

## Digital Transformation in the Agricultural Sector: Concept and Challenges

التحول الرقمي في القطاع الزراعي: المفهوم والتحديات

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### Abstract:

The aim of this research paper is to explore the scope of digital transformation in the agricultural sector (tools, mechanisms, and risks) by analyzing a range of studies related to our research topic.

The study concluded that the digital transformation in the agricultural sector is a complex and challenging process that requires additional time and effort. This complexity is attributed to the environmental composition of rural and agricultural communities and the weak digital infrastructure, which in turn imposes challenges on the digital transformation process. However, enabling the agricultural sector to embrace digitalization will contribute to improving performance and enhancing the ability to control and monitor illegal practices and behaviors that arise within agricultural, commercial, and other activities.

**Keywords:** Digitization; Digital transformation; The agricultural sector; Information and Communication Technology (ICT); The farm.

**Jel Classification Codes:** O33, O13.

### الملخص:

تهدف من وراء هذه الورقة البحثية إلى التعرف على مضمون التحول الرقمي في القطاع الزراعي (أدواته، آلياته ومخاطره)، وهذا عبر تحليل مجموعة من الأبحاث والدراسات ذات الصلة بموضوع بحثنا.

وقد توصلت الدراسة إلى نتيجة مفادها أن التحول الرقمي في القطاع الزراعي هو عملية معقدة وشاقة تتطلب المزيد من الوقت والجهد، ويرجع ذلك إلى التركيبة البيئية للمجتمعات الريفية والزراعية وضعف البنية التحتية الرقمية والتي بدورها تفرض تحديات على عملية التحول الرقمي. إلا أن تمكين القطاع الزراعي من الرقمنة سوف يساهم في تحسين الأداء، والرفع من القدرة في التحكم والمراقبة على الممارسات والسلوكيات غير القانونية التي تنشأ في ظل الأنشطة الزراعية والتجارية وغيرها. الكلمات مفتاحية: الرقمنة، التحول الرقمي، القطاع الزراعي، تكنولوجيا الإعلام والاتصال، المزرعة.

تصنيف JEL: O33, O13.

## **1. Introduction:**

Achieving food security is vital for human survival. Therefore, ensuring availability of nutritious and affordable food is fundamental to the future progress of humanity. This is accomplished through the use of various tools and technologies to optimize agricultural production. Over time, as rural and agricultural communities have evolved, so have the technologies and methods used in farming. However, some aspects still suffer from shortcomings and weaknesses, particularly concerning the negative impacts of their use, such as excessive application of fertilizers and pesticides, and the emergence of illegal practices and behaviors.

By the onset of the millennium and the digital revolution, digital transformation in agriculture became a key to development and the most efficient and the fastest way to address the growing global food demand. This revolution contributes to advancing digital innovations in agriculture and facilitates monitoring and control of agricultural supply chains.

While digitization provides numerous benefits to the agricultural sector, its adoption and implementation along with the empowerment of farmers at all levels present a complex and costly challenge. In fact, the key issue lies in directing these technologies towards effective operations and implementing them on a comprehensive strategic scale.

### **Study problem:**

Accordingly, this research paper aims to analyze the nature of digital transformation within the agricultural sector, and to identify the challenges and strategies needed to accelerate and empower the sector.

Therefore, the problem can be formulated as follows:

**What is a digital transformation in agriculture and what are the obstacles that encounter it?.**

### **Study Hypotheses:**

This study proceeds from the following hypotheses:

- Digital transformation in the agricultural sector involves empowering agricultural communities to use information and communication technology across all areas of agriculture.
- The obstacles to digital transformation in the agricultural sector lie in the fact that it is more technology-driven than human-oriented.

### **Study objectives:**

This study aims to achieve the following objectives:

- Identify the various concepts of digital transformation in the agricultural sector and the prevailing technological techniques that underpin it.
- Analyze the obstacles and challenges encountered in the digital transformation of the agricultural sector.

