The Role of Innovation and Technology in the Food Industry for Future Food Safety

دور الابتكار والتكنولوجيا في صناعة الأغذية من أجل سلامة الغذاء في المستقبل

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Abstract:

This research paper highlights the critical role of creativity, innovation, and technological progress in the food industry and their significant impact on addressing food security and ensuring future food safety—issues that rank among the most urgent challenges of our era. A key finding of the study underscores the potential of innovations such as advanced analytical methods, gene-editing technologies, and cutting-edge food production techniques in building more efficient and resilient food systems. Additionally, major scientific breakthroughs like Whole Genome Sequencing (WGS) hold great promise for improving the identification, analysis, and management of potential risks. These advancements not only help prevent and mitigate hazards within the food supply chain but also play a pivotal role in safeguarding the future of food safety.

Keywords: Technological advancement; food industry; digital transformation; food safety.

JELClassificationCodes:D40,L1,L66

ملخص:

تسلط ورقة البحث هذه الضوء على الدور الحاسم للإبداع والابتكار والتقدم التكنولوجي في صناعة الأغذية وتأثيرها الكبير على معالجة الأمن الغذائي وضمان سلامة الأغذية في المستقبل – وهي قضايا تصنف

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ضمن التحديات الأكثر إلحاحًا في عصرنا. ويؤكد أحد النتائج الرئيسية للدراسة على إمكانات الابتكارات مثل الأساليب التحليلية المتقدمة وتقنيات تحرير الجينات وتقنيات إنتاج الأغذية المتطورة في بناء أنظمة غذائية أكثر كفاءة ومرونة. بالإضافة إلى ذلك، فإن الاختراقات العلمية الكبرى مثل تسلسل الجينوم الكامل (*WGS*) تحمل وعدًا كبيرًا لتحسين تحديد المخاطر المحتملة وتحليلها وإدارتها. لا تساعد هذه التطورات في منع وتخفيف المخاطر داخل سلسلة توريد الأغذية فحسب، بل تلعب أيضًا دورًا محوريًا في حماية مستقبل سلامة الأغذية.

كلمات مفتاحية: التقدم. التكنولوجي، صناعة. الأغذية، التحول. الرقمي، سلامة. الغذاء.

تصنيفات JEL: D40، L1، L66

1. INTRODUCTION

The ongoing wave of digitalization is catalyzing a transformative era across industries, compelling companies to rethink and reshape their traditional ways of operation. From redefining business models and strategies to revamping processes, products, and services, this transformation represents a paradigm shift in how organizations operate. Central to this evolution is the integration of intelligent technologies such as the Internet of Things (IoT), information and communication technologies (ICT), and other digital innovations. To thrive in this dynamic environment, companies must not only adopt these advanced tools but also cultivate new capabilities to translate knowledge into specialized expertise. Moreover, they must harmonize these technological advancements with existing skill sets across diverse sectors. Notably, one of these critical sectors is the food industry, which serves as the focus of this study. Against this backdrop, the study seeks to address a pivotal research question: **How can digital transformation shape the future landscape of food safety?**

This overarching inquiry paves the way for a set of interconnected sub-questions that delve deeper into the relationship between digital advancements and food systems:

- What are the principal global challenges driving the adoption of technology and innovation in food systems?

- To what extent can emerging technologies and innovative solutions ensure sustainable food safety in the future?
- How is Algeria, as a case study, responding to the transformative pressures of technological advancements within its food industry?

Hypotheses : The research rests on three key hypotheses aimed at exploring this digital-food nexus:

- Global imperatives, such as combating hunger and ensuring safe food systems, act as powerful drivers for adopting digital technologies and fostering innovation.
- The deployment of advanced technologies and innovative practices can play a critical role in securing sustainable and reliable food safety outcomes.
- Algeria has taken meaningful steps toward embracing technology and innovation within its food industry, demonstrating an active engagement in this global transformation.

