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Solutions to Enhance Agricultural Digital Transformation in Vietnam

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Abstract: The purpose of this article aims to assess the current status of the agricultural digital transformation in Vietnam, thereby suggesting some solutions to promote this process. Agricultural digital transformation in Vietnam has only been started since 2018, but it has brought many outstanding benefits, making an important contribution to sustainable agricultural development and increasing income for farmers. Besides the advantages, the digital transformation of agriculture is facing difficulties that need to be overcome such as policies, and laws on digital transformation have not met the practical needs of agricultural production; the information technology infrastructure in the agricultural sector hasn't been synchronously invested and is still backward; awareness of agricultural digital transformation of most localities, businesses and especially farmers is still limited; the average size of arable land per household is very low and the level of mechanization is still low, the supporting technologies for agricultural development are inadequate.

Key words: agriculture, difficulties, digital, transformation, solutions

JEL code: Q

1. Introduction

Agriculture is a foundation for a state's economic development, sustainable society, political stability, and national security. If agricultural development is managed well, it also preserves and promotes the national cultural identity and can contribute to ecological sustainability (Luong, 2013). Agriculture has always been a pioneer in the Doi Moi (renovation) process, contributing significantly to achievements in poverty reduction and food security in Vietnam (Le & Carolyn, 2021; Otsuka, 2013; Wegren & Elvestad, 2018). Furthermore, Vietnam has a great role in ensuring the world's food security because it is a major exporter of rice, seafood, and coffee (Anh et al., 2023). Nowadays, agriculture plays a relatively important role in the development of the economy and society (Tu et al., 2021) with nearly half of the country's labor force working in this sector (Anh et al., 2022). In the context of the outbreak of the Covid-19 epidemic, agriculture was considered a bright spot and a pillar of the economy, with the growth rate reaching 2.88%. Agriculture not only contributed to ensuring food security, but the

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export turnover of agriculture, forestry, and fishery products in 2022 reached 24.73 billion USD, up 3.9% compared to 2021 (General Statistics Office of Vietnam, 2022). Although the agricultural sector has achieved encouraging results, it is also facing difficulties and challenges such as population growth, urbanization, climate change, epidemics, supply and demand disruptions, logistics costs, and high input prices, which requires restructuring for adaptation. In addition, the share of the industry in GDP structure is only 13.96%, very low compared to the potential and advantages due to the small, inefficient production model and the lack of value chain linkages.

To solve all disadvantages completely as well as make a strong motivation in Vietnam's agriculture, which transforms thinking from "agricultural production" to "agricultural economy", towards integrated multi-value agriculture, builds ecological agriculture with the objective of sustainable development agriculture, modern rural areas, and civilized farmers, masters science and technology, promoting digital transformation in agriculture is an extremely inevitable trend. Digital transformation and high-technology applications are expected to help the sector improve production productivity, adapt to climate change, ensure income for farmers, and reduce food waste. However, digital transformation in agriculture in Vietnam is still local and lacks comprehensiveness on the national scale. This article aims to assess the current status of the agricultural digital transformation in Vietnam, thereby suggesting some solutions to promote this process.

2. Policy Framework on Digital Transformation in Agriculture

The Fourth Industrial Revolution creates many opportunities and poses many challenges for each country, organization, and individual. In Vietnam, the Party and Government have recently led and directed all levels and sectors to promote the application and development of science, technology, research, and innovation, and improve the capacity to access and participate actively in the Fourth Industrial Revolution. Resolution No. 52-NQ/TW dated September 27, 2019, of the Politburo set out guidelines and policies to participate actively in the Fourth industrial revolution, focusing on completing the institution that brings advantage to the active participation in the Fourth Industrial Revolution and the national digital transformation process (Central Committee of the Communist Party of Vietnam, 2019).

