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Revolutionising agriculture and rural economy through digital transformation: Bridging theory with practice

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Abstract:

Digital transformation presents an avenue for fostering the sustainable growth of agriculture, rural economies, and the farming community. Findings from comprehensive desk research and field surveys conducted across three provinces - Son La, Nam Dinh, and Ninh Thuan in 2023 - indicate that the agricultural sector has initiated its journey towards digital transformation. The strategy for digital transformation prioritises the establishment of big data systems, digital infrastructure, and digital platforms, alongside initiatives aimed at modernising state governance and fostering e-commerce. The rural economy benefits from rapidly developing digital infrastructure, easy Internet access for people, digital technology platforms in business management, and expanding consumer markets through e-commerce. Nonetheless, digital transformation also presents numerous challenges. Drawing from theoretical frameworks and practical evaluations, proposed solutions entail the development of a comprehensive architecture for digital transformation within the agricultural sector. This includes the establishment of a national digital database for agriculture and rural economies, incentivising investments, deploying digital technologies, and enhancing the digital literacy of farmers through capacity-building initiatives.

Keywords: **agricultural development, digital transformation, rural economic development.**

Classification numbers: **2.1, 2.2, 4.1**

1. Introduction

Digital transformation in the era of the fourth industrial revolution is a global trend with significant implications for all industries and economies. The application of digital transformation in the agricultural sector will help farmers, cooperatives, and businesses improve productivity and quality, optimise resources in production and distribution activities, and address issues of sustainable development [1, 2]. The application of digital technology is also the "key" to unlocking modern agricultural development [3-5].

In Vietnam, rural dwellers account for 63% of the population, 66% of households, and 68% of workers. The value of the agricultural sector contributes 13.96% to GDP. The digital transformation of the agricultural sector will be an opportunity for Vietnam to overcome the current shortcomings of the agricultural sector, such as small production models, low productivity, lack of value chain links, and the impacts of climate change. Digital transformation creates opportunities to develop a more sustainable agricultural sector. Additionally, digital transformation induces significant changes in rural economic development and improves the lives and roles of farmers [6, 7].

Given the high expectations of digital transformation for national development, Decision No. 749/QD-TTg of the Prime Minister approved the "National digital transformation programme until 2025, orientation to 2030", which identifies agriculture as one of eight priority areas for digital transformation. The Ministry of Agriculture and Rural Development (MARD) has established a Digital Transformation Steering Committee to direct the implementation of digital transformation tasks under three pillars: digitalising state management of MARD, the digital agricultural economy, and digital farmers. Currently, digital transformation of the agricultural sector will focus on data digitisation to serve digital applications, helping

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farmers add value, increase production efficiency, and meet the needs of both domestic and international markets in terms of transparency in the production process and product traceability.

In fact, digital transformation is only in the beginning stages. Many opportunities are opening up, but they also come with many challenges and barriers. Therefore, appropriate and synchronous solutions are necessary for successful digital transformation in agricultural development, rural economy, and for improving farmers' ability to master digital technology. This article is based on document research and social survey results in three provinces - Son La, Nam Dinh, and Ninh Thuan in 2023. It focuses on building a theoretical basis for digital transformation, assessing the current status of digital transformation in agriculture and rural economy, and proposing solutions to promote digital transformation in the agricultural sector and rural development.

Digital transformation is still in its infancy, presenting numerous opportunities alongside significant challenges and hurdles. Hence, there is a pressing need for synchronised solutions to ensure successful digitalisation in agricultural development, rural economies, and the enhancement of farmers' digital literacy. This article draws upon document analysis and social surveys conducted in three provinces - Son La, Nam Dinh, and Ninh Thuan - during 2023. It primarily focuses on establishing a theoretical framework for digital transformation, evaluating its current practices in agriculture and rural development, and proposing strategies to advance digitalisation within these sectors.

2. Research methods

The research leverages both secondary data sourced from published documents and primary data. To collect primary data, we selected three provinces with a moderately high level of digital transformation (Nam Dinh), and an average level (Ninh Thuan, Son La) (Ministry of Information and Communications, 2023, cited from Nhan Dan Newspaper). Additionally, these three provinces represent different rural areas of Vietnam [8]: Nam Dinh represents the coastal plain, Son La represents the northern mountains, and Ninh Thuan represents the coastal mountains. Regarding data collection techniques, a mix of qualitative and quantitative methodologies was employed. This included in-depth interviews and group discussions with key stakeholders such as local government officials, managerial personnel, cooperative leaders, business leaders, alongside a household survey conducted through a semi-structured questionnaire.