- Offer a set of solutions and recommendations to facilitate the digitization of the agricultural sector.

### **Methodology of the research**

The descriptive-analytical approach was utilized to comprehend the various aspects of the topic, address the raised issues, and achieve the intended results. This method enables us to present the phenomenon under study and examine its different dimensions, specifically focusing on the content of digital transformation in the agricultural sector, through a set of indicators and their analysis.

### **Study Departments:**

To answer the question, we will try to approach this research paper according to a three axis plan, as follows:

**First Axis:** Digital Transformation in the Agriculture : concepts and theories.

**Second Axis:** Challenges of digital transformation in the agricultural sector.

**Third Axis:** Mechanisms of digital transformation in agriculture.

## **2. Digital Transformation in Agriculture : concepts and theories:**

Digitalization helps the agricultural sector integrate and align with other sectors, and enhance its development opportunities and performance by adopting available digital technologies and advanced innovations.

### **2.1 Definition of the Digital Agriculture:**

The digitization of the agricultural sector has garnered significant attention from many experts, who have explored it from various perspectives to understand the process thoroughly. To understand the concepts of digitization, digital transformation, and digital agriculture deeply, we provided detailed definitions to the concepts above.

• **Digitalization:** is the use of digital technologies and data as well as inter-connection that results in new or changes to existing activities. (mitchell, 2021, p. 05)

• **Digital transformation:** an ongoing process that affects society on a global scale, and the way society has changed since the advent of (ICT). (FAO, 2020, p. 02)

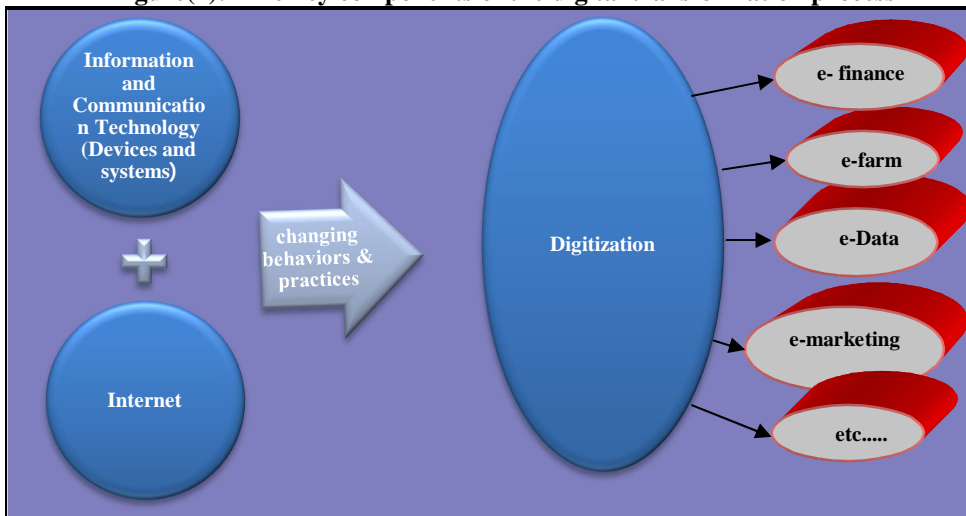
• **Digital agriculture:** can also involve the use of new and advanced technologies, integrated into one system, to enable farmers and other stakeholders within the agriculture value chain to improve food production. (shana & al, 2019, p. 166)

• **Digital agriculture:** is concerned with designing, developing and applying new ways of using information and communication technologies

and digital technologies in the rural area, especially in the agricultural sector, including fisheries, forestry and livestock. (soudani, 2023, p. 49)

Based on the previous definitions, we can conclude that digital transformation in agriculture is a modern approach aimed at revolutionizing information and communication technology by connecting it to the internet. It seeks to shift the agricultural and rural sector from traditional methods to digital ones, through various digital services (such as marketing, financial services, data, etc.). Consequently, this transformation results in a significant qualitative and quantitative improvement in the performance of the agricultural sector. This process is illustrated in the following Figure, which depicts the key components of digital transformation in the agricultural sector.