On June 3, 2020, the Prime Minister issued Decision No. 749/QD-TTg approving the "National Digital Transformation Program to 2025, with orientation to 2030". Digital transformation in agriculture is identified as 1 of 8 priority areas, in which farmers are identified as the center of digital transformation. Digital transformation of agriculture and rural development is an indispensable and objective requirement and is the responsibility, obligation, and interest of the whole political system, enterprises, and especially farmers; is a method to realize the goal of developing smart agriculture and modern rural areas, increasing the proportion of digital agriculture in the production, processing chain, as well as in market and economy. The main contents of digital transformation in the agricultural sector are as follows: (i) To develop high-tech agriculture in the direction of focusing on smart agriculture and precision agriculture, increasing the proportion of digital agriculture in the economy; (ii) To implement digital transformation in agriculture based on data. Focusing on building the big data systems of the industries such as land, crops, livestock, and fisheries. Building an integrated observation and monitoring network in the air and on the ground for agricultural activities. Promote the provision of information on the environment, weather, and land quality so that farmers can actively improve productivity and quality of crops and support the sharing of agricultural equipment through digital platforms; (iii) To apply digital technology to automate

production and business processes; managing and monitoring the origin and supply chain of products, ensuring fast, transparent, accurate, safe, and food hygiene. Consider piloting the implementation of the initiative "Every farmer is a trader, each cooperative is an enterprise applying digital technology" with the goal that each farmer is oriented and trained in digital technology application in produce, supply, distribute, forecast (price, season, etc) agricultural products, promote the development of e-commerce in agriculture; (iv) To implement digital transformation strongly in management to have timely policies and administration for agricultural development such as forecasting, providing a market alert, managing master plan (Prime Minister of Vietnam, 2020).

Determining that the digital revolution will create a breakthrough for the country in the coming decades, the 13th National Party Congress has set out a requirement to strongly promote national digital transformation, develop a digital economy and a digital society to create breakthroughs in improving productivity, quality, efficiency, and competitiveness of the economy. The specific goal of digital economic development in the Document of the XIII National Congress is to strive to complete the construction of a digital government by 2030, ranking at 3st in the ASEAN in terms of e-government and digital economy (Communist Party of Vietnam, 2021).

On December 31, 2021, the Ministry of Agriculture and Rural Development issued Decision No. 5275/QD-BNN-VP on Promulgating the Digital Transformation Plan of the Ministry of Agriculture and Rural Development in 2022. In this plan, the Ministry of Agriculture and Rural Development has set the goal of promoting enterprises and people to participate in agricultural activities, increasing the application of digital technology to the production process, providing agricultural services; managing and supervising product origin; forming a digital agricultural ecosystem etc. The ministry also set a target that 80% of agricultural databases will be built and updated on the platform of big data, which will be a completed database on plants, livestock, and aquatic products; building a digital agricultural map ready to connect, share and provide open data to perform online public services for people and businesses; 50% of observation and monitoring devices use digital technology, ensure direct reception of digital data, use the Internet of Things (IoT) to integrate into the air and on the ground to serve agricultural activities (Ministry of Agriculture and Rural Development, 2021).

On June 15, 2022, the Ministry of Agriculture and Rural Development issued Decision 2151/QD-BNN-VP on the plan for digital transformation of agriculture and rural development in the period of 2022-2025 with three specific purposes, they are as follows: (i) digital transformation in agriculture is to create an environment and an agricultural digital ecosystem as the foundation, create institutions, promote the transformation from "Agricultural production" to "Agricultural economy"; develop hi-tech agriculture in the direction of focusing on smart agriculture and precision agriculture, increasing the proportion of digital agriculture in the economy; (ii) create a change from awareness to action on digital transformation of agencies and units in the industry and organizations and individuals participating in agricultural value chains; (iii) propose orientations, plans and roadmaps for digital transformation of agriculture and rural development up to 2025, oriented to 2030 as a platform for formulating annual plans and organizing implementation a united, efficient digital transformation (Ministry of Agriculture and Rural Development, 2022).

