

Sustainable agricultural development and agricultural production in the Algerian Sahara: ways to respond to the challenges of food security, water and energy security, and climate change.

Bouchenafa Redha¹ ♦, Arous Amina²

¹ University of Blida -2- Lounici Ali (Algeria), r.bouchenafa@univ-blida2.dz

 ORCID <https://orcid.org/0009-0005-2834-1266>

² University of Blida -2- Lounici Ali (Algeria), a.arous@univ-blida2.dz

 ORCID <https://orcid.org/0009-0003-3826-954X>

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Abstract:

The study aimed at examining the role of sustainable agricultural development in Algerian Sahara for food security. The study explained that the main challenges facing Algerian Sahara agriculture were climatic changes; poor rainfall; fear of the exploitation of southern Algerian Shale gas; weak water resources management. And in order to meet the challenges of Algerian Sahara agricultural activity, sustainable agricultural development must be relied upon through: Aquaculture, Renewable energies (solar energy), Attracting modern agricultural technical innovations, Water security through more efficient management of water resources in the Algerian desert through increased investment in the desalination of salt water in southern Algeria.

Keywords: Sustainable, agricultural, development, Algerian Sahara, food security, climate change.

♦ Corresponding author.



I- Introduction:

As population growth accelerated, the provision of food was of increasing importance to States and Governments. Worldwide by following up and monitoring developments in their food security. identifying and analysing its indicators and developing their decisions with regard to sectors related to food security; raising agricultural productive capacity, reducing malnutrition and providing food to all segments of society, especially in times of crisis, including climate change.

Climate change has highlighted the importance of food security. Developed countries have taken the initiative to embody sustainable peasant development through various systematic and institutional strategies to reconceptualize peasant development and the way in which it is growing. Sustainable peasant development will enable the use of information and communication technologies and ecosystem data to support and develop timely information and services for farmers, and to experiment with and expand innovative ideas with great potential for influencing food and agriculture. On the other hand, rural families will be empowered and youth entrepreneurship in food and agriculture will be inspired.

With the growing importance of sustainable agricultural development, the Algerian Government is trying to strengthen its capacities so that the agricultural sector can fulfil its role in the area of food security and the maintenance of economic and social stability.

In this context, this study examines the main factors affecting agricultural production by presenting the following main problems: **How can sustainable agricultural development contribute to increasing agricultural production in the Algerian Sahara to achieve food security in light of climate change, decline in water security, and lack of energy security?**

I. Theoretical framework

In this area, we will address the concepts of food security and the most important perceptions of climate change, In addition to the implications of climate change for global food security, and finally the role of sustainable agriculture in the provision of food,

1. Dimensions of the food security problem

The term food security was first used in 1974 during the World Food Conference to clarify the importance of food supplies and to emphasize the need for basic food availability and price stability as a prerequisite for food security at the international and national levels.

FAO defines food security as situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. (Mark Gibson, The feeding of nations, redefining food security for the 21st century,

Food security also reflects society's ability to provide adequate food to citizens in the long term, in quantitative and qualitative terms and at prices commensurate with their income. Ensuring food security requires action in multiple dimensions, including improving the governance of food systems; inclusive and responsible investments in agriculture and rural areas, in health and education; empowering small producers; and strengthening social protection mechanisms for risk reduction. (<http://www.fao.org/right-to-food>, 2014, P01)

2. What is the water security

UN-Water defined water security as follows: The capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability (UN water. 2013)

This is the definition proposed by UN-Water to serve as a starting point for dialogue in the UN system. Discover on this infographic the key elements of water security, and the centrality of water to achieving a larger sense of security, sustainability, development and human well-being. UN-Water hence supports the inclusion of water security on the agenda of the UN Security Council and in the post-2015 development agenda as part of the Sustainable (UN water. 2013)

3. DEFINITIONS OF ENERGY SECURITY

Many definitions have been proposed for energy security. Much of the academic literature in this area proposes frameworks for describing energy security, and general policies to improve energy security, rather than trying to measure energy security. Where energy security analyses have been performed, a wide range of methods from economics, engineering, political science, system studies and natural science have been adopted.