Objective : The primary goal of this research is to analyze and emphasize the importance of fostering creativity, innovation, and technological progress within the food industry. Specifically, it seeks to explore how digitalization can influence the management practices in food systems and contribute to ensuring adequate food availability and safety standards in both present and future contexts.

Methodology : This study employs a descriptive-analytical approach to address the identified research problem methodically. By synthesizing existing knowledge with analytical insights, the methodology aims to provide an in-depth understanding of how ongoing digital transformations intersect with the food industry's evolving landscape.

2. The Concept of the Food Industry and the Importance of Technological Methods:

The food industry is defined as:

- "The science that studies the processing of surplus plant and animal raw materials beyond fresh consumption, converting them into other food products by preserving them from spoilage for the longest possible period. This allows their use in seasons different from their production periods or their consumption in regions other than where they were produced while ensuring they remain safe for health and nutrition." (KetafSouheila&Bouzeroura Linda, December 2019, p. 110)

- "The food industry is the industrial sector that processes agricultural raw materials according to specific standards. These industries aim to keep food products usable for as long as possible through processing, preservation, canning, conditioning, etc., in line with the evolving consumer demands driven by ongoing developments." (AyouneAbdelkrim, p. 212)
- "The food industry is a productive activity that utilizes available production elements in the best possible ways, employing production techniques in interconnected relationships to transform economic resources from their natural state into products that satisfy human needs. This occurs within production units governed by technological advancements." (Noha Al-Khatib, 2000, p. 09)
- "Food processing involves the activities and procedures applied to food to preserve it, prevent spoilage, and extend its shelf life (including fermentation, drying, canning, refrigeration, and more)." (Sarah Daniel, 2024)

Food processing helps reduce food loss by transforming fruits and vegetables that are not preferred for fresh consumption or remain unsold into new products that are in demand in the market. Food loss and waste in the Near East and North Africa region are estimated at 250 kg per person per year, equivalent to one-third of the region's food supply, amounting to more than 60 billion USD annually:

  - Food Loss refers to the decrease in the quantity or quality of food resulting from decisions and actions taken by food suppliers along the supply chain, excluding retailers, food service providers, and consumers.
  - Food Waste refers to the decrease in the quantity or quality of food resulting from decisions and actions taken by retailers, food service providers, and consumers.

- The food industry is also defined as "industries that apply theories and facts from exact sciences such as chemistry, engineering, and bacteriology to transform raw materials or products into new goods that benefit humanity." (Mohamed Mokhtar El-Gendy, 1985, p. 10)

The food industry is one of the oldest manufacturing sectors in the country and has always been a leading industry. It contributes significantly to

rapid economic growth, not only by keeping up with population growth and creating jobs for the expanding workforce but also by ensuring basic food supplies, reducing dependence on imports to meet individual needs, and generating substantial export revenue that can be invested in various sectors to enhance national prosperity.

Among the key advantages of the food industry:

- Ensuring food security and producing safer food.
- Providing certain food products outside their natural seasons.
- Making food products more suitable for transportation and storage.
- Creating new job opportunities and additional income for local communities.
- Increasing the profitability of some processed food products.
- Contributing to the activation and revitalization of rural communities.

This has led Algeria to focus on developing this sector by supporting investors, increasing production levels to achieve local self-sufficiency, and integrating into the global economy in the field of food processing industries. Algeria boasts several key factories, including those for:

Processing tuna into canned tuna, Processing agricultural products, Processing milk, Processing meat, among others.

The Food Industry as a Transformative Sector in Light of Scientific Developments. The food industry, as a transformative sector for food production, has evolved significantly with the scientific advancements of the twentieth and twenty-first centuries, distinguishing itself from the food industries of previous centuries. This evolution is evident in technological progress as well as in the global standards and specifications required for food quality and safety. Current advancements in technological research have enabled the food industry to integrate the latest innovations worldwide, improving both food quality and preservation. These advancements also facilitate the long-term storage of food and its transportation across oceans and continents while maintaining its safety and quality.

