

# Digital agriculture in economic development in Vietnam

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## KEYWORDS

Digital agriculture, Smart agriculture, Internet of Things, IoT.

## ABSTRACT

Digital agriculture, incorporating artificial intelligence, IoT, and big data, is becoming a crucial trend in Vietnam to address challenges posed by population growth and climate change. The Ministry of Agriculture and Rural Development has devised a Digital Transformation Plan to confront these challenges, particularly significant in a nation heavily reliant on agriculture. Our research employs a multi-method approach to assess the contribution of digital agriculture to Vietnam's economic development, focusing on private enterprises and public-private collaborations. Results demonstrate that digital agriculture has enhanced resource management and agricultural productivity. This study provides detailed insights into the current status and potential of digital agriculture in Vietnam, highlighting the roles of private enterprises and public-private partnerships in the nation's digital transformation.

## 1. Introduction

The term “digital agriculture” refers to the integration of computers and electronic devices in farming and other agricultural activities. This approach allows farmers to enhance food production through the adoption of advanced technologies. Digital farming encompasses a comprehensive database containing information ranging from soil conditions to market assessments. This system serves as a crucial tool for managing agricultural risks, evaluating climate change impacts, establishing revenue protection policies, and implementing soil

quality management programs (Ahmed, 2022).

Vietnam, heavily reliant on agriculture with a 2020 GDP contribution of 14.85%, faces challenges in its agricultural sector due to population growth, urbanization, and climate change (Swe Htet, 2021). To adapt to these challenges, the sector is turning to digital transformation and the application of high technology. This strategic shift is anticipated to improve production productivity, enable climate change adaptation, ensure farmers' income, and reduce food waste (Thang et al., 2021).

Experts emphasize that swift digital transformation is pivotal for Vietnam's agriculture to recover

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and thrive in the post-pandemic era. Positioned as a key pillar of the country's economic growth, digitalization is seen as a solution to challenges posed by climate change, market fluctuations, and evolving consumption trends. It is anticipated to usher in a new era for the sustainable development of Vietnam's agricultural industry (Truong, 2022).

The Digital Transformation Plan aims to facilitate a comprehensive and cost-effective shift towards digitalization within the Ministry of Agriculture and Rural Development. By seeking support and collaboration from businesses and IT associations, the plan aims to move beyond awareness and initiate concrete actions for digital transformation across various agencies and units. Specifically focused on the agricultural sector, the plan aims to cultivate a professional work culture emphasizing values such as creativity, cooperation, sharing, respect, and a sense of community responsibility. The overarching goal is to align with the key objectives set by the National Committee on Digital Transformation for the Ministry of Agriculture and Rural Development in 2023 (Thanh, 2023).

The agriculture sector plays an important role in agriculture development in Viet Nam, and it witnessed a significant transformation through application digital. Our research questions are formulated as:

*RQ1: How is digital agriculture contributing to the economic development in Viet Nam?*

*RQ2: What is the scale and extent of digital technology adoption in the agricultural sector in Viet Nam?*

To investigate these inquiries, we utilized a multi-method approach, as preliminary research suggested that digital applications have not been widely implemented in Vietnam. It is essential to emphasize that our research outcomes aim to provide a general overview of the potential for digital transformation within the agricultural sector in Vietnam, rather than focusing on specific applications (Loi, 2022).

## 2. Literature review

### 2.1. Overview of digital agriculture

Digital agriculture involves leveraging data and artificial intelligence to enhance agricultural practices globally, encompassing the entire food production and distribution chain (Casto, 2021).

This approach integrates precision farming and smart farming through the implementation of intelligent software and hardware. Digital farming can be achieved by deploying network-connected 'smart' devices as part of the Internet of Things (IoT) or through software-as-a-service (SaaS) based agricultural technology (agtech). In the realm of IoT in agriculture, various tools such as sensors, drones, robots, and cameras are installed on farms to capture and record data. However, it's important to note that IoT requires technical expertise for operating the equipment, and it entails high maintenance and setup costs (Cropin, n.d.).