The definition of energy security has expanded beyond the initial focus on security of supply to include a wider range of factors, often referred to as the four As” of energy security – availability, affordability, accessibility and acceptability. These tend to be applied to security of supply .

Reliability is defined as the ability to cope with short-term shocks. Identify five dimensions: availability, affordability, technology development, sustainability and regulation. (Owain J,Paul E. 2017. P23).

The four components of energy security can be described in the following points:

- **Availability:** ensures that energy supplies are available in sufficient amounts.
- **Affordability:** aims to have these resources available at sufficiently-low prices.
- **Accessibility:** focuses on ensuring all citizens have access to energy, which is to some extent about ensuring that reliable infrastructure is in place to ensure a robust supply for the end user, but this is generally interpreted in practice as ensuring that energy prices are kept low and fuel poverty is minimised.
- **Acceptability:** is concerned with the negative impacts of energy, such as pollution and environmental damage, and ensuring that these impacts are minimised in order to make the energy acceptable to the customer.

4. The concept of climate change

Climate change has become one of the most significant and fastest growing threats to people and their food security worldwide. Climate change is a phenomenon due to emissions of greenhouse gases from fuel combustion, deforestation, urbanization and industrialization, resulting variations in solar energy, temperature and precipitation. It is a

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real threat to the lives in the world that largely affects water resources, agriculture, coastal regions, freshwater habitats, vegetation and forests, snow cover and melting and geological processes such as landslide, desertification and floods, and has long-term effects on food security as well as in human health (G. Malla. 2008).

Climate change has significant impacts on agriculture and its pattern, as well as on food security. Understanding the full range of climate change impacts on food security therefore requires understanding the implications for prices, incomes and trade, as well as on production. For example, if domestic food production falls, food prices will rise, undermining access to food by everyone who depends on markets for their consumption needs. Moving beyond such broad-brush generalities is more difficult. The impacts of climate change will be highly differentiated across continents, countries and livelihood systems, according to local resource endowments, the nature of agriculture (mechanised or plough-based, irrigated or rain-fed, commercial or subsistence-oriented), urbanisation and economic diversification (agriculture versus (S. Devereux. J. Edwards. 2004)

5. Climate change impact on global food security

Climate change affects food systems, which encompass the entire cycle of "production, aggregation, processing, distribution, consumption, and disposal of food products," in multiple ways. For instance, extreme weather events such as hurricanes, floods, droughts, and wildfires can destroy crops before they are harvested and destroy essential infrastructure. While rising temperatures contribute to pollen sterility and water stress, resulting in decreased yields, and High temperatures suppress the plant's immune response, leading to increased vulnerability. Weeds become more prolific, competing for resources with the main crop and requiring more intense chemical or mechanical intervention. (K. Hadley. and all. 2023. P02).

6. What is sustainable agricultural development for food security and nutrition?

Agricultural development plays a major role in improving food security and nutrition by increasing the quantity and diversity of food; as a driver of economic transformation; and because agriculture is the main source of income for a majority of the people who live in the most extreme poverty. Earning sufficient income from agriculture is key for the 1.3 billion people who work in the sector, and directly determines their food security. Extensive experience across many countries over many years shows that both agricultural development and economy-wide growth are needed to improve FSN, and that the former can reinforce the latter (HLPE Reports series, 2016, P 25)

Sustainable Agriculture Sustainable agriculture refers to the practice of producing food, fiber, and other agricultural products in a way that promotes environmental stewardship, economic viability, and social well-being. It involves balancing the needs of food production with the preservation and improvement of ecosystems, natural resources, and rural livelihoods. Here are some key aspects of sustainable agriculture:

- **Conservation of Resources:** Sustainable agriculture aims to conserve natural resources, such as soil, water, and biodiversity. Conservation practices include soil erosion control, water management strategies, agroforestry, and integrated pest management, which minimize the use of synthetic pesticides and fertilizers.

