Modern Agricultural Development Through Artificial Intelligence

Laksi Fouzia
University of Mostaganem (ALGERIA), fouzia.laksi@univ-mosta.dz
ORCID:https://orcid.org/0009-0007-8604-8636

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Abstract: This study aims to highlight the role of artificial intelligence in achieving modern agricultural development by examining the main smart technologies and applications used in the agricultural sector and analyzing their impact on productivity and the performance of agricultural enterprises. The study adopts a descriptiveanalytical approach to explore the different dimensions of AI applications in modern agriculture.Thefindings indicate that artificial intelligence plays a vital role in promoting smart agriculture through improving resource efficiency, increasing productivity, and supporting accurate decision-making based on data analysis. The study also shows that AI contributes to reducing waste, improving crop quality, enhancing supply chain management and market forecasting, and helping farmers adapt to consumer demands. Furthermore, AI technologies support the management of agricultural challenges, including pest control, soil health improvement, and climate change mitigation, thereby strengthening innovation-driven agricultural development.

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Corresponding author: Laksi Fouzia, fouzia.laksi@univ-mosta.dz

1.INTRODUCTION

Artificial Intelligence (AI) is regarded as one of the most significant modern technologies contributing to rapid technological advancement and expanding opportunities for innovation and growth across various sectors. It plays a pivotal role in improving quality, enhancing capabilities, increasing operational efficiency, and boosting productivity. Despite the widespread adoption of AI technologies and the extensive discussions surrounding their potential, these technologies are often associated with ambiguity and exaggerated expectations, which may create unrealistic perceptions regarding their actual capabilities. Consequently, the understanding of artificial intelligence, its technologies, and its practical applications remains unclear for many decision-makers and executives in both the public and private sectors.

With the emergence of the contemporary technological wave driven by artificial intelligence applications, expectations have increased regarding the global economy entering a phase of exceptional growth accompanied by profound transformations in labor market structures, noticeable improvements in production levels and productivity efficiency, and the development of innovative solutions capable of addressing crises across vital sectors, particularly the agricultural sector. In light of these developments, the present study seeks to address the following research problem: **How can artificial intelligence be utilized to develop the agricultural sector and enhance the competitiveness of agricultural enterprises?**

Based on the main research problem, several sub-questions are raised. These include examining whether artificial intelligence contributes to economic development, determining the extent of Algeria's interest in developing the agricultural sector, identifying the concept of smart agriculture, and exploring the role of artificial intelligence in enhancing the competitiveness of agricultural enterprises.

The study is built upon a set of hypotheses formulated as preliminary answers to the research questions. It assumes that artificial intelligence plays a significant role in achieving economic development and that the agricultural sector represents one of the promising sectors upon which Algeria relies to support economic growth. The study also assumes that smart agriculture is fundamentally reflected in the digitalization of agricultural activities and that artificial intelligence contributes positively to strengthening the competitiveness of agricultural enterprises.

This study primarily aims to examine the important role of artificial intelligence in the development of the agricultural sector. It also seeks to analyze the impact of agricultural digitalization on economic development and smart agriculture, while highlighting the various applications of artificial intelligence within the agricultural sector, with particular emphasis on their contribution to enhancing the competitiveness of agricultural enterprises.

The significance of this study stems from the strategic importance of the agricultural sector within the Algerian economy, in addition to the growing importance of artificial intelligence and its applications in supporting smart agriculture and improving the competitiveness of agricultural enterprises. Furthermore, the study contributes to enriching the academic discussion on the integration of advanced technologies into agricultural development strategies. To achieve the objectives of the study, the descriptive–analytical approach is adopted. This approach relies on collecting relevant information and data related

to the topic, organizing and utilizing them effectively, and subsequently analyzing them in order to reach scientifically grounded conclusions regarding the role of artificial intelligence in the development of the agricultural sector.

