

# Research on the Development Paradigm of Information Technology-induced Agricultural Modernization

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**Abstract**—Agriculture used to be a closed field. With the development of information technologies such as the Internet of Things and the Internet, agriculture began to enter a new stage of opening, connecting and coordinated development. Through the empowerment of information technology, smart agriculture gives full play to the leading role of information technology in advanced operation, management and marketing, taking market demand as the basis, with the input and output of intelligent elements, making agricultural information resources the basis for a new paradigm of agricultural modernization. This information technology paradigm subverts the traditional agricultural industry paradigm and redefines the cooperative relationship among the government, the market, enterprises, farmers, consumers and other subjects.

**Keywords**—development paradigm, technology-induced, agricultural modernization, smart agriculture, data decision-making

## I. INTRODUCTION

Agriculture has a natural weak quality, large industrial investment, long recovery cycle, economic benefits are slow. Traditional agriculture faces three major problems: high labor cost and low production efficiency; production process is difficult supervision, quality guarantee; sales link agricultural brand is difficult to build, brand building requires huge manpower, material resources, resources, time cost, unscientific water and fertilizer management, soil and water quality damage, and planting information cannot be collected, difficult to supervise and timely solve problems. And the introduction of the system architecture and application technology of agricultural modernization can realize the transformation from traditional agriculture to modern agriculture paradigm.

Smart agriculture is gradually moving from the pilot stage of scientific research bases to more and more civil enterprises, and initially realizing the intelligent business form of using data and making decisions with data. Using sensors, NB-IOT communication, big data and other Internet of Things technologies to promote smart

agriculture has become an inevitable trend of development, and has also become a new direction of modern agriculture development. Agricultural modernization needs the development of “The sixth industry”, namely the combination of the primary industry, the secondary industry and the tertiary industry, and the industry needs the support of the Internet of Things technology, which gives the Internet related enterprises in the Internet of Things industry opportunities. Agriculture has been an open and all-round development, so what needs is the support of the whole industrial chain, and the Internet of Things enterprises need to cooperate to replace the mode of fighting alone.

## II. KEY TECHNOLOGIES AND APPLICATION SCENARIOS

### A. Technical Application

Smart agriculture has changed from early focus on agricultural mechanization, hilly and mountainous areas to focus on whole-process mechanization, agricultural carbon sink, ecological agriculture and low Carbon agriculture, Internet of Things technology, etc. Smart agricultural enterprises rely on core technologies to survive. Only with their own competitiveness can they win vitality in the market. Starting from the concept of big data, discover and mining the hidden information behind the data, explain the relationship between data mining, machine learning and deep learning, and the evaluation model, and design the agricultural modernization application scenarios of big data technology data mining.

Agricultural machinery and equipment and the new generation of information technology are the material basis and hardware conditions for the transformation and upgrading of modern agriculture, and the coordination of equipment and information technology will become a new trend of the development of intelligent agriculture. Promote the deployment of smart agricultural sensor network communication nodes in the three-dimensional space, build a smart agricultural information transmission network, optimize the design of the terminal nodes of the smart agricultural Internet of Things, and realize the access to agricultural equipment. The information system

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of intelligent agricultural equipment improves the efficiency of agricultural equipment manufacturing and enhances the competitiveness of intelligent agriculture. The production management efficiency of traditional agricultural greenhouses is low, and the automation of environmental monitoring and control is low, while intelligent agricultural greenhouses realize remote real-time monitoring, regulation control and improved production efficiency through the measurement and control system and the optimal scheduling of micro energy network (see Table I).