For the household survey conducted in 2023, we applied a two-stage stratified random sampling method. Firstly, based on the assessment via in-depth interviews and focus group discussions of relevant stakeholders in the selected provinces about the level of digital transformation, we selected representative districts with an average level of transformation in each province (e.g, Giao Thuy, Hai Hau in Nam Dinh; Moc Chau, Mai Son, Bac Yen in Son La; Ninh Son, Ninh Phuoc, Ninh Hai in Ninh Thuan). In every district, we selected two representative communes. Then, using the systematic random sampling method, the surveyed sample of households was withdrawn from the household list of each commune. With a large sample size of 1,330 selected households, the confidence level is assured at over 95% [9, 10].

Regarding data processing and analysis, with data from document research, interviews, and discussions with relevant parties, we used the triangulation technique to verify the information's reliability. Particularly, initial results from document research were discussed in in-depth interviews and group discussions with relevant stakeholders including local government leaders and officers, agricultural extension staff, and private actors in the studied sites. Only consistent results from various information sources are synthesised into research findings. Additionally, key findings relating to the status of digital transformation in agriculture obtained from document research were included in the household survey to gain a new bottom-up perspective on digital transformation practices in agriculture. We used SPSS 22 to analyse quantitative data, measuring the central tendency of various aspects of farmers' digital transformation, including access to smart devices and the internet, knowledge and openness to digital transformation, and the use of digital platforms in communication, production, trade, and payment.

3. Research findings

3.1. Theory on digital transformation in agriculture and rural economy

3.1.1. Digital transformation

Digital transformation is the process of overall and comprehensive change of individuals and organisations in the way of living, working and production methods based on digital technologies. According to the Ministry of Information and Communications, digital

transformation is the next development step of computerisation, achieved thanks to the outstanding progress of new technologies from the groundbreaking Industrial Revolution 4.0, especially digital technology with its main pillars being cloud computing technology, big data, artificial intelligence, internet of things, blockchain, and virtual reality [11]. From another approach, digital transformation is the process of change in the real digital environment about how to live and work with digital technologies. Change includes changes in the way of life of individuals and changes in the way of working of organisations, businesses, and countries [12].

Particularly in Vietnam, the national digital transformation programme aims to sharply increase labour productivity and create momentum for new economic growth. Digital transformation is defined as creating a digital environment and ecosystem, changing how all government agencies and businesses operate and all people's socio-economic practices based on technological innovations. Therefore, digital transformation is focused on three main pillars: digital government, digital economy, and digital society [12].

Challenges of digital transformation: Digital transformation offers abundant opportunities, yet it also presents numerous hurdles and challenges. The most significant obstacles pertain to shifting perceptions, human capabilities, institutional frameworks, and technological advancements. Firstly, the foremost challenge in digital transformation lies in altering perceptions. Transitioning to a fully digital environment necessitates changing habits, shifting worldviews, and transforming mindsets. Secondly, the institutional challenge involves adapting to the rapid change of digital technology, the real-digital environment and creating a suitable legal environment to support individuals, organisations, and businesses associated with digital technology and the digital environment. Thirdly, technological challenges relate to the ability to create and master digital technology. Distinct challenges revolve around managerial proficiency, data management, safeguarding information, investment in innovative development, crafting digital technologies, and nurturing digital technology talent [12].

3.1.2. Argument for agricultural and rural economic development

Digital transformation for agricultural development: The sustainable agricultural and rural development strategy for the period 2021-2030, with a vision to 2050, has been approved, in which "promoting digital transformation in the field of agriculture and rural development" is one of the core solutions to carry out this strategy. In line with this strategy, MARD has developed a digital transformation project for the agriculture sector for the period 2021-2025, oriented to 2030 with three main pillars: digital government, digital agricultural economy, digital rural areas, and digital farmers to achieve the goal of implementing agricultural digital transformation synchronously and effectively. The focus of digital transformation in Vietnamese agriculture is applying digital technology solutions to create products with higher value and more efficient production. Argument-shifting subjects include state agencies, businesses, cooperatives, and farmers. In particular, state agencies play the role of directing, orienting, managing, and promoting (digital government); businesses play a key pioneering role (digital economy); cooperatives and farmer households master the application of digital technology (digital society). Digital transformation orientation for agricultural development focuses on eight main goals:

- Develop strategies and plans to develop precision agriculture and smart agriculture.

