

Digitalize agriculture in Vietnam, opportunities and challenges

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ABSTRACT

Digitalization can transform the fundamentals of production and supply chain. Digitalization technology will shape both the future the benefits of manufacturing industries. In agriculture, this is even more important in the face of growing demand. For the past 30 years, Vietnam's agriculture has remained with the traditional model, with a proven tendency to slow down and decrease quantity and quality of production. How to develop a completely modernize agriculture model to produce quality goods with high efficiency and competitiveness? What is the technological solution to advance each region's agricultural development in the context of this Fourth technological revolution? In what ways will the economic regions have to adapt their mindsets, ways of thinking, and ways of action? The paper is based on a summary of studies to generalize the problems, assess the current situation, analyze the current applications of high technology and point out the opportunities and challenges that need to be addressed for Vietnamese agriculture.

Key words: Hi-tech, digital technology, agriculture digitalization, precision agriculture

1. WHY DOES VIETNAMESE AGRICULTURE NEED TO BE REVOLUTIONIZED?

1.1. Current condition of Vietnamese agriculture

According to statistics from the Ministry of Agriculture and Rural Development, compared to 2018, in 2019, the total export revenue of agriculture, forestry, and fishery reached 41.3 billion USD, up 3.2%, a trade surplus of the whole industry is estimated at 10.4 billion USD, an increase of 19.3%, newly established enterprises 2,756, an increase of 25.3%,... Many large enterprises have stepped up investment in agriculture, exceptionally high technology applied agriculture, with the investment of 17 projects totaling over VND 20,000 billion, up 36.23%. It is expected that by the year 2020, the GDP of the industry will increase by 2.8-3%, the value of agricultural, forestry, and fishery production will increase by 2.9 - 3.05%. By 2030, the industry's output will increase by 60%, and by 2050 it will be 90% [1].

However, in general, the proportion of agriculture in the general production value

tends to decrease because the available agricultural land area tends to decrease rapidly, agricultural labor grows increasingly scarce, labor costs are high, and agricultural products' prices are volatile. They grow slowly compared to other sectors like industry, services. Therefore, technology applications in production are almost ignored. Even in the Mekong Delta, where the equatorial climate is favorable for agricultural development, the region's agricultural growth rate has also slowed down, from 7.15% in the 2001-2010 period to about 5% from 2011 - 2016 [2].

1.2. Origins and limitations of Vietnam's agriculture

According to the World Bank, after 30 years of agricultural innovation, Vietnam struggles in the first steps because of the limitations of the current growth model, which originate from production systems that favor increasing labor, chemicals, and natural resources rather than increasing effectivity and value-adding. Besides,

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most productions are unplanned, small-scale, fragmented, and goods supply are dispersed and homogenous. The application of scientific and technological advances have progressed to the current model, processing, preserving, and subsistence consumption without applying to support technology, not yet courageously applied for the advances in selective livestock breeding, applying biotechnology. Thus plants and animals' productivity is low, with subpar product quality, hammering the overall product's competitiveness [3].

Meanwhile, the agricultural land area per capita is low; harsh weather, unregulated chemical, and soil fertility are being depleted. Furthermore, population density is not evenly distributed, limiting human resources, economic structure shifted slowly. Industry and support services are developing but are small in scale with low operation efficiency. In-field transport has not been developed to meet production requirements. Objects produced are monotonous, generic, with no unique value offering; High seed production and supply; Epidemic diseases, uncontrollable, and massive development set the stage for negative ecological and environmental consequences [4].

However, in the context of expanding globalization and integration at the dawn of the fourth industrial revolution, Vietnam cannot stand outside this wave. How can Vietnam build a comprehensive modern agricultural development, quality commodity production that is productive and efficient with high competitiveness? For the Mekong Delta, what are the technological solutions to promote the region's agricultural development in the context of this fourth technological revolution? In what way will the economic region have to change its mindset, thinking, and action?

