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DIGITAL TRANSFORMATION IN AGRICULTURE IN VIETNAM: TRENDS, OPPORTUNITIES, AND CHALLENGES

Thi Thanh Huyen Pham, Tuan Anh Tran*

Ho Chi Minh City University of Industry and Trade, Ho Chi Minh City, Vietnam

*Email: *anhtt@huit.edu.vn*

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ABSTRACT

Digital transformation is emerging as a crucial driver for enhancing productivity, optimizing value chains, and promoting sustainable development in the agricultural sector. In Vietnam, digital transformation in agriculture has shown promising initial results, particularly in provinces like Lam Dong, An Giang, and the Mekong Delta, with the application of technologies such as IoT, AI, and Blockchain. Leading enterprises like VinEco and Nafoods have pioneered the adoption of digital solutions for supply chain management and product traceability, resulting in increased productivity and added value for agricultural products. However, the transformation process remains fragmented, with significant disparities between large-scale farmers and smallholder farmers. While digitally advanced models thrive in areas with favorable infrastructure and enterprise-driven ecosystems, smallholder farmers still face barriers related to capital, digital literacy, and technology access. By employing theoretical frameworks such as Innovation Diffusion, Absorptive Capacity, Farming Systems, Open Innovation, and Sustainable Development, this study analyzes the driving forces, disparities, and challenges of digital transformation in Vietnamese agriculture. The findings highlight that successful digital transformation requires more than just technology adoption; it necessitates an integrated ecosystem involving the government, enterprises, research institutions, and farmers. Coordinated efforts in improving rural digital infrastructure, enhancing farmers' digital capabilities, and fostering public-private partnerships are essential to ensure that digital transformation becomes a catalyst for inclusive and sustainable agricultural development in Vietnam.

Keywords: Digital transformation, Smart agriculture, IoT, AI, Blockchain, Supply chain, Smallholder farmers, Vietnam.

1. INTRODUCTION

Digital transformation has become an inevitable global trend, creating significant opportunities for various economic sectors, including agriculture. This is especially true for developing countries like Vietnam, where agriculture remains a cornerstone of the economy, contributing approximately 12-14% of GDP and providing livelihoods for over 60% of the rural population. Digital transformation is expected to serve as a key driver for sustainable growth, enhancing productivity and agricultural product quality, optimizing value chains, and improving farmers' incomes.

In Vietnam, the application of digital technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), Big Data, Blockchain, electronic diaries, smart irrigation systems, and e-commerce platforms has been introduced in several provinces, including Lam Dong, An

Giang, and the Mekong Delta region. These pilot models have demonstrated clear benefits, including reducing production costs, increasing productivity, and improving the value of agricultural products. The positive impacts have been particularly evident among large-scale producers, cooperatives, and enterprises with strong financial capacity. However, smallholder farmers, especially those in remote and disadvantaged areas, still face significant challenges in accessing digital technologies due to limited financial resources, technical knowledge, and underdeveloped technological infrastructure.

Furthermore, unlike the industrial and service sectors, digital transformation in agriculture requires flexible adaptation to the unique ecological conditions, soil characteristics, cultivation practices, and farmers' readiness in each locality. This process cannot succeed solely through the individual efforts of farmers or enterprises; it necessitates close collaboration among four key stakeholders: the Government, Scientists, Businesses, and Farmers. The Government plays a crucial role in developing digital infrastructure and establishing supportive policies and mechanisms. Businesses provide technological solutions and expand market access. Scientists contribute by conducting research and transferring technical knowledge. Farmers, as the primary users, directly apply digital technologies in their production processes.

Given these practical requirements, this study aims to analyze the current state of digital transformation in Vietnam's agricultural sector, identify emerging trends, opportunities, and challenges, and propose solutions to promote comprehensive and sustainable digital transformation. The ultimate goal is to modernize the agricultural sector and enhance the competitiveness of Vietnamese agricultural products in the global market.

2. LITERATURE REVIEW

2.1. Fundamental concepts

Digital transformation is the process of applying digital technologies to all activities of an organization or business, leading to fundamental changes in how operations are managed and how value is delivered to customers [1]. In agriculture, this transformation helps modernize production, improve productivity, reduce costs, and increase the value of agricultural products. It also allows farmers to better manage their processes from cultivation to harvesting, processing, and distribution. In Vietnam, where smallholder farmers dominate and agriculture plays a vital role in the economy, digital transformation is considered a key solution to enhance productivity and income.