- Build a big data system.

- Promote the development of digital farmers.

- Promote the application of digital technology.

- Automate production processes.

- Monitor product origin and supply chain.

- Develop e-commerce in the agricultural industry.

- Digital transformation in executive management.

In the current period, digital transformation efforts in agriculture aim to contribute to building a "transparent - responsible - sustainable" food system. In fact, MARD has prioritised livestock and crop sectors as a pioneering field in digital transformation. The first step is to digitise and build a digital database for the crop and livestock industry.

Digital transformation for a rural economy: Digital transformation in agricultural economics includes the application of digital technologies to all agricultural production and business activities from production to processing, distribution, and consumption. The key contents of digital transformation for rural economy development include: i) Traceability - Using digital technology (blockchain) to track origins and manage supply chains in agriculture; ii) Collect and analyse digitalised data - Apply big data technology; iii) Smart

production: Using technology such as Internet of Things (IoT) and artificial intelligence (AI) to optimise and automate processes in the agricultural product value chain; iv) Managing production and logistics information: Applying digital technology to effectively manage production information and logistics; v) Multi-channel sales - Expanding sales channels through online platforms, for example through the company's official website, through social networking platforms (YouTube, Facebook, TikTok, etc.), e-commerce platforms, and vi) Providing information and support for connecting sellers/buyers - Creating a digital agricultural ecosystem to encourage people and businesses to participate in digital transformation.

Currently, in Vietnam, a number of smart farm/ business models for agricultural production and business (smart farm/smart business) have emerged. These models have applied digital technology in production, processing, consumption, and even in management. However, these models are not complete and have not been widely applied in enterprises and production and business cooperatives in the agricultural industry [7].

Digitalising farmers: Farmers are the main subjects of digital transformation in agriculture and rural areas. Digital transformation for farmers means changing the traditional production mindset of farmers to a transparent and responsible agriculture. Farmers directly participate in building big data about agriculture such as crops, livestock, fisheries, and land. Farmers are provided with information about the environment, weather, and land quality so that they can make informed decisions regarding appropriate production and business directions. Thus, digital transformation for farmers can be summarised as the change of farmers in production processes and product consumption based on digital technology application software and extensive participation in e-commerce. Digital transformation creates "digital farmers", who are farmers that use digital technology in their agricultural production process. Farmers use digital devices and applications to improve performance, productivity, product quality and value, and actively engage in e-commerce. Currently, the trend of digital transformation serving farmers is focused on two main types of platforms: Digital agricultural database and Smart village. The smart village model is built on five main pillars: i) Smart institutions, ii) Smart infrastructure, iii) Smart production and business, iv) Smart services, and v) Intelligent resources [13].

3.2. Current practices of digital transformation for agricultural development and rural economy in Vietnam

This section analyses the current practices of digital transformation in agriculture in Vietnam. The content is scoped to digital transformation in state management of the agricultural sector (under the digital government pillar), digital transformation in the rural economy (under the digital economy pillar), and digital transformation for farmers (under the digital society pillar). The above digital transformation aspects are focused on content related to the agricultural industry.

3.2.1. State management of digital transformation for agricultural development

Strategy and plan for developing precision agriculture, smart agriculture, and infrastructure for digital transformation of the agricultural sector*:* MARD has developed the "Digital transformation project of the agriculture and rural development sector for the period 2021-2025, with a vision to 2030" as a basis for the entire sector to implement the transformation. This project aims to create new motivation for improving production efficiency; attract the participation of all components in the production chain from farmers, rural areas, businesses, and cooperatives to engage in the digital transformation process in the agricultural industry. The most important goal in the 2021-2025 period is to build a database of the agricultural sector at a national level and build digital technology application platforms in product traceability and information provision.

Particularly, MARD has promoted the formation of an agricultural digital data platform and developed e-commerce and digital agricultural services. In addition, Decision No. 150/QD-TTg of the Prime Minister approved the strategy for sustainable agricultural and rural development for the period 2021-2030, with a vision to 2050, sets the goal to "Develop and synchronise tools for digital transformation in the field of agriculture and rural areas including data creation, and standardisation of databases on agricultural land, crops, livestock, and fisheries, irrigation, natural disaster and epidemic prevention; connect and share these databases to serve the direction and administration of state agencies and the production and business of people and businesses."

