

Smart Agriculture as a Strategic Approach to Achieving Economic Diversification in Algeria

Rima Amri^{1*}

Mohamed Khider University of Biskra (Algeria),

Rima.amri@univ-biskra.dz 

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Abstract This study examines the transition toward smart agriculture as a strategic avenue for addressing Algeria's intertwined economic and environmental challenges, particularly its reliance on oil revenues. It highlights the role of advanced technologies—such as robotics, satellite systems, water-efficient irrigation, and the Internet of Things—in fostering agricultural modernization and economic diversification. Adopting a descriptive-analytical approach, the research evaluates the current state of Algeria's agricultural sector and the requirements for its digital transformation. The findings indicate that integrating smart agriculture into national economic policies is a critical driver for enhancing diversification, strengthening food security, and creating employment opportunities. Moreover, it contributes to building a more resilient and sustainable economic model by reducing dependency on hydrocarbons and promoting innovation-led growth.

Keywords:

Smart Agriculture;
Economic Diversification;
Digitalization of the Agricultural
Sector;
Algeria.

JEL Classification Codes: Q16 ; Q33 ;
Q25.

* Corresponding author

1. INTRODUCTION

Contemporary economies are increasingly confronted with multifaceted challenges arising from volatility in global markets, climate change, and mounting pressures to ensure food security while safeguarding the sustainability of natural resources. Within this evolving context, smart agriculture has emerged as a strategic paradigm that leverages modern technologies, big data analytics, and digital innovation to enhance productivity, optimize resource efficiency, and mitigate risks associated with climate variability. The adoption of this agricultural model is no longer a supplementary option; rather, it has become an imperative for ensuring the sustainability of socio-economic development across many countries.

Conversely, economic diversification constitutes a foundational pillar for reducing dependency on a single revenue stream, particularly within rentier economies heavily reliant on hydrocarbons. Strengthening the role of non-oil sectors, foremost among them agriculture, represents a strategic avenue toward achieving balanced and sustainable development.

In Algeria, this issue assumes heightened significance due to the economy's structural dependence on oil and gas revenues, which exposes it to the volatility of global energy markets. Despite the country's considerable natural endowments and human potential in the agricultural sector, its contribution to GDP remains below optimal levels. This situation underscores the necessity of restructuring the agricultural sector through the adoption of smart agriculture technologies as a strategic lever for diversifying public revenue sources and enhancing productivity. Accordingly, the central research question is formulated as follows:

How can smart agriculture contribute to economic diversification in Algeria?

To address this question, the paper is structured into two main sections:

- Section One: The conceptual framework of smart agriculture.
- Section Two: The contribution of smart agriculture to economic diversification in Algeria.

2. The Conceptual Framework of Smart Agriculture

Smart agriculture refers to the integration of Fourth Industrial Revolution technologies and modern information and communication technologies into agricultural management. Its main objectives are to improve both the quality and quantity of agricultural production, increase the efficiency of resource management, and promote the sustainable use of available resources. Because of its contribution to sustainable agricultural development, it is often described as a "green revolution." This section discusses the concept of smart agriculture, the main drivers of its digital transformation, and its significance and objectives.

2.1 The Concept of Smart Agriculture

The concept of *smart* or *digital agriculture* first appeared in the United States in 1997. It later gained wider recognition during the Hague Conference organized by the Food and Agriculture Organization (FAO) in 2010, where agriculture, food security, and climate change were discussed as closely interconnected issues. Since then, a number of definitions have been proposed.

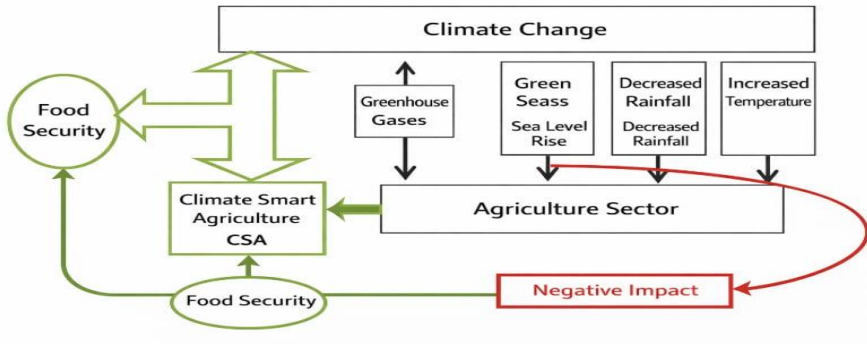
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Smart agriculture has been defined as the application of scientific knowledge together with information and communication technologies to support sustainable agricultural practices. It helps mitigate, or at least reduce, the effects of drought and other climate-related changes by encouraging farming methods adapted to changing environmental conditions. In doing so, it improves agricultural productivity while supporting the sustainable management of natural resources. (Omar, Lekhal, & Abed, 2020, p. 207)