TABLE I. TECHNOLOGICAL APPLICATION OF SMART AGRICULTURE

<i>Technology Application</i>	<i>Content</i>
Internet of Things technology	Hardware and software products, 5G gateway, etc
Artificial Intelligence Technology	From the area, shape, color, size, gloss and other aspects of the epidemic, pest and timely intelligent management
observation system	Including planting environment monitoring system, video monitoring system, APP monitoring system, etc
Tracing anti-counterfeiting system	Establish a food safety information database to ensure the safety and reliability of agricultural products, improve consumers' confidence in buying, and enhance the premium of agricultural products

A key issue in the development of the Internet of Things is how to change from the use of the consumer side to increasing production on the basis of quality improvement. The Internet of Things industry is a key field and high-end technology industry both in Both China and in the world, with the industry characteristics of industrialization and high entry threshold. Just like the global development trend of the Internet, the trend of industrialization is inevitable. When the complete industrial chain is formed, the added value of the industry is improved. The research work focuses on many fields such as land, machinery, skills, construction and management, matching the support fields for the development of smart agriculture, and gradually forming a support system for promoting the development of smart agriculture.

The main applications of smart agriculture include field precision agriculture, smart animal husbandry, smart fishery, smart greenhouse, etc. The main technologies include remote sensing and sensor system, agricultural big data and cloud service technology, and intelligent agricultural equipment (UAV, robot). Many technology companies participate in it, starting from different application scenarios and segments, and constantly improve the smart agriculture solutions and product lines with the Internet of Things as the core.

Smart agriculture has the characteristics of significant interdisciplinary. Due to the biological characteristics of agriculture, the direct access of industrial information technology to the agricultural field often cannot effectively solve agricultural problems. The application of agricultural sensors, agricultural artificial intelligence and agricultural robots has found new solutions to these problems.

*B. Application Scenario*

Agricultural Internet of Things Smart agriculture is closely related to healthy diet and people's health. There are many scenarios in soil testing, standardized planting of agricultural products, fruit control and other aspects. For example, UAV spraying can reduce labor costs, improve spraying efficiency, and have the advantages of high efficiency, low risk and good effect. The LPWA technology is applied to poultry monitoring and application, with outstanding technology research and development, system integration and industrialization capabilities. In addition to poultry breeding, the low-power Internet of Things ecological breeding solutions will also be extended to large livestock such as cattle, sheep and pigs through terminal forms and data models such as ear tags and collars. Sensors can provide low-power consumption solutions for temperature, light, air pressure, temperature and humidity and other factors, which can be connected with related projects of other enterprises. UAV spraying can reduce labor cost, improve spraying efficiency, and has the advantages of high efficiency and low risk.

In terms of intelligent planting, the application mainly focuses on greenhouse planting, intelligent irrigation, intelligent meteorology, and safety traceability. Specifically, it can realize the environmental information collection and control of greenhouse, real-time measurement of air, soil humidity, humidity and other environmental parameters, and automatic adjustment, so as to achieve the purpose of increasing crop yield, improving quality, regulating the growth cycle and improving economic benefits.

Water-saving irrigation system uses the sensor to sense the soil moisture, and control the valve of the irrigation system to open and close, so as to achieve the purpose of automatic water-saving irrigation. Application safety traceability of agricultural products, using RFID and two-dimensional code and other technologies to identify and manage agricultural products, monitor and record all product circulation links, and provide traceability for government law enforcement personnel, enterprises and consumers.

In the intelligent aquatic product scene, it provides sensing equipment, transmission network, intelligent application and other services. The intelligent water product networking system integrates the functions of online collection of aquaculture environmental parameters, intelligent networking, wireless transmission, intelligent processing, early warning information release, decision support, remote and automatic control. Through the monitoring system in the monitoring center, the breeding technicians can grasp the breeding environment information in real time, and obtain the abnormal alarm information and early warning information in time, and can adjust the control equipment in real time according to the environmental monitoring results to realize the scientific management of breeding, and finally achieve the goal of energy saving and consumption reduction, green environmental protection, increasing production and income. In addition, the group users can also grasp

the environmental information of the breeding sites and the working conditions of employees in different locations through the network.