2. DEVELOPMENT OF HIGH-TECH AGRICULTURE

2.1. What is high technology?

According to the Law on High Technology, "High technology is a technology with a high content of scientific research and technological deve-

lopment, integrated from modern scientific and technological achievements, creating quality products, outstanding features, high added value, environmentally friendly, plays an important role in forming a new service production industry or modernizing an existing service production industry" [5].

According to the Department of Science and Technology, Ministry of Agriculture and Rural Development, "High-tech applied agriculture is the agriculture applied new technologies to production, including agricultural industrialization, automation, information technology, new material technology, biotechnology and plant varieties and animal breeds with high productivity and quality, high economic efficiency per unit area and sustainable development on organic farming facilities." The objective is to ensure stable growth with high productivity and output, efficiency, and quality. Utilizing the best human and resource coordination, maximizing effect, harmonizing, and unifying with society goals, economic, and ecological environment benefits [5].

2.2. History of high technology application development in agriculture

The historical record of the development of agricultural technology began in 1940 with the US's green revolution through irrigation and new crop management techniques; in 1960 with the development of new wheat varieties; in 1974, with the invention of Roundup agricultural herbicide; in 197, the invention of a system combined two blades to create grooves in the field, separating the seed pods and cutting the crop's trunk; in 1982 with Agrobacterium genetically modified plant cell technology; in 1994 with satellite technology helped better track and plan; in 1996 with genetically modified crop technology tolerated herbicides against borers. In 2000 with software technology and mobile devices, they were helping farmers to harvest better. In 2015, digital data technology revolutionized farming potential, harnessing information's power to make better decisions

about the sustainable use of resources [6].

2.3. The content of high technology development in agriculture

High-tech development in agriculture focuses on the following main tasks: Breeding and propagating plants and animals for high productivity and quality; Preventing and eliminating epidemics; Planting, raising animals with high efficiency; Creating materials, machinery, and equipment used in agriculture; Preserving and processing agricultural products; Develop high-tech agricultural enterprises; Developing high-tech services for agriculture. Thus, high technology in agriculture is understood as the logical application of the most advanced techniques in selecting plant varieties and animal breeds in which biotechnology plays a leading role.

In our country today, the development of high-tech agriculture includes: (1) Selecting and applying the most advanced technologies in breed selection, advanced farming and breeding technologies, irrigation technologies, and post-harvesting - preservation - processing technologies; applying information technology to management, branding and market promotion; (2) Creating products that are specific to each ecological region, achieve high productivity and economic efficiency per unit of area, highly competitive, capable of expanding production scale, and quantity; (3) Building a closed production cycle, overcoming the risk factors of nature and limiting market risks; (4) Development in stages, levels, and the situation of each place, but must show the essential characteristics, creating a much greater efficiency than average production.

2.4. Criteria for developing hi-tech applications

Development of high-tech agriculture requires the following basic criteria: (1) Technically, advanced technology is required to produce products with at least a 30% increase in productivity and superior quality compared to the technology being used; (2) Economically, create products with at least 30% higher

economic efficiency than the technology being used; (3) In addition, there are also other social and environmental criteria such as enterprises, which must create good products and increase productivity at least 2 times. If it is an agricultural area, productivity and efficiency must increase by at least 30%. The application results must meet three aspects: technical, functional, and service, with high profitability.

2.5. Practical high-tech applications in agriculture and lessons learned

In Vietnam, high technology applications have been introduced in cultivation such as breeding technology; In vitro plant tissue culture technology; Technology for growing plants in a greenhouse; Technology for growing plants in solution (hydroponic), aeroponics and on cultivating media; Drip irrigation technology. In animal husbandry and aquaculture such as putting animal breeds through artificial insemination and embryo transfer into production; Use of fish species through chromosome change and sex reversal in fish; Assist animal nutrition and technology in disease and epidemiological diagnosis.