Another definition describes smart agriculture as an agricultural system that relies on mobile technologies and other digital tools to provide timely and relevant agricultural information. Access to such information improves farm management throughout the production cycle, from land preparation to harvesting. (Al-Dulaimi, 2023, p. 514).

Taken together, these definitions suggest that smart agriculture is an agricultural system that relies on artificial intelligence and other advanced digital technologies to address the challenges associated with climate change. At the same time, it seeks to improve crop yields, enhance the quality and quantity of agricultural production, and reduce production costs wherever possible. Its broader objective is to strengthen food security by promoting sustainable agricultural productivity and increasing resilience to climate change. Figure 1 illustrates the relationship between climate change and smart agriculture

Fig 01: The various linkages between climate change and smart agriculture.



Source: (Moussaoui & Yousfi, 2021, p. 910)

2.2 Advantages of Digital Transformation in the Agricultural Sector

Digital transformation in agriculture provides a set of advantages that may be presented as follows: (Soudani, Ben Aichouba, & Sedkaoui, 2022, p. 457)

1. Enhancing productivity:

Information and communication technologies, together with other advanced technologies, improve agricultural productivity in both quality and quantity. They achieve this by reducing the use of agricultural inputs such as fertilizers, pesticides, and energy. As a result, production costs decline, environmental impacts are reduced, and overall output increases.

2. Efficiency of agricultural management:

Digital transformation strengthens agricultural management by encouraging regional participation and creating opportunities for collaboration with governments and other institutions involved in agricultural development. This collaborative approach supports more informed and effective decision-making.

3. Increasing profitability: Data collected on cultivation practices and their environmental impact provide valuable insights into production requirements at the beginning of the growing season. Such information helps anticipate market demand and facilitates the identification of potential buyers for surplus production before harvesting.

4. Accurate information: Digital technologies enable farmers to deliver higher-value agricultural services through the use of high-resolution satellite imagery capable of predicting crop readiness for harvest. They also rely on robots deployed across agricultural fields to collect data continuously. The analysis of these data allows crops to be monitored more effectively and makes it possible to detect potential problems at an early stage, enabling timely intervention before crop growth is adversely affected.

2.3. The Importance of Smart Agriculture

The importance of smart agriculture, according to the report of the Arab Organization for Agricultural Development, is reflected in the following: (Al-Tihami, 2024, p. 105)

- Monitoring field conditions and tracking climate changes effectively and accurately.
- Improving the use of agricultural inputs such as pesticides and fertilizers.
- Enhancing the use of agricultural equipment.
- Achieving better cost rationalization and attaining maximum profitability of agricultural projects.
- Preserving natural resources, particularly irrigation water.
- Assisting in making decisions at the appropriate time through reliance on mobile applications.
- Monitoring livestock and tracking their health status with minimal cost and effort.
- Providing sustainable food for millions of individuals.

2.4 Objectives of Smart Agriculture

The adoption of smart agriculture promotes agricultural development and generates considerable economic value without imposing additional financial burdens. Instead, it produces substantial economic and environmental benefits over both the short and the long term. Its objectives can be summarized in three main areas : (Bouthaljah, 2020, p.220)

- Increasing agricultural productivity in a sustainable manner to strengthen food security, support development, and promote equitable growth in income.
- Enhancing the capacity to adapt to and withstand crises and shocks at the farm, local, and national levels, while helping rural communities and farmers become more resilient to the impacts of climate change.

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- Reducing the use of unsafe agricultural inputs, particularly chemical pesticides and fertilizers that have harmful effects on the environment.

Based on these objectives, countries can increase public revenues generated by the agricultural sector. Higher productivity, combined with lower production costs, contributes directly to greater returns from agricultural assets, thereby supporting the diversification of public financial resources.