**Figure(1): The key components of the digital transformation process**



source: Prepared by the researchers

## **2.2 Benefits of digitizing the agricultural sector:**

The benefits of digitizing the agricultural sector include numerous advantages that can enhance productivity and achieve greater efficiency in farming. Some of these benefits are:

### **2.2.1 Economic Benefits of Digital Agriculture:**

The significance of digitalization in the agricultural sector lies in its ability to transform traditional practices and behaviors, and shifting them towards more advanced and sophisticated methods that enhance both quantitative and qualitative performance. therefore, many economic benefits are recorded as follows: (brini, 2023, p. 08)

- **Efficiency:** Digital agriculture technologies help farmers optimize resource use, reducing inputs such as water, fertilizer, and labor, while maximizing crop yields.
- **Productivity:** Real-time monitoring and predictive analytics enhance decision-making, leading to increased crop productivity and quality.
- **Sustainability:** By optimizing resource use and minimizing waste, digital agriculture supports more sustainable farming practices, which are crucial for mitigating climate change and ensuring food security.
- **Traceability:** Digital tools improve traceability along the food supply chain, enhancing transparency and aiding in food safety measures.

### **2.2.2 Marketing benefits of digital agriculture:**

Digital marketing offers significant benefits to the agricultural sector. According to (Solekan & al, 2024), 68% of consumers starting their product search online. This statistic presents a substantial opportunity for farmers and agricultural suppliers to leverage digital marketing to access new markets and increase the visibility of their products. Among the main benefits that digital marketing provides to the agricultural sector are: (Solekan & al, 2024)

- **Increased Reach and Visibility:** The Internet allows farmers and agricultural suppliers to connect with a broader audience, enhancing product awareness and boosting the potential to attract new customers.
- **Enhanced Efficiency and Transparency:** Digital marketing enables farmers to monitor the performance of their campaigns with precision. This capability allows for data-driven adjustments to improve campaign effectiveness. Additionally, by leveraging analytics tools, farmers can gain insights into consumer preferences and market trends, enabling them to tailor their marketing strategies to better align with consumer needs.
- **Building a strong online presence:** Utilizing digital platforms such as websites, blogs, and social media helps in promoting products and fostering robust customer relationships.
- **Establishing Trust:** Maintaining a consistent online presence and offering valuable content helps farmers and suppliers build trust with their customers, which can lead to increased sales and greater brand loyalty.

### **2.2.3 Financial benefits of digital agriculture:**

The digitization of financial services targeted at rural and agricultural sectors (such as cash transfers, payments, savings, credit, insurance, etc.) contributes to the establishment of a broader system and environment for digital financial services; This is achieved by accelerating and simplifying transactions, which in turn enhances access to financing, enables more effective financial management, improves payment and transfer processes, and strengthens risk management, among other benefits. (Millerl & al, 2019, pp. 1-2) Consequently, the agricultural sector can achieve significant improvements in financial performance, which supports its sustainability and growth.