Smart Technologies in Agriculture Smart agriculture is an advanced farming model that builds on digital agriculture through the use of real-time data and automated systems. IoT (Internet of Things) enables the connection of sensors and devices that monitor environmental variables such as soil moisture and temperature. This facilitates precision farming, reduces waste, and increases productivity. IoT, combined with big data analytics, significantly enhances the efficiency of agricultural systems and supply chains [1] and also plays an important role in automation [2]. In Vietnam, IoT technology has been applied in Lam Dong and the Mekong Delta to monitor soil and irrigation, reducing water usage by up to 30% [3].

Artificial Intelligence (AI) supports tasks such as crop health monitoring, pest detection, yield forecasting, and automatic harvesting. Previous studies have demonstrated that AI improves productivity and predictive accuracy in agriculture [4, 5]. In Vietnam, several high-tech farms in Da Lat have tested AI systems for pest monitoring and fertilizer optimization, reducing costs by 20% and improving product quality [3]. Moreover, combining AI with IoT has been shown to reduce post-harvest losses [6].

Big Data plays a critical role by analyzing large sets of environmental and production information, supporting strategic planning and forecasting in agriculture. Big Data has been described as foundational to smart farming [1], with significant contributions to the transformation of agriculture in Europe [7] and precision agriculture in the United States [8]. In Vietnam, Big Data has been applied on farms in Da Lat to improve fertilizer management and monitor plant health [3].

Blockchain and E-commerce Blockchain technology is increasingly used in agriculture to enhance data transparency and traceability. Early studies demonstrated its application in food traceability in China [9]. Further research has confirmed its contributions to sustainable food supply chains [10] and its effectiveness in improving transaction transparency [11]. In Vietnam, companies such as VinEco and Nafoods have applied blockchain to trace agricultural products exported to the U.S. and Europe, resulting in a 10–20% increase in value [12].

E-commerce facilitates the online buying and selling of agricultural products, helping farmers reduce reliance on intermediaries, expand markets, and increase product value. E-commerce has been recognized as a key factor in modernizing agricultural markets [13]. Studies have observed its role in increasing rural incomes in China [14] and bridging information gaps for farmers [15]. In Vietnam, platforms such as Postmart and Voso enabled farmers to distribute large volumes of produce during the COVID-19 pandemic, increasing incomes by 10–15% [16].

Summary, Digital transformation in agriculture involves the integration of multiple technologies rather than isolated implementation. Smart agriculture technologies such as IoT, AI, and Big Data, along with supporting systems like blockchain and e-commerce, enable farmers to increase efficiency, sustainability, and profitability. However, adoption remains unequal, calling for ecosystem-level support and inclusive digital strategies.

2.2. Relevant Theories on Digital Transformation in Agriculture

Digital transformation in agriculture is not only a technological shift but also a process influenced by economic conditions, farmer behavior, and regional production systems. Analyzing this process in Vietnam requires a combination of different theoretical approaches, as each theory sheds light on specific aspects while complementing one another.

The **Technology Adoption Theory** provides a foundation for understanding why digital technologies are adopted unevenly among farmers [17]. In provinces such as Lam Dong and An Giang, cooperative farmers with better access to financial resources and information have adopted automated irrigation and greenhouse monitoring systems at a rate exceeding 70% [3, 18]. In contrast, smallholder farmers without such support show a much lower adoption rate of around 30% [19]. This aligns with the view that early adopters are often those with higher education levels and stronger economic capacity.

However, adoption alone is not sufficient. Farmers also need the ability to effectively absorb and apply new technologies. The **Absorptive Capacity Theory** highlights that this capacity depends on farmers' prior knowledge, education, and access to training [20]. Evidence from An Giang shows that farmers involved in enterprise-led smart agriculture initiatives reduced production costs by 10–15% and increased yields by 20% due to their enhanced capacity to integrate IoT sensors and electronic farm diaries into their daily operations [18].