3. The Contribution of Smart Agriculture to Economic Diversification in Algeria

The Algerian economy depends primarily on oil revenues as its main source of public income. This dependence has long posed a major challenge to the national economy and placed considerable pressure on the state budget, particularly during periods of oil price volatility driven by complex political and economic factors. In response, Algeria has sought to diversify its sources of income by promoting the development of various productive sectors and reducing its reliance on exhaustible natural resources. Against this background, this section examines the concept of smart agriculture and discusses its potential contribution to economic diversification in Algeria.

3.1 The Concept of Economic Diversification

Economic diversification has become a major concern for policymakers seeking to protect national economies from the risks associated with excessive dependence on a single source of revenue. Although the concept has been defined in different ways, the following definitions are among the most widely cited.

Economic diversification is generally defined as the process of reducing dependence on a single resource by strengthening the

industrial and agricultural base and expanding productive activities. It aims to build a sound national economy capable of achieving greater self-sufficiency through the development of multiple productive sectors(Tirash, Kaki, & Ben Daqfal, 2020, p.307)

It is also described as the process of diversifying sources of income, broadening the production base, and increasing the contribution of productive sectors, including both goods and services, to gross domestic product (GDP). This process reduces the risks associated with dependence on a single primary commodity while promoting the efficient use of domestic resources and production capacities. It also supports the accumulation of national productive capabilities, enabling the creation of renewable sources of income and strengthening the ability of domestic production to meet local demand.(Mazrouk & Makki, 2014)

In hydrocarbon-producing countries, economic diversification generally refers to developing the oil economy while expanding non-oil exports. In economies where the public sector dominates economic activity, diversification also requires strengthening the private sector and giving it a more prominent role in economic development. (Kadi, 2015)

Economic diversification has become a central objective of development strategies in most Arab oil-exporting countries. For many years, these economies have relied heavily on the energy sector as the principal contributor to GDP, public revenues, and government expenditure, often at the expense of other value-creating sectors such as agriculture, manufacturing, and services. The following section outlines the main objectives pursued through economic diversification.

3.2 Objectives of Economic Diversification

The main objectives of economic diversification may be summarized as follows : (Tirash, Kaki, & Ben Daqfal, 2020)

- Reducing economic vulnerability and strengthening the capacity to respond to external crises and economic shocks.
- Sustaining economic development by expanding and diversifying productive sectors as sources of income, foreign exchange earnings, and public revenues.
- Achieving greater self-sufficiency in goods and services, increasing exports, and reducing dependence on imported consumer products.
- Creating employment opportunities and improving the standard of living.
- Strengthening the role of the private sector in economic development while reducing the financial burden on the state.
- Reducing excessive dependence on a single economic sector or a single natural resource, particularly oil, as the principal source of public revenue, as is the case in many oil-producing countries.

3.3 Mechanisms of Economic Diversification

The relationship between economic diversification and economic growth has been interpreted from two main perspectives. The first is based on Ricardo's theory of comparative advantage, which considers specialization a key driver of economic growth.

The second, supported by numerous empirical studies, argues that limited economic diversification and the concentration of production and exports have adverse effects on growth. From this perspective, expanding the degree of diversification and avoiding excessive concentration in a small number of products, sectors, or activities are regarded as essential for sustainable economic development. Accordingly, most studies conclude that economic diversification promotes economic growth through the following mechanisms (Tirash, Kaki, & Ben Daqfal, pp. 308-309. 2020)

- **Reducing investment risk:** In financial theory, Markowitz's well-known principle, *"Do not put all your eggs in one basket,"* emphasizes the importance of diversification. Allocating investments across different sectors reduces the likelihood of losses while improving expected returns.
- **Restoring the developmental role of the state:** The state's role extends beyond achieving high GDP growth rates. It also involves promoting structural transformation within the domestic economy and strengthening its integration into the global economy. This process requires changes in production structures, the contribution of production factors, and the allocation of resources across economic sectors.
- **Strengthening the role of the private sector:** The private sector plays a central role in economic diversification. Driven by profitability and long-term sustainability, private firms continuously seek new production methods, improve efficiency, reduce costs, and maintain product quality in order to meet both domestic and international market demand.