The concept of food quality and safety has become a fundamental component of healthcare. Scientists and researchers in human and veterinary health have demonstrated that foodborne diseases are among the most widespread health problems globally and are closely linked to food production

processes in factories. Consequently, necessary measures, including legal and regulatory frameworks for health and food monitoring, have been implemented.

Thus, the real challenge facing nations is not merely the availability of sufficient food for survival but ensuring access to food that enhances living standards. This requires equipping food production facilities with modern laboratories, equipment, and devices to enforce the standards and specifications established by global laws and regulations. Additionally, it necessitates highly trained personnel and continuous skill development to stay updated with the latest scientific and technical knowledge on food safety. Developing nations, in particular, must focus on scientific advancements to strengthen their regulatory systems, enabling them to access global markets while adhering to international standards and laws. This, in turn, positively impacts investments in the food industry sector within these countries. (AbdelwahabAbdat, 2010-2011, p. 86)

3. The Importance of Innovation and Technological Methods in Food Systems for Future Food Safety:

The agricultural and food systems worldwide face an array of complex and interconnected challenges. Factors such as conflict, climate variability, extreme weather events, and economic instability—further intensified by the COVID-19 pandemic—are major contributors to food insecurity and malnutrition. These drivers played a significant role in the alarming rise in global hunger rates observed in 2020. At the same time, agricultural and food systems are both a source and a victim of climate change and environmental degradation. Issues such as biodiversity loss, water scarcity, and land degradation necessitate an urgent transformation of these systems to ensure their sustainability. Building agricultural and food systems that are more efficient, inclusive, resilient, and sustainable is vital for advancing the Sustainable Development Goals (SDGs) and promoting social, economic, and environmental sustainability. Within this context, science and innovation have become pivotal tools for addressing global challenges. The 2030 Sustainable Development Agenda recognizes the importance of science, technology, and innovation, embedding them within several SDG targets and various regional strategies. The Global Sustainable Development Report of 2019 also

emphasized that science and technology are essential enablers for transformation, helping to accelerate progress toward achieving the SDGs while minimizing trade-offs. This perspective was reinforced in 2021 by the UN Secretary-General's Food Systems Summit Outcome Document and the Glasgow Climate Pact, both underlining the critical need to invest in science and innovation for effective climate action and sustainable development. These priorities were further echoed in the FAO Climate Change Strategy (2022-2031)(https://openknowledge.fao.org/ ،2024).Aligned with this vision, the FAO Strategic Framework (2022-2031) is guided by the principle of "leaving no one behind." It emphasizes strengthening agricultural and food systems to make them more efficient, inclusive, sustainable, and resilient. Technology and innovation are identified as key accelerators within this framework, alongside data, governance, human capital, and institutions. By harnessing these tools effectively, opportunities can be maximized to create a world free from poverty, hunger, and malnutrition. To further this mission, FAO unveiled its first Science and Innovation Strategy to ensure better coordination of efforts and to facilitate the creation of new initiatives. The strategy underscores the necessity of integrating technologies and innovations into broader programs involving complementary interventions for reducing hunger, addressing malnutrition, and tackling global inequalities. Part of these efforts is the Science and Innovation Forum, which operates under the umbrella of the World Food Forum(https://www.fao.org,2025). This initiative works in conjunction with the Global Youth Forum and the Private Sector Investment Forum to drive comprehensive changes in the food sector. A critical dimension in achieving sustainability lies in adopting smart systems and modern technologies within the food industry. Beyond enhancing operational efficiency and productivity, these technologies provide a foundation for advancing economic and social sustainability. However, despite their far-reaching potential, the implementation of smart technologies brings challenges that require careful consideration from multiple perspectives. A deeper exploration of the implications of this transformation on the agri-food sector is needed to maximize its benefits while addressing potential hurdles effectively.(Carmela Annosi, Maria, Brunetta, Federica, Capo, Francesca, &Heideveld, Laurens, 2020, p. 2)

Key Global Issues Driving the Adoption of Technology and Innovation in Food Systems: (https://openknowledge.fao.org/, 2024)