Moreover, technology adoption and absorptive capacity must be assessed within the broader context of production environments. The **Farming Systems Theory** emphasizes that technological solutions need to be adapted to the specific ecological and socio-economic conditions of each region [21]. In the Mekong Delta, for instance, salinity sensors and water-

saving irrigation systems have proven effective, enabling farmers to reduce water usage by 25% and minimize drought damage by 30% during dry seasons [3]. However, these same technologies may not be equally applicable in upland areas like the Central Highlands, where greenhouse systems and microclimate monitoring are more relevant.

To overcome the barriers faced by smallholder farmers and promote large-scale transformation, a broader ecosystem approach is needed. The **Open Innovation Theory** suggests that digital transformation requires collaboration among multiple stakeholders [22]. In Vietnam, successful models often involve public–private partnerships (PPP), such as the cooperation between the Department of Agriculture and Rural Development of An Giang and AgriTech, which facilitated the installation of 120 automated irrigation systems and digital farm logs. This initiative reduced water wastage by 20% and improved product quality for export [18].

Finally, the digital transformation process must align with long-term environmental and social sustainability. The **Sustainable Development Theory** underscores the importance of balancing productivity gains with environmental protection and social equity [23]. In Soc Trang, salinity intrusion warning systems helped more than 500 households adjust their production schedules, reducing seasonal losses by up to 35% [19]. This aligns with warnings from FAO [24] and Klerkx et al. [25], who emphasize that without inclusive policies, digital transformation may widen the gap between large-scale and smallholder farmers.

To provide a visual synthesis of how these five theoretical lenses collectively explain the digital transformation process in Vietnamese agriculture, Figure 1 presents a conceptual framework summarizing their interconnections and sequential contributions.

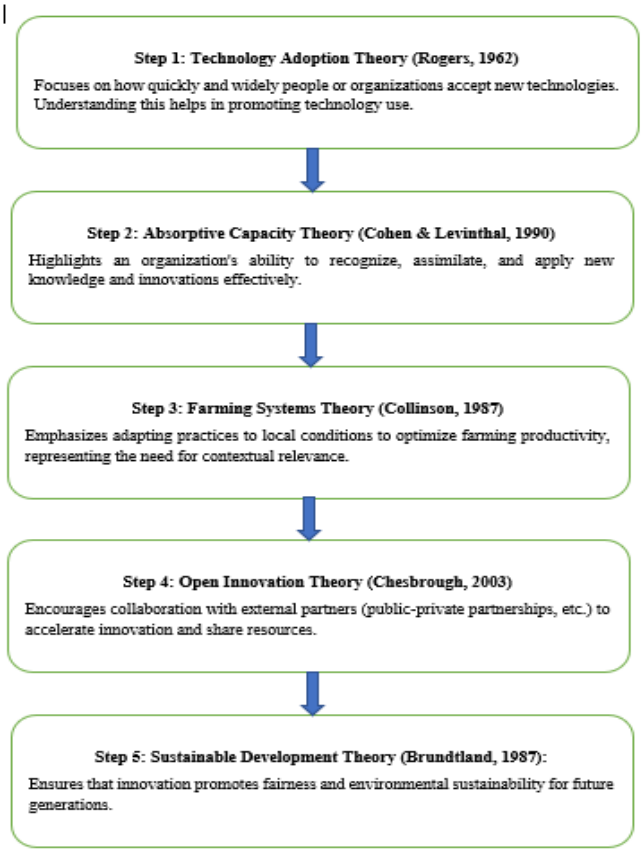

Figure 1. Conceptual framework integrating five theoretical lenses of digital transformation in agriculture
Source: Author's syntheis based on prior research

This visual model presents the sequential and interdependent roles of five theories—Technology Adoption, Absorptive Capacity, Farming Systems, Open Innovation, and Sustainable Development—in shaping an inclusive and context-specific digital transformation process in Vietnamese agriculture.

To further clarify the analytical contributions of each theoretical perspective, Table 1 below summarizes how the five theories relate to the three core dimensions analyzed in this study: driving forces, disparities, and challenges of digital transformation in Vietnamese agriculture.