2.The Economic Orientation of Artificial Intelligence

Artificial intelligence consists of two words: intelligence, which refers to the ability to understand, perceive, and learn new situations or conditions; and artificial, which relates to the act of creating and shaping things without direct human intervention. Among its most important characteristics is that the extensive use of technological advancement contributes to achieving flexibility in handling tasks, saving time and effort, ease of implementation, and accuracy in performance (Tadmastafawi Hayat & A. Faisal Mohammed Maida, 2022).

Artificial intelligence is defined as a scientific and technological field concerned with the design and development of systems and machines capable of simulating a range of cognitive functions traditionally attributed to the human mind, such as perception processes, logical reasoning, learning from experience, interaction with the surrounding environment, decision-making, and solving complex problems, in addition to the ability to produce limited forms of creativity. However, artificial intelligence (AI) does not constitute a single homogeneous entity; rather, it represents a comprehensive framework that encompasses an integrated set of advanced technologies and computational models, which differ in their levels of development and scientific and practical maturity. These technologies rely on mathematical algorithms and the processing of massive amounts of data, enabling intelligent systems to gradually improve their performance and adapt their behavior based on available patterns and data, reflecting the dynamic and evolving nature of this field (Safia Ben Qarab, 2022, p. 119).

Algeria ranked 11th among 11 Arab countries included in the report out of 83 countries, and 80th globally, according to the Global Artificial Intelligence Index in its annual 2024 report. The index measures the level of artificial intelligence advancement across countries worldwide by analyzing national strategies and comparing them with the scale of government spending through several core indicators, including government strategy, operational environment, infrastructure, research and development, talent, and trade. The index comprises 122 sub-indicators based on data from both the public and private sectors. Regarding the major countries dominating the artificial intelligence landscape, the United States topped the index, followed by China, while Singapore ranked third as the second most active country in artificial intelligence in Asia after China. The United Kingdom came fourth, followed by France. Meanwhile, global concerns persist regarding the ability of artificial intelligence to dominate various job functions, impose involuntary unemployment on humans, and, more critically, replace individuals in decision-making and responsibility (according to the Global Artificial Intelligence Index, 2025).

Statistics indicate that the artificial intelligence market is expanding at a compound annual growth rate (CAGR) of 38.1% between 2022 and 2030, and its size is expected to increase by no less than 120% annually. Artificial intelligence has reached a level of importance that requires it not to be left solely to computer scientists. This is emphasized by Sendhil Mullainathan, a behavioral economics expert at the Massachusetts Institute of Technology, who has devoted more than a decade to applying artificial intelligence to economic research (International Monetary Fund, 2025).

The relationship between artificial intelligence and the economy is characterized by complexity and interdependence, combining vast opportunities with profound andmultidimensional challenges. On one hand, artificial intelligence has the potential to bring about radical transformations across various sectors and industries by enhancing efficiency, increasing productivity, and stimulating innovation. On the other hand, these transformations necessitate serious analytical thinking to address challenges related to labor markets, particularly with regard to job restructuring, income and wealth distribution, as well as ethical and social considerations. Maximizing the benefits of artificial intelligence technologies depends on the ability of public policies and regulatory frameworks to strike a balance between maximizing economic gains and ensuring adherence to ethical and social safeguards, thereby preventing the widening of gaps and inequalities.

The concept of artificial intelligence has become a priority on the agenda of entrepreneurs due to its revolutionary potential to transform business performance and value creation in the twenty-first century. In this context, a study by Coatsworth (2018) indicated that approximately 63% of U.S. companies had adopted machine learning, making it the most widely used artificial intelligence technology in 2018. Google and Microsoft have also integrated artificial intelligence into their messaging platforms. The impact of these developments on reshaping the business and trade environment is evident, as traditional stores have increasingly been transformed into digital marketplaces (ThamerAttihSber Al-Anazi, 2022, p. 53).