❖ **Whole Genome Sequencing (WGS):** WGS has become indispensable for identifying foodborne pathogens, tracking microbial persistence, monitoring antimicrobial resistance, and investigating foodborne disease outbreaks. For instance, during the Listeriosis outbreak in South Africa (2017–2018), WGS played a crucial role in containing the crisis and tracing its source. While advanced food monitoring systems worldwide are increasingly adopting WGS, global implementation remains a challenge, especially in developing nations due to inadequate laboratory infrastructure, limited resources, and a shortage of bioinformatics capabilities. Achieving universal access to this technology calls for a concerted global effort to make WGS accessible, which would significantly bolster both regional and international food safety systems.

❖ **New Analytical Models for Enhanced Food Safety Monitoring:**The globalization of food markets exposes supply chains to safety risks, such as widespread mycotoxin contamination in Africa. This intensifies the demand from regulatory bodies, industries, and consumers for faster and more reliable safety technologies. Developing cost-effective yet accurate analytical tools to detect genetic, chemical, and microbiological contaminants is especially critical in regions most vulnerable to foodborne illnesses.

❖ **Emerging Food Production Systems:** Technological and scientific advancements have given rise to innovative food production methods that focus on sustainability and scalability, including: - Cultured meat (lab-grown skeletal muscle for consumption). - Personalized nutrition through meal replacement beverages. - Large-scale production of insect-based food and feed ingredients. - 3D-printed foods. Genetically modified (GM) foods are now grown in 25 countries, with widespread adoption in Southeast Asia and the Americas. However, certain nations like Algeria have stringent restrictions against GM plants in food production, distribution, marketing, or importation, as stipulated by its Ministry of Agriculture's 1993 regulation on seeds, reinforced by Law 05-03 (2005). Algeria also outlines specific conditions for the use of food additives through Executive Decree 12-214 (2012), emphasizing the justification for their inclusion.

❖ **Technology in Local Value Chains:** In many low- and middle-income

countries, the reliance on subpar equipment and outdated infrastructure in food handling and processing contributes to heightened safety risks. Small-scale enterprises, which are vital for employment—especially for women—and household incomes, often dominate these regions. Introducing simple yet effective innovations could greatly enhance food safety, cut down on waste, and reduce environmental impacts. Examples include:

- Solar-powered fruit drying systems.
- Edible transport containers.
- Improved fish-smoking technologies.
- Waste-to-energy projects.
- Fermentation-based food preservation techniques that also reduce pathogens.
- Proper use of disinfectants in cleaning protocols.

Driving the adoption of these solutions requires affordable technologies, targeted capacity-building initiatives, and incentives to encourage stakeholders along the value chain to integrate these advancements into their practices.

❖ **Digital Transformation of Food Systems:** The increasing integration of digital technologies and big data analytics presents new opportunities and challenges within food systems. Tackling emerging food safety risks requires attention; however, digitalization also enables significant improvements in global trade and safety efforts. Benefits include:

- Faster and less bureaucratic electronic certifications for internationally traded foods.
- Enhanced detection of food safety issues and fraud.
- Blockchain-based traceability systems that streamline risk management processes globally.

By leveraging these digital advancements, international cooperation on safety standards can be improved while fostering more efficient global trade practices.

4. Steps for Digital Transformation in the Food Industry: Digital technologies are vital for tackling challenges in the food industry, yet implementing them successfully and achieving commercial impact remains difficult. Despite recognizing their importance, the food sector trails behind

other industries in adopting digital transformation.

The industry is now undergoing significant digitalization, marked by:

- Transitioning to data-driven technologies across the value chain.
- Integrating digital tools in supply chain management, production, distribution, marketing, and customer engagement.
- Employing advanced technologies like AI, IoT, Blockchain, and Data Analytics to boost efficiency, ensure safety, improve quality, and offer personalized experiences.