Table 1. Theoretical contributions to understanding key aspects of digital transformation in agriculture

Theoretical Lens	Driving Forces	Disparities	Challenges
Technology Adoption Theory	Explains how innovation diffusion among farmers acts as a catalyst for early transformation	Highlights gaps between early adopters (enterprises /cooperatives) and late adopters (smallholders)	Resistance to change, limited awareness of benefits
Absorptive Capacity Theory	Emphasizes the role of education, prior knowledge, and training as enablers	Explains variation in farmers' capacity to understand and use digital tools	Lack of learning opportunities, weak support services
Farming Systems Theory	Advocates for locally adapted technologies based on ecological and social contexts	Reflects differences in technology suitability across regions	Risk of applying mismatched or unsustainable digital models
Open Innovation Theory	Supports multi-stakeholder collaboration as a transformative force	Identifies exclusion of smallholders from PPPs and innovation ecosystems	Coordination failures, limited incentives for private sector participation
Sustainable Development Theory	Frames environmental protection and social equity as integral parts of digital transformation	Warns that benefits may concentrate among resource-rich actors	Need to balance growth with ecological and social sustainability

Source: Author's syntheis based on prior research

In summary, the process of digital transformation in agriculture cannot be explained by a single theory. Theories on technology adoption and absorptive capacity clarify why farmers adopt technologies at different rates. Farming systems thinking emphasizes the need for locally adapted solutions. Open innovation highlights the importance of multi-stakeholder cooperation, while sustainable development ensures that technological progress does not come at the expense of the environment or vulnerable farmer groups. Together, these theoretical perspectives provide a comprehensive framework to understand the progress and challenges of digital transformation in Vietnamese agriculture.

2.3. Overview of domestic and international studies

Digital transformation in agriculture has emerged as a global trend, particularly under the influence of Industry 4.0, which promotes widespread digital technology adoption across economic sectors. Numerous studies confirm that digital tools enhance productivity,

streamline processes, and boost agricultural competitiveness, while also addressing climate change, food security, and sustainability challenges [1, 13, 24, 25].

In developed countries such as the Netherlands and the U.S., integrated models of smart agriculture using IoT, Big Data, and AI have yielded measurable improvements in production efficiency and environmental outcomes. Wolfert et al. [1] emphasize the role of data-driven decision-making in resource optimization and yield forecasting. Similarly, Kamilaris et al. [7] and Basso and Antle [8] illustrate the benefits of real-time monitoring and precision agriculture in minimizing costs and environmental impact.

In developing contexts, digital agriculture has also shown significant potential. For example, in China, Couture et al. [14] found that e-commerce platforms expanded market access and raised rural incomes by 15–20%. In India, the integration of IoT and AI has been shown to reduce post-harvest losses and optimize input usage [26].

Vietnamese esearch supports similar conclusions. Studies have explored how IoT, AI, Big Data, and Blockchain contribute to agricultural modernization [27, 28]. IPSARD underscores digital transformation as key to productivity and market access [29], while ministries such as MARD and MIC identify it as a strategic response to climate change and supply chain disruptions [26].

Field evidence from provinces like Lam Dong, An Giang, and the Mekong Delta highlights early successes. IoT-based irrigation systems in Lam Dong reduced water consumption by 30%, and blockchain tools applied by VinEco and Nafoods improved traceability and boosted export value by 10–20% [3, 12]. However, these successes are largely tied to enterprise-led models and well-resourced regions, illustrating the uneven adoption explained by the **Technology Adoption Theory** and the **Absorptive Capacity Theory [**17**,** 20**]**.

Despite these advancements, several constraints persist. Reports from IPSARD [29] and MIC [26] indicate a national agricultural digitalization rate of just 2.1%. Smallholder farmers, especially in remote areas, face barriers such as high costs, limited digital access, and low digital literacy. These challenges align with the **Farming Systems Theory**, which emphasizes tailored solutions for diverse ecological and socio-economic contexts [30].

Moreover, FAO [24] and Klerkx et al. [25] warn that without inclusive policy design and stakeholder coordination, digital transformation could deepen inequalities between large-scale and smallholder producers. The relevance of the **Open Innovation Theory** is evident in Vietnam's PPP models in An Giang and Lam Dong, which demonstrate that collaborative frameworks can help close this gap [18].

Although the environmental value of digital agriculture is recognized globally, it remains underexplored in Vietnam. Initiatives like salinity monitoring in Soc Trang [19] and AI-assisted pest control in Da Lat [3] reflect positive ecological outcomes, but comprehensive sustainability assessments are lacking. This reinforces Brundtland's **Sustainable Development Theory**, which stresses that productivity gains must align with environmental stewardship and social equity [30].

