Scientific and Social Research
2022, Volume 4, Issue 3

The Practical Dilemma and Development Path of Agricultural Transformation in the Digital Era

Jingpeng Chen[1]*, Xinyi Huang[2], Xingyue Zhang[2], Xidan Luo[1], Shiyue Wang[3]

[1]School of Management, Hainan University, Hainan Province, China

[2]Hainan University and Arizona University Joint International Tourism College, Hainan Province, China

[3]School of Foreign Languages, Hainan University, Hainan Province, China

***Corresponding author:** Jingpeng Chen, 18876089149@163.com

Abstract: In the new era where agricultural modernization has upgraded from industrialization to digitalization, how digital agriculture will develop is an issue that agricultural modernization needs to focus on. This paper makes an in-depth analysis of current agricultural production, management, marketing, after-sales, delivery, and other problems, as well as the current research situation of digital agriculture in China; it subsequently puts forward the digital agriculture development path, comprising of "digital breeding – digital field management – digital picking processing – digital warehousing logistics," in order to realize the modernization of agriculture and the revitalization of rural areas.

Keywords: Agricultural modernization; Digital agriculture; Development path

Online publication: March 22, 2022

1. Introduction

In the face of digital industrialization and digital industrial transformation today, how agricultural modernization will upgrade is the main issue studied in this paper. From upgrading from traditional agriculture to industrial agriculture to digital agriculture, the connotation, characteristics, and development power of agriculture at different stages of development vary. In recent years, an increasing number of scholars have begun to study the transformation and development process of traditional agriculture to modern agriculture. Chen Yuangang and another researcher proposed that it is particularly important to promote the smooth transformation of traditional agriculture to modern agriculture, believing that to accelerate agricultural modernization and promote large-scale agricultural production, professional division of labor, cooperation, and information construction are needed [1]. In addition to that, Zhang Min explored the development strategies for the transformation of traditional agriculture to modern agriculture from the aspects of cultivating agricultural subjects, rural talents, agricultural industrial structure, government funds, agricultural cooperatives, agricultural science and technology informatization, ecological agricultural construction, and agricultural production level [2]. Wu Jie and other researchers asserted that "Internet +" has driven the innovative development of traditional agriculture and suggested that local governments should formulate "Internet +" strategic policies and also attach great importance to the role of human capital stock in agricultural innovation and development [3].

1.1. Agriculture in the industrial times

The research achievements on agricultural industrialization are abundant. Qi Xiangdong stated that agricultural industrialization, agricultural marketization, and agricultural modernization are related to each other. In terms of mutual relations, agricultural industrialization gives birth to agricultural marketization, agricultural marketization promotes agricultural industrialization, and agricultural industrialization and agricultural marketization jointly promote agricultural modernization [4]. Liu Maosong believes that the construction of a new socialist countryside must accelerate the transformation of traditional agriculture to modern agriculture, combine agriculture with new industrialization, and fundamentally transform traditional agriculture [5]. Chen Tong believes that the agricultural industrialization of the United States benefits from the advanced agricultural development research and technology, advanced industrial manufacturing technology, and industrial management paradigm. After the structural transformation of the post-industrialization stage, its agriculture continues to develop until the global layout is realized [6]. China's agricultural industrialization also faces many problems in its development process. At the present stage, its agriculture is in the transformation stage, and the long-standing contradiction between agriculture, rural areas, and farmers has been very prominent. Zhang Xiaode believes that in the face of problems arising in the process of promoting agricultural industrialization at home and abroad, it crucial to reflect on the development road of agricultural modernization with agricultural industrialization as the goal [7]. Ji Rongting strengthened the prevention and control of pollution in China's agricultural industrialization as well as improved the level of governance and governance capacity as the goal, sorted out the development process of China's agricultural industrialization, and clarified the problems caused by the process of agricultural industrialization [8]. On the basis of fully studying and learning from the international experience of agricultural industrialization transformation in Europe, America, Japan, South Korea, and other countries through institutional changes, Cao Zhiling targeted the obstacles to the current agricultural system innovation in China and proposed the agricultural innovation system to provide a more suitable institutional environment for the implementation of the development strategy of agricultural industrialization [9].

1.2. Agriculture in the digital age

With the continuous development of information technology and its deep integration with the operation of national economy, the rapid development of digital economy has changed the production and life mode of the society and has become a new economic form following agricultural economy and industrial economy [10]. Ma Jiantang believes that the connotation of digital economy is the marketization of information technology and the result of the extensive application of the new generation of information technology, resulting in many new industries, new business forms, and new models [11]. Fu Guohua proposed the theory of "three numbers": digital industry society, digital industry economy, and digital industry civilization [12]. Yu Haihong and others described the meaning of digital agriculture, pointing out that the development of digital agriculture in China is still in the enlightenment stage, but as a new model of agriculture in the 21st century, it will be vigorously developed [13]. Yi Jiabin and other researchers pointed out that the main goal of digital agriculture featuring digital agricultural production is to build on data collection, digital transmission network, digital analysis and processing, and CNC (computer numerical control) agricultural machinery to realize the digitalization, networking, and automation of agricultural production [14]. On the basis of analyzing the necessity and feasibility of the development of digital agricultural engineering in China, Yang Yushu pointed out that the focus of development in this field at this stage should be on the research of information acquisition technology and development methods [15]. Liu Haiqi believes that precision agriculture is the impetus and carrier for the digital transformation of modern agriculture and that the digital transformation of modern agriculture provides key production factors and technical support for

the development of digital agriculture [16].

2. Dilemma faced by digital agricultural development

At present, the innovation of the new generation of information technology is unprecedentedly active and constantly promotes deep changes in the global economic pattern and industrial shape. Digital agriculture is a new agricultural model supported by high and new technologies such as biotechnology and information technology. It is an important strategy for future agricultural development. Although China's digital agriculture is developing rapidly, it is still in the initial stage. At the present stage, China has increased its investment in digital agriculture, but in fact, it has not been solved. The alienation of digital concept from the actual production environment is still a relatively prominent problem, mainly manifested in agricultural breeding, field management, picking and processing, warehousing logistics, sales settlement, and the overall requirements of digital agriculture. Although some parts have acknowledged the information, it is difficult to get through the whole production chain and realize data connectivity, thus eventually resulting in the hindrance to digital system upgrade.