Currently, MARD has focused on building and implementing the national database system on crop and livestock production. Regarding the crop database, the Department of crop production is assigned to be

the leading unit to organise and coordinate with Vietnam Posts and Telecommunications Group (VNPT) Group to organise the implementation. This system has been in operation since August 2023, starting with managing the database and managing planting area codes. Up to this point, the information system, updated database, and management of planting area codes have been built on the website version and mobile application[1].

Regarding the development of the livestock production database, the Department of livestock production also coordinated with VNPT Group to develop and pilot information collection software to build a database on animal feed and a database on livestock facilities. To date, the software has been piloted in seven provinces and cities and 269 animal feed factories across the country; granted 600 accounts to update the database to factories, commune-level veterinary staff, and large farms and livestock enterprises[2].

MARD has also issued e-government architecture version 2.0. In particular, this Ministry has deployed applications and services to serve people and businesses such as: Electronic information portal; Online public service portal; Electronic one-stop system; Synchronise and publicise 241 administrative procedures on the national public service portal and 24 level 3 online public services provided on the customs single-window system. For electronic public services and online public service systems, MARD provides many online public services at levels 3 and 4[3].

Regarding building digital platforms, many digital platforms have been built and begun to operate. To date, there have been 50 digital platforms announced, including 18 platforms serving the digital government, 16 platforms serving the digital economy, and 16 platforms serving the digital society. There are 63/63 provinces that have been assigned the task of deploying and using at least one digital platform; 43/63 provinces have announced the selection of digital platforms to be deployed in 2022 integrated into the digital transformation plan.

However, digital application is still limited in the rural economy. By the end of 2021, only about 2,200/19,000 agricultural cooperatives had implemented digital transformation, with nearly 2% of the total number of farming households trained in digital technology[4]. Therefore, MARD needs to coordinate with the Ministry of Labour, War Invalids and Social Affairs to develop a training framework programme on digital technology and digital transformation for agricultural enterprises, agricultural cooperatives, and farmers. This will promote the application of digital technology in the rural economy.

Promoting the use of digital applications/platforms: Currently, MARD promotes the use of digital technology applications/platforms for the e-commerce of agricultural products. Supports focus on training on digital skills; instructions for registering an account on e-commerce platforms; instructions for registering an online payment account and implementing the packaging-connection-delivery process for agricultural producers. In addition, there is support for farmers to sell on online platforms (Facebook, Zalo, YouTube, etc.). By the end of 2021, more than 2 million agricultural households were trained in digital skills; nearly 50,000 agricultural products were launched on the e-commerce platform with thousands of transactions. Vietnamese e-commerce platforms such as Postmart and Voso are providing great support for agricultural products. Statistics from the Ministry of Information and Communications show that from August 2022 to June 2023, there were more than 5.4 million active accounts on the two e-commerce platforms: Voso (voso.vn of Viettel) and Postmart (postmart.vn of VNPT).

In addition, Vietnamese agricultural products have been available on many e-commerce platforms such as Shopee, Lazada, and Tiki. According to information from MARD, from 1 June 2022 to 1 June 2023, Vietnam's agricultural product revenues reached about 4.6 billion VND with more than 49,000 products sold, of which Shopee accounts for 95.2% of total revenues and 90.5% of output quantity, followed by Lazada and Tiki. For agricultural products, customer segments often buy mainly at prices of 100,000-200,000 VND per purchase[5].

3.2.2. Current status of digital transformation for rural economy development

Building digital infrastructure, access, and use of the Internet of rural people*:* Evidence shows that

[1]https://csdltrongtrot.mard.gov.vn/#/pages/home, accessed 2 December 2023 (in Vietnamese).

[2]https://csdlchannuoi.mard.gov.vn/#/pages/home, accessed 2 December 2023 (in Vietnamese).

[3]https://dichvucong.mard.gov.vn/portaldvc/Home/default.aspx, accessed 2 December 2023 (in Vietnamese).

[4]https://tmdt.mic.gov.vn/tin-tuc-hoat-dong/hoat-dong-chuong-trinh/chuyen-doi-so-nong-dan-viet-nam-tren-hanh-trinh-cong-listen-so-2442.html, accessed 2 December 2023 (in Vietnamese).