### 2.2. Global trends in digital agriculture

The field of smart agriculture, also known as smart farming, has experienced significant growth recently, increasing from \$15 billion in 2022, its market value is expected to grow up to \$33 billion by 2027 (infopulse, 2023). The trend of deploying advanced technology in agriculture is increasingly essential due to challenges such as population growth (expected to reach 9.1 billion by 2050), high resource consumption, and air pollution issues (with agriculture contributing 40%). Technology plays a crucial role in enhancing food production, optimizing resource utilization, and mitigating environmental pollution (infopulse, 2023).

According to a recent McKinsey report, farmers in Europe and North America lead the global adoption of agtech, with adoption rates at 62% and 61%, respectively. In terms of specific solutions implemented in agricultural settings, farm workflow management software takes the lead, being adopted by 21% of farmers, followed by sensor and precision agriculture systems, utilized by 15% of farmers (infopulse, 2023).

#### 2.2.1. Artificial Intelligence

In the digital agriculture trends of 2024, Gen AI or generative AI is considered one of the most important points. Gen AI's potential for the global economy is estimated to be in the trillions of dollars, opening up historic opportunities to optimize processes, reduce costs, and drive innovation through innovative models. decisive move. Tools like Digital Crop Advisors use Gen AI to transform agronomic data into actionable recommendations for farmers, providing AI-powered



**Figure 1. Artificial Intelligence (AI) in Digital Agriculture (Jain, 2020)**

insights to optimize crop management and shape performance across crops. farm. This helps farmers understand the factors that affect crops and production on their farms, and respond to climate change through monitoring climate trends (Ron, 2023).

### 2.2.2. IoT and smart sensors

The popularity of sensors and IoT in agriculture is driven by their valuable applications (infopulse, 2023):

**Crop Management:** IoT devices monitor plant health and moisture for disease detection and optimized irrigation, preventing crop damage

**Greenhouse Monitoring:** Measures temperature, lighting, humidity, and soil conditions in greenhouses to enhance resource efficiency and yield.

**Cattle Supervision:** IoT sensors on animals monitor health and activities, preventing potential infections.

**Smart Irrigation:** Soil moisture sensors aid agronomists in precise water level determination for efficient irrigation planning.

**Fertilizer Management:** Electrochemical sensors analyze soil parameters for informed decisions on seed planting and fertilizer application.

### 2.2.3. Others technologies for digital agriculture

**Big Data:** offering great opportunities for farmers to manage resources effectively, optimize productivity, and reduce global poverty. Precision agriculture uses data from multiple sources such as GPS, sensors, and drones to optimize processes and reduce waste. Resource management, by monitoring irrigation water, and reducing erosion, and energy, is also improved through big data savings. Market analysis relies on big data to predict trends and help farmers decide on farming strategies. Weather forecasting uses big data to provide accurate information to help farmers plan planting, irrigation, and harvest. In the agricultural lending sector, big data is being used to assess credit risk, providing better financing for farmers. All these improvements bring transparency to agricultural production and increase trust between consumers and farmers (Bankbarn, n.d.).

**Biotechnology:** Biotechnology is providing farmers with effective tools, from herbicide-tolerant crops to nutritious foods. Genetically modified crops help control pests and pollution, and biotechnology also contributes to the production of antibiotics and vaccines for animals. This helps improve efficiency and sustainability in agriculture (USDA, n.d.).