In light of the various challenges facing the world whether economic, political, or environmental achieving the Sustainable Development Goals (SDGs) has become one of the top priorities of countries. With unlimited technological advancement and the emergence of artificial intelligence technologies, countries have inevitably moved toward harnessing and adapting these technologies to achieve their goals, particularly the Sustainable Development Goals. UNESCO has played an effective role in leveraging artificial intelligence to achieve the SDGs by assisting countries in a manner tailored to their specific contexts, through setting standards, supporting policy formulation, and building national capacities. In 2019, the Beijing Consensus document emerged, in which representatives of states, international organizations, academic institutions, civil society, and the private sector agreed on the importance of artificial intelligence in education and scientific research. The document also emphasized the centrality of the human element and its importance in disseminating artificial intelligence technologies in education to enhance sustainable development and protect human rights through cooperation between humans and machines (Prof. Nagham Hussein Naama, 2024, p. 01).

Through these analyses, the impact of artificial intelligence and the magnitude of the value available for exploitation become evident. Artificial intelligence could contribute up to USD 15.7 trillion to the global economy by 2030, exceeding the current combined output of China and India. Of this total, an estimated USD 6.6 trillion would come from increased productivity, while USD 9.1 trillion would result from consumption-side effects (AI Statistics Worldwide, 2025).

Debate continues among economists regarding when massive investments in artificial intelligence will yield productivity gains if they do so at all. Nevertheless, governments are

treating artificial intelligence as the new frontier of industrial policy, with initiatives on a scale previously reserved for sectors such as space exploration or nuclear energy. The United Arab Emirates appointed the world's first Minister of Artificial Intelligence in 2017, while Francepledged to allocate more than EUR 100 billion to artificial intelligence spending. In the two leading countries in artificial intelligence, the race has become increasingly geopolitical: the United States imposed controls on exports of advanced semiconductor chips, and China responded by restricting sales of key minerals. Competition in algorithms is no less intense than competition over energy, land, water, semiconductors, and minerals. Supplies of energy and electronic chips will determine the pace of the artificial intelligence revolution and which countries and companies will ultimately control it (IMF, 2025).

3.The Actual Orientation Toward Enhancing the Competitiveness of the Agricultural Sector in Algeria within the Framework of Achieving Economic Diversification:

The projections outlined in the Finance Law for 2026 indicate an economic growth rate estimated at approximately 4.1%, expected to rise gradually to 4.4% in 2027 and 4.5% by 2028. This positive trajectory is mainly attributed to the notable improvement in the performance of non-oil sectors, particularly industry, agriculture, and services, within the framework of a strategic orientation aimed at consolidating economic diversification, reducing excessive dependence on oil rent, strengthening local productive activities, and curbing imports, rather than relying solely on revenues from the hydrocarbons sector, especially gas and oil.

In this context, a budget estimated at around USD 135 billion, the largest in Algeria's history, has been allocated. The majority of this budget is directed toward supporting public spending and investment in infrastructure and productive sectors, alongside the continuation of social support policies, including unemployment benefits and subsidies for basic commodities. The agricultural sector has also benefited from a significant increase in financial allocations, with the aim of improving domestic production levels and reducing reliance on imports, while targeting an increase in its contribution to approximately 20% of GDP.

This orientation also highlights efforts to lay the foundations of a digital economy, particularly in the fields of food industries, pharmaceuticals, mechanics, and electronics, in addition to strengthening integration into the requirements of the Fourth Industrial Revolution, especially in areas related to artificial intelligence. Within this framework, the industrial sector is viewed as a key pillar for achieving economic diversification, while the digital economy represents a strategic bet to enhance productivity, competitiveness, and innovative capacities. Achieving these objectives requires the provision of an appropriate ecosystem and the acceleration of digital transformation, as international experiences—most notably that of the United States demonstrate that nearly 90% of its economy relies on digital data (Radio Algérie, 2025).