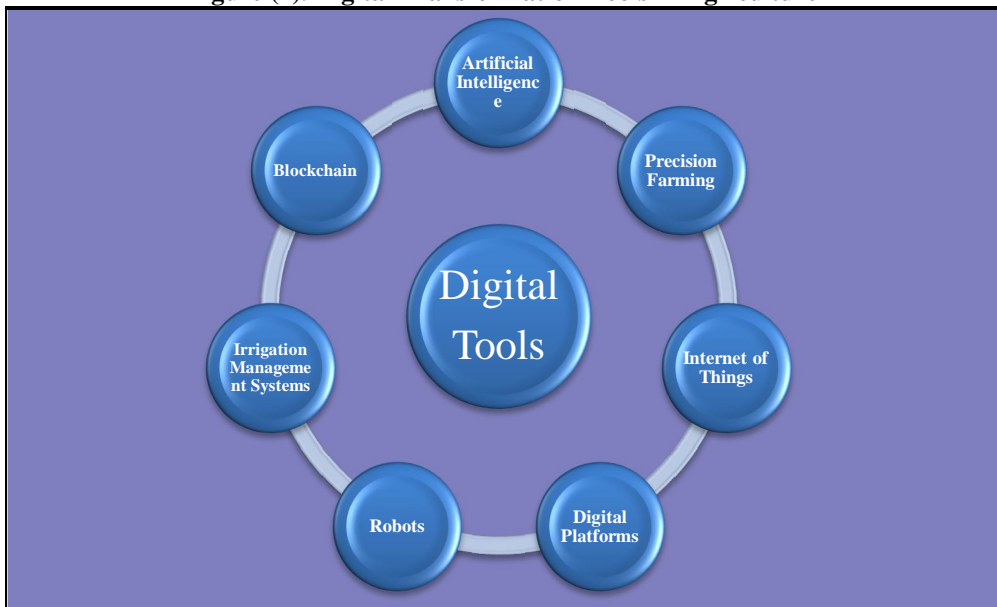
### **2.3 Tools used in digital agriculture:**

Digitization offers a crucial and dynamic opportunity for the agricultural sector by transforming the management and utilization of accumulated data. It facilitates the analysis and application of this data in optimal ways. The tools provided by digitization to the agricultural sector include: (African food Paize, 2021)

- **Data Analytics and Artificial Intelligence:** Data analytics and (AI) are vital in digital agriculture, employing advanced techniques to process and analyze extensive agricultural data, such as weather, soil, and crop performance information. Machine learning algorithms and predictive modeling are used to enhance insights and decision-making.
- **Cloud Computing and Data Storage:** Cloud computing and storage infrastructure are crucial for managing and processing large volumes of agricultural data. Cloud platforms enable secure storage, management, and sharing of agricultural information.
- **Internet of Things (IoT) and Sensor Networks:** (IoT) and sensor networks are essential for gathering real-time data on soil moisture, temperature, humidity, and crop growth. These technologies allow farmers to monitor field conditions remotely and make informed, data-driven decisions by integrating IoT devices and sensors.
- **Precision Farming Techniques:** Precision farming enhances farm management and resource use through tools like GPS, drones, and sensors to gather detailed data on soil conditions, crop health, and nutrient levels. This data is integrated with digital maps to create precise farm profiles, allowing farmers to apply inputs accurately, reduce waste, and boost productivity.
- **Digital Platforms for Market Access:** Digital platforms and e-commerce connect farmers with markets, buyers, and value chain participants. These tools facilitate direct marketing, enable price discovery, and provide valuable market information.

- **Use of Robots:** Robots in agriculture enhance crop productivity by performing tasks such as spraying water, applying pesticides, and removing weeds; Advanced robots equipped with lasers and cameras are being developed to identify and eliminate harmful weeds autonomously, reducing the need for human intervention. (soudani, 2023, p. 51)
- **Blockchain:** Blockchain technology tracks and records all types of plant information, from seed quality to crop growth, and even the plant's journey after leaving the farm; This enhances supply chain transparency and helps reduce issues related to illegal and unethical production practices. (Johns & al, 2024, pp. 85-93)
- **Irrigation Management Systems:** Many experiments and studies have proven that digital systems automate and improve irrigation processes based on weather data and soil moisture levels. Digital technologies enhance irrigation management efficiency, reducing water use by over 22% with sensor automation compared to traditional irrigation methods, without penalties on yield. (Tunca & Eyüp, 2020)

**Figure (2). Digital Transformation Tools in Agriculture**



source: Prepared by the researchers.