### 2.3. Previous studies on digital agriculture in Viet Nam

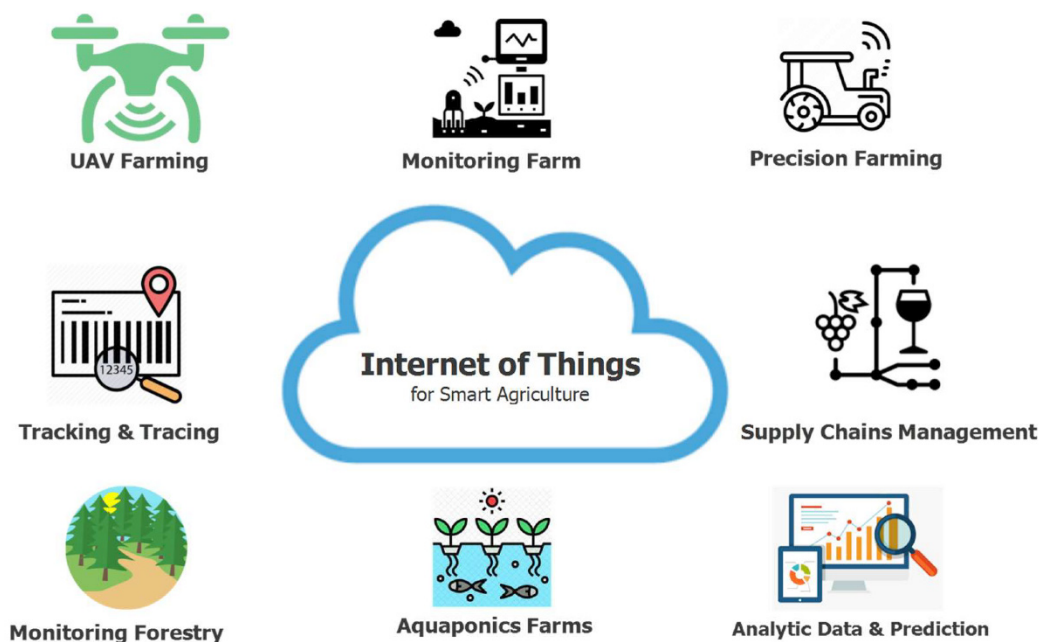


Figure 2. IoT for Smart Agriculture (Quy et al., 2022)

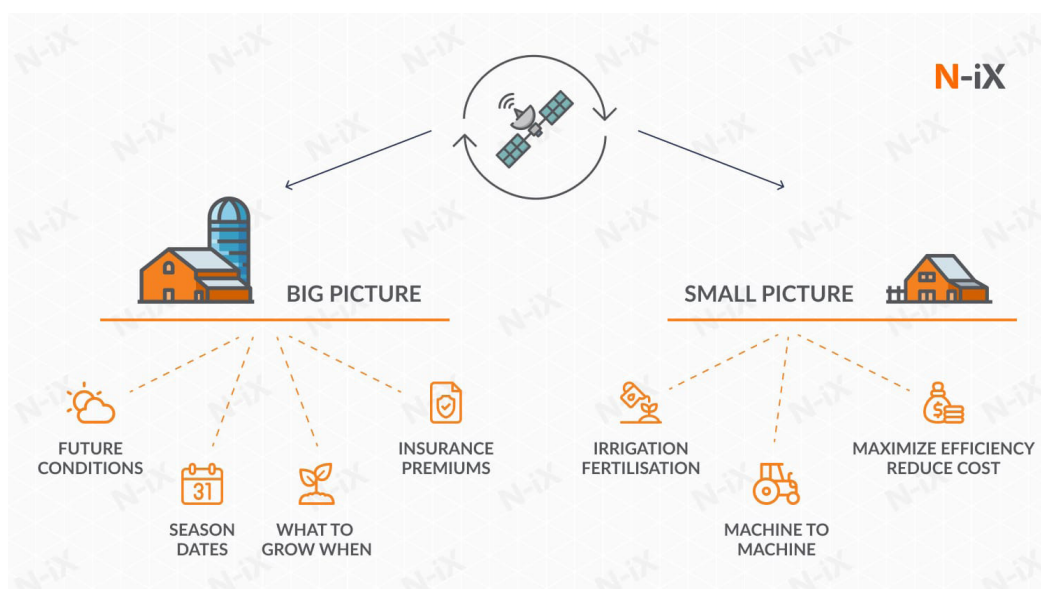


Figure 3. Big Data in Digital Agriculture (N-iX, 2023)