In conclusion, while existing studies showcase both the promise and the limitations of digital transformation in agriculture, Vietnam's path forward depends on aligning global insights with localized adaptations. A framework integrating five theoretical perspectives—Technology Adoption, Absorptive Capacity, Farming Systems, Open Innovation, and Sustainable Development—can guide future research and policy to ensure equitable and effective transformation.

2.4. Evaluation

The review of international and domestic studies confirms that digital transformation is an inevitable trend in agriculture, offering potential to improve productivity, optimize value chains, and promote sustainable development. However, practical implementation in Vietnam still faces many difficulties, especially for smallholder farmers.

Theories on **Technology Adoption [**17**]** and **Absorptive Capacity [**20**]** explain why digital technologies have been adopted more rapidly in areas like Lam Dong and An Giang, where farmers have better resources and support from enterprises. In contrast, smallholders in remote regions struggle due to limited capital, digital skills, and poor infrastructure.

Practical experiences in the Mekong Delta show that technologies such as IoT-based irrigation and salinity sensors are only effective when adapted to local production conditions, in line with Farming Systems Theory [31]. However, the digital gap between large-scale producers and smallholders remains wide, highlighting the need for cooperation among the Government, enterprises, scientists, and farmers, as suggested by Open Innovation Theory [22].

While some pilot models have demonstrated positive environmental impacts, comprehensive assessments of the long-term effects on sustainability are still lacking. This reflects the caution emphasized in Sustainable Development Theory [30] regarding the need to balance productivity gains with environmental and social concerns.

In summary, digital transformation holds significant promise for Vietnamese agriculture, but scaling up requires a comprehensive, inclusive approach, with special attention to smallholder farmers and long-term sustainability.

3. METHODOLOGY

This study employs a qualitative approach, based on the collection and analysis of secondary data to assess the current situation, trends, opportunities, and challenges of digital transformation in Vietnamese agriculture.

Secondary data is collected from reports issued by the Ministry of Agriculture and Rural Development, the Institute of Policy and Strategy for Agriculture and Rural Development (IPSARD [29]), the General Statistics Office, FAO [24], World Bank [13], as well as academic studies published in domestic and international scientific journals. Notably, key documents such as IPSARD's Annual Agricultural Reports [29], reports on digital transformation in Lam Dong [3], An Giang [18], and the Mekong Delta (2023 - 2024), along with studies on IoT, AI, Blockchain, and Big Data applications in agriculture, serve as primary sources of information.

The advantage of secondary data is its high reliability, providing a broad picture of the digital transformation landscape in Vietnamese agriculture. However, this approach has limitations as it may not capture rapid changes at the household level or in small production areas. Therefore, during the analysis process, this study integrates synthesis, cross-checking, and comparisons with experiences from countries such as China, Thailand, and the Netherlands to draw lessons applicable to the Vietnamese context.

To enhance analytical transparency, the research process was conducted in three key stages. First, relevant documents were identified and selected based on two criteria: (i) relevance to the agricultural sector in Vietnam or comparable developing economies, and (ii) inclusion of empirical content related to digital technology adoption. Second, data was thematically organized into three core categories aligned with the research objectives: driving forces, disparities, and challenges of digital transformation. This organization was guided by the theoretical framework presented in Section 2.2. Third, qualitative content analysis was applied to synthesize findings and draw cross-regional comparisons. Patterns and insights were

then interpreted using the conceptual framework introduced in Figure 1 and further illustrated in Table 1.

4. RESULTS AND DISCUSSION

4.1. Results

The digital transformation process in Vietnamese agriculture has achieved some initial encouraging results, mainly concentrated in localities with favorable conditions and large enterprises leading the way. However, the level of technology adoption still varies significantly among farmer groups and production regions.

In practice, Lam Dong is a pioneering locality in applying digital technologies to agricultural production, especially in vegetable and flower cultivation. According to IPSARD [29], about 60% of the cultivated area in the province has adopted greenhouses, automated drip irrigation, and environmental monitoring sensors. These applications have helped reduce costs by 10-15% and increased productivity by 20-30%.