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- **Reducing fluctuations in GDP:** Economies characterized by limited diversification and a high concentration of production tend to experience greater fluctuations in GDP. Several studies have identified an inverse relationship between GDP volatility and economic growth.
- **Creating employment opportunities:** By stimulating economic growth and strengthening linkages among productive sectors, diversification increases demand for labor and contributes to job creation.
- **Attracting foreign direct investment (FDI):** Foreign direct investment is widely recognized as an important mechanism for economic diversification. Many developing countries face limited domestic financial resources because of insufficient savings, while the rising cost of external borrowing has increased the importance of attracting foreign investment to support economic development.
- **Increasing value added:** Diversification contributes to employment creation and improves the returns to the factors of production. These effects increase value added at both the sectoral and national levels.
- **Supporting economic reform programs:** Fiscal, monetary, and trade reforms play a vital role in advancing economic diversification. Their continued implementation creates a more favorable environment for broad-based economic development.
- **Promoting sustainable development:** A diversified economy is generally more resilient to external shocks and economic cycles. It is also better positioned to create

employment opportunities, generate higher value added, and sustain long-term growth. In addition, greater reliance on renewable energy sources, such as solar and wind power, supports sustainable development by reducing dependence on a single source of energy.

The above discussion shows that economic diversification is more than a development objective; it has become a strategic necessity for achieving sustainable economic growth and strengthening the resilience of national economies. Broadening the productive base, creating employment opportunities, increasing value added, and expanding the contribution of non-oil sectors to Gross Domestic Product (GDP) all contribute to this objective. Within this context, agriculture stands out as one of the sectors with the greatest potential to support economic diversification in Algeria. The country's abundant natural resources and considerable production potential provide a strong foundation for diversifying national income, strengthening food security, reducing dependence on food imports, and creating new opportunities for investment and employment. Against this background, examining the current state of Algeria's agricultural sector is essential for assessing its contribution to economic diversification and identifying the major constraints that continue to limit its development potential.

3.4 The State of the Agricultural Sector in Algeria

Algeria possesses considerable natural resources and favorable geographical conditions that should, in principle, support the development of a productive agricultural sector. Despite these advantages and the sector's strategic importance, available data on agricultural production, exports, and imports indicate that the country continues to experience a high degree of food dependence. Food imports therefore remain an important component of meeting domestic demand.

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Dependence on cereals increased from **51.24%** to **71.74%** during the period **1980–1990** and remained high at **70.30%** during **1991–2001**. During the same period, dependence on wheat rose from **56.8%** to **71.55%**. These figures illustrate the persistence of food dependence in Algeria, a challenge resulting from numerous interrelated factors.

The following table presents the value of food exports and imports in Algeria.

**Table No. 01: Value of exports and imports in Algeria during
the period 2010–2013**

Years	2010	2011	2012	2013
Exports	315	355	315	402
Imports	6058	9850	9022	9580

Source: (Omar, Lekhal, & Abed, Smart Agriculture as a Mechanism for
Achieving Agricultural Development and Sustainable Food Security
According to Modern Technological Trends, 2020, p. 208)

Table 1 shows a clear imbalance in Algeria's agricultural trade balance over the period 2010–2013, with agricultural imports consistently exceeding exports by a wide margin. Agricultural exports ranged from USD 315 million to USD 402 million, whereas imports remained above USD 6 billion throughout the period and reached USD 9.85 billion in 2011 before declining slightly in the following two years. These figures indicate Algeria's continued reliance on international markets to meet a large share of its domestic food demand. They also reflect the limited contribution of the agricultural sector to the development of non-hydrocarbon exports. Despite the country's considerable

agricultural resources, the sector has not yet become a major driver of economic diversification or a significant source of sustainable value creation.

To address these challenges, the Algerian government launched a series of economic recovery and development programs aimed at strengthening productive capacity and supporting economic diversification. The Economic Recovery Program (2001–2004) allocated DZD 525 billion, followed by the Complementary Program to Support Growth (2005–2009), with an allocation of DZD 4,202 billion. This was followed by the Five-Year Development Program (2010–2014), which received DZD 21,214 billion. These public investment programs sought to improve living standards, create employment opportunities, provide a more favorable environment for economic activity, and promote balanced regional development. Their impact on the agricultural sector is presented in the following table.