- **Soil Health and Fertility:** Maintaining soil health is crucial for sustainable agriculture. Practices such as crop rotation, cover cropping, organic matter additions, and minimal tillage help improve soil structure, enhance fertility, promote nutrient cycling, and reduce soil erosion.
- **Water Management:** Sustainable agriculture emphasizes efficient water use and conservation. Techniques like precision irrigation, rainwater harvesting, and water-efficient crop selection help minimize water wastage and ensure sustainable water supplies for agriculture.
- **Biodiversity and Ecosystem Services:** Sustainable agriculture promotes biodiversity conservation and the protection of ecosystem services. Preserving natural habitats, establishing wildlife corridors, and adopting agroecological practices that promote beneficial insects and pollinators contribute to biodiversity conservation and the maintenance of ecosystem balance.
- **Climate Change Resilience:** Sustainable agriculture addresses the challenges posed by climate change. Practices such as agroforestry, conservation agriculture, and the use of climate-resilient crop varieties help build resilience to climate-related stresses, mitigate greenhouse gas emissions, and contribute to carbon sequestration.
- **Livelihoods and Social Equity:** Sustainable agriculture recognizes the social and economic aspects of farming communities. It promotes fair wages, safe working conditions, access to resources for small-scale farmers, and equitable distribution of benefits throughout the agricultural value chain.
- **Agroecology and Diversification:** Agroecology principles, which involve understanding and mimicking natural ecosystems, are central to sustainable agriculture. Diversifying crops, integrating livestock and crops, and adopting ecological farming practices enhance resilience, improve productivity, and reduce reliance on external inputs.
- **Knowledge Sharing and Education:** Promoting knowledge sharing, research, and education is essential for advancing sustainable agriculture. It enables farmers, researchers, policymakers, and consumers to make informed decisions, adopt sustainable practices, and support sustainable food systems.

Sustainable agriculture acknowledges the interconnectedness of ecological, economic, and social aspects of food production. It aims to ensure long-term food security, protect the environment, support rural communities, and promote healthy and resilient food systems. Transitioning towards sustainable agriculture requires collaboration, innovation, and the integration of traditional knowledge with scientific advancements.

II. Algerian Sahara and its available agricultural resources

The agricultural sector plays an important role in stimulating economic growth in many countries; and in providing employment and raw materials to the various relevant productive sectors. Through a set of public policies and directives that will reflect on the ground through the scale of agricultural production and the employment opportunities achieved.

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1. Overview of the agricultural sector in Algeria

The agricultural sector plays an important role in stimulating economic growth in many countries; and in providing employment and raw materials to the various relevant productive sectors. Through a set of public policies and directives that will reflect on the ground through the scale of agricultural production and the employment opportunities achieved.

1.1 Agricultural development plans in Algeria

Algeria has many development plans for the development of the agricultural sector to stimulate and strengthen investors and farmers to achieve effective economic growth in the agricultural sector, which reduce food imports and increase the possibility of food security. These plans are as follows:

1.1.1 National Agricultural Development Programme

The programme of the National Agricultural Development Plan was launched in the second six months of 2000 to achieve the following objectives:

- ❖ To support the adaptation of production systems.
- ❖ Development of national production and agricultural productivity.
- ❖ Support and rehabilitation of land through concession contracts.
- ❖ Support for the national afforestation programme.
- ❖ Support for land rehabilitation in the South .

However, this programme has had a range of challenges:

- ❖ The State shall bear all expenditures for subsidized projects.
- ❖ Lack of access to support for good farmers and poor results from the support policy.

In 2005, the Government introduced a new scheme to try to give more rigorous and easier access to support by determining the proportion of support in the cost of each project.

1.1.2 Agricultural and rural renewal programme

The agricultural and rural renewal policy is an attempt to achieve sustainability of national food security, by examining important changes and impacts in the infrastructure that underpins food security and establishes a public-private partnership, as well as the influence of all actors in the development process and the emergence of new governance for farming and rural areas. The Government has allocated 1,000 billion Algerian dinars to this programme of public expenditure.