Thus, up to now, the policy framework on digital transformation in general and in the agricultural sector, in particular, has gradually been completed, creating an important legal corridor to implement digital transformation in the agricultural sector to improve productivity, quality, and competitiveness; meanwhile, creating 3 arrays of agricultural products: quality, food safety, and development towards green, clean and smart agriculture.

3. Situation and Difficulties in Digital Transformation in Agriculture

3.1 Situation of Digital Transformation in Agriculture

In the agricultural sector, the legal environment has been built and completed; the infrastructure has been developed and the technical platforms ensure and create favorable conditions for the deployment of digital transformation applications in agriculture: The Ministry of Agriculture and Rural Development has established a Steering Committee for Digital Transformation in the agricultural sector under Decision No. 2688/QD-BNN-TCCB dated June 16, 2021. The ministry has issued a plan for the digital transformation of the agriculture and rural development sectors for the period of 2022-2025. Besides, this institution has implemented a wide area network (WAN) that enables it to connect the centralized headquarters of the units under the Ministry of Agriculture and Rural Development with 30 servers, of which 60% have been virtualized on a VMware technology platform. Finally, the Ministry has also digitized the guiding document, providing data to connect, communicate and share with local authorities and enterprises involved in the agricultural sector. Up to now, the Ministry of Agriculture and Rural Development has 113 types of databases and 32 specialized software for management and expertise activities in the fields of agriculture, forestry, fisheries, and irrigation; deploying online public service applications through e-portals, online public service portals, e-one-stop office; synchronized and publicized 241 administrative procedures on the National Public Service Portal (Department of Informatization, Ministry of Information and Communications, 2021). In addition, the Ministry of Agriculture and Rural Development also applies digital technology to organize and host online conferences among departments; online conferences between the leaders of the Ministry and related Ministries and Departments, and 63 online sites nationwide to promote agricultural product consumption in the context of the Covid-19 epidemic. Thereby, the management and administration of agricultural product consumption are more convenient, timely, and effective.

Application of digital transformation in agricultural farming: Recently, most of the basic digital technologies in agriculture have been deployed or tested in Vietnam. *According to the* Vietnam Digital Agriculture Association (2021), in farming, the IoT platform; big data; AI; autonomous technology (robotics); sensors; … began to be applied through digital technology products such as software that allows analysis of data on the environment, genetic resources, plants, and plant growth stages, which consumers can access and track these parameters in real-time (Vietnam Digital Agriculture Association, 2021). Currently, many localities have issued identification codes to monitor and control production, track the origin, and improve the quality of agricultural products such as Rice in the Mekong Delta; coffee, passion fruit in the Central Highlands; dragon fruit in Binh Thuan; longan, lychee in Hai Duong, Bac Giang, Hung Yen, Son La etc (Nguyen, 2022). For animal husbandry, IoT technology, blockchain, and biotechnology apply to large-scale farms. The dairy industry leads the application of digital technology, with the prominent models being the modern farms of TH TrueMilk Group and Vinamilk Company. For fishery, the use of ultrasonic fish detectors, flow meters, satellite phones; seine receivers (standing); capture and drop net capture system, GIS and GPS technology are to help manage offshore fishing fleet. Applying biotechnology is to select and breed varieties with high yield, quality, disease resistance and good tolerance to the environment. Recirculating aquaculture systems (RAS), biofloc technology, nanotechnology, marine cage culture technology, cold water fish farming technology are all being researched and applied. Artificial intelligence (AI) technology has been used in shrimp farming to analyze water quality data, feed management, and the health of farmed shrimp. Automation technology has been widely applied in fishery processing from sorting, steaming, packaging, and production lines etc., helping to reduce production costs and ensure the quality of seafood

products (Vietnam Digital Agriculture Association, 2021). For forestry, DND barcode technology is applied in the management of forest varieties and forest products; GIS technology (a tool used to collect, manage and analyze data from geospatial) and remote sensing images are used to build forest fire warning software from satellite images, monitoring software in management forest, early detection of forest degradation or loss, thereby contributing to an effective assessment of forest resources as a basis for sustainable forest management, protection and development (Mien, 2022).