### **3.Challenges of digital transformation in the agricultural sector:**

Challenges are represented by various obstacles that may impede the digital transformation efforts in the agricultural sector. Specialists in

agricultural affairs describe digital transformation as a revolution that encompasses both benefits and drawbacks, impacting all aspects of the agricultural environment. This process may encounter numerous complications and obstacles, both at the rural community level and within individual farms. These obstacles are categorized into two levels based on their nature as follows:

### **3.1 Challenges at the rural community level (Off-Farm):**

According to reports and studies by the (FAO), the main challenges facing digital transformation in the agricultural sector stem from the complexity of the broader environment, and the specific nature of rural and agricultural societies. Among the most significant challenges are:

**3.1.1 Underinvestment in Digital Agriculture:** Investment in digital agriculture remains less widespread and appealing compared to other sectors. From 2010 to 2015, financial technology investments grew at an annual rate of 65 percent, reaching \$22 billion. In contrast, digital agriculture investments grew at a slower rate, totaling only \$4.6 billion. (FAO, 2020, p. 03)

### **3.1.2 Human Resource Challenges:**

The challenges that may arise from the human resource aspect include a range of barriers that prevent individuals from absorbing technology. This is due to factors such as resistance to change, educational level, and the environmental conditions in which rural populations were raised. Among these obstacles are:

- **Educational Level:** Education is a double-edged factor, While illiteracy rates in developing countries are decreasing among younger generations, they remain high and continue to pose a challenge, This is partly due to the lack of digital educational infrastructure that could enhance the quality of education and reduce student dropout rates, Additionally, schools face the challenge of equipping students with the knowledge and skills required to effectively engage with digital technologies. (Abdellahi, 2021, p. 123)

- **The Skills Gap:** This gap impacts the adoption of digital solutions and must address the inclusion of everyone in the digital revolution, particularly in rural communities, Data literacy is a significant barrier for the sector. Even when farmers are online, they may lack the education to effectively utilize the wealth of new information available, Therefore, education remains crucial for accessing the new digital opportunities that technology will offer, especially in rural areas. (FAO, 2020, p. 04)

### **3.1.3 Weak (ICT) Infrastructure in Rural and Agricultural Areas:**

The adoption of digital tools, particularly mobile ones, has increased recently. However, smart phone use remains higher in urban areas compared to rural regions, where technology adoption is still limited. This disparity is largely due to inadequate coverage and infrastructure in rural and agricultural areas. (Abdellahi, 2021, p. 123)

**3.1.4 Cyber security:**

Intensive and increasing use of technology raises the volume of vulnerabilities and breaches that can damage the data and information created by farmers. Consequently, there is a higher risk of cyberattacks, as it becomes challenging for farmers to control such digital threats. Therefore, the greater the reliance on digital systems, the higher the risks of cyberattacks and data breaches. (Jussi & al, 2020, pp. 2-6)

**3.2 Farm-level challenges (On-Farm):**

Digital transformation within the farm is considered one of the critical stages, as these technologies will lead to structural changes in the farm. Consequently, this will result in various challenges, as illustrated in the following table:

**Table(1).Identified constraints to digital adoption on-farm**

<b>Obstacle</b>	<b>reason.</b>
Cost	<ul style="list-style-type: none"> <li>• Upfront investment</li> <li>• Subscription for services (eg, annual cost)</li> <li>• Switching costs</li> </ul>
User-friendliness	<ul style="list-style-type: none"> <li>• Skills</li> <li>• Operator's age</li> <li>• Human capital</li> <li>• Farmer-centric innovation</li> </ul>
Relevance	<ul style="list-style-type: none"> <li>• Farm size</li> <li>• Lack of field research</li> <li>• Context-specific</li> <li>• Accuracy</li> </ul>
Risk & Trust	<ul style="list-style-type: none"> <li>• Accuracy</li> <li>• Data governance</li> <li>• Perceived benefits</li> <li>• Technology preference</li> </ul>
Connectivity	

**source: Prepared by the researchers, based on**  
 - (McFadden & al, 2022, p. 35)

Based on the above challenges, we can conclude that there are two categories of challenges, which face digital transformation in the agricultural sector according to their impacts Off-Farm and On-Farm.