[5]https://www.mard.gov.vn/Pages/phat-trien-thuong-mai-dien-tu-cho-nong-san-tai-lam-dong.aspx, accessed 2 December 2023 (in Vietnamese).

digital infrastructure and the proportion of households connected to information technology infrastructure systems in rural areas have been improving rapidly over the past few years. Analysis results of the Vietnam rural report conducted by MMA Global (2021) [11] show that 60% of Vietnam's population still lives in rural areas and is increasingly transforming into a digital community. While traditional television usage has declined, the Internet, especially through smartphones, is growing strongly, especially since 2018 in rural areas. The results reported by the Ministry of Information and Communications also show that digital infrastructure in rural areas has developed rapidly in recent years. Telecommunications infrastructure has expanded throughout the country with more than 600,000 km of fibre optic cables, providing high access speeds (>27 Mbps). The number of fixed broadband subscribers has surpassed 13 million, of which more than 12 million use fibre optic cables with access speeds of more than 10 Mbps. Total international bandwidth reached more than 8.1 Tbps. The mobile network has a coverage rate of up to 99.7%, and the 5G mobile network has been licensed for testing, promising to bring a breakthrough in connection speed, especially as a foundation for IoT infrastructure in the process of digital transformation.

Table 1. Current status of internet access and use by rural citizens.

Or.	Access and use of internet	Proportion (%)
1	Internet usage rate in rural Vietnam	77
2	Daily internet access level	91
3	Percentage of rural citizens who shop online	70
4	Entertainment internet access rate	79
5	Percentage of internet access searching for information about health and education	76
6	Rate of searching and viewing videos on social networks	67

Source: MMA Global (2021) [11].

Additionally, smartphones are currently the most popular device for accessing the Internet in rural areas. Internet use in rural Vietnam is increasing, with 77% of the rural population having Internet access, of which 91% access it daily (Table 1). The Internet plays an important role in the daily lives of rural people, allowing them to access online resources to meet personal needs such as online shopping (70%), entertainment (79%), and health and education (76%). Rural people also frequently search and watch videos on social networks, with a weekly usage rate of up to 67%.

Within the framework of the national digital transformation programme, to promote rural people to connect and apply technology applications and digital platforms, support focuses mainly on communication and capacity building through various training courses. Along with that are training courses and peer-to-peer instructions on how to use these applications (Fig. 1). Survey results show that localities have mobilised local youth unions to propagate and support people in installing and using applications on smartphones. This is an innovative and cost-effective solution to implement digital transformation in rural communities.

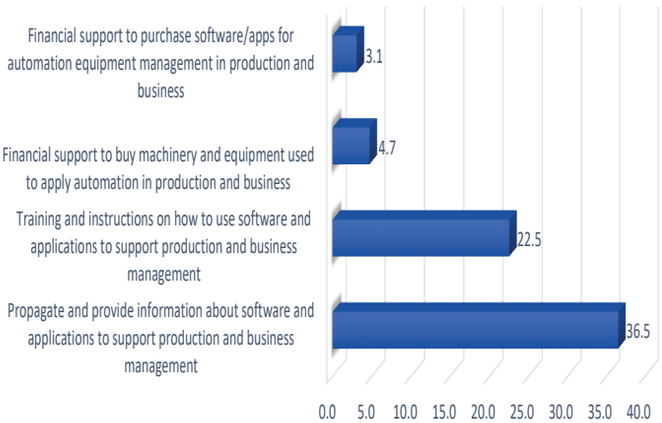

Fig. 1. Support received by rural households (%). Source: Summary of survey data in Son La, Nam Dinh, and Ninh Thuan (2023).

The development of rural economic organisations is associated with digital transformation: As of 1 July 2020, Vietnam has 9,123 thousand agriculture-forestry-fishery production units, of which the number of households is 9,108 thousand, the number of cooperatives is 7,418, and the number of enterprises is 7,471. Enterprises, including cooperatives in the agricultural sector, have begun to make rapid changes in the digital economy. Recent research results show that awareness of the importance of digital technology has improved significantly. However, according to the 2022 Digital transformation annual report, only 6.2% of businesses have completed determining digital transformation goals and 7.6% have gradually built a digital transformation plan[6].

[6]https://digital.business.gov.vn/thuc-trang-va-nhu-cau-ung-dung-cong-nghe-so-trong-nghiep-vu-hoat-dong-cua-mot-so-doanh-Vietnamese-American industry/, accessed 2 December 2023 (in Vietnamese).