Many large enterprises such as VinEco, Hoang Anh Gia Lai, NAFOOD, and DABACO have also applied high technology in agriculture for their production, distribution, and consumption. For agricultural cooperatives, according to the 2017 report of the Department of Cooperative Economy, there are 199/12,600 agricultural cooperatives (accounting for 1.5%) applying high technology, of which, 164 cooperatives apply high technology. Using cultivation, farming, and preservation techniques, 17 cooperatives applied irrigation automation technology, 17 used biotechnology, and 1 applied technology in the production of agricultural materials. Lam Dong is considered one of the provinces that have achieved many achievements in the initial digital transformation for agriculture when up to 25/52 agricultural enterprises use IoT solutions… (Minh Le, 2022).

Digital transformation application in marketing and consuming agricultural products: marketing and consuming products play a very important role in agricultural production to improve productivity, quality, and value of agricultural products, at the same time, to increase the scale of commodity production, apply modern production processes, improve management, administration and production organization capacity for enterprises and households. Recently, to overcome difficulties in the consumption of agricultural products due to the impact of the COVID-19 epidemic, many localities and enterprises have applied digital technology to promote and consume products in diverse forms. Various methods such as connecting with e-commerce platforms, and promoting through social media channels such as Facebook, Instagram, and Tiktok etc. assists enterprises and farmers to connect directly with consumers. To promote the development of the digital economy in agriculture and rural areas, the Ministry of Information and Communications has issued Decision No. 1034/QD-BTTTT dated July 21, 2021, and Decision No. 350/QD-BTTTT dated February 24. 2022 on approving a plan to support agricultural production households on the e-commerce platform. The goal of this plan is that 100% of OCOP products that meet the 3-star criteria at the provincial central-city level are posted on the e-commerce platforms postmark.vn, and voso.vn; 100% of agricultural production households listed on the e-commerce platform receive training in business skills; setting up 10 million active accounts on the e-commerce platform; promoting the increase in the number of transactions and transaction value on e-commerce platforms; supporting agricultural production households to promote the consumption of agricultural products on e-commerce platforms; promote, introduce products, expand domestic and international markets; Through e-commerce platforms and digital platforms, useful information to agricultural producers such as agricultural product market information, demand forecast, and agricultural production capacity, weather information. , crops, varieties, fertilizers, etc are provided. Raw materials, input materials, and tools for agricultural production with reputable brands, good quality, and reasonable prices are selected to put on the e-commerce platform for agricultural production households; promoting the development of the agricultural and rural digital economy in localities across the country.

According to the Department of E-commerce and Digital Economy, Ministry of Industry and Trade, from the early months of 2022, interdisciplinary units in the Mekong Delta such as Can Tho, Dong Thap etc.; or the Northern region such as Bac Giang, Hung Yen etc. have issued plans to consume agricultural products through e-commerce promotion. These provinces and cities have also worked closely with the Department of E-commerce

and Digital Economy in connecting local departments and sectors with major e-commerce platforms in Vietnam (Minh Hoa, 2022). The most typical is Bac Giang province connected to the 6 largest e-commerce platforms including Vo So, Sen Do, Shopee, Tiki, Postmart, and Lazada through "National online Vietnamese stall for lychee consumption". In the two years 2021 and 2022, over 10,500 tons of lychee were consumed on e-commerce platforms, of which 8 tons of lychee were exported to European countries. Up to now, Bac Giang has over 113,670 enterprises, Cooperatives, and households that have Voso.vn and Postmart.vn platforms created a shopping space on the e-commerce trading floor; many agricultural products and 180 OCOP products of the province have been and are being sold. support to upload to voso.vn, Postmart.vn, etc. (Trang, 2022).

