 65

2.2 The reality of the agricultural sector in desert regions:

2.2.1 Area of desert lands in Algeria:

The Algerian Sahara covers more than two million km², or 4/5 of the total area. To the north, the Algerian Sahara is bordered by the Atlas Mountains, which consist of two high mountain ranges enclosing a series of high plateaus. The two ranges are the Tell Atlas in the non-Saharan north and the Saharan Atlas to its south. The Atlas Mountains are located in the northwest of the Sahara Desert. (Baali, 2018).

2.2.2 .Area of arable desert land in Algeria:

Over the past decade, the irrigated agricultural area (SAI) in the Sahara has expanded by more than 106,000 hectares. It currently stands at 35,911 hectares, representing 30% of

the total national irrigated area, and is distributed across the regions of Ziban, Wadi Righ, Touat, M'zab, Wadi Souf, and Ouargla (Ministry of Agriculture and Rural Development, 2023).

2.2.3 Challenges of Agriculture in Desert Regions:

In desert regions, the agricultural sector faces unique challenges ranging from water scarcity to arid soil and harsh weather conditions. These challenges make farming in these areas difficult and complex, but there are some efforts and technologies that can help improve the agricultural sector there.

•**Water scarcity**: This is the biggest challenge in desert regions, where water resources are extremely limited. To overcome this problem, modern technologies such as drip irrigation and groundwater reclamation are used to increase water use efficiency in agriculture.

•**Arid soil and desertification**: Desert regions suffer from soil loss and desertification, which reduces their fertility and ability to support agriculture. Artificial reclaiming, planting drought-resistant trees, and soil and water conservation are among the solutions used to combat this problem.

•**Harsh weather conditions**: Desert regions are characterized by high daytime temperatures and low nighttime temperatures, in addition to significant weather fluctuations. These harsh conditions necessitate the adoption of appropriate agricultural technologies, such as the use of controlled irrigation systems and the cultivation of crops adapted to the climatic conditions.

• **Economic and social challenges**: Farmers in desert regions face economic and social challenges related to a lack of economic opportunities and limited agricultural infrastructure. To improve their situation, financial and technical support must be provided to promote sustainable agriculture and develop agricultural infrastructure. The reality of the agricultural sector in desert regions requires integrated and comprehensive efforts from governments and the international community to provide the necessary support and resources to improve the conditions of farmers and promote the sustainability of agriculture in these harsh regions.

3. The Reality of Agricultural Development in Steppe and Desert Regions:

The agricultural sector in steppe and desert regions faces unique challenges, including water scarcity, arid soil, and harsh weather conditions. These challenges hinder agriculture and impede the achievement of agricultural sustainability in these areas.

Therefore, addressing the current state of agricultural development requires comprehensive efforts to improve agricultural infrastructure, adopt sustainable technologies, provide financial and technical support to farmers, develop the livestock sector, and enhance marketing and export opportunities for agricultural products.

3.1 Agricultural Development in Steppe Regions:

The dominant production systems in the steppe region rely on the close link between agriculture and livestock. Crops are cultivated to meet the nutritional needs of livestock, thus forming a steppe ecosystem that aims to achieve sufficiency between natural resources and the needs of the activities carried out in these areas. Fertilizers are used, and crop

rotation is not followed to regulate production (Mahmoud Younes & Abdel-Naim Mubarak, 1986).

However, this system is experiencing regressive changes, most notably the continuous degradation caused by natural and human impacts. These impacts have disrupted the traditional balance between pastoral activity and available natural resources, leading to a significant reduction in rangeland vegetation cover due to climatic effects, accelerated deforestation, and overgrazing. This includes agricultural lands as well as unused lands that studies have shown can be reclaimed, such as lands that have been fallow for more than five years and have been transformed into pastures, natural meadows, and waterways (Khadija, 2024).

These phenomena practically affect the majority of the Algerian steppe areas, which cover 25 provinces (8 steppe provinces, 13 agro-pastoral provinces, and 4 semi-desert pastoral provinces) and extend over an estimated total area of 32 million hectares, or about 14% of the country's area. These are pastures and grazing lands where esparto grass grows, and livestock farming dominates. The steppe livestock herd consists of 23,410,694 sheep, of which 60% are for breeding, and 3,997,372 goats. This ensures a socio-economic function, representing 42% of the added value of the agricultural sector and allowing for the preservation of jobs and income. This activity benefits 80% of the population, estimated at 9 million people (Ministry of Agriculture and Rural Development, 2023).