In the subdivision field of intelligent breeding, it is mainly used in pork production, processing and transportation. For example, data collection of large-scale livestock and poultry house breeding environment, automatic control of livestock house equipment, monitoring and intelligent adjustment of livestock house breeding environment, and real-time forecast and early warning of animal hair conditions, diseases and epidemics through mobile phones or PAD. The product lines of smart planting, smart aquatic products, smart animal husbandry and other scenarios began to serve the leading agricultural enterprises, and gained stable business income by gradually accumulating product and market development experience. Attach importance to the sustainable development of agriculture and rural areas and environmental protection issues, environmental protection related product lines involve garbage classification, water pollution treatment, rural environmental improvement and other businesses, to promote the green and sustainable development of agriculture and rural areas (see Fig. 1).

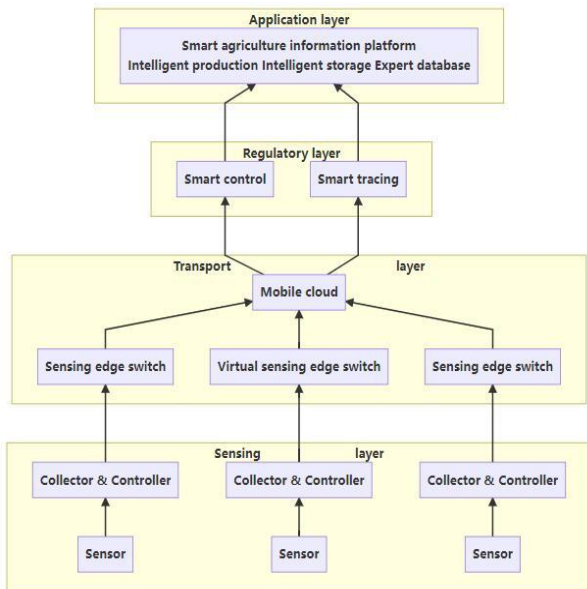


Figure 1. Smart agriculture information platform.

### III. INNOVATION FROM TECHNOLOGICAL PARADIGM TO INDUSTRIAL PARADIGM

Agricultural Internet solutions and projects are the common choice of their own advantages and the industry status quo. Based on the Internet of Things, we provide multi-scenario solutions. In the smart agriculture sector is mainly divided into three parts: smart planting, smart aquatic products and smart animal husbandry. In the construction of products, pay attention to the establishment of ecological chain and the extension of industrial chain.

Technology reshaped the appearance and development paradigm of modern agriculture. This is also the important reason that the government, capital invests

agriculture vigorously. The innovation of technological paradigm has led to the innovation of industrial paradigm. In the field of intelligent agricultural system represented by the Internet of Things, intelligent hardware and decision analysis system has achieved results in practice. Technological innovation in the agricultural field is subverting the existing agricultural tradition and providing more effective methods for the development of agricultural modernization, which is embodied in the new industrial technology foundation, industrial structure, industrial operation mode and industrial scale.

Technology has become an important driver of change in the agricultural industry. China's agriculture has entered the era of smart agriculture (Agriculture 4.0), which features information as the factor of production, Internet, Internet of Things, big data, cloud computing, blockchain, artificial intelligence and intelligent equipment application. Through the implementation of a number of major smart agriculture projects, the deployment of agricultural Internet of Things and agricultural machinery on-board monitoring application terminals in the main links of the whole agricultural industry chain, and combined with agricultural remote sensing, agricultural UAV and traditional artificial acquisition system, the implementation of dynamic monitoring of the whole field, whole process and full coverage of agricultural production.

Because the government defines agricultural information as “public goods”, it promotes the wide application of agricultural information technology in the society. Agricultural information technology includes information network, information service and information technology. Agricultural information technology plays a positive role in the development of modern agriculture. Agricultural information technology also needs to further promote the full use of agricultural resources, to avoid the situation of excess resources or insufficient resources, but also can use the advanced science and technology to supervise the agricultural production, and at the same time to popularize more agricultural knowledge to the agricultural producers, so as to achieve the purpose of promoting the development of agricultural economy. There have been a number of leading technology practitioners in the industry. Focusing on the reliable technology and service of information technology, it has helped agricultural enterprises to enter the advanced information technology such as modern agriculture and big data, and promoted a wide understanding of information technology.