1.1.3 Plan of Action for Agriculture 2015-2019

The first pillar of the Plan of Action for Agriculture 2015-2019 is based on agriculture and livestock by modifying, modernizing and developing the structure of the agricultural sector, encouraging the competence of the agricultural sector and monitoring and supporting agricultural entrepreneurs. Pillar II is based on the importance of forest production and the promotion of ecotourism. While the third pillar is based on pursuing and

supporting investment programmes in the fishing and aquaculture sector, increasing and developing fish exports while ensuring the protection and protection of fishing grounds. In general, the plan of action for agriculture, through the above points, aims at:

- Average growth in the agricultural sector of 5%.
- The value of production is estimated at 4,300 billion Algerian dinars.
- A reduction in the value of imports by \$2 billion and an estimated \$1.1 billion in exports.
- Reaching 1.5 million jobs.

1.1.4 Agricultural model 2020-2024 oriented towards sustainable development

The agricultural sector of Algeria has been included in Government programmes 2020-2024, focusing efforts on the development of desert farming, by establishing the Office for the Development of Industrial Agriculture in the Sahara to accompany entrepreneurs in the south of the country and to allow them to benefit from the benefits contained in the various relevant laws. In the 2020-2024 model, agricultural policy also seeks to:

- Upgrading of the green economy to rationalize the management of natural resources, through the application of spraying and drip irrigation systems at a level of approximately 939.200 hectares, or 64% of the total area of water (1,473.919) hectares.
- Since 2020, the sector has also promoted the use of renewable energies at the level of agricultural investments located in the highlands and the south.
- The new strategy for the agricultural sector also targeted the Forestry Branch to contribute to the diversification of the economy and improve the incomes of the rural population in order to create green jobs.
- The sector has also decided to rely on the University as a partner to promote innovation and research in fertilizers, environmentally friendly pesticides and innovative technology solutions.

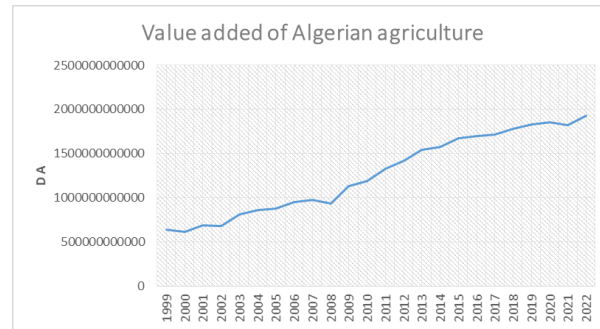
This strategy enabled the export of about 50,000 tons of agricultural products during the first quarter of 2021, and exports of more than 100,000 tons of vegetables and fruits in 2020.

1.2 Evolution of local agricultural production in Algeria

From Supplement No (01), we note an upward trend in the monetary value added of Algerian agriculture from 640.63 billion DA in 1999 to 972.42 billion DA in 2007 because of the agricultural policies of the Algerian Government. In 2008, however, the value added of Algerian agriculture declined by 3.8%. With the introduction of the agricultural and rural renewal programme in 2009, the value added of Algerian agriculture was 1.19 trillion Algerian dinars in 2010. To continue to rise and achieve 1.93 trillion Algerian dinars in 2022. The following figure shows the evolution of the value added of Algerian agriculture for the period 1999-2022.

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Figure 01: Evolution of the value added of Algerian agriculture (1999-2022)



Source:

The

World

Bank.

<https://data.worldbank.org/indicator/NV.AGR.TOTL.KN?locations=DZ>.