Field indicators are extremely worrying due to the significant reduction in steppe rangeland and its control by some herders, despite the intervention of public authorities. Since 2000, these authorities have implemented a strategy aimed at developing over 3.2 million hectares of previously off-limits grazing areas, planting over 400,000 hectares of rangeland with forage plants, and constructing and rehabilitating over 1,600 secondary barriers. This has allowed for the intensification of fodder cultivation across 440,000 hectares. In addition, water and soil conservation activities have covered approximately 3.6 million cubic meters, and over 9,000 water points have been constructed and rehabilitated. Furthermore, more than 6,000 solar and wind turbine systems have been acquired and installed for drilling wells and providing lighting for livestock enclosures, creating 165,000 jobs (Ministry of Agriculture and Rural Development, 2023).

Although the results achieved are encouraging, they require unifying, strengthening and supporting efforts for greater effectiveness. From this perspective, a number of regional meetings were organized with livestock breeders in the steppe and semi-desert regions, culminating in the convening of the National Meeting of Livestock Breeders in the state of Tiaret, chaired by the Minister of Agriculture and Rural Development and with the participation of more than 600 livestock breeders from 25 states. This formed a broad consultative base and a source of proposals to find sustainable solutions for pastoral activity, preserve pastures and develop livestock breeding activity.

Given the prevailing situation and in order to mitigate its deterioration and prevent it from spiraling out of control, a specific strategy was necessary. This strategy aimed at the harmonious development and preservation of steppe and semi-desert rangelands through the modernization and enhancement of sheep and goat farming. This necessitates the establishment of a balanced and integrated production system, including slaughterhouses, to meet consumption needs. This is particularly crucial considering that approximately

300,000 tons of the national meat production, estimated at 525,650 tons of red meat (all meat combined), originates from sheep meat.

In this context, a series of necessary measures and procedures emerged to revitalize grazing activities, preserve rangelands, and modernize the sheep and goat farming sector. Their implementation is undeniably imperative and includes the following:

•Social protection for livestock breeders and improvement of their living conditions through their integration into social security systems, ensuring their families benefit from various services without incurring financial hardship.

•Sustainability of livestock farming activities through profit-sharing and the development of breeders' children.

•Preservation of rangelands through the widespread implementation of grazing control measures, a key tool for achieving 7 million hectares by 2025.

•Effective and efficient management of grazing control through the involvement of breeder organizations and local communities.

•Guidance in the use of agro-pastoral areas by ensuring the integration of agricultural land reclamation with grazing areas designated exclusively for grazing.

•Organization of grazing areas through the establishment of tools and mechanisms that prevent conflicts of interest among different users, preserve and regenerate vegetation cover, integrate agro-pastoral activities, and promote exchange and marketing.

•Integration of slaughterhouses and abattoirs into sales networks established by breeders, with the aim of better organizing marketing. • Finalizing the specific law on the management of steppe and semi-desert rangelands, which is a fundamental legal instrument for regulating the activities of various stakeholders and investors.

•Effective utilization of available resources through sustainable development and rational use.

•Identifying livestock herds through the use of distinctive tags, in a simple and reliable manner, thus facilitating inventory, health monitoring, and tracking movements.

•Developing and preserving local breeds and their genetic characteristics.

•Activating intervention programs and utilizing and enhancing existing infrastructure.

• Encouraging sheep and goat farming by engaging and involving breeders in efforts to develop the sector and preserve steppe rangelands.

3.2. Agricultural Development in Desert Regions

The desert regions are rich in resources and significant potential capable of meeting their own needs in terms of employment opportunities and the food requirements of the population, and they play an important role in improving food security. The agricultural climatic conditions in the Saharan Atlas, the Lower Sahara (Biskra and El Oued), and even the Central Sahara (Ouargla and Ghardaia) provide opportunities for developing non-seasonal production sectors. These sectors can enhance the supply of vegetables, including potatoes, to the major urban centers in the north. Furthermore, Algeria receives 197 billion m^3 of rainfall annually, with an average annual rainfall of 82 mm (Zouhair, 2024).

The implementation of various development programs for the southern regions by the relevant ministry has allowed for the necessary conditions to be met in providing

employment opportunities and improving the living conditions and income of rural populations.