The agricultural sector is considered a major sector in Algeria and a fundamental pillar of the national economy due to its contribution to employment and gross domestic product. It employs approximately 2.6 million people as agricultural workers, representing more than 74% of the rural workforce and 24% of the national labor force. Moreover, it ensures national food security by covering more than 74% of domestic demand for agricultural products. The

sector is characterized by crop diversity and a wide range of activities, including cereals, vegetables, fruits, and livestock. Its most important outputs include cereals, vegetables, fruits, and industrial crops.

Agriculture in Algeria relies on a combination of traditional and modern techniques, such as traditional irrigation methods (flood and sprinkler irrigation), plowing, planting and harvesting machinery, the use of chemical fertilizers and pesticides, as well as remote sensing technologies and geographic information systems (GIS). A policy for developing the agricultural and rural sector has been designed through a structured and integrative approach aligned with other sectoral policies. This approach is expected to promote agricultural development, making it a driver of economic diversification and growth.

The adopted agricultural growth model, which responds to several challenges, is primarily based on promoting agricultural investment and agri-food industries through greater mobilization of capital and private initiative necessary to revitalize the agricultural and rural sector. In this regard, the priority actions that the government aims to achieve by the 2024 horizon mainly include (AAPI, 2025):

- Meeting basic food needs by increasing agricultural production and productivity.
- Developing a new agricultural and rural model driven by private investment and the emergence of a new generation of producers.
- Improving the competitiveness of agri-food and forestry products and integrating international value chains.
- Achieving sustainable and balanced development of rural areas, particularly in mountainous and desert regions.

Modernizing agriculture through the integration of knowledge-based and digital productsExperts in the field emphasize that Algeria has the potential to become a regional model for smart agriculture by 2030, provided that the national digital transformation strategy is effectively implemented, infrastructure is developed, and local competencies are adequately trained. Digitalization contributes to reducing costs, improving quality, and enhancing the competitiveness of Algerian products. One of the most prominent challenges in this regard is the high level of logistics costs, which exceed 50% of product value, compared to a global average of no more than 15%.

It is also emphasized that the modernization of the agricultural sector represents one of the major challenges for ensuring food security and strengthening national sovereignty in this field. Such modernization should be based on a clearly defined strategic vision that builds on achieved gains, integrates modern technologies, and establishes effective international partnerships. The main challenge lies in improving performance and productivity through a sustainable and smart agricultural model encompassing crop production, livestock, and fisheries, while granting applied research particularly in the development of seeds and genetic resources adapted to the Algerian environment a central role.

Furthermore, the integration of modern technologies into the agricultural sector is no longer an option but an urgent necessity. Artificial intelligence enables the analysis of vast amounts of climatic and agricultural data, assisting farmers in making precise decisions related to irrigation, fertilization, and disease prevention. Drones and sensors allow real-time monitoring of crop conditions, soil quality, and moisture levels, thereby increasing productivity and reducing losses. These tools also contribute to improving statistics and

building a solid national databasethat serves as a fundamental reference for agricultural policy planning (Al-Mostathmir Magazine, 2025).

The year 2025 witnessed one of the most prominent national initiatives to develop the agricultural sector in Algeria, represented by the launch of several projects aimed at developing and modernizing the agricultural information system through the establishment of digital platforms for all agricultural value chains. These platforms enable the accurate identification of needs related to inputs, equipment, and the quantities produced and stored for various crops. This system also allows for real-time monitoring and addressing of obstacles faced by different subsectors, thereby contributing to the creation of appropriate conditions to achieve self-sufficiency and move toward export orientation in many agricultural branches.

In parallel, the Ministry launched a study to assess the effectiveness of public policies in the agricultural field, with the aim of improving the support granted to farmers and adapting government decisions to ongoing economic transformations (The Agricultural Sector in Algeria 2025: A Year of Transformation between Investment and Incentives, 2025).