So far, Lang Son province has had more than 202,000 selling accounts and more than 115,000 buying accounts on Postmart.vn e-commerce platform and voso.vn, bringing 19,438 turns of specialty agricultural products and OCOP products to online stores, sales on e-commerce channels reached more than 13.7 billion VND, especially custard apple products. On the e-commerce platforms voso.vn and postmart.vn so far, there have been 593 orders with a consumption volume of 2,945kg etc. (Thanh Hien, 2023). Nghe An ranked third in the country in terms of the number of agricultural products put on the e-commerce floor, as of September 31, 2022, the province had 266,373 agricultural production households and 6,923 products were posted on the e-commerce (Kim Oanh, 2022). As of November 2021, the whole country has nearly 50,000 agricultural products listed on e-commerce floors and thousands of electronic transactions have been made. Up to November 2021, the country has nearly 50,000 agricultural products put on e-commerce floors, and thousands of electronic transactions have been made (Khoi Nguyen, 2021). Thanks to the cooperation with e-commerce platforms and implementation of product promotion programs through social media channels along with the development of selling sites in central areas, agricultural products of localities are more and more well-known and chosen. The growth of specialty agricultural products will contribute to local economic development and improve the livelihood of local people.

3.2 Difficulties in Agricultural Digital Transformation

Policies and laws on digital transformation have not met the practical needs of agricultural production. The credit support policy of high-tech agriculture is mainly for businesses and cooperatives, but it is difficult to access because the procedures are cumbersome and complicated. Criteria on high-tech agriculture, smart agriculture, and regulations for each animal and plant haven’t been promulgated yet.

The implementation of agricultural digital transformation requires a modern and synchronous information technology infrastructure, software system, and database. However, nowadays, the information technology infrastructure in the agricultural sector hasn’t been synchronously invested and is still backward, leading to difficulties in connecting, sharing, and effectively exploiting agricultural databases with relevant agencies and localities. The agricultural data system currently has 113 types, but it is still small-scale, incomplete, and inconsistent, and it has not yet complied with the e-Government architectural framework. Although the number of software systems in the fields of agriculture, irrigation, forestry, and fishery is large (32 software), the ability to link and integrate data is still limited. In addition, the cost of 3G and 4G is still high, which makes it difficult for people to access and apply digital technology to agricultural production and business, especially in remote and isolated areas. The synchronization and publicity of administrative procedures have been well done and publicized on the National Public Service Portal, but the percentage of online public services reaching level 3 and level 4 is still low (about 10%).

In Vietnam, the digital transformation started to be mentioned a lot in 2018 (Ministry of Information and Communication, 2021). Therefore, the awareness of agricultural digital transformation of most localities, businesses, and especially farmers is still limited. This makes it difficult to apply modern technologies to agricultural production. Besides, Vietnam is very short of skilled, highly qualified, and professional workers to meet the demand for human resources for agricultural digital transformation. According to statistics, the rate of trained workers in our country is very low, reaching only 24.1% in 2020 (General Statistics Office, 2021). Meanwhile, if you compared with countries right in the region, this rate in Indonesia is 42%, in Malaysia this figure is up to 66.8% (UNDP, 2020). The number of farmers trained in digital transformation skills is small, with only over 2 million agricultural production households by November 2021 (Khoi Nguyen, 2021).

The average size of arable land per household is very low, over 69% of households have less than 0.5 ha of cultivated land, 25% of households have 0.5-2 ha of cultivation area, and the number of households with cultivation area over 2 hectares accounts for a small proportion, only 6% (General Statistics Office of Viet Nam, 2017). In addition, the current land law only allows households and individuals to receive a transfer of agricultural land use rights no more than 10 times the agricultural land allocation limit are also a major barrier to the application of digital technology in agricultural production.

The level of mechanization is still low, and the supporting technologies for agricultural development (mechanics, deep processing, agricultural product testing lines, etc.) are inadequate. In addition, resources from the state budget and credit capital for digital transformation and high-tech and smart agriculture development are still limited. Although the research, application, and transfer of science and technology have been intensively invested, it still has not kept up with the actual production requirements.