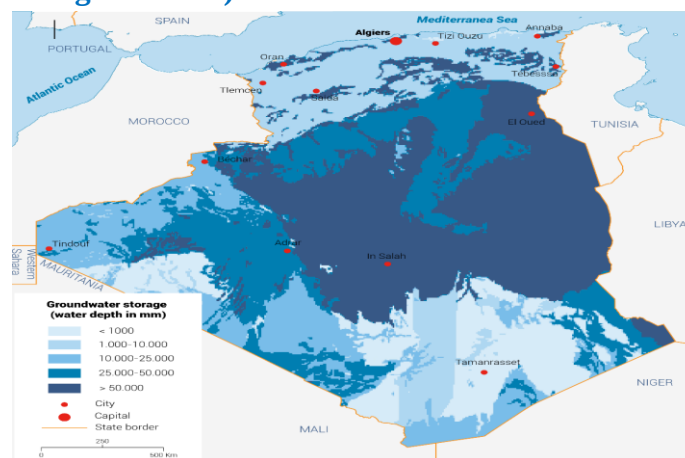
2. Algerian Sahara and its available agricultural resources

The Algerian Sahara covers over 90% of Algerian territory. It is crossed by ergs (sand dunes), regs (stony terrain), as well as volcanic massifs in the far south. The Algerian Desert is characterized by low rainfall, recording less than 100 mm per year. However, it rarely snows and floods, sometimes reviving the wadis (river valleys) that have been dry since prehistoric times. The subsoil is full of water in the Albian Aquifer which extends under a large part of the Algerian Desert, a remnant of the steppe climate that the region experienced 10,000 years ago

2.1 Water resources in the Algerian Sahara

The groundwater in the Algerian Sahara is essentially fossilized with a very low regenerative capacity. Water resources are located within two major interlocking water basins, the final and inter-continental compound, which constitute the transboundary aquifer system in north-west Sahara. The final boat basin (100 to 400 metres deep) and the continental intersect basin (1000 to 1,500 metres deep) contain large reserves ranging from 30,000 to 40,000 billion cubic metres (map 1).

The extraction of water from deep aquifers is mainly done using deep wells, while the extraction of water from shallow basins is done using the traditional poverty system. (Water resources in Algeria. 2019).



Source: <https://water.fanack.com/ar/algeria/water-resources/>.

2.2 Development of Algerian Sahara agriculture

The regions of the Algerian Sahara are full of great resources and potential that can meet their specific needs in terms of employment and food needs of the population and play an important role in improving food security.

There are a series of indicators showing the importance of the Algerian Sahara in the national agricultural economy ([Sahara agriculture. Ministry of Agriculture and Rural Development. 2024](#)):

- ❖ Ten (10) Sahrawi provinces: Adrar, Béchar, Biskra, El Oued, Ghardaia, Illizi, Laghouat, Ouargla, Tamanrasset and Tindouf.
- ❖ Fourteen (14) natural areas: Al-Daya, Al-Ziban, Oued Righ, Oued M'Zab, Al-Ksour, M'Zab, Ouargla, Gourara, Al-Saoura, Tawat, Tassili, Tadiklet.
- ❖ The reclaimable area in the Algerian Sahara is about 1.4 million hectares and is distributed to the large areas that were studied in ancient palm oases of the Oued, Rhir, Tawat, Guarara and Tedikilt, in addition to the new areas of Qasi Tawil, Hassi-Messaoud, Ain Amenas and El Abadla.
- ❖ The exploitable potential of groundwater in northern Sahara is estimated at 6.1 billion cubic metres by 2050.
- ❖ Renewable energies: represented by solar energy with a capacity of 9 TWh/year, wind energy with a capacity of 35 TWh/year, and geothermal energy. Warm water layers (ALBIEN).

2.3 Challenges of agriculture in the Algerian Sahara

The Agriculture in Sahara areas is a major challenge for nature, with high temperatures and lack of soil-based nutrients losing the potential for healthy growth. The main challenges facing agriculture in the Algerian Sahara and the threat to food security are as follows:

2.3.1 Climate change

The Algerian Sahara has a difficult climate, yet it is concerned with climate change as the temperature is expected to rise in the future, and droughts are more frequent and severe, threatening to reduce agricultural production. On the other hand, Climate change is expected to reduce renewable water in the Algerian desert, and to lead to a change in agricultural ranges.