In An Giang, IoT-based models for soil moisture monitoring, smart irrigation, and electronic farm diaries have helped farmers cut production costs by 10-15% and increase yields by 20% (Department of Agriculture and Rural Development of An Giang Province, [18]. The Mekong Delta region has also begun deploying salinity warning sensor systems, which support farmers in timely production adjustments.

Blockchain technology has been initially applied by companies like VinEco and Nafoods to manage supply chains and trace the origin of agricultural exports to markets in the United States and the EU. As a result, the value of agricultural products increased by 10-20%, and the risk of commercial fraud was reduced (IPSARD, [29]).

Artificial Intelligence (AI) and Big Data have been piloted at several farms in Da Lat to monitor pests and optimize fertilizer usage, reducing costs by 20% and improving agricultural product quality (Department of Agriculture and Rural Development of Lam Dong Province, [3]).

E-commerce platforms have supported farmers in expanding their sales channels, especially during supply chain disruptions caused by the COVID-19 pandemic. Platforms like Postmart and Voso facilitated the sale of thousands of tons of agricultural products, increasing farmers' incomes by 10-15% (Ministry of Information and Communications, [26]).

However, the digitalization rate in Vietnamese agriculture remains very low. According to the Ministry of Information and Communications [26], this rate is only about 2.1%, significantly lower than the global average. The main barriers include incomplete technological infrastructure, high investment costs, and farmers' limited digital skills.

While the current findings highlight prominent case studies and successful pilot initiatives, they primarily focus on provincial-level data and enterprise-led models. Future research could benefit from incorporating household-level data, more diverse regional samples, and longitudinal studies to better capture the dynamics of digital transformation over time. Expanding the evidence base in this direction would help strengthen generalizability and provide deeper insights into smallholder farmers' experiences, which remain underrepresented in existing datasets.

4.2. Discussion

Although Vietnam has made a promising start with digital transformation in agriculture, the process is still far from widespread. The theories discussed earlier help us make sense of both the successes and the ongoing challenges.

Take Lam Dong and An Giang, for instance—these provinces have seen faster adoption of technologies like IoT and AI thanks to better infrastructure and strong support from cooperatives or enterprises. This trend lines up with Rogers' Innovation Diffusion Theory [32], which points out that people or groups with more resources tend to adopt innovations earlier.

On the flip side, small-scale farmers in remote regions face many barriers. Things like high costs, limited access to technology, and low digital literacy make it hard for them to keep up. This reflects the essence of Cohen and Levinthal's Absorptive Capacity Theory [20], which emphasizes that having the capacity to absorb and apply new technology depends a lot on existing knowledge and resources.

The environment also matters. Technologies like smart irrigation and environmental sensors only work well when they match local conditions. In the Mekong Delta, for example, these tools have been effective, which is in line with Collinson's Farming Systems Theory [33]. It reminds us that one-size-fits-all solutions rarely work in agriculture.

There's also a big difference between what large enterprises can do compared to smallholders. Companies like VinEco and Nafoods have managed to apply Blockchain and AI successfully. But smaller farmers are still struggling to get access to basic tools. To close this gap, a strong, well-connected ecosystem is needed—something Chesbrough's Open Innovation Theory [22] strongly supports.

And of course, we can't forget about sustainability. Solutions like AI-powered pest monitoring, salinity alerts, and drip irrigation are helping save resources and protect the environment. These efforts are in line with Brundtland's Sustainable Development Theory [30]. Still, researchers like FAO [24] and Klerkx et al. [25] warn that if we don't have inclusive policies, we might unintentionally widen the gap between rich and poor farmers—or even harm the environment.

To sum it up, while there are great examples of success, most efforts are still at the pilot stage. For digital transformation to truly take off across Vietnamese agriculture, there needs to be more investment in infrastructure, better support for farmers, and stronger cooperation among government, businesses, scientists, and the farmers themselves. Only then can digital transformation become a force for sustainable and inclusive growth in the sector.

5. CONCLUSION

Digital transformation is an essential driver to improve productivity, optimize value chains, and promote sustainable development in Vietnamese agriculture. Practical experiences in Lam Dong, An Giang, and the Mekong Delta, along with the pioneering efforts of enterprises such as VinEco and Nafoods, have shown promising initial results.