4. Solutions to Enhance Agricultural Digital Transformation in Vietnam

Developing and perfecting policies and laws to create a legal corridor to promote the development of smart agriculture and precision agriculture, and at the same time increase the proportion of digital agriculture in the economy. Completing the system of legal documents, standards, regulations, and technical regulations to meet the requirements of the agricultural digital transformation. Simplifying procedures for accessing digital technology infrastructure, land, and capital for high-tech and smart agriculture development. Reviewing and finalizing policies to encourage organizations and businesses to provide agricultural digital services. Formulating and promulgating regulations on receipt, digitization, storage, and handling of electronic documents; regulations on management, operation, and maintenance of digital infrastructures, information systems, and databases to ensure information security. Completing support policies, specifying criteria for the development of high-tech agriculture and smart agriculture.

Upgrading and building a modern and synchronous digital technology infrastructure for data connection, exploitation, and sharing. Developing infrastructure and connecting high-quality broadband internet (4G, 5G mobile network infrastructure, IoT connection infrastructure) to communes, villages, and hamlets. Improving the quality and ability to access telecommunications services for the people; supporting farmers to use information technology equipment. Providing free wireless internet at commune centers, community cultural activities, and rural tourist spots. Developing a digital platform and integration platform to share data. Building and developing application platforms on mobile devices to support people and businesses in using digital agricultural services and utilities. Focusing on building and standardizing the database of the agricultural industry, building agricultural

digital maps on a synchronous big data platform to connect, share and provide open data. Developing software to manage, monitor, evaluate, and classify agricultural products, especially typical products of each locality. Focusing on building a large database on land, crops, environment, climate, weather etc. to provide people and businesses. Encouraging people and businesses to digitize production processes, towards product integration and transparency with a QR code scanning system.

Raising awareness of localities, businesses, and especially farmers about the role and importance of agricultural digital transformation in the management, production, and consumption of agricultural products in the context of climate change, technology 4.0, and international integration. To adapt to digital transformation, training and improving digital skills for farmers is an urgent requirement that needs more attention from the State agencies. In addition, farmers can actively go on the e-commerce trading platform to interact with buyers and introduce different agricultural products. It is necessary to ensure that there are enough human resources to carry out digital transformation. For business owners, cooperatives, and individual production households, in addition to the knowledge of digital transformation, it is necessary to foster knowledge about the agricultural product market and be able to forecast the supply and demand movements of the market. to decide to invest in expanding the area of agricultural production…

The State should accelerate the process of land accumulation and concentration to attract financial resources outside the State budget, especially resources from the private sector to invest in agriculture, to develop the closed agricultural model and sustainable agricultural value chain. The limit on the transfer of agricultural land use rights should be necessarily removed. The procedures for renting and receiving a transfer of agricultural land use rights should be simplified.

Modern and advanced technologies in the processing and preservation of some typical and typical agricultural products of the region should be invested, thereby prolonging the shelf life of agricultural products, forming the foundation to push up these products traded on e-commerce platforms. By implementing measures to simplify loan procedures, develop consulting services to support loans and use loans; allocate adequate budget to implement preferential policies to encourage enterprises to invest in hi-tech agriculture it further strengthens agricultural credit capital, especially credit for chain lending. agricultural value. To generate more capital for innovation and digital transformation applications in agriculture, it is necessary to form venture capital funds and credit guarantee funds with the initial investment and capital share of the State. These funds should be managed and operated directly by independent professional private organizations. The State supervises these funds through the application of modern management software, such as applications of cloud computing technology to manage and trace cash flows transparently. In addition, amending the post-investment support mechanism specified in Decree 57/2018/ND-CP according to the disbursement mechanism for each item to ensure timely capital support for enterprises investing in public applications. digital technology in agriculture.