Table No. 02: The Position of Agriculture within Development Plans for the Period 2001–2014

Plans	Economic Recovery Plan	Growth Support Plan	Five-Year Plan
Total	525	4202	21214
Investments			
Agriculture	65.4	300	1000
%	12.46	7.14	4.71

Source: (Omar, Lekhal, & Abed, 2020, p. 209)

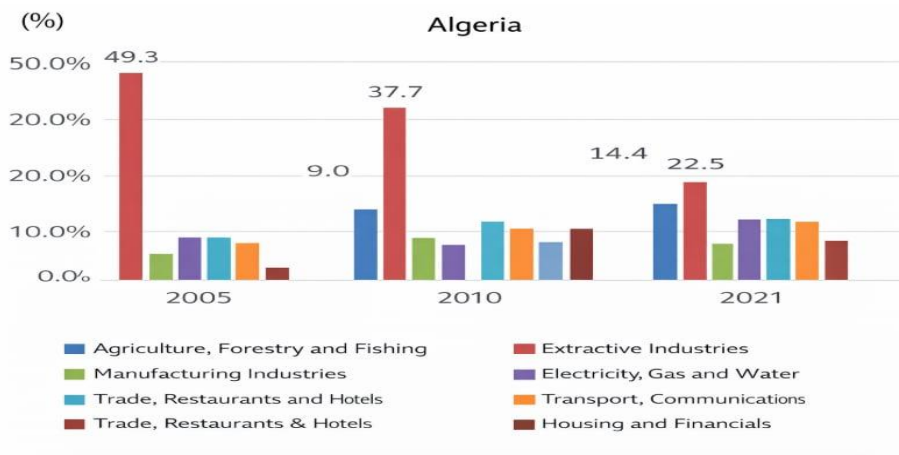
The above table shows that the share of financial resources allocated to agriculture declined markedly across the successive development programs, falling from 12.64% to about 4%. This substantial reduction suggests that public investment priorities gradually shifted toward other sectors. Since financial allocations

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generally reflect government priorities, the decline indicates that less emphasis was placed on the agricultural sector.

Official statistics also show that agriculture accounted for 8.2% of GDP in 2005. Its contribution increased to 9% in 2010 and reached 14.4% in 2021. This trend reflects the government's efforts to diversify economic activity and broaden its investment base. The following figure also shows that the share of the extractive industries sector declined from 49.3% to 22.5% in 2021. At the same time, the contribution of the services sector, including transport, hospitality, insurance, and banking, increased. These developments provide further evidence of Algeria's efforts to diversify its economy.

Fig 02: Share of economic activities in GDP in Algeria



Source: (Hassan, Qaloul, & Al-Farran, 2023, p.14)

Although the agricultural sector has recorded noticeable progress and some non-hydrocarbon activities have gradually expanded, these developments have not fundamentally changed the structure of the Algerian economy. Hydrocarbon activities

remain the main source of national income and public revenues, which limits the overall impact of economic diversification efforts. Consequently, Algeria's heavy dependence on hydrocarbon revenues has continued to expose both the state budget and public expenditure to recurring financial pressures. Fluctuations in global energy markets, together with the sensitivity of oil prices to political and economic developments, have made this dependence a continuing source of fiscal instability and economic uncertainty. The following figure shows the share of hydrocarbon revenues in total public revenues and highlights the continued importance of the hydrocarbon sector within Algeria's public finances.

Fig 03: Share of oil revenues in total public revenues

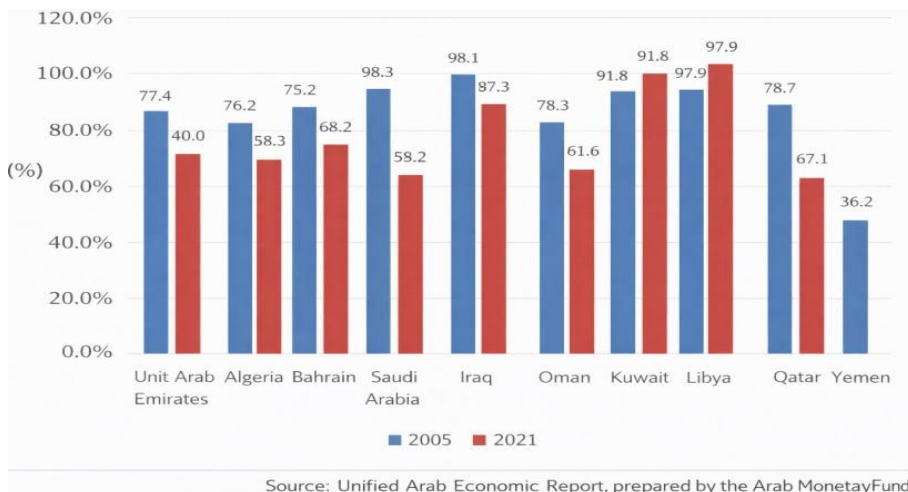


Figure 2 shows the share of fuel exports in total merchandise exports in a number of Arab countries in 2005 and 2021. The data reveal clear differences in the extent to which these economies depend on hydrocarbon exports. Although the share of fuel exports declined in most countries during the period

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under review, hydrocarbons continued to dominate the export structure of many Arab economies.