4.Artificial Intelligence and Smart Agriculture

Agricultural production systems that rely on traditional methods are increasingly facing difficulties in meeting the growing global demand for agricultural products. To address these challenges, the sector has embarked on a broader transition toward Agriculture 4.0, which aims to enhance productivity, resource-use efficiency, and sustainability. Within the framework of this transformation, digitalization enables the integration of technologies into agricultural systems to improve decision-making, optimize resource utilization, and achieve sustainable outcomes. Evidence primarily focuses on laboratory simulations used to develop and enhance artificial intelligence–supported solutions to address specific problems in a targeted manner (The Use of Artificial Intelligence in Food and Agriculture Systems, 2025).

Qu Dongyu stated that artificial intelligence is not merely a technological shift, but rather a driver of profound economic and social transformation on a broad scale, noting that the Food and Agriculture Organization of the United Nations (FAO) recognizes its potential to deliver benefits to wide segments of the population and to contribute to improving efficiency and sustainability. He added that “digital agriculture can revolutionize how we produce, distribute, and consume food,” explaining that the potential benefits for farmers and stakeholders in agrifood systems include improved pricing data, reduced food loss and waste, enhanced food safety, and the promotion of better seeds, fertilizers, and sustainable agricultural practices (FAO Highlights the Potential of AI and the Digital Revolution to Transform the World’s Agrifood Systems, 2025).

According to the Food and Agriculture Organization of the United Nations (FAO), agricultural production must increase by 70% by 2050 to meet the needs of the growing global population. Achieving this increase without depleting natural resources requires an innovative approach, and this is where artificial intelligence plays a crucial role, given its potential to bring about significant change worldwide (The Impact of AI on Efficient Agriculture: A Revolution in the Field, 2025).

The significance of smart agriculture lies in its ability to increase agricultural productivity, reduce waste, and improve the efficient use of resources (water and fertilizers),

thereby contributing to global food security and addressing the challenges of sustainable nutrition in the context of population growth.

Table 01. Selected Digital Technologies and AI-Powered Robots by Agricultural Production System

Livestock	Crops	Aquaculture	Forestry
Electronic tagging	Driverless tractor	Certified aquaculture management	Global positioning for transport
Milking robot	Spraying robot	Automated feeder	Forest monitoring
Automated feeder	Harvesting robot		

Source: (Food and Agriculture Organization (FAO)).

The AI market in agriculture is expected to rise from $1.7 billion in 2023 to $4.7 billion by 2028, highlighting the pivotal role of advanced technologies in this sector (https://www.argaam.com/, 2025). There is no doubt about the crucial role that AI technologies, such as those offered by Farmonaut, play in enhancing the competitiveness of agricultural enterprises and revolutionizing the agricultural sector by providing significant improvements in sustainability and agricultural productivity. By leveraging these technologies, agricultural enterprises can achieve substantial efficiency gains and reduce the environmental impact of their farming operations.

Table 02. The Real Impact of Artificial Intelligence on the Sustainability of the Agricultural Sector

Aspects of Agriculture	Traditional Practices	AI-Supported Practices	Efficiency Improvement (%)
Water Management	Broad irrigation based on fixed schedules	Smart irrigation based on real-time soil moisture data	35%
Pest Control	Periodic and broad pesticide spraying	Targeted spraying based on satellite and drone image analysis	50%
Crop Planning	Based on past experience and tradition	Historical data analysis and market forecasting using AI	40%
Soil Management	Uniform fieldfertilization	Precision fertilization based on AI-generated soil fertility maps	30%
YieldPrediction	Approximate estimates based on visual observations	Accurate predictions using AI models and satellite data	60%
Plant Health Monitoring	Periodicmanualcrop inspection	Continuous monitoring using sensors and satellite image analysis	70%

Source: (Enhancing AI in Agriculture: How Farmonaut is Driving a Sustainable Agricultural Technology Revolution, 2025)

5. The Most Important Applications of Artificial Intelligence in the Agricultural Sector:

Artificial intelligence contributes to enhancing the efficiency of agricultural operations by improving irrigation and fertilization management, identifying the most appropriate agricultural practices, and supporting the development of crop varieties with greater adaptability to harsh environmental conditions. Collectively, these applications lead to higher levels of agricultural productivity, more efficient resource use, and enhanced sustainability of the agricultural sector in the long term. Consequently, the integration of artificial intelligence technologies into agriculture represents a fundamental strategic pillar for addressing the growing current and future challenges facing this vital sector.