Smart agriculture has endowed agriculture with the characteristics of intelligence, informatization, intelligence, digitalization and capital and technology intensive, focusing on its base This goal, ultimate goal and industrial form, emphasize the stickiness and integration of different intelligent systems and agricultural organizations, intelligent activities, will The new generation of information technology is widely used in agricultural decision-making, production, circulation, trading and other links, forming data science, agricultural and commercial knowledge, The modern agricultural

industry form combining intelligent terminals. The development of smart agriculture is of great significance for the realization of intelligent management and information management of agricultural production, information interconnection and interconnection of agricultural supply chain, innovation and application of agricultural production and operation models, and matching agricultural product market with changes in the consumer demand.

Smart agriculture makes the use of emerging technologies to foster new drivers for smart agriculture, open up new tracks, constantly upgrade and transform agricultural machinery and equipment, train agricultural technical and technical personnel, optimize and extend the agricultural industrial chain, and promote the transformation and upgrading of agricultural development to a more informationized, intelligent and comprehensive direction. At the same time, the government will also increase subsidies and preferential treatment, reduce related network transmission fees in rural areas, and further strengthen support for the development of smart agriculture in terms of policies, funds, talents and technologies (see Table II).

TABLE II. THE WHOLE CHAIN OF SMART AGRICULTURE

Node	Process	Result
Smart seed selection and breeding	Develop the seed industry and establish a high-quality germplasm resource bank	Seed industry technology to reshape the source of modern agriculture, covering the "first kilometer" of agricultural products, improve the resistance to adversity
Production process	Environmental monitoring, obtain abnormal alarm information and early warning information; automatic integration of water and fertilizer; intelligent irrigation, drought emergency, automatic adjustment	Increase the crop yield, improve the crop quality, adjust the growth cycle, reduce the costs, and improve the economic benefits; better understand the work situation of employees
Marketing process	E-commerce, live broadcast (village broadcast), We Media, TikTok, Xiaohongshu, etc.; obtaining big data; new technology; product traceability	Product picking, packaging design, development, processing, can quickly find the docking market and consumers (enterprises), forming a close agricultural Internet of Things ecosystem
Industry chain	Enhance the industrial level and develop the "sixth industry", namely, the integration of the primary industry, the secondary industry and the tertiary industry	The industrial chain is complete, and the needs of upstream and downstream enterprises and business forms can be connected as soon as possible to achieve the maximum benefits

#### IV. CONCLUSION

With 5G network application and digital accumulation, focusing on cloud computing, Internet of Things, big data and artificial intelligence, establishing a global digital agricultural cloud, and more and more agricultural digital companies are launched around the world. Modern agriculture is a modern revolution, and the success of modern agriculture will surely lead other industries to realize the revolution of the Internet of Things together. The overall solution of smart agriculture is based on accurate agricultural sensors, and multi-level analysis of the Internet of Things, big data, artificial intelligence, cloud computing and other technologies to conduct multi-level analysis, realize efficient coordination, scientific decision-making, environmental protection and emergency response, and improve the ability of agricultural production to respond to natural environmental risks. To develop agricultural and rural modernization, we should carry out digital transformation of the whole agricultural industrial chain, the whole process and from multiple angles, realize the intelligent transformation of agriculture and rural areas, and promote digital rural governance. Through the application of smart agriculture in the whole agricultural industrial chain, agricultural cost saving, quality improvement and efficiency improvement can be realized, and the value of agricultural data elements can be fully released. We should also promote the industrialization of smart agriculture, vigorously develop agricultural Internet of Things equipment, intelligent agricultural machinery and other industries, promote the construction of rural e-commerce, build demonstration zones in agriculture and rural areas, and foster new space for agriculture and rural areas, so that smart agriculture and related technologies can play an important role in rural revitalization.

#### CONFLICT OF INTEREST

The authors have no competing interests or personal relationships that are relevant to the content of this article to disclose.

#### AUTHOR CONTRIBUTIONS

Li Zhou made substantial contributions to conceptualization, design, draft review & editing; Tao Huang contributed to the establishment of "the smart agriculture information platform"; all authors had approved the final version.

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