In Algeria, the share of fuel exports fell from 76.2% in 2005 to 58.3% in 2021, a decline of 17.9 percentage points. This change indicates a gradual, although still limited, improvement in the composition of the country's exports as non-hydrocarbon exports expanded. Nevertheless, fuel exports continued to account for the largest share of total exports, reflecting the Algerian economy's continued dependence on hydrocarbon revenues. As a result, the economy remains highly exposed to fluctuations in international oil markets, which continue to constrain efforts to achieve a more diversified and sustainable pattern of economic growth.

The effects of this dependence are also evident in Algeria's public finances. Despite the reforms and diversification initiatives introduced by the government, hydrocarbon revenues have remained the principal source of public income, while tax revenues continue to play a secondary role. In 2021, tax revenues represented approximately 39.2% of total public revenues. Taxes on income and profits accounted for 43.8% of total tax revenues, whereas taxes on goods and services represented about 41.8%. The figure also shows that, unlike Kuwait, Iraq, and Libya, most Arab hydrocarbon-exporting countries have increased the contribution of tax revenues to their public finances, reflecting gradual progress toward more diversified fiscal structures.

Overall, these findings indicate that Algeria has made some progress in reducing its dependence on hydrocarbon exports. However, this progress has not yet brought about a substantial change in either the structure of exports or the composition of

public revenues. This highlights the need to accelerate economic diversification by strengthening productive sectors, particularly agriculture. In addition to its essential role in improving food security, the agricultural sector offers significant opportunities to expand non-hydrocarbon exports, generate more sustainable public revenues, and strengthen the resilience of the national economy to external shocks. In this way, it can make a meaningful contribution to long-term and inclusive economic development.

.3.5 Smart Agriculture Technologies for Advancing the Agricultural Sector in Algeria

Artificial intelligence technologies comprise a range of algorithms and mathematical models designed to process data and simulate human cognitive abilities in support of decision-making. In agriculture, large volumes of data are generated daily by sensors and Internet of Things (IoT) devices. These data include information on temperature, weather conditions, humidity, soil characteristics, crop health, pests, water quantity, and water salinity. Because these data are collected continuously and in real time, artificial intelligence plays an essential role in analyzing and processing them. It also helps generate accurate information on field conditions and provides predictive insights that support more effective agricultural management. According to (Siari & Jebli, 2023, p.p.32-34) these technologies can be classified into two main categories.

- ✓ **First classification:** This category includes a range of smart agricultural technologies designed to improve production efficiency by helping farmers better understand their land and select appropriate cultivation practices. It comprises three groups:

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- **Equipment-based technologies:** These include advances in agricultural machinery, such as autonomous tractors, automated grain unloading systems, electric irrigation drive systems, and agricultural robots.
 - **Information technology-based technologies:** These include Global Positioning System (GPS) applications and remote sensing technologies used to monitor crops and assess soil conditions.
 - **Biotechnology-based technologies:** These include high-throughput screening techniques that accelerate the multiplication of beneficial organisms and support innovations such as drought-resistant crops and soil acidity testing.
- ✓ **Second classification:** his category includes technologies and mechanisms that improve agricultural processes and increase production while making more efficient use of available resources. It includes the following:
- **Monitoring and observation systems: These include:**
- ✓ **Satellites:**
The use of satellites in agriculture has expanded considerably in recent years. They enable remote crop monitoring, reducing both time and operational costs. When integrated with soil and crop sensors, satellite systems can provide early warnings of potential risks. They also support weather forecasting, helping farmers determine the most suitable periods for planting and harvesting.
- ✓ **Internet of Things (IoT):**
The Internet of Things is one of the most important technological developments in modern agriculture. It provides comprehensive information on farm conditions,

including soil characteristics, humidity, and wind levels, allowing farmers to make better-informed decisions. This contributes to higher productivity and lower crop losses. In addition, air sensors mounted on drones provide information on the optimal timing for planting and harvesting, crop health, and the presence of pests and insects that may damage crops. These technologies improve production efficiency while reducing time, labor, and costs. Among their main applications are the following (Bouabdelli & Gharbi, 2023, p.p220-221)