By leveraging the advanced analytical and predictive capabilities of artificial intelligence, agricultural producers can improve production performance, rationalize resource utilization, and strengthen their ability to adapt to complex environmental and economic changes, thereby supporting the long-term sustainability of agricultural activity. Despite its economic importance, agriculture continues to face increasing and complex challenges in the contemporary era. As human societies transitioned from nomadic and pastoral lifestyles to settled agricultural systems, accompanied by a continuous rise in demand for food products, agricultural systems have come under mounting pressure that constrains their ability to meet these requirements.

Food producers face multiple risks, most notably the spread of crop pests and diseases, whose severity has been exacerbated by several factors, including climate change, the prevalence of monoculture farming systems, and the intensive use of pesticides. These challenges place significant pressure on farmers, particularly in the context of unstable rainfall patterns, labor shortages, and the growing need to continuously improve agricultural productivity to meet rising food demand. In this regard, the importance of smart agriculture has increased due to mounting pressure on agricultural systems caused by population growth and climate change. Estimates indicate that food production must increase by approximately 70% by 2050 to meet global demand.

The core components of smart agriculture include the use of sensors to collect data on soil, crops, and weather conditions, agricultural information systems and big data analytics, as well as automation and robotics technologies to perform tasks such as precision irrigation and pest control (Sabir Hussain Awan, Sheeraz Ahmed, & Muhammad Zaheer Hashim, 2018, pp. 49–50).

Among the most important artificial intelligence practices in the agricultural sector are the following (Applications of Artificial Intelligence in Agriculture: Enhancing Productivity and Sustainability, 2025):

- **AI-Supported Precision Agriculture :** Studies indicate that the application of precision agriculture can increase crop yields by 20% to 30% by reducing waste and maximizing the efficient use of agricultural resources. This approach relies on data analysis to make accurate and effective decisions in crop management. By analyzing large volumes of data from multiple sources such as climatic conditions, soil characteristics, and historical production records farmers can refine and optimize their agricultural practices.

Artificial intelligence helps agricultural systems identify key factors influencing crop productivity, such as temperature levels and humidity, enabling farmers to adjust planting schedules, irrigation methods, and fertilization rates in line with crop requirements.

- **Crop Health Monitoring :** Artificial intelligence plays a vital role in modern agricultural technologies by enabling continuous monitoring of crop health through advanced imaging tools and smart sensors. Early disease detection is achieved through AI-powered image recognition systems that analyze crop images to identify signs of pest infestation or disease, allowing farmers to intervene promptly and take preventive measures that reduce crop losses.

Continuous monitoring using AI-based sensors also enables the immediate detection of emerging problems, thereby preserving crop health, improving productivity, and increasing overall yields.

- **Smart Irrigation Systems :** Artificial intelligence contributes to the development of agricultural irrigation methods by optimizing water use based on real-time and accurate data, thereby enhancing sustainability and improving agricultural productivity. AI-supported irrigation systems analyze soil moisture levels, crop characteristics, and short- and long-term weather forecasts to determine optimal irrigation schedules and quantities.

Studies have shown that this approach can reduce water consumption by 20% to 30%, and in some cases achieve savings of up to 25%, while maintaining or even improving crop quality. Moreover, through advanced predictive models, artificial intelligence can forecast future irrigation needs based on environmental and climatic changes, helping farmers supply crops with appropriate water quantities without over- or under-irrigation. Statistics indicate that these technologies can increase crop productivity by 10% to 20%, while reducing water stress and improving soil health over the long term.