Research, application, and transfer of science and technology to agricultural production should be strengthened. New and modern technologies must be applied to all stages of production, harvesting, preservation, processing, transportation, and consumption of products. Propaganda, awareness raising, and encouragement, businesses to expand the application of technical advances, integrated pest management programs (IPM), integrated crop management programs (ICM) and the program of improved rice cultivation into agricultural production should be promoted; agricultural extension program, safe crop production according to VietGAP process etc. must also be promoted; finally, trade promotion activities to support enterprises to find markets to consume products must also be strengthened.

5. Discussion and Conclusion

Agricultural digital transformation is understood and approached in different ways. According to Skvortsov (2020), digital transformation in agriculture is an objective process associated with scientific and technological progress. This process is due to the use of technologies of a new generation, which include the IoT, Big Data, AI, and robotics. The main scientific idea is that the digitalization of agriculture will result in a significant transformation of labor relations (Skvortsov, 2020). Digital transformation in agriculture is applying digital technologies from production to processing, distribution, and consumption of products. Digital transformation in agriculture includes basic activities such as applying modern technology in farming, linking value chains, and changing management methods (Linh, 2022). Digital transformation in agriculture has been happening for decades, however, it was mainly considered behind the concepts of smart farming, precision agriculture or p*recision farming*, *decision Agriculture*, d*igital Agriculture*, and *agriculture 4.0* (Klerkx et al., 2019). All of these terms could be part of the digital transformation because implies that management tasks in any part of the food system are based on data obtained from the use of different technologies (Duncanet al., 2021; Eastwood et al., 2019). Many studies have shown that digital transformation is an effective solution to solve the challenges that agriculture and rural areas face (Trendov et al., 2019), as part of a transition towards 'Agriculture 4.0' (Klerkx & Rose, 2020) contributing to the agrifood system transformation (Klerkx & Begemann, 2020). Applying digital technologies in agriculture is necessary to increase the efficiency and sustainability of its functioning by cardinal changes in the quality of management of technological processes, decision-making at all levels of the hierarchy based on modern methods of production, and further use of information on the state and forecasting possible changes in controlled elements and subsystems, as well as economic conditions in agriculture (Mustashkina et al., 2020).

Agricultural digital transformation in Vietnam has only been started since 2018, but it has brought many outstanding benefits, making an important contribution to sustainable agricultural development, especially during the context of the Covid-19 epidemic. In addition, digital transformation helps Vietnam's agriculture to reduce risks and damages caused by climate change. Vietnam is one of the countries most affected by global climate change… Rising sea level rise, rising temperatures, rainfall changes, extreme weather phenomena, and natural disasters… have been seriously affecting agricultural activities. The inevitable consequence is a decrease in arable land area and productivity, and quality of crops (Yen et al., 2023). Applying AI technology, and data analysis in agriculture will help with early warning of risks (72 hours before the storm passes). The application of IoT, big data, and biotechnology has helped to analyze data about the environment, soil, plants, and plant growth stages. Based on the provided data, the producer will make appropriate decisions (fertilizing, watering, spraying pesticides, harvesting etc.), thereby reducing costs, environmental pollution, and protecting biodiversity. The application of digital technology to agricultural production has reduced costs and labor by half, reduced greenhouse gas emissions by 50%, and increased productivity by 30%, thereby increasing income for farmers. Moreover, the application of digital technology in agriculture helps to strengthen the connection between producers and consumers, between supply and demand, limiting the situation of "good season, bad price", so that production is more efficient and sustainable agriculture.

Agricultural digital transformation plays a particularly important role in restructuring the agricultural sector and developing concentrated and large-scale commodity agriculture towards modernity, high-added value, and sustainability. Digital transformation is an important solution to help farmers and businesses produce quality

agricultural products at the lowest cost but with the highest profit. This goal is also being promoted by industries, localities, businesses, and people, with the expectation of creating a breakthrough in productivity, quality, and competitiveness for agricultural products.

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