From precision agriculture and smart packaging to online ordering platforms, digital solutions help the industry stay competitive and meet changing consumer needs. This transformation promotes sustainability, transparency, and adaptability to market trends and consumer preferences.

Three key steps define this digital revolution: (GalihNugroho, et al., 2023, p. 775)

- **Stage 1: Digitization:** The food industry is moving away from traditional paper-based processes and adopting digital formats. This involves converting analog information, such as recipes, inventory records, and customer data, into digital files and electronic databases. By doing so, companies establish a foundation for improved data accessibility, streamlined storage, and easier sharing. Digitization helps organize information more efficiently, allowing food businesses to better manage inventory, track sales, and analyze consumer preferences—opening the door to more sophisticated digital advancements.
- **Stage 2: Digitalization:** In this phase, the focus shifts to leveraging digital data to optimize operations and decision-making. This involves integrating digital tools and software across various facets of the food industry's workflow. Businesses can adopt advanced inventory management systems, automate production processes, and deploy digital point-of-sale (POS) systems, resulting in more efficient supply chains, heightened production capabilities, and enhanced customer service. Digitalization also enables real-time data analysis, empowering companies to make quicker, data-driven responses to market trends and consumer needs.
- **Stage 3: Digital Transformation:** The final and most impactful stage

is digital transformation, marking a fundamental cultural and strategic change within the food industry. This phase requires a holistic adoption of digital technologies, redefining business models, operational strategies, and customer interactions. Key advancements in this stage include:

- Using Artificial Intelligence (AI) and Machine Learning to forecast consumer demand.
- Applying predictive analytics to optimize the allocation of resources.
- Implementing Internet of Things (IoT) devices for live supply chain monitoring.
- Harnessing data-driven insights to offer personalized customer experiences, fostering loyalty and a competitive edge.

By fully embracing digital transformation, food companies unlock new opportunities for innovation, sustain market relevance, and shape the future of their industry in a data-centric digital ecosystem.

5. Impact of Digital Transformation on the Food Industry Supply Chain:

Changing consumer preferences are driving ingredient and packaged food companies to reformulate their products, requiring a data-driven approach for success. Companies that fail to embrace digital product development strategies risk falling behind, while digitally integrated competitors gain ground. Leveraging ingredient data with synthetic biology and fermentation-based approaches will shape the industry's future, making early investments critical.

Benefits of Digital Transformation in the Supply Chain:

- ✓ **Short Term:**Automation, real-time monitoring, and data-driven logistics enhance efficiency.
- ✓ **Long Term:**

- Digital tools like soft robotics and last-mile delivery will streamline operations as the industry integrates closer to consumers.
- Blockchain paired with IoT sensors will enable end-to-end traceability and transparency.
- AI-powered sensors improve food safety management.
- Stakeholders resisting digital transformation will lose competitive ground.

- **The Rise of Digital Retail in Food:**Digital integration is reshaping

food retail and e-commerce, driven by leaders like Amazon and Alibaba. The expansion of omnichannel retailing requires both retailers and CPG companies to adopt "digital-first" approaches to stay competitive.

- Applications of Digitalization Across the Food Industry:

✓ **Food Production:**

- Production Quantity Optimization: Enterprise systems help balance supply and demand to avoid underproduction or inventory waste.

- Production Speed: Automated or hybrid manufacturing improves production rates for high-demand products.

- **Quality Control:** Digital tools ensure food safety at every production stage through advanced monitoring and analytics.

✓ **Inventory Management:**

- Digital systems maintain proper storage conditions (e.g., temperature, humidity), enhancing product quality.

- Regular monitoring identifies unsellable inventory for disposal, ensuring the rest meets safety standards.

✓ **Transportation Management:**

- Digital optimization reduces transport distances, food loss, and costs.

- For cold-chain goods, low-emission refrigerated vehicles maintain freshness while minimizing carbon footprint.

✓ **Food Sales:**

- Personalized digital-driven sales strategies cater to diverse consumer needs more effectively than traditional methods.

- Market data integration ensures optimal pricing based on demand, costs, and competition.