Among the key indicators that demonstrate the importance of the desert in the national agricultural economy are the following:

3.2.1. Natural Resources:

The area suitable for reclamation is approximately 1.4 million hectares, distributed across the large areas studied in the old palm oases of the valley, Rhir, Touat, Gourara, and Tidikelt, as well as the newer areas of Gassi Touil, Hassi Messaoud, In Amenas, and Abadla. The exploitable potential for water resources, according to the numerical model of the Sahara Aquifer System (SASS), is estimated at approximately 6.1 billion cubic meters by 2050.

Renewable energy sources consist of solar energy with a capacity of 9 terawatt-hours per year, wind energy with a capacity of 35 terawatt-hours per year, and geothermal energy. Warm water aquifers (ALBIEN)

The available water and soil potential, as well as the use of modern and advanced irrigation methods, and the search for the necessary water for irrigation in the event of the unavailability of rainwater (Mandour and Ahmed Ramadan, 1990), and energy, in addition to the consolidation of existing production areas with the creation of new areas, allow, in the medium term, an increase in production by 30% with regard to vegetables, grains and red meat, compared to the levels recorded in recent years. Statistics also indicate that the volume of groundwater is estimated at 33 billion m^3, and that the groundwater reserve in the Algerian Sahara is estimated at 60 billion m^3, but its exploitation remains weak due to the high costs of preparing wells as well as the weak rate of its renewal, which does not exceed 6.0 billion m^3 per year (Bouzid, 2006-2007).

3.2.2.Agricultural Activities:

Agriculture has been the primary activity for the population and a key factor in their stability over the past decade. It is also the most important occupation in the world, both in terms of its prevalence and the number of people employed in it (Haroun, 2006). Irrigated agricultural land (SAI) in the Sahara has expanded by more than 106,000 hectares, currently reaching 35,911 hectares, representing 30% of the total national irrigated area. This land is distributed across the Ziban, Wadi Righ, Touat, M'zab, Souf, and Ouargla regions.

Date Palm Cultivation: Date palm cultivation relies on the cultivation of date palms (comprising approximately 1,000 varieties) due to their adaptability to the harsh climatic conditions, which are the cornerstone of the oasis ecosystem. The palm groves experienced abandonment and neglect during the period (1960/1980), which led to a decline in production capacities and the aging of the groves. However, the situation was rectified starting from 1980, as palm cultivation activity was revived and restored thanks to the means provided by the country's higher authorities. The wealth of the palm sector is estimated at about 167,279 hectares, equivalent to a production of 10,255,000 quintals, with the Deglet Nour variety leading at 53%. Dates are mainly produced in the Ziban, Souf, and Wadi Righ regions. These regions are leaders in date production, particularly the Deglet Nour and Ghars varieties, while Gourara and Touat are renowned for the Takarboucht variety. Despite the harsh desert climate, the Sahara region has witnessed significant

development in cereal cultivation, which now occupies over 81,900 hectares, especially in the Ziban and Djebel Dhaya regions. This leads to seasonal agricultural work, seasonal unemployment, the seasonal use of agricultural machinery, and the seasonality of agricultural product sales (Al-Masri, 2002). Other crops that have experienced exceptional growth over the past decade include vegetables, which currently occupy approximately 92,736 hectares, 41% of which are dedicated to potato production. These crops are distributed across the Touat, Wadi Righ, M'zab, Souf, and Ziban regions. Fruit tree cultivation occupies an area of 21,203 hectares. Olives are the most prominent crop, covering 10,800 hectares, followed by apricot and pomegranate trees, with significant harvests in the Ziban and M'zab regions.

Other crops: 19,196 hectares are dedicated to fodder crops and 5,225 hectares to industrial crops (tobacco, henna, saffron, and tomatoes).