- ✓ **Precision agriculture:** Precision agriculture is a farm management approach that combines information and communication technologies with sensors, remote-control systems, and automated machinery to collect accurate data and apply it to agricultural operations. This enables more precise management of farming activities, improves production quality, and reduces costs. It also allows decisions to be made at the level of individual plants or even individual square meters within a field.
- ✓ **Unmanned aerial vehicles (drones):** Drones operate at low altitudes and facilitate the monitoring of large agricultural areas through infrared and multispectral imaging. They collect detailed information on crops and land conditions and support site-specific fertilizer application according to the characteristics of each field.
- ✓ **Remote sensing devices:** These devices are distributed throughout agricultural fields to monitor environmental conditions continuously. They measure soil properties such as nitrogen, phosphorus, moisture, acidity, and temperature, while also providing weather-related information that supports timely and well-informed agricultural decisions.

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- **Artificial intelligence-driven equipment:** These include: (Siari & Jebli, 2023, pp. 34–35)
- ✓ **Agricultural robots:** Advances in artificial intelligence and computer programming have led to the development of autonomous agricultural robots capable of performing essential farming tasks. These include harvesting crops more rapidly than manual labor, monitoring crops and soil conditions, processing data collected by drones, using computer vision technologies, and controlling weeds.
- ✓ **Autonomous tractors:** Smart tractors represent an important technological development in modern agriculture. They perform plowing and seed distribution with a high degree of precision and can monitor crop growth while estimating harvest dates. By combining GPS technology with automated control systems, these tractors improve operational accuracy, reduce soil compaction, save time, and optimize harvesting routes. They are also capable of identifying field paths and operating autonomously.
- **Modern technological approaches in agriculture:** These include:
 - ✓ **Vertical farming:** Vertical farming refers to the cultivation of crops in stacked layers within controlled environments and confined spaces. It is primarily used for soilless cultivation, particularly hydroponic systems, in which plant roots receive a continuous supply of water and nutrients. These systems rely on advanced technologies to monitor crop growth and regulate environmental conditions such as light and humidity. They also support the local production of food and pharmaceutical crops through production systems similar to greenhouses, where artificial lighting and

reflective materials are used to supplement natural sunlight. Their main objective is to improve the efficient use of resources while promoting waste recycling.

- ✓ **Nuclear techniques in agriculture:** Nuclear techniques in agriculture: Nuclear techniques in agriculture involve modifying plant genetic material to eliminate genes associated with diseases or to accelerate plant growth. Their application has been facilitated by advances in technologies such as electron microscopy and microinjection.

3.6 Requirements for Smart Agriculture in Algeria

Algeria possesses significant natural, financial, and human resources that provide a solid foundation for the adoption of smart agriculture as a means of supporting economic diversification. However, achieving this objective requires addressing a number of challenges, including the following : (Bouabdelli & Gharbi, 2023, pp. 323–324)

- Developing appropriate policies and regulatory frameworks. Governments and policymakers have a central role in creating an environment that supports agricultural digitalization while ensuring transparency, security, and fairness in financing mechanisms.
- Raising awareness among farmers and livestock breeders of the benefits of investing in smart agriculture.
- Encouraging greater private sector investment in smart agriculture.
- Strengthening partnerships among different stakeholders to expand the adoption of smart agriculture and improve investment returns.
- Integrating climate adaptation and mitigation measures into local budget planning.

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- Addressing the constraints faced by small farmers and small and medium-sized agricultural enterprises.
- Providing incentives for smallholders engaged in subsistence farming.
- Strengthening agricultural governance through the development of effective national policies.

3.7 Steps Taken Toward the Digitalization of the Agricultural Sector in Algeria

Algeria has made sustained efforts to keep pace with technological developments by promoting the use of artificial intelligence and digital technologies across a range of sectors, particularly agriculture. These efforts form part of the country's broader strategy to advance economic diversification. Among the most notable initiatives are the following (Naeem & Haid, 2025, p.391)

- The launch of the **ELFIRMA DZ** platform by the Directorate of Information Systems and Statistics under the supervision of the Ministry and the Director General of the National Professional Office for Vegetables and Meats. The platform facilitates the direct marketing of high-quality agricultural products from producers to consumers at competitive prices. It provides information on approximately 500 sales outlets, including 300 public outlets affiliated with the Ministry and 200 private outlets and agricultural enterprises. It also includes a mobile application that allows consumers to monitor prices daily across markets and sales points.
- Support for start-ups has become an important component of Algeria's strategy to encourage entrepreneurship and

innovation. The adoption of **Law 1275** by the Ministry of Higher Education and Scientific Research has enabled students to develop innovative business ideas based on new products and services. This initiative has encouraged the creation of start-ups capable of contributing to the development of several sectors, including agriculture.