✓ **Off-Farm:**

Challenges such as developing digital infrastructure, protecting data from security threats, ensuring compatibility between different systems, and coordinating partnerships with stakeholders like suppliers, distributors, and rural residents hinder the adoption of digital technologies in agriculture.

✓ **On-farm:**

Challenges include issues such as the lack of integration between technology and daily agricultural operations, training workers, maintaining equipment, and dealing with problems like weather conditions and soil issues. These factors prevent farms from effectively utilizing digital technologies.

#### **4. Mechanisms of digital transformation in agriculture**

Digital transformation in the agricultural sector is considered more complex compared to other sectors due to the sector's sensitivity and its unique structure concerning the adoption of various technological innovations. This nature of the agricultural sector requires the involvement of multiple stakeholders and the deployment of various tools to enable digitization. This is achieved through a set of mechanisms proposed by the relevant agricultural authorities, as follows:

##### **4.1 Digital Transformation Frameworks:**

The digital transformation framework serves as an initial step in this process. Within this framework, the digital transformation strategy is defined according to the following four key dimensions: (Hess & al, 2016, p. 04)

- **The Use of Technologies:** Reflects the company's approach and capability to explore and utilize new digital technologies.
- **Changes in Value Creation:** Indicates the impact of digital transformation on the company's value creation.
- **Structural Changes:** Refers to adjustments in organizational structures, processes, and skill sets required to handle and leverage new technologies.
- **Financial Aspects:** Concerns the company's need to address challenges in its core business and its capacity to fund the digital transformation efforts.

##### **4.2 Empowering the Agricultural Sector with Information and Communication Technology (ICT):**

According to the World Bank (2017), the potential of (ICT) to advance agricultural sector development, is significantly boosted by increased investment in agricultural research and strong private sector engagement in developing digital technologies. (Nikola & al, 2019, p. 68)

From the above, it is evident that communications and information technology play a crucial role in advancing the digital transformation of the agricultural sector. This is achieved through various roles provided by these technologies, as detailed in the following table.

**Table(2). The role of information and communication technologies (ICT) for information in agriculture.**

<b>The roles</b>	<b>The Method</b>
Agricultural extension & advisory service	(Ict) bridge the gap between agricultural researchers, extension agents and farmers theyreby enhancing agricultural production
Promote envirenmentally sustainable farming practices	(Ict) improve access to climate-smart solutions as well as appropriate knowledge to use them
Disaster management& early warning system	(Ict) provide actionable information to communities and governments on disaster prevention in real time.
Enhanced market access	(Ict) facilitate market access for inputs as well as product marketing and trade in a variety of ways
Food safety and traceability	(Ict) Help deliver more efficient and reliable data to comply with international traceability and standards
Financial inclusion, insurance & risk management	(Ict) Increase access to financial services for rural communities, find affordable insurance and tools to better manage risks
Regulatory & policy	(Ict) assist with implementing regulatory policies, frameworks and ways to monitor progress
Capacity building & empowerment	(Ict) Can widen the reach of local communities, including women and youth, and provide newer business opportunities, thereby enhancing livelihoods

**source: Prepared by the researchers, based on  
- (FAO, 2018, p. 08)**

### **4.3 Adoption of Digital Tools for All Farms:**

This is achieved by empowering farmers with various suitable digital technologies through the following measures: (Rouby & al, 2023, pp. 2-5)

- **Technology Training:** Providing training for farmers on the use of digital tools and new technologies, through offering courses and workshops to teach them how to use digital technologies and their applications.
- **Online Education:** Online courses and educational resources to enhance digital literacy.
- **Technical Support:** Providing technical assistance and advice to help farmers address technical challenges and implement digital tools.