Livestock farming: Sheep farming leads the way at 69%, concentrated in the Ksour El-Daya, Souf, and Ziban regions. Camel farming is also a significant activity in the southern provinces, with a population of 339,784 head, representing a substantial portion of the national livestock. The following table illustrates the most extensive desert regions within the agricultural sector:

Table 2: The most extensive desert areas in the agricultural division

	N	**Naming**
The desert states:	10	Adrar, Bechar, Biskra, El Oued, Ghardaia, Illizi, Laghouat, Ouargla, Tamanrasset and Tindouf;
Desert municipalities	188	Comprising approximately 141 rural municipalities
Administrative districts	10	Bordj Badji Mokhtar and Timimoun (Adrar), Beni Abbes (Bechar), Ouled Djellal (Biskra), El M'Ghair (El Oued), El Menia (Ghardaia), Djanet (Illizi), Touggourt (Ouargla), Ain Salah and Ain Guezzam (Tamanrasset) Fourteen (14) natural areas: El Dhaya, Ziban, Wadi Righ and Wadi M'zab, El Ksour, M'zab, Ouargla, Gourara, Saoura, Touat, Tassili, Tidikelt
Area	18181839 hectares	18181839HIC
Total active population	1,203,725 people	Among them are 465,177 farmers

Source: Prepared by the researcher

4. Preventive Measures in Steppe Regions and Agricultural Development Programs in Desert Regions:

In steppe regions, preventive measures focus on improving water and soil resource management and adopting modern irrigation techniques such as drip irrigation and water-saving methods. Agricultural development programs emphasize developing drought-resistant crops and achieving environmental sustainability through sustainable agricultural practices.

In desert regions, preventive measures include implementing agricultural development programs aimed at developing agricultural infrastructure and enhancing biodiversity. These programs focus on improving water management and developing arid farming techniques, thereby increasing land productivity and improving the livelihoods of local communities.

By using these measures and agricultural development programs, resilience and sustainability in agriculture can be enhanced in steppe and desert regions, improving the livelihoods of agriculture-dependent populations in these harsh environments

4.1. Preventive Measures for the Preservation and Development of Steppe Agricultural Areas:

These key measures, and others listed in the annexes, cannot have a positive impact on the ground in the medium and long term without strengthening coordination and dialogue among the various stakeholders, particularly livestock breeders' organizations, through their direct and coordinated contribution to efforts to develop and protect steppe and semi-desert areas and modernize the sheep and goat breeding sector.

4.1.1. Preservation of Steppe Pastures:

To preserve these resources, at a minimum, the following measures must be taken:

•Planting forage crops with the participation of those concerned with cultivation on lands recognized as private.

•Updating studies that differentiate between pastures and lands with agricultural potential in the steppe region.

•Prohibiting illegal tillage and weeding through legal deterrents (joint ministerial circular, etc.).

•Establishing a monitoring, control, and information system involving forestry departments, agricultural service directorates, and agricultural chambers.

4.1.2. Supplying Livestock Breeders with Barley:

Livestock breeders will be supplied with barley in order to:

•Streamline the current system by reviewing and organizing breeder lists into cooperatives.

•Strengthen the existing system through new sales outlets and move towards the gradual liberalization of the market.

•Develop irrigated forage crops, especially barley.

4.1.3. Land Reclamation:

Land reclamation is the process of converting barren land into arable land. This is often done in desert areas by drilling wells to access groundwater for irrigation. Irrigation is done using drip or sprinkler methods, depending on the type of crop being grown. To sustain this process, the following must be done:

•Feasibility studies should be conducted for the areas to be developed by HCDS and BNEDER;

•Reclamation efforts should be primarily directed towards establishing modern intensive farming units that rely on irrigated forage crops and the use of water-efficient irrigation systems.

4.2. The Agricultural Electrification Program as a Strategic Alternative in Desert Areas:

The energy sector, particularly agricultural electrification, did not receive any development program until 1995. Until 1988, electricity supply for agricultural use was included in the traditional electrification program aimed at meeting residential needs. At that time, 13% of this program was allocated annually to agriculture, specifically for overseeing the acquisition of agricultural land (APFA) and the reclamation of isolated lands.

The persistent demands of local farmers for this structural measure led the government to implement a series of steps to remove the obstacles hindering the implementation of agricultural reclamation projects.

Renewable Energy in Agriculture:

Algeria possesses significant potential for producing all types of renewable energy. However, efforts must be intensified and directed towards developing this alternative natural resource. This will allow the country to meet its growing energy needs and address the increasing demand for this vital resource.

Due to its geographical location, Algeria enjoys one of the highest solar irradiance levels in the world. Sunlight exceeds 2,000 hours annually across the entire country and can reach 3,900 hours in the High Plateaus and the Sahara. The average daily energy received on a horizontal surface area of one million square meters is approximately 5 kilowatt-hours (kWh) across most of the country, which translates to roughly 1,700 kWh/m²/year in the north and 2,263 kWh/m²/year in the south. The average annual sunshine duration in the south is 3,500 hours.