Agri-tech (Agtech) integrates technology into agriculture for increased production, efficiency, and profits. In Vietnam, startups are developing environmentally friendly, affordable, and easily integrable solutions. They focus on reducing gaps in food and water access, catering to safe dietary needs, setting them apart from regional competitors. Despite being an agricultural country, Vietnam's high-tech agricultural sector lags due to numerous smallholder farmers and a shortage of agricultural enterprises and

innovation. Agricultural tech businesses represent a small portion of the market compared to the vast agri-food workforce. However, Vietnam's agricultural industry is booming, with startups innovating and expanding into Southeast Asian markets. Collaboration between businesses, startups, and farmers through contracts is a growing and favorable trend. Global organizations and associations strongly support Vietnam's AgTech sector (Innolab, 2023).



**Figure 4. Biotechnology in Digital Agriculture (Samuel, 2023)**

### 3. Methodology

The employed methodology in this study is based on established systematic review procedures, encompassing search strategies, data extraction, and result reporting (Loi, 2022), as outlined by Kitchenham and Charters (2007). Such an approach is suitable as a research method when the aim is to investigate specific topics, theoretical perspectives, or issues within a particular field of study or expertise to identify elements of a concept or a new approach (Snyder, 2019). It is currently extensively utilized in agricultural research (Koutsos et al., 2019).

As a result, we established a category of scientific articles employing keywords associated with digital agriculture, including digital agriculture, digital/smart farming, technology, and agriculture 4.0. The majority of these documents were published between 2017 and 2021. Deductive content analysis was utilized to scrutinize the retrieved documents, aiming to identify the conditions and potentials for the development of digital agriculture.

In response to ‘RQ1: How is digital agriculture contributing to the economic development in Viet Nam?’. In response to RQ1, we examined abstracts to ensure the emphasis on agriculture and digital technology. We systematized concepts, defining the essence of digital agriculture and identifying attributes crucial for its transformation. With the aid of official statistics, we presented a comprehensive overview

of the digital agricultural transformation in Vietnam. Notably, during the pandemic, digitization served as the cornerstone for the modernization of economic sectors, fostering the emergence of new business models adaptable to the current reality.

Thus, to answer ‘What is the scale and extent of digital technology adoption in Vietnam’s agricultural sector?’. To address RQ2, we thoroughly searched materials to pinpoint cases illustrating how digital technology has been applied in Vietnamese agricultural production. Our goal was to ascertain the extent and scale of digital technology adoption in the agricultural sector. In conclusion, we assessed the study’s outcomes and drew conclusions regarding the current prospects for the development of digital agriculture in Vietnam, ensuring no duplication with the references.

### 4. Results and discussion

#### 4.1. Digital agriculture in Viet Nam

In the realm of digital agriculture in Vietnam, private companies play a central role as primary solution providers. Notable entities in this domain include VinEco, Hachi, TH True Milk, Vinamilk, Agrimedia, GreenCoffee, MimosaTEK, BacTom, RTAnalytics, Fsoft, TraceVerify, and the Digital Agriculture Association of Vietnam (Innolab, 2023).

The progress of digital agriculture innovation has been significantly boosted through public-private

collaborations. For instance, partnerships involving the International Rice Research Institute, SwissRe, Sarmap, the German Society for International Cooperation, and the Swiss Agency for Development and Cooperation resulted in the implementation of the remote sensing-based Information and Insurance for Crops in Emerging Economies (RIICE) project. This initiative aimed to provide advanced technologies to low-income farmers, expanding their access to transformative tools.

In 2017, Google, in collaboration with the Vietnam Farmers' Union (VNFU), initiated a program geared towards enhancing farmers' digital skills. The program involved deploying 40 trainers and 500 support workers to provide training to at least 30,000 farmers across nine provinces by 2020.