Although there are some successful examples: Lam Dong, Bac Ninh, ... but in general, high-tech application models still focus on production, expansion and technology transfer capability is difficult. Partly due to the company's secret technology requirements; The construction requires large infrastructure investment capital so the ability to recover capital is slow, businesses with low capital are unlikely to invest. Applying asynchronous high technology, thus products quality is still uneven and high. The product consumption process is unstable because of dependence on the contract. Some lessons learned, need to pay more attention to planning development of land, build models of high-tech applications in production and labor, create integration between farmers and cooperatives - Enterprises in the production and consumption of products, improving the management role of the state and promoting the agriculture-forestry-fishery extension.

3. DIGITAL TECHNOLOGY AND DEVELOPMENT REQUIREMENTS OF AGRICULTURAL DIGITIZATION

3.1. What is digital technology?

Nowadays, no one doubts a new world of digital. It's a world of artificial intelligence, robots will completely replace people, the world of smart houses, smart cities, smart nations, everything has the ability to connect to the internet (IoT) with the desire to bring the virtual and the real world together. This connectivity trend is called the Industrial Revolution 4.0, built on the basis of the digital revolution. Currently, the world is in the early stages of this industrial revolution. The ubiquity of technologies, such as all connected things, artificial intelligence, cloud computing ... is blurring all boundaries so that people, products, and machines can connect and communicate together.

3.2. Why does agriculture need digital technology?

In the world, AgTech or agricultural digitization has been studied and applied in the field of agriculture since 2011. At present, AgTech has been making rapid and great changes. The general trend is that farmers and food producers in many countries have quickly embraced digital transformation trends, using digital technologies as a sustainable and open source to bring agriculture to new heights. Digital or agricultural transformation for the future, which is the use of computer technology and sensors on farms, is applied evenly to make the potential of equipment fully realized. Agriculture collects and accumulates all special information about gene identification and has the ability to quickly analyze and completely understand the data generated. The chain of agricultural activities reduces risks and uncertainty. Overcoming the adverse impacts of climate change, energy costs, the availability of skilled labor, market fluctuations, increasing decision-making ability for farmers and policy-makers. Develop automation from the internet to increase access to information, reduce time to make decisions and get where you need to go.

3.3. What is digital agricultural development?

The nature of digitized agriculture is smart agriculture 4.0 with features, the production and business activities from the farm to processing, marketing and consumption are all through the Internet of the system, combining centralized management and operation systems, automation and intelligence between physical technology, biotechnology, and operating technology ensure the continuous, efficient and sustainable production and business process. Agricultural development 4.0 is an inevitable trend in the context of deeper and wider globalization and integration, applied in sustainable cultivation, husbandry and aquaculture; Application of internet of all things in agriculture and fishery; technology to improve the aquatic environment...

Digital agriculture is now developing rapidly to become a major problem compared to the partial development of technology. The potential for data collected through digital agriculture, through the accumulation and analysis of large data is predicted to fundamentally alter the entire supply chain and business system, transforming producing practices on the farm, create opportunities to improve the efficiency of supply chains and build entirely new models for service delivery. In general, digital agriculture are technological systems that use field application equipment and sensor platforms to collect real-time data and analysis software to help growers control the purchase of materials and production, harvesting, and sales, thus, contribute to reducing waste, increasing profits, and protecting the environment [7].

3.4. Which strategy for agricultural development 4.0?

According to research by Harold Van es and Joshua Woodard [8], the effective strategy for achieving advanced levels of agricultural production should focus on sustainable improvement in five key areas: Continuing resource optimization in agricultural areas that are currently under production; Increasing

production in areas where good basic agricultural resources are available but currently at low levels of production; Expanding the local production environment and controlling systems such as urban farms, greenhouses, and indoor growing systems that provide high-value crops to local and market areas; Improved plants and genetic diversity of animals by creating conditions that are higher than production levels and result in less susceptibility to allergens such as diseases and insects; Higher efficiency and less waste in the food supply chain.