However, this process has not yet achieved widespread adoption. Most efforts remain at the pilot stage and are concentrated in economically capable regions and organizations, while small-scale farmers still face barriers related to funding, digital skills, and technological infrastructure.

The research results indicate that digital transformation is only truly effective when there is strong coordination and connection among all components of the agricultural ecosystem, including the Government, Businesses, Scientists, and Farmers. The Government plays a key

role in developing digital infrastructure and improving supportive policies. Businesses provide technology and expand markets. Scientists ensure the applicability and technical relevance of digital solutions. Farmers are the central actors who directly adopt and apply technology in production.

To ensure that digital transformation becomes a sustainable driving force for Vietnamese agriculture, efforts should focus on developing rural technological infrastructure, enhancing farmers' digital skills, promoting public-private partnership (PPP) models, and establishing appropriate financial support mechanisms.

In the future, experimental research conducted across regions with different farming conditions will serve as a crucial basis for more accurately assessing the impact of digital transformation. This will help policymakers develop practical and comprehensive strategies to drive the digital transformation process in agriculture.

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TÓM TẮT

CHUYỂN ĐỔI SỐ TRONG NÔNG NGHIỆP VIỆT NAM: XU HƯỚNG, CƠ HỘI VÀ THÁCH THỨC

Phạm Thị Thanh Huyền, Trần Tuấn Anh*

Trường Đại học Công Thương Thành phố Hồ Chí Minh, Việt Nam

*Email: *anhtt@huit.edu.vn*

Chuyển đổi số đang nổi lên như một động lực then chốt nhằm nâng cao năng suất, tối ưu hóa chuỗi giá trị và thúc đẩy phát triển bền vững trong lĩnh vực nông nghiệp. Tại Việt Nam, quá trình chuyển đổi số trong nông nghiệp đã ghi nhận những kết quả bước đầu đầy triển vọng, đặc biệt tại các tỉnh như Lâm Đồng, An Giang và khu vực Đồng bằng sông Cửu Long, thông qua việc ứng dụng các công nghệ như Internet vạn vật (IoT), trí tuệ nhân tạo (AI) và chuỗi khối (Blockchain). Những doanh nghiệp tiên phong như VinEco và Nafoods đã triển khai các giải pháp số trong quản lý chuỗi cung ứng và truy xuất nguồn gốc sản phẩm, góp phần nâng cao năng suất và giá trị gia tăng cho nông sản. Tuy nhiên, quá trình chuyển đổi hiện vẫn còn rời rạc, với sự chênh lệch đáng kể giữa các nông hộ sản xuất lớn và nông hộ quy mô nhỏ. Trong khi các mô hình tiên tiến về công nghệ phát triển mạnh ở những khu vực có hạ tầng thuận lợi và hệ sinh thái do doanh nghiệp dẫn dắt, thì các nông hộ nhỏ vẫn gặp phải nhiều rào cản liên quan đến vốn, năng lực số và khả năng tiếp cận công nghệ. Thông qua việc vận dụng các khung lý thuyết như Lý thuyết Khuếch tán Đổi mới (Innovation Diffusion), Năng lực Hấp thụ (Absorptive Capacity), Hệ thống Canh tác (Farming Systems), Đổi mới Mở (Open Innovation) và Phát triển Bền vững, nghiên cứu này phân tích các động lực, mức độ chênh lệch và các thách thức của chuyển đổi số trong nông nghiệp Việt Nam. Kết quả nghiên cứu cho thấy rằng, để chuyển đổi số thành công không chỉ đơn thuần là áp dụng công nghệ, mà cần một hệ sinh thái tích hợp, bao gồm sự tham gia của chính phủ, doanh nghiệp, viện nghiên cứu và nông dân. Các nỗ lực phối hợp trong việc nâng cấp hạ tầng số nông thôn, tăng cường năng lực số cho nông dân và thúc đẩy hợp tác công – tư là điều kiện thiết yếu nhằm đảm bảo rằng chuyển đổi số thực sự trở thành động lực cho phát triển nông nghiệp bền vững và toàn diện tại Việt Nam.

Từ khóa: Chuyển đổi số, Nông nghiệp thông minh, IoT, AI, Blockchain, Chuỗi cung ứng, Nông hộ nhỏ, Việt Nam.