Vietnam has designated 12 areas as certified hubs for hi-tech agriculture, with notable regions including Hau Giang, Phu Yen, and Bac Lieu provinces. The State Bank of Vietnam (SBV) and commercial banks have also introduced a financial package amounting to VND 100 trillion (US\$4.37 billion) to support enterprises adopting high-tech farming practices.

#### ***4.2. The impact of digital agriculture***

Digital agriculture technology has propelled a significant transformation in farming, improving resource management and enhancing crop production. Digital tools, sensors, and data analysis assist farmers in precisely adjusting irrigation, fertilization, and pest control processes. This technology also plays a crucial role in optimizing crop yields and increasing agricultural productivity. Beyond crops, digital agriculture technology revolutionizes animal farming, providing solutions for monitoring the health and productivity of animals through sensors and remote monitoring systems. The widespread application of this technology not only benefits production but also contributes to minimizing negative impacts on the environment by efficiently utilizing resources and implementing sustainable farming methods.

#### ***4.3. Opportunities in digital agriculture***

Digital agriculture, or precision farming, brings forth significant opportunities for the agricultural sector in Vietnam. Integrating information technology into the production process enhances efficiency, from effective management of resources like water and

fertilizers to predicting weather patterns and crop demands. Furthermore, digital agriculture supports supply chain management, all the way from farms to markets, enhancing monitoring and ensuring the quality of agricultural products. This contributes to the sustainable development of the agricultural industry.

#### ***4.4. Challenges in digital agriculture***

Digital transformation of the agriculture sector faces significant challenges, including digital literacy limitations among farmers in developing countries, hindering the process of digital transformation. The disparity between small-scale farmers and large enterprises poses obstacles, and infrastructure issues and language barriers further complicate the application of new technologies. Information security and data privacy are major concerns in the context of agriculture digitization, with a need to address the risks of cyber-attacks. The conflict between economic growth and sustainability goals presents challenges in decision-making, while the growing global population and climate change add substantial sustainability concerns in agriculture. Evaluating the true benefits of technology for productivity and sustainability remains a complex challenge that necessitates ongoing research (Scott et al., 2021).

#### ***4.5. Recommendations***

To promote the development of digital agriculture, there is a need to focus on building and improving technological infrastructure, especially in rural areas or areas with poor infrastructure. Additionally, emphasis should be placed on training farmers in the effective use of digital agriculture applications and equipment.

Furthermore, ensuring information security during the digitization of agricultural data is a critical point that needs attention. It is recommended to invest in cybersecurity measures to prevent risks related to data loss and safeguard agricultural data.

Enhancing uniformity in the types of machinery and software in digital agriculture is also a priority. Establishing standards and encouraging integration among systems and devices will help optimize efficiency and facilitate easier management.

Lastly, financial support and incentive policies can alleviate the cost burden for farmers when adopting digital technologies. These measures aim to

create a conducive environment for the sustainable development of digital agriculture and ensure that its benefits extend throughout the entire agricultural supply chain.

## 5. Conclusion

In summary, the application of digital agriculture in Vietnam holds significant promise in addressing agricultural challenges, promoting economic development, and fostering sustainability. Our research, utilizing a multi-method approach, sheds light on the current state of digital agriculture in Vietnam.

Digital agriculture technology has brought about substantial changes, improving resource management and increasing agricultural production. Simultaneously, it opens up significant opportunities for the sustainable development of the agricultural sector.

However, challenges persist, including limitations in farmers' digital literacy, disparities between small-scale and large enterprises, and issues related to infrastructure and information security.

To promote the development of digital agriculture, the focus should be on improving technical infrastructure, training farmers in digital technology applications, ensuring information security, and providing financial support for farmers when adopting digital technologies. These measures will create a conducive environment for the sustainable development of digital agriculture, ensuring its benefits extend throughout the entire agricultural supply chain.

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