By embracing digitalization, companies can improve operational efficiency, enhance consumer experience, and position themselves for long-term growth. (Yuqing Huang & Zheng Liu, 2022, p. 39)

6. Technological Enablement in the Food Industry in Algeria: The food industry in Algeria began its development in the 1970s with national development programs aimed at establishing national companies in key sectors such as grains, milk, water, and beverages. These were later followed by other industries such as sugar, pasta, canned goods, and meat. The agri-food sector is one of the most significant branches of industrial production in

Algeria, showing a noticeable increase of 15.1% in 2021 compared to the previous year, 2020, which experienced a slight decline of 0.9%. (HadjajiAsma&BouazizNacer, 2017, p. 102).

Production in the agri-food sector continues to perform well, registering a new positive variation in the first quarter of 2024, with a recorded growth rate of +10.7%. This result is mainly driven by the dairy industry, which shows a growth rate of +27.6%, and by the production of animal-based food products, which recorded a change of +74.7%, compared to a decline of 29.9% in the same period of 2023. Conversely, the "grain processing" sector experienced a negative growth of -3.6%, compared to an increase of 8.7% in the previous year. (https://www.ons.dz/IMG/pdf/I.IPI1T2024.pdf, 2025)

Several key features, including, characterize the Algerian food industry: (IbtissamRezoug, 2022-2023, p. 108)

- A high number of small and medium-sized enterprises (SMEs) in the private sector, which dominates most economic activities in Algeria.
- A variety of activities within the food industry, offering multiple investment opportunities.
- Uneven distribution of food products across the country.
- Lack of integration between the food industry and agriculture.
- A limited number of companies that adhere to quality standards and regulations.
- Some sectors rely entirely on importing raw materials, such as the oil, coffee, sugar, and juice industries, which import all components needed for production. Similarly, wheat flour mills depend heavily on imports, while the dairy sector covers 70% of its needs through imported milk powder.
- Cold chain logistics are controlled only by a few major producers, and quality assurance is only guaranteed until the product leaves the factory, with no assurance during distribution.
- Public enterprises have a weak contribution to the food industry sector, with private companies serving as the primary drivers of growth.

Algeria has launched a specialized strategy to boost its food industry by establishing the Technical Center for the Food Industry in Boumerdes through Executive Decree No. 12-98 on March 1, 2012. This public institution, supervised by the Ministry of Industry, is the country's first facility of its kind.

The center bridges companies and research institutions, facilitating the application of scientific findings to advance technology. It monitors global developments, adapts technologies to local needs, and helps improve product quality, aligning with market demands and international standards. Additional support includes training, capacity-building, and technical assistance.quipped with advanced European-standard laboratories, the center enhances competitiveness, promotes innovation, and supports research and development in the food sector. Core tasks include performance studies, product analysis, process modernization, quality management implementation, and tailored training programs.

These initiatives aim to modernize production, adopt advanced technologies, ensure quality control, and strengthen Algeria's food industry for greater economic competitiveness.
(https://ctiaa.dz/index.php/media/articles-de-presse/147-ctiaa, 2024)

In analyzing technology and innovation in Algeria's food industry, it is crucial to assess the state of innovation based on global competitiveness reports issued annually by the World Economic Forum. The following table presents Algeria's ranking in the Global Innovation Index from(2020 to 2024).

Table 01:Algeria's Ranking in the Global Innovation Index (2020-2024*)*

Year	Arrangement	Innovation inputs	Innovation Outputs
2020	121	111	126
2021	120	109	128
2022	115	110	118
2023	119	118	116
2024	115	113	115

Source :(Algeria Ranking in the Global Innovation Index 2024.)

The table showcases Algeria's rankings in the Global Innovation Index over the past four years. It is noted that annual comparisons are influenced by data availability and changes in the index's framework. For 2024, Algeria's statistical confidence interval for its ranking falls between 106 and 124.