Regarding wind energy potential, Algeria has a moderate wind system (2 to 6 m/s), which is well-suited for water pumping, particularly in the High Plateaus and the Sahara.

Objectives of Energy Programs in Desert Agriculture Development:

The National Program for the Development of Renewable Energies and Energy Efficiency aims to achieve renewable energy production capacity ranging from 47 to 51 terawatt-hours by 2030, representing 37% of installed capacity and 27% of electricity production allocated for national consumption. It is worth noting that 14 provinces, particularly in the south, have renewable energy power plants with a capacity of 343 megawatts.

3.2.4. Commitments and Measures:

Algeria committed to taking certain measures to reduce greenhouse gas (GHG) emissions, specifically targeting the three most significant emitting gases: carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O), at the 21st Conference of the Parties (COP21). In this context, efforts continue to promote the use and development of renewable energies, which are considered the most viable, ecologically clean, and commercially profitable alternative.

From this perspective, the agricultural sector must continue production without polluting the environment, disrupting ecosystems, and depleting fossil resources, which requires resorting to the exploitation of natural and renewable resources in agricultural and rural development programs.

4.2.4.The Ministry of Agriculture and Rural Development's Strategy for Preserving Desert Agriculture:

The Ministry of Agriculture and Rural Development's strategy for promoting and developing new and renewable energies aligns with the national strategy, which has been elevated to a national priority. Agricultural policies are among the most important branches of economic policy, representing a set of rules, methods, and procedures through which specific objectives are achieved. These policies aim to bring about qualitative changes in the structure of the agricultural sector through modifications affecting crop composition, production techniques, the structure of agricultural exports, and other factors.

Consequently, they effect qualitative changes in the agricultural economic structure (Raqia Khalaf, 2012). The sector's experience in water pumping and solar-powered electricity generation for rural households is pioneering, dating back to the late 1970s. Its objectives include:

•Replacing traditional direct energy sources with renewable energies (as an alternative);

•Conserving water resources (economically managing water use);

•Electrifying scattered communities (mini-power plants);

•Establishing incentive mechanisms, particularly subsidies. • Gradual deployment of renewable energies across all unelectrified villages; isolated areas (irrigation of small agricultural plots); pastures by upgrading livestock watering points with relevant equipment and electrifying tents); and marginal palm groves in semi-desert regions that must be preserved (electrification of homes).

•Improvement of living conditions for the population.

•Cold storage of perishable local products (milk, dairy products, meat, etc.).

Electricity production from renewable energies on farms (particularly biomass and geothermal energy, etc.) will allow for the reinforcement of the national grid by feeding the generated energy into it. This will incentivize producers of this energy, in addition to the measures and incentives provided under the Energy Management Law (financial benefits, etc.).

5. The Role of Steppe and Desert Agriculture in Enhancing Food Security

Steppe and desert agriculture is crucial for food security in Algeria, as evidenced by:

-Diversifying local food sources

-Utilizing vast areas in the south that are often underutilized due to limited water resources

-Supporting the stability of local populations
-Enhancing resilience to global food supply disruptions through more sustainable local production in the context of climate change
-Producing crops suitable for arid environments, including drought-resistant crops and those that can be grown in protected environments
-Integrating agricultural and livestock activities
-Strengthening local food security through shorter value chains, including simple processing, packaging, and storage in desert regions
- Improving the efficiency of water resource utilization

6.Results

•Steppe and desert regions face significant challenges in agricultural development due to harsh environmental conditions and water scarcity.

•Dominant production systems in steppe regions rely on the close link between agriculture and livestock.

•Desert regions face unique challenges, including water scarcity, arid soil, and harsh weather conditions.

•Agricultural development in steppe and desert regions requires comprehensive efforts to improve agricultural infrastructure and adopt sustainable technologies.

•Achieving sustainable development in steppe and desert regions requires providing financial and technical support to farmers and developing the livestock sector.

•Algeria has significant potential for renewable energy production and needs to strengthen efforts to develop this alternative resource.

•The agricultural development strategy in steppe and desert regions should include replacing traditional energy sources with renewable energy and improving the living conditions of the population.

•An agricultural electrification strategy can contribute to achieving sustainable development in desert regions by utilizing renewable natural resources. Achieving sustainable development in steppe and desert regions requires enhanced coordination and dialogue among various stakeholders and encourages direct and coordinated participation by livestock breeders.