### **4.4 Providing Digital Infrastructure:**

Digital infrastructure is crucial for enabling various digital technologies For rural areas to integrate into the digital world, it is essential to provide a digital infrastructure that supports a range of digital services. This includes: (World Bank, 2021, pp. 18-23)

- **Creating digital platforms:** Technology platforms serve as a bridge between various data providers and consumers, enabling secure, consent-based access to valuable agricultural datasets, including farmer identities, land records, soil health information, weather data, market information, and more. By leveraging (APIs) and standardized data models, these platforms help agtech companies identify reliable data sources and develop agricultural solutions efficiently.
- Improving access to high-speed internet in rural areas to support the use of digital tools.
- Providing the necessary energy to operate digital devices and technologies on farms.

### **4.5 Policies and Legislation:**

Policies and legislation reflect the political will of governments to adopt digital transformation projects. This will is demonstrated through various interventions by authorities aimed at enabling the agricultural sector to embrace digitalization. This includes: (Schroeder & al, 2021, pp. 5-9)

- **Legal Framework:** Developing policies and regulations that support the use of technology in agriculture and ensure digital security.
- **Incentives:** Providing incentives for farmers to adopt digital technologies and improve their efficiency.

- **Financial Support:** Offering funding and financial support for digital transformation projects in agriculture and facilitating farmers' access to modern technologies.

## **5. Analysis of the results:**

The research paper has revealed a set of findings from the study of digital transformation in the agricultural sector. These results provide several explanations about the process. The findings are as follows:

- Digital transformation in the agricultural sector is inherently complex and costly compared to other sectors. This complexity arises from the nature of the rural and agricultural environment, which is characterized by various uncontrollable variables, particularly those related to agricultural production and the complexities involved in different farming processes.
- Empowering small-scale farmers with digitization is essential for expanding it throughout the agricultural sector, Small-scale farmers form the core of the agricultural landscape, and therefore, they represent the bridge through which digital transformation in agriculture can be achieved.
- Digitalization can enhance farm performance by providing technologies that enable farmers to estimate product yields and production over time. This, in turn, allows for better control of costs and risks. For instance, digital tools can include weather forecasting technologies and early pest detection systems, among other interventions.
- Digitization in the agricultural sector Assists to reduce illegal practices and behaviors by enabling the monitoring and control of various pathways and supply chains. It enhances the ability to track and manage the value created throughout the agricultural processes, including supply, production, and marketing.

## **6. Conclusion:**

Digital transformation is a new phenomenon arising from the rapid development of modern technologies and their widespread use across various fields of life. Despite the swift adoption of digitization in multiple sectors, the agricultural sector has not experienced the same pace of transformation.

Digital transformation in agriculture involves using technology to improve productivity and efficiency in agricultural processes, such as artificial intelligence applications, data analysis, and the Internet of Things, etc.

However, this transformation faces challenges imposed by the complex nature of its components and the characteristics of rural and agricultural communities; these challenges include technology costs, worker training, limited infrastructure, high risks, and resistance to change. To enable digitization in the agricultural sector, it is essential to mobilize

all stakeholders and enhance digital integration through the development of clear and comprehensive strategies.

The findings of this research paper are:

- Digital transformation is an inevitable necessity imposed on the agricultural sector, and it is essential for sectoral integration.
- Technology is a key factor in achieving digital transformation.
- Human resources are considered one of the essential elements in the digital transformation process within the agricultural sector.
- Digital transformation in agriculture involves integrating digital technologies with smart farm management systems to enhance efficiency and productivity.
- Digital transformation in agriculture remains an ongoing process that requires constant adaptation to technological and environmental challenges.

**Recommendations:**

the results of this research paper lead to a set of recommendations for accelerating the digital transformation process in the agricultural sector as follows:

- Support and Attract Investment for Digital Agriculture in the Region and Build Agricultural Entrepreneurs in Rural Areas to Foster Innovations in Rural Communities.
- Establish multi-sector and multi-stakeholder partnerships that connect various digital efforts with the agricultural sector.
- Exploring How Digitizing Food and Agriculture Systems Can Address Agricultural Challenges, with a Focus on Enhancing the Capabilities of Smallholder Farmers.
- Work on integrating small farms into the digital transformation process by utilizing available support and incentives, thereby creating a reliable digital infrastructure that can be leveraged to digitize other components of the agricultural sector.