- **Improving Crop Nutrition :** Artificial intelligence supports a better balance between high agricultural output and the conservation of natural resources, thereby promoting long-term sustainable agriculture. AI plays a central role in improving nutrient-use efficiency, positively affecting crop health, productivity, and environmental sustainability.
- **The Role of Machinery and Robotics :** Smart agricultural machinery represents a significant step toward more efficient and sustainable farming, combining advanced technology with optimal utilization of agricultural resources. Artificial intelligence is transforming agricultural machinery through automation and intelligent robotics, thereby increasing operational efficiency, reducing costs, and improving productivity.

AI-supported tractors rely on advanced technologies such as the Global Positioning System (GPS) and sensors to analyze field data and operate autonomously without direct human intervention. This enables highly precise plowing and planting operations, reduces path overlap and soil compaction, and helps maintain soil fertility. Statistics indicate that the use of autonomous tractors can improve field operation efficiency by up to 15%–20%, while reducing fuel consumption and human error.

Similarly, smart harvesting systems use artificial intelligence algorithms to analyze crop maturity, health status, and environmental conditions to determine the optimal harvest time. This approach reduces losses resulting from premature or delayed harvesting and lowers reliance on manual labor. Studies show that automated harvesting can reduce labor costs by 25% to 40%, while increasing harvesting speed and improving crop quality by 10% to 15%.

- **Predictive Analytics for Risk Management :** Artificial intelligence enhances the agricultural sector's ability to adapt to climatic and environmental changes and supports the long-term sustainability of agricultural production. AI's predictive capabilities help

farmers manage agricultural risks resulting from climate change and pest outbreaks more effectively through advanced data analysis and proactive decision-making.

Artificial intelligence analyzes vast amounts of historical weather data, current climatic information, and satellite imagery to provide more accurate forecasts than traditional methods. These forecasts help farmers determine optimal planting, irrigation, and harvesting schedules, thereby reducing the impact of sudden climatic events such as droughts or heavy rainfall. Studies indicate that AI-supported climate forecasting can reduce weather-related crop losses by 15% to 25%.

By analyzing temporal patterns of pest behavior, temperature, humidity, and crop growth cycles, artificial intelligence can accurately predict pest outbreak locations and periods. This enables farmers to take early preventive measures, such as targeted pesticide application or integrated pest management. Statistics show that these predictive models can reduce pest-related losses by 20% to 30%, while decreasing pesticide use by approximately 15% to 20%.

6. Artificial Intelligence for Enhancing the Competitiveness of Agricultural Enterprises:

Competitive advantage is a fundamental and decisive element for an enterprise's success in creating added value for customers within the contemporary business environment, which is characterized by rapid change and intense competition. Competitive advantage is viewed as theenterprise's ability to utilize its resources and capabilities in an effective and unique way that distinguishes it from its competitors, granting it a better position in the market. The essence of strategic success in the modern business environment lies in the enterprise's ability to efficiently exploit its distinctive resources and transform them into unique capabilities that are difficult for competitors to imitate or surpass. (Ezzedine Ali Sweisi&Naama Abbas Al-Khafaji, Arabic Edition, 2015, p. 70)

- According to Michael Porter (1985), competitive advantage is: "the value a firm creates for its customers that exceeds the cost of producing it, enabling the firm to achieve superior performance relative to its competitors." He emphasizes that a firm attains competitive advantage through cost leadership, product differentiation (uniqueness), or focusing on a specific market segment. (M. Porter, 1993, p. 48)
- According to Heizer & Render, competitive advantage "means creating a distinctive advantage by which the firm surpasses its competitors; that is, competitive advantage makes the firm unique and distinguished from other competitors." (Hisham Othman Al-Mubaidin, Vol. 11, No. 2, 2015)
- According to Harsch, competitive advantage is the influencing factor that allows enterprises, regardless of the goods or services they produce, to compete with others, ultimately leading to an increased market share. (Mohyeddine Al-Qotb, First Edition, 2012, p. 80)
- In the agricultural sector, competitiveness includes efficiency in resource utilization, product quality, export capacity, and the ability to adapt to climate changes. Agricultural competitiveness is seen as a result of the integration of technology, human capital, and organizational innovation. Agricultural enterprises that adopt artificial intelligence are capable of improving productivity by up to 30% compared to traditional enterprises.