4. ASSESS THE IMPACT OF DIGITIZATION ON AGRICULTURAL TECHNOLOGY TRANSFORMATION

4.1. The foundation of digital agriculture development

Digital agriculture is built on digital data, which is expected to be collected at least 40 zettabytes (40 trillion gigabytes), allowing for increased storage and computation, along with environmental sensor data and remote with high resolution, providing unprecedented opportunities to explore data analytics in agricultural and food systems. It is expected that the world will have more agricultural innovations supported by digital technology, implementing calculations and information. Digitizing agriculture creates new opportunities through ubiquitous availability. High and interconnected computing technologies will be applied to all aspects of the production system, reflecting the shift in the overall management of resources towards optimization, personalization, and real-time hyperlinked and data processing. Instead of handling the whole field or the herd, each small area, each pet can receive management and monitoring rules for their own optimization [8]. The result of digitization will make agricultural activities more efficient, profitable, and more sustainable. Data and smart communication will be used to achieve system optimization. Digital tools, such as decision calculations, analytics, clouds, sensors, robots, and digital communication tools will be diversified. Agriculture and food will use

geolocation technologies such as the Global Positioning System (GPS), geographic information systems (GIS), productivity screens to obtain accurate soil samples, through spectrum sensors for controlling drones and guided equipment. Pets will use digital technologies such as radio frequency identification (RFID), milking systems, and automatic feeding. The environment will be controlled and activated through sensors and robots that have accumulated a large amount of data and are capable of complex analysis [4].

4.2. The importance of digital technology in agriculture

According to research by Syed Asif [9], modern technologies and digital technologies in agriculture has a wide range, capable of providing reliable energy and technology, in order to increase productivity, increase hybrid seeds, reduce waste, build networks, market new products, as well as increase modern communication, raise awareness of information technology in agriculture and in product preservation. In farming, digital technology is used to harvest crops. In production, digital technology is used to create genetically engineered crop varieties, produce fertilizers, and detect new pests and diseases, creating valuable resonance. In animal husbandry, digital technology is used to help animals become resistant to diseases, expanding a wide range of irrigation plants. In cultivation, digital technology is used to create new crops, increasing the usefulness of the green revolution such as hybrids, genetically modified crops with high quality and productivity.

4.3. The impact of digital technology on agriculture and the issues raised

According to the Australian Farm Institute [10], using digital technology in agriculture can have major impacts on many aspects of the labor force and rural communities; agricultural products and services; management; telecommunications and other infrastructure needs; social and environmental; governance

and compliance system. The question is how to respond to compliance requirements more effectively than management programs and legal requirements.

5. OPPORTUNITIES AND CHALLENGES OF VIETNAM'S AGRICULTURAL TECHNOLOGIZATION

5.1. Digital technology transformation trend in agriculture

AgTech has rapidly transformed agriculture. Only in 2015, investment in technology into the industry reached \$ 4.6 billion. To meet the industry's output demand of 60% increase by 2030 requires huge investment. According to Daniel Newman [11] has the following six application trends: (1) IoT and sensor; (2) IoT and image recognition technology; (3) Drone and plant monitoring; (4) Agriculture and Robotics; (5) RFID sensor and tracking; (6) Machine learning and analysis.

It is assumed that the future of agriculture depends on digital transformation, farmers will benefit from each digital transformation trend, giving them freedom from the environmental, crop type, and management capabilities concerns. As the world's population continues to grow, new methods must grow together. It is time for farmers to take advantage of existing digital technology to handle food and create peace of mind for consumers.

5.2. What opportunities there is for Vietnamese agriculture?

Digitalization of agriculture offers many new opportunities for Vietnam's agricultural development to achieve the millennium goals: (1) Understand digital breakthroughs and implications through a broad overview; (2) Create digital breakthroughs on the farm, transforming the production system and bringing efficiency and productivity; (3) Discovering digital development in the field of input, applying to information management systems; (4) Applied through supply chain, in food processing and retail.