Price and market volatility, coupled with the lack of robust marketing channels for some desert products, pose challenges.

7. Conclusion:

In conclusion, desert and steppe agriculture is a crucial component of Algeria's food security system in addressing climatic and economic challenges. This is achieved through enhancing water resource efficiency, adopting modern technologies, and developing local value chains. The findings indicate that steppe and desert regions face significant challenges in achieving sustainable agricultural development due to harsh environmental conditions and water scarcity. However, the study also reveals new opportunities to boost agricultural productivity and achieve sustainability in these harsh environments. Furthermore, the study highlights the importance of understanding and analyzing the challenges and opportunities in agricultural development in steppe and desert regions, contributing to the guidance of agricultural policies and programs for achieving sustainable development in these areas.

Proposed preventive measures include improving water and soil resource management, adopting modern irrigation techniques, developing drought-resistant crops, and achieving environmental sustainability through sustainable agricultural practices. In addition, developing the agricultural sector in steppe and desert regions requires comprehensive strategies to promote agricultural sustainability and provide financial and technical support to farmers to address the environmental and economic challenges they face. Proposed strategies include utilizing renewable resources such as solar and wind energy to meet the agricultural needs of these regions. This type of agriculture can contribute to increasing local production, reducing dependence on imports, and improving food security in the southern and even northern regions.

Based on the results and data obtained from the study, the following hypotheses can be discussed:

Improving the agricultural situation in steppe and desert regions through the adoption of advanced agricultural technologies: The results confirm that the use of advanced irrigation techniques, such as drip irrigation, and the application of pesticides and synthetic fertilizers can improve the agricultural situation in steppe and desert regions. The results indicate that these techniques are well-suited to harsh environmental conditions and contribute to increased agricultural productivity.

Successful agricultural development in steppe and desert regions requires concerted efforts from multiple stakeholders: The results indicate that successful agricultural development in steppe and desert regions requires the combined efforts of the government, institutions, and farmers. The results confirm that providing strategic policies and allocating substantial funds to encourage agricultural development plays a crucial role in achieving success.

Strengthening agricultural infrastructure and providing financial and technical support to farmers: The results indicate that strengthening agricultural infrastructure and providing financial and technical support to farmers can contribute to enhancing agricultural development in steppe and desert regions. The results confirm that providing the necessary infrastructure and financial and technical support enhances farmers' ability to achieve agricultural sustainability and increase productivity. Support programs and preventive measures contribute to the maintenance and development of agriculture in steppe and desert regions: The results confirm that support programs and preventive measures play a crucial role in maintaining and developing agriculture in steppe and desert regions. The findings indicate that these programs promote agricultural sustainability and improve the living conditions of farmers in these areas.

Based on the results, the proposed hypotheses have been confirmed.

The following conclusions can be drawn:

- Steppe and desert regions face significant challenges in agricultural development due to harsh environmental conditions and water scarcity.
- The dominant production systems in steppe regions rely on the close link between agriculture and livestock.
- Desert regions face unique challenges, including water scarcity, arid soil, and harsh weather conditions.

•Agricultural development in steppe and desert regions requires comprehensive efforts to improve agricultural infrastructure and adopt sustainable technologies.

•Achieving sustainable development in steppe and desert regions necessitates providing financial and technical support to farmers and developing the livestock sector. • Algeria possesses significant potential for renewable energy production and needs to intensify efforts to develop this alternative resource.

•The agricultural development strategy in steppe and desert regions should include replacing traditional energy sources with renewable energy and improving the living conditions of the population.

•An agricultural electrification strategy can contribute to achieving sustainable development in desert regions by utilizing renewable natural resources.

•Achieving sustainable development in steppe and desert regions requires strengthening coordination and dialogue among various stakeholders and encouraging direct and coordinated participation from livestock breeders.

Based on this study, the following future prospects and research areas can be proposed:

• A study of the impact of modern technology on agricultural development in steppe and desert regions; an assessment of the impact of government policies on agricultural development in steppe and desert regions; a study of the impact of climate change on agricultural development in steppe and desert regions; the integration of the livestock sector with desert agriculture, supporting value addition and local and international marketing; providing incentives for desert water and agricultural projects; facilitating access to financing and insurance; and supporting the necessary infrastructure.

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