Regarding the Digital transformation roadmap, there are still many shortcomings. Findings obtained from the survey in the three provinces of Son La, Nam Dinh, and Ninh Thuan show that only 35.3% of businesses have digitised data and built a digital transformation plan. Survey results also show that enterprises/cooperatives in the agricultural sector are mainly small-scale, applying scientific and technological advances in some stages and depending on the characteristics and field of activity. Most businesses and cooperatives have an Internet connection and have applied software for production management, warehousing, accounting, and electronic payment. However, there are very few businesses that carry out synchronous digital transformation, with a coherent digital transformation design and roadmap.

State-supported e-commerce and e-payments are the focus of many transformation support efforts from the government. However, this transformation of the rural economy sector is not as expected. Some businesses/cooperatives have launched products on e-commerce platforms, but these platforms have not been effective (increased costs for both sellers and buyers, transaction procedures, and payments are still slow). Instead, rural businesses/cooperatives choose other alternative online sales channels via YouTube, Zalo, Facebook, TikTok rather than using state-supported e-commerce platforms. Most cooperatives are still slow in digital transformation, unable to keep up with changes in technology, although they have also applied social networks and electronic payments in promotion, sales, and payment.

3.2.3. Current status of digitalising farmer

Vietnamese farmers are more interested in digitalisation than anywhere else in the ASEAN region. According to a survey by the Asian crop life association, in the first quarter of 2021, 42% of Vietnamese rice, vegetable, and fruit farmers polled said they wanted to apply digitalisation in agriculture. Compared to the three ASEAN countries in the same survey, Vietnam has the highest rate. In addition, the survey also showed that more than 89% of Vietnamese people use mobile phones and 68% of them use smartphones. This is a great opportunity for farmers to popularise and apply improved agricultural technologies. At the same time, this is also a great opportunity for partners in the agricultural and food production chain to continue to cooperate in promoting testing activities, applying new technology, and implementing training programmes so that farmers understand and use those technologies effectively and safely with the goal of ensuring access opportunities and increasing technology application rates for farmers.

Our household survey results confirm that smart devices have become popular and the proportion of households with internet connection is quite high (Table 2). Among smart devices, smartphones and smart TVs are the most popular devices in rural households, followed by laptops. These devices serve both communication needs and entertainment, learning, and internet connection needs. This has a huge role in connecting people to the world through applications and the internet. This is an important foundation to start digital transformation for farmers. For example, the percentage of households that reported having access to the internet is 83.6%, of which the broadband connection is 26.1% and the level of access to 3G/4G services is 58.8% (Fig. 2). However, compared to the goal of the national digital transformation programme, by 2025, the rate of broadband internet coverage will be 80% of households; this percentage of access to the internet in rural areas is still quite far away.

Table 2. Number of smart devices with internet connection per 100 households.

Device	Average number/100 households
Smart television	83
Computer	30
Smartphone	284
Tablet	9
Security camera	56

Source: Summary of survey data in Son La, Nam Dinh, and Ninh Thuan (2023).

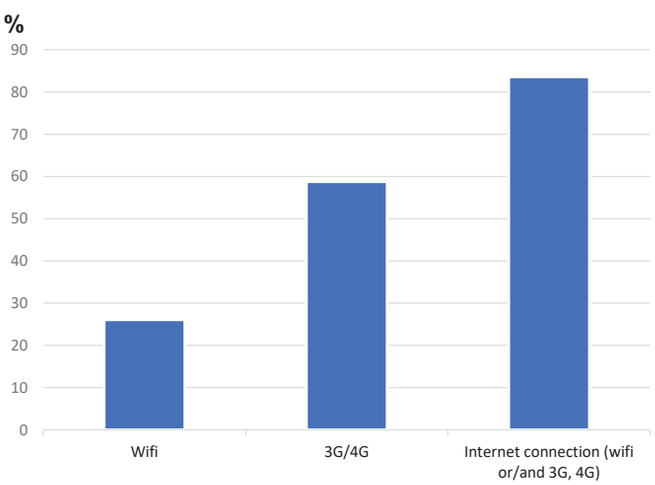

Fig. 2. The percentage of households who reported that they have access to the internet (%). Source: Summary of survey data in Son La, Nam Dinh, and Ninh Thuan (2023).

Table 3. Household's knowledge of digital transformation and digital technology.