- Among the main advantages that enterprises derive from implementing AI in their core operations are the following: (https://www.sap.com/mena-ar/products/artificial-intelligence/what-is-artificial-intelligence.html, 2025).
- **Enhancing Efficiency and Productivity:** One of the main advantages of artificial intelligence in an organization is its ability to automate tasks and streamline processes. AI-powered systems can process vast amounts of data at lightning speed, freeing up valuable human resources to focus on higher-value activities. This increased efficiency improves productivity, allowing employees to devote time to strategic decision-making and innovation instead of routine, mundane tasks.

Improving Customer Experience: AI technology has revolutionized the way companies interact with their customers. Through NLP (Natural Language Processing) and ML (Machine Learning) algorithms, AI-powered chatbots and virtual assistants can provide personalized and instant customer support around the clock. This availability not only enhances customer satisfaction but also helps companies deliver a seamless experience across channels while reducing response times and human errors.

- **Data-Driven Decision Making:** AI systems can analyze enormous volumes of structured and unstructured data, enabling organizations to make more informed decisions. Extracting meaningful insights from this data allows companies to identify trends, predict customer behavior, and optimize operations. AI algorithms can detect patterns that humans might overlook, providing valuable information for strategic planning, risk assessment, and business process optimization.
- **Operational Efficiency:** AI can automate repetitive and time-consuming workflows, handle complex calculations, analyze data, and perform other tedious tasks with precision, improving accuracy and reducing errors. Additionally, AI can help detect anomalies, fraud, and security breaches quickly, mitigating potential losses.
- **Enhancing Workforce Collaboration:** AI can foster greater collaboration and knowledge sharing among employees. Intelligent systems facilitate data discovery by providing easier access to relevant information and offering insights that assist employees in making informed decisions. Moreover, AI-powered collaboration tools enable seamless communication and knowledge exchange across teams, departments, and geographically dispersed locations, encouraging innovation and boosting productivity.

7. Conclusion

The analysis demonstrates that artificial intelligence (AI) has evolved from being merely a technological trend into a strategic necessity for agricultural enterprises striving to achieve sustainability and strengthen their competitiveness amid climate change, market pressures, and rapid technological advancement. AI applications have transformed agricultural production through the adoption of data analytics, production forecasting systems, and advanced resource management tools, thereby enhancing efficiency, innovation, and sustainability simultaneously.

Agricultural enterprises that have integrated AI technologies have achieved notable improvements in productivity, reduced waste, and enhanced product quality, which positively influenced their competitiveness in both domestic and international markets. This transformation extends beyond technical development to encompass a strategic shift based on knowledge,

innovation, and smart resource utilization rather than dependence on traditional production factors alone.

Nevertheless, maximizing the benefits of AI in agriculture requires several essential conditions, including the availability of advanced digital infrastructure, the development of qualified human resources capable of managing modern technologies, and the establishment of supportive legislative frameworks that encourage investment in agricultural innovation. In addition, effective cooperation between governments, the private sector, and research institutions remains crucial for developing intelligent solutions adapted to local agricultural needs.

To strengthen smart agriculture and improve the competitiveness of agricultural enterprises, it is necessary to reinforce scientific research systems, integrate AI-related knowledge and skills into educational and vocational training programs, and expand investment in research and technological innovation. Furthermore, capacity-building initiatives should focus on developing technical competencies through specialized training programs, while promoting applied research aimed at addressing national agricultural challenges. It is equally important to create an investment-friendly environment that supports entrepreneurship, ensures appropriate regulatory frameworks for the safe adoption of AI technologies, and implements comprehensive national AI strategies through coordination among governmental, academic, and private-sector institutions.

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