Besides, the forced displacement of the population of the Algerian Sahara caused by climate change and the inability to reclaim more land for agricultural activity. With a technological crisis in case, appropriate investments are not made in the field of developing agricultural technological regarding adaptation to climate changes.

2.3.2 The search for enhanced energy security through Shale gaz in Algerian Sahara and its impact on water

Algeria has the third retrievable reserve of shale gaz in the world, estimated at 707 trillion cubic feet. A study carried out by the United States Department of Energy in cooperation with the United States Company for Advanced International Resources confirmed that Algeria has seven important major basins containing shale gaz (Tindouf,

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Revan, Timimoun, Ahnat, Ain Salah, and Widir in northwest Tamanrasset, in addition to Ghardaia, Berkine, and Illizi). Most of which are in the Sahara. As shown in the following map:



Source: Salmi Rachid. The Shale gas revolution and its repercussions on Algeria. The Journal of Economic Analysis and Foresight. Vol 01. Dec (2020): P 25-49. <https://www.asjp.cerist.dz/en/article/168390>.

The most significant negative impact of shale gas on agriculture in the Algerian Sahara is that the process of rock systolicing requires large amounts of water, which reduces the access of agricultural activity to this essential resource. In addition, air and groundwater pollution and the difficulty of disposing of sediment.

2.3.3 Weak management of water resources in the Sahara regions of Algeria and declining rainfall

Water resources management is the process of managing land, water and related resources for equitable economic and social development without compromising the sustainability of vital ecosystems. In Algeria, the management of water resources in the desert regions has not reached the required level and the water of the desert from salt is only 100,000 cubic metres in the state of Tamnarasset. On the other hand, the rainfall rate in the Algerian desert is only 10 mm per year.

III. Ways to implement sustainable agricultural development in the Sahara of Algeria to enhance food security

From the above, it has become clear that the most important challenge to agricultural activity in the Algerian Sahara is climate change, the risks of Shale gas and its impact on water resources, the decline in rainfall and the lack of effective water resources management for agriculture in the Algerian Sahara.

The best way to avoid these challenges to Sahara agricultural activity in Algeria is through sustainable agricultural development, which offers many effective solutions that can adapt to climate change and not be affected by the lack of rainfall.

1. Aquaculture in the Algerian Sahara

Aquaculture involves the science of cultivating both marine and freshwater organisms in a controlled environment, with production influenced by economic, technological, biological and environmental factors (Jang and Yamazaki, 2020, Kaleem and Sabi, 2021). Since 1980, aquaculture has been the fastest growing global food-producing sector at 8.6% (Oyebola and Olutande, 2019), and Africa has exhibited the fastest regional growth at 7% (Nadarajah and Flaaten, 2017).

Aquaculture enables the efficient use of water, leading to the provision of resources and energy, and is considered a sustainable solution for increasing food production in the desert and meeting the growing needs of the population.

On the Algerian sahara, aquaculture is highly underdeveloped, and small-holder-specific, having direct impact on food security and ecosystem services while also acting as an indirect driver of the economy. Several different methods of aquaculture are available in Algerian Sahara, the choice of which depends on factors such as the availability of water, available resources and surrounding climatic conditions.

- **Hydrodistillation agriculture (Fog Harvesting):** This method is used to extract water from the haze formed in the desert, where fog is directed through special networks or nets for the collection of water substrates and directed to the vegetation irrigation system.
- **Hydroponics agriculture:** This method is based on soilless plant cultivation, which is placed in food solutions with the necessary nutrients. This method provides effective water use where the water solution used is recycled and reused.
- **Agriculture with the semi-floating system (Floating Raft System):** Plants are placed on floating boards floating on the surface of water, and plants are fed through the purification of surrounding water, contributing to their good growth and improving water use.
- **Urban spraying agriculture (Aeroponics):** Urban spraying: In this way, plant roots are sprayed with carefully fed solution in the form of spray. This method is effective in water use and promotes equal and rapid growth of plants.