Knowledge	Don't know	Have heard it before	Know but don't understand	Understand a little	Understand very well	Average score
Digital transformation	37.7	23.6	14.3	17.7	6.8	2.3
Digitisation	45.7	22.3	14.2	13.4	4.5	2.1
Digital technologies	60.1	20.4	10.1	6.9	2.6	1.7
Online public services	31.1	20.9	18.6	21.7	7.8	2.5
E-commerce (online market)	29.2	16.8	9.2	22.4	22.4	2.9
Electronic banking: Non-cash payment	31.8	19.5	9.7	18.1	20.9	2.8

Source: Summary of survey data in Son La, Nam Dinh, and Ninh Thuan (2023).

Regarding people's knowledge of digitalisation and digital transformation, the findings show that people's knowledge is still at a low level (Table 3). The concepts and terms of digitalisation, digital transformation, digital technology, or digital platforms that are available for application in production, business, and economic transactions are still new to them. Among the surveyed contents, e-commerce and e-banking are more familiar to rural households. This is understandable because these two fields have grown rapidly in popularity in the past three years due to the COVID-19 pandemic and social isolation, which has pushed businesses to develop e-commerce applications and platforms, digital banking, and they are relatively widely accepted and used by people.

Regarding skills in using digital applications, the applications that people have higher proficiency in relate to applications that are easy to use and aimed at meeting communication and entertainment needs like Zalo, Facebook, and Google. Applications serving production, business, and online payments require more advanced knowledge, so their level of mastery is relatively low, with the average score mostly around 2 on a 5-level Likert scale (Fig. 3).

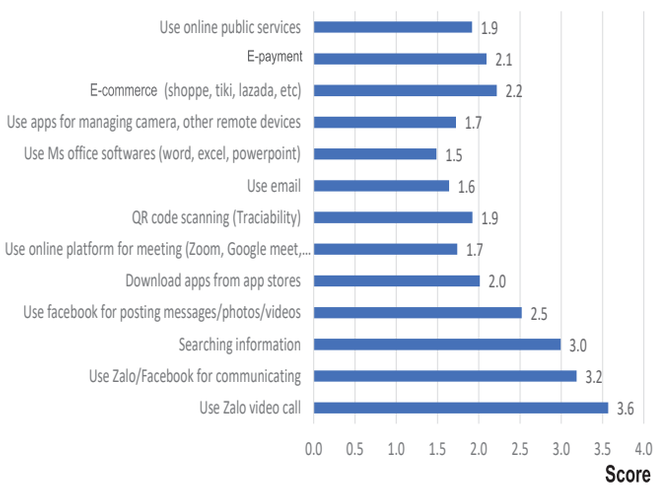

Fig. 3. Skills in using digital technology applications on smart devices. Source: Summary of survey data in Son La, Nam Dinh and Ninh Thuan (2023).

It is interesting that rural households show openness to accepting digital technologies and have a desire for digital transformation. According to the 5-level Likert scale, the average score that people rate on the necessity of digitalisation, digital transformation, application of digital technologies, and digital platforms is above 3.5 (Table 4). People's openness and support for digital technology are very favourable conditions for implementing digital transformation in agriculture and rural areas.

Table 4. Acceptance level of digital technology application and digital transformation.

	Completely unnecessary	Unnecessary	Normal	Necessary	Very necessary	Average score
Digitising	7.1	13.5	19.1	38.5	21.8	3.5
Digital transformation	6.5	14.9	18.2	40.1	20.3	3.5
Online public services	6.2	13.5	18.5	41.5	20.4	3.6
E-commerce	6.2	11.8	15.7	40.1	26.3	3.7
Electronic banking	6.5	11.4	14.8	36.7	30.6	3.7

Source: Summary of survey data in Son La, Nam Dinh, and Ninh Thuan (2023).

However, in practice, the adoption of applications and platforms for production, commerce, and trade remains relatively low. Survey findings indicate that fewer than 50% of households utilise smartphones for accessing digital platforms for production and business purposes, such as online shopping, cashless transactions, automated equipment control applications, and product origin traceability (Table 5).

Table 5. Usage level of digital applications and platforms for production and business.