5.3. The challenge for agriculture in Vietnam

However, to achieve opportunities, Vietnam also faces many challenges, first to focus on handling, newly added value, increasing income, then dealing with food quality and hygiene safety issues to meet the world's standards. In addition, it needs to handle a series of problems on resource management, the management system that has not kept up with the market; Improve the quality of human resources in rural areas; Technological adoption capacity of the enterprise; The market of technological science is still small, weak and difficult to transfer; Lack of connected infrastructure and information infrastructure is still common; Farm plants are yet to considered living entities; Biological research capacity is not adequate. Warning, the digital revolution will enter the agricultural market, the labor market will also have stronger competition, especially rudimentary labor. The disparity in education and research is too large, training required too much time and output, the level of mobile applications, the use of iPad; Connection and the digital divide is still dependent on the cost; Legal and managerial issues for business development and employment for the workforce; Especially destruction and forgery [12].

5.4. Proposing a number of solutions to renew Vietnam's agricultural digitalization

According to Harold Van es and Joshua Woodard [8], to achieve advanced levels of agricultural production should focus on sustainable improvement in five key areas (1) Continue to optimize resources in existing agricultural areas; (2) Increase production in areas where good agricultural resources are available, but currently at low production levels; (3) Expand local environmental production and control of market systems and areas; (4) Improve crops and animal genetics and (5) Higher efficiency and less waste in the food supply chain.

In addition, in order to fully apply digital technology, Vietnam's agriculture needs to solve a series of issues such as: planning the

use of land, land consolidation, investment capital, technology application, mechanisms, policies, the suitability of the application model, connecting production with consumption markets, supporting training, attracting human resources, climate change and environmental issues.

In addition, developing a deep understanding of biological, physical, chemical and socio-economic processes require the talents of science and entrepreneurship. Telecommunications capacity must be adequate. Computational growth and data science in the fields of hybridization. Competition and natural resources are associated with the ability to innovate in aspects of production systems.

6. CONCLUSION

In general, the world is becoming more connected through digital technology; Smart devices are getting smaller, faster and cheaper; Most industries have leveraged to successfully address challenges in their fields; The question is whether intelligent digital services have the potential to help the agricultural sector meet productivity and sustainability challenges? It can be affirmed that the 4th industrial revolution is a golden opportunity for Vietnam's agricultural industry, to create high-quality and high-yield agricultural products even under unfavorable conditions; Better working conditions of workers, through connection with smart mobile.

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Số hóa nông nghiệp Việt Nam, cơ hội và thách thức

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TÓM TẮT

Kỹ thuật số có khả năng biến đổi cơ bản các hệ thống sản xuất và chuỗi cung ứng. Công nghệ kỹ thuật số sẽ định hình cả tương lai và lợi ích cho các ngành sản xuất. Trong nông nghiệp, điều này thậm chí còn có ý nghĩa quan trọng hơn trước nhu cầu ngày càng cao của con người. 30 năm qua nông nghiệp Việt Nam vẫn còn luẩn quẩn trong mô hình cũ, với xu hướng chậm và giảm dần cả về mặt lượng và chất. Vấn đề đặt ra là làm thế nào để có thể xây dựng nền nông nghiệp Việt Nam phát triển toàn diện hiện đại, sản xuất hàng hóa, có năng suất, chất lượng, hiệu quả và có sức cạnh tranh cao? Giải pháp công nghệ nào để đẩy mạnh phát triển nông nghiệp của từng vùng trước bối cảnh cuộc cách mạng công nghệ lần thứ tư này? Các vùng kinh tế sẽ phải thay đổi tư duy, cách nghĩ và cách làm như thế nào? Bài viết dựa trên cơ sở tổng hợp các nghiên cứu để khái quát hóa vấn đề, đánh giá thực trạng, phân tích tình hình ứng dụng công nghệ cao và chỉ ra những cơ hội và thách thức đặt ra cần giải quyết cho nông nghiệp Việt Nam.

Từ khóa: công nghệ cao, công nghệ số, số hóa nông nghiệp, nông nghiệp chính xác

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