Algeria's innovation landscape demonstrates significant strengths, particularly in areas such as education expenditure (ranked 10th), overall training capital (ranked 10th), and the number of graduates in science and engineering (ranked 20th).

Agriculture remains critical to ensuring food security, serving as a cornerstone for both food availability and accessibility. While agriculture contributes only 7% of the GDP in the Arab region, it plays a vital role as nearly 40% of the population—particularly those from underprivileged communities—depend on it for their livelihood. Large-scale local food production is essential to guaranteeing consistent food supply and access.As part of its commitment to achieving self-sufficiency and enhancing food security, Algeria has implemented a comprehensive national strategy aimed at transforming its agricultural sector. This transformative approach opens up opportunities for substantial progress in farming practices across the country.The strategy prioritizes the development of key strategic crops critical to Algeria's food security, including wheat, barley, legumes, olives, and dates. Several objectives underpin this strategy:

- Reducing reliance on agricultural imports
- Boosting local production
- Optimizing the use of natural resources
- Promoting long-term sustainability within the agricultural sector

To achieve these ambitious goals, Algeria integrates modern agricultural technologies and methodologies. The following areas have been key focal points:

- Efficient Water Resource Management: Tackling water scarcity through modern irrigation systems aimed at optimizing water usage.

-Digital Transformation in Agriculture: Leveraging digital tools to enhance farm management, monitor crops, and increase productivity.

- Improvement of Strategic Crops: Developing superior varieties of essential crops like wheat and barley.

- Encouraging Sustainable Practices: Advocating for eco-friendly approaches to ensure the sector's environmental sustainability.

Digital transformation plays a pivotal role in Algeria’s agricultural development efforts. Key initiatives include:

- Establishing detailed agricultural databases for better decision-making
- Building geographic information systems (GIS) to manage agricultural lands efficiently.
- Utilizing remote sensing technologies to monitor crops

- Implementing artificial intelligence for forecasting crop yields and managing agricultural risks.

Through these measures, Algeria positions itself to achieve resilience in its agricultural sector while addressing its food security challenges effectively.

7. CONCLUSION

The food production and processing industry has seen significant advancements in recent years, with improved preservation techniques and long-distance food transportation. However, this progress comes with challenges and side effects that impact human health, plant and animal well-being, and environmental pollution.

Food contamination is no longer limited to natural pollution but also includes chemical contamination, which can have severe and harmful effects that are not easily detectable by the human senses, requiring technological tools for identification. Proper food processing and handling are therefore essential for ensuring safe food.

These challenges have driven research and efforts to enhance food industry management by incorporating the latest technological advancements in science and digitalization. Scientific progress, technological innovations, and digital technologies have the potential to drive large-scale structural transformation in food systems.

In the field of food safety and process monitoring, as in other sectors, technological advancements often outpace the understanding of how to maximize their benefits and regulate them effectively. Given the need for increased food production and enhanced food safety, under the pressure of demographic and dietary changes and climate change, it is crucial to adapt and integrate useful technologies, especially in low-income countries.

Another critical role of science is to generate the best evidence to inform decision-makers, private sector stakeholders, and consumers. Currently, many food safety priorities and management decisions are not based on science, which may lead to inefficient use of limited resources.

It is essential to explore both obstacles and opportunities for the equitable implementation of scientific progress and responsible digitalization in food systems. This includes evaluating their impact on food safety, accessibility, and global sustainability, while ensuring that regulatory

frameworks are ready and accepted by consumers.

The food industry faces numerous challenges in meeting consumer expectations regarding safety, health, and sustainability. However, the integration of industrial robotics into food production offers potential solutions to some of these challenges. Robotics can help reduce production time and costs, enhance productivity and production capacity, and minimize manual labor and associated expenses.

Recognizing the need to enhance and develop the food industry, Algeria has established its first technical center for the food industry. This center serves as a bridge between companies within the sector and research laboratories in scientific institutions. These technical centers ensure mutual collaboration, allowing the commercialization of scientific research results and their application in technological advancements to support development goals and technological progress in the food industry.

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