No	Applications, platforms	Frequency of use				
		Absolutely no use	*Little use*	*Use occasionally*	*Frequent*	*Very often*
1	Scan QR code (traceability)	58.0	13.9	12.0	10.3	5.9
2	Use bookkeeping and production management software (Word, Excel, accounting software, etc.)	74.0	12.1	7.3	4.3	2.3
3	Using automatic machinery control applications in production: cameras, automatic irrigation machines, etc.	64.7	13.8	10.1	7.4	4.1
4	Buy and sell online (via trading floors: Shopee, Tiki, Sendo,...)	48.7	12.1	16.2	14.9	8.2
5	Cashless payment	54.8	10.4	13.6	12.9	8.3
6	Use of online public services: register birth and death, buy health insurance, etc.	52.6	17.8	18.3	7.5	3.7

Source: Summary of survey data in Son La, Nam Dinh, and Ninh Thuan (2023).

3.3. Shortcomings, challenges, and solutions to promote digital transformation for agricultural and rural development

Based on the aforementioned findings, it is evident that digital transformation for agricultural and rural development in Vietnam is still in its nascent phase. To leverage the benefits of digital technology, it is imperative to address existing shortcomings and challenges. The shortcomings can be summarised as follows: (i) The digital infrastructure in some places is limited, the database is underdeveloped, and connectivity is poor; (ii) There are still few digital technology applications and platforms suitable for farmers and small businesses; (iii) The understanding of digital technology is low; (iv) The majority of farming households, cooperatives and businesses are small-scale; and (v) There is a lack of young workers and financial resources in the agricultural sector. These difficulties hinder the speed of digital transformation in the fields of agriculture, rural areas, and farmers.

Regarding the challenges, it can be seen that the challenges posed in the digital transformation process include the rapid change of digital technology, leading to short technology life cycles, uncertainty, and high digital transformation costs. In addition, digital transformation also faces many risks related to network/data security, fraud, and crime in cyberspace. This is especially worrying in the context that rural people's knowledge of digital technology is limited and state management measures in this field are weak and incomplete.

Therefore, several solutions should be considered:

First, on a macro level, as part of the national digital transformation programme, the MARD should finalise and disseminate the comprehensive architectural blueprint for digital transformation within the agricultural sector and rural development. This entails synchronising the development of digital infrastructure, platforms, and data systems tailored for agricultural and rural progress.

Second, in terms of technical infrastructure and technology, there are still underserved areas lacking internet coverage. Therefore, efforts should be intensified to extend internet and mobile network accessibility to these disadvantaged villages and remote communes.

Third, regarding the agricultural digital database system and data analysis technology, the nascent agricultural database is yet to be fully interconnected and synchronised. Hence, there is a crucial need to prioritise the construction of an integrated agricultural database system leveraging big data analytics for real-time insights. This system will serve research, management, decision-making, and empower businesses, cooperatives, and farmers to make informed decisions and optimise their production and operations.

Fourth, along with building and strengthening sanctions to ensure network security, it is necessary to communicate and improve people's capacity for security, safe online transactions, and fraud prevention on online platforms.

Finally, to encourage the adoption of digital technology among cooperatives, agricultural businesses, and farmers, emphasis should be placed on enhancing their digital transformation capabilities through training programmes. This necessitates implementing promotional initiatives such as online training platforms dedicated to digital transformation. Furthermore, ongoing efforts should be made to facilitate the application of digital technologies and platforms by businesses, cooperatives, and individuals to enhance production efficiency. Specifically, the focus should be on leveraging digital platforms for traceability, e-commerce, and logistics to boost competitiveness and economic outcomes.

4. Conclusions

In theory, digital transformation is a strong driving force for the sustainable development of agriculture and the rural economy as the world enters the fourth industrial revolution. However, in reality, the Government's efforts to achieve rapid digital transformation while still lacking good infrastructure and quality human resources for digital transformation, application of digital technology in agriculture as well as the digital transformation process in the rural economy is facing many challenges. Therefore, to advance digital transformation, it is imperative to establish a comprehensive framework for digitalisation within the agricultural sector, with a key emphasis on constructing a nationwide digital database that is both synchronised and interconnected across various ministries and sectors. Furthermore, there ought to be policies aimed at incentivising the private sector to invest in digital technology development and applications and engage cooperatives, agricultural enterprises, and farmers in value chains actively. Lastly, during the present phase, there should be a concerted effort to prioritise the training and assistance of farmers, cooperatives, and businesses in navigating the digital transformation journey. Simultaneously, there is a need to encourage the adoption of existing digital technologies like automation, traceability, e-commerce, online payment, and digital logistics.

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COMPETING INTERESTS

The authors declare that there is no conflict of interest regarding the publication of this article.

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