## **7. Bibliography:**

### **➤ Books:**

- Johns Tiyndel.G &al, (2024), Sustainable Agriculture: The Role of Blockchain Technology in Ensuring Food Security, Edition: First, Published by : Shubham & Arulmanikandan B, Chaudhary Charan Singh Haryana Agricultural University, India.
- Schroeder Kateryna. &al, (2021), WhAat's Cooking: Digital Transformation of the Agrifood system, World Bank Publications , Washington, USA.

### **➤ Articles in a scientific journal:**

- Ashraf Abdellahi Mahmoud Solyman,(2021), Digitalization in the Agricultural Sector: Foreseeing the Opinion of Vegetable Farmers in an Egyptian village, Arab Journal of Agricultural Sciences, Vol 04 N°11, p: 123, Agricultural Research Center, Egypt.
- FAO, (2018), Digital Innovation Tackling Poverty and Hunger through, P:08, rome.
- Hess Thomas & al, (2016) Options for Formulating a Digital Transformation Strategy, Article in MIS Quarterly Executive, Vol. 15 No2, p: 04, Atlanta, USA.
- Nikander Jussi &al, (2020), Requirements for cybersecurity in agricultural communication networks, ELSEVIER, vol 179, p:2-6.
- Solekan, Muhamad &al, (2024) Sustainability Innovation: Digital Marketin of Agribusiness Products for Farmers, International Journal of Society Reviews, Vol. 2 No. 6, p: 1628-1632, Indonesia.
- Sahana. S, & al,(2019), Digital Agriculture, Bulletin of Environment, Pharmacology and Life Sciences, AELS journal, Vol 8 No 6, p:166, INDIA.
- Soudani Nadia,(2023), Transition to Digital Agriculture in the UAE –A Case sStudy of The experience of Rice cultivation in the desert of Sharjah during the period 2019-2021, Namaa Economy and Trade Journal, Vol 6 No 2, p49, Université de Jijel.

### **➤ A conference paper and notes:**

- Emre Tunca, Eyüp Selim Köksal, (2020) Improving Agricultural Water use Efficiency by using Satellite and Un-manned Air Vehicle Systems, Digital Systems for Irrigation Management, Technical Report -II, European Union.
- Howard Miller &al, (2019), What Works for Digital Financial Services in Agricultural Development?, Research Paper, (USAID),USA.
- Fadden.Mc & al, (2022) The Digitalisation of Agriculture a literature review and Emerging Policy issues, Paper N°176, OECD, Europe.
- FAO, (2020), Realizing the Potential of Digitalization to improve the Agri-Food system, Proposing a New International Digital Council for Food and Agriculture, A Concept Note, Rome.
- Mitchell, J, (2021), Digital supply-use tables: A step toward making digital transformation more visible in economic statistics, Toolkit note, OCDE publishing, Europe .
- Nikola, M & al, (2019), Digital Technologies in Agriculture and Rural areas, status report, FAO, Rome.
- Rouby, Alexia & all,(2023), Strengthening digital skills of rural people to benefit from the digital era, Highlights report, European Union.
- World Bank, (2021), Program for the Acceleration of the Digital Transformation of Cameroon, Project Information Document, Report No: PIDA30015, USA.

### **➤ Websites:**

- African Food Paize, (2021); Digital Agriculture; link: <https://www.icrisat.org/research/digital-agriculture/tools-and-technology>, (01/07/2024).
- Brini, Marco, (2023), Digital Agriculture an Updated & Comprehensive Overview, e-book; link: <https://www.researchgate.net/publication/371598930>, (13/07/2024)