2. Renewable energies: alternative security for agricultural activity in the Algerian Sahara

In order to avoid the negative impact of Shale gas on agricultural development in Algerian Sahara, renewable energies must be relied upon to enhance the role of sustainable agricultural development in agricultural activity in Algerian Sahara.

Solar energy is the most important renewable energy available to Algeria. The largest proportion of solar energy at the medium-sized country level contains the equivalent of four times the world ' s total energy consumption, i.e., about 37,000 billion cubic metres of gas per year. Algeria has established a hybrid, sandy power plant, the world ' s first of its kind, which operates with gas and solar energy at a production rate of up to 150 megawatts, and the other with a capacity of 1.1 megawatts

Solar energy helps to combat climate change in Algerian Sahara by reducing greenhouse emissions and provides access to energy for Algerian desert farmers. Solar energy can be used in Algerian desert agriculture to dry crops or heat houses, barns and

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agricultural houses, and solar energy also provides hot water for processing and operations of desert farms. In addition to generating power to operate agricultural equipment and water pumps (United Nations, ESCWA, 2019).

3. Attracting modern agricultural technical innovations

Among the modern farming techniques that are compatible with the Sahara environment is Biochar, which is biocoal. Biocoal is a carbon-rich substance, which is made when organic matter is exposed to temperatures greater than 400 degrees Celsius, with no oxygen, in a process called thermal transformation. This process captures the carbon contained in the organic material in a stable manner and prevents its re-entry into the atmosphere.

Biocoal is used to increase soil fertility, improve physical characteristics, increase agricultural production and protect plants from certain soil-induced diseases. In addition, coal is carbon-rich and can withstand the soil for thousands of years, making it an effective means of carbon capture, thereby mitigating global warming and climate change.

4. Nanoclay liquid technology cultivation

Nanoclay is a new innovation produced by the emerging Norwegian company Desert Control. Nanoclay is liquid consists of water and mud only, and the company designed it to be sprayed on sand or sandy soil.

5. Increasing the efficiency of Algerian water resources in the Sahara regions

Increasing the efficiency of Algeria ' s water resources in the Sahara requires a series of actions, mainly the following:

- Increasing water dams.
- Increase in salt Sahara desalination plants.
- Directing research desalination water to areas in the south that suffer from severe rainfall and lack of water resources and their use in agricultural activity and that are consistent with the objectives of sustainable agricultural development
- Activate major water conversion systems for: The Alpine layer towards the states of Djelfa, Tiaret, M'Sila, Biskra, Batna, Saïda, Tiaret and Medea; and The Alpine layer of Ain Salah towards Tamanrasset.

IV. Conclusion

The promotion of food security requires a range of policies. This is what Algeria has sought through its various agricultural development programmes, the most recent of which was the 2020-2024 agricultural model aimed at sustainable development, which has achieved encouraging results over previous periods of time. However, the sustainability of its implementation is uncertain if we take into account climate changes, which have a significant impact on Algerian food security through negative impacts on various agricultural resources and on various branches of agricultural production, which are leading to a decline in agricultural production.

The climatic changes in the Algerian desert from declining rainfall; combined with weak water resources management and fear of the exploitation of Algerian Shale gas in the

south, will have a clear reflection on Algerian agricultural production and thus increase Algerian food security.

The challenges facing Algerian desert agriculture require the best way to develop agricultural production in order to promote and sustain Algerian food security by building on sustainable agricultural development, which has proved to be effective in increasing agricultural production and preserving the environment by:

- Aquaculture
- Renewable energies (solar energy)
- Attracting modern agricultural technical innovations
- Water security through more efficient management of water resources in the Algerian desert through increased investment in the desalination of salt water in southern Algeria

At the conclusion of this research paper, we make a series of suggestions:

- To foster sustainable agricultural development to meet the challenges of climate change at the political and individual levels.
- Increased investments in scientific research centres for sustainable peasant development to develop agricultural patterns compatible with the desert environment of Algeria
- Research on regional clusters concerned with agricultural activity in Algerian Sahara, for which sustainable agricultural development is a priority

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