As part of these efforts, a growing number of innovative Algerian enterprises have emerged in recent years. By using digital technologies, they have developed practical solutions to improve agricultural production and address many of the challenges facing the sector. Their activities have encouraged the adoption of smart farming practices, improved production efficiency, promoted more efficient use of natural resources, and strengthened agricultural value chains. These developments demonstrate the growing contribution of entrepreneurship and technological innovation to the modernization of Algerian agriculture.

Table 3 presents a selection of Algerian start-ups that illustrate how digital technologies and entrepreneurship are being applied to support the development of smart agriculture.

Table No. 03: Major start-ups in the agricultural sector

Project Name	Description
Algisnova (Smart Project)	The platform works to link farmers with retail stores through: - Providing a special marketing store for farmers to display their products, giving them complete freedom

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	in managing it. - Registering retail stores on the platform to contact farmers directly, ensuring that farmers receive full profit without intermediaries.
Filahati	A project consisting of equipping smart greenhouses (<i>serres intelligentes</i>) with automated agricultural production systems.
AITECH Project	This company relies on artificial intelligence technologies in several smart agricultural operations, especially to address the risks of diseases and pests.
Logistics Milk	A project that allows the transport of milk over any distance and under harsh conditions while maintaining its quality, to ensure it reaches the consumer without bacterial contamination.
Valley Aquaponic	A project aimed at optimal use of water resources to achieve food security without waste, by using a closed-cycle system to produce organic vegetables free from pesticides, along with converting agricultural waste into fish feed.
Entomaqua	A project based on creating smart enclosures and industrial systems for insect farming to produce large quantities of proteins as an alternative to animal consumption.

Source: (Naeem & Haid, 2025, p. 392)

Table 3 shows that the activities of Algerian start-ups have expanded beyond conventional agricultural production to include the use of advanced technologies such as artificial intelligence (AI), the Internet of Things (IoT), digital platforms, precision agriculture, and integrated production systems. These technologies contribute to higher productivity, better product quality, and more efficient use of natural resources.

The table also illustrates the diversity of agricultural innovations introduced by these enterprises. Their activities include digital platforms for marketing agricultural products, smart farming applications, agricultural risk management systems, logistics services for perishable products, integrated fish and vegetable

production systems, and the development of alternative proteins. Together, these initiatives demonstrate the growing contribution of innovation and entrepreneurship to the modernization of agriculture. They also support economic diversification by creating new sources of value added, generating employment opportunities, reducing dependence on food imports, and improving the competitiveness of Algerian agricultural products.

Despite this progress and the government's continued efforts to modernize the agricultural sector within the broader strategy of economic diversification, several challenges continue to limit the wider adoption of these technologies. These include inadequate digital infrastructure, particularly in rural areas, the high cost of advanced technologies required for smart agriculture, most of which are imported, and the need for a skilled workforce capable of operating and managing these technologies effectively. In addition, limited collaboration among farmers, universities, and innovation institutions continues to slow the transfer and practical application of technological advances. Addressing these challenges through sustained public support, stronger institutional coordination, and greater investment in digital infrastructure and human capital would strengthen the role of agricultural innovation in promoting economic diversification and supporting sustainable and inclusive economic growth in Algeria.

4. CONCLUSION

The findings of this study can be summarized as follows:

- Smart agriculture has the potential to increase agricultural productivity, improve crop quality, and reduce the costs associated with water and energy use.
- Smart agriculture technologies enable farmers to make more accurate and timely decisions, reducing resource

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waste and production costs while improving the management of agricultural operations.

- The findings show that Algeria's heavy dependence on hydrocarbons continues to constrain economic diversification, making the development of smart agriculture an important alternative for reducing this dependence.
- The use of digital technologies and artificial intelligence in agriculture improves planning and farm management while enhancing the competitiveness of Algerian agricultural products.
- Smart agriculture can contribute to economic diversification, strengthen food security, and support social stability through the creation of sustainable employment opportunities.
- Although Algeria is still at an early stage in the digital transformation of its agricultural sector, the initiatives already introduced demonstrate the growing importance of agriculture and its potential to make a greater contribution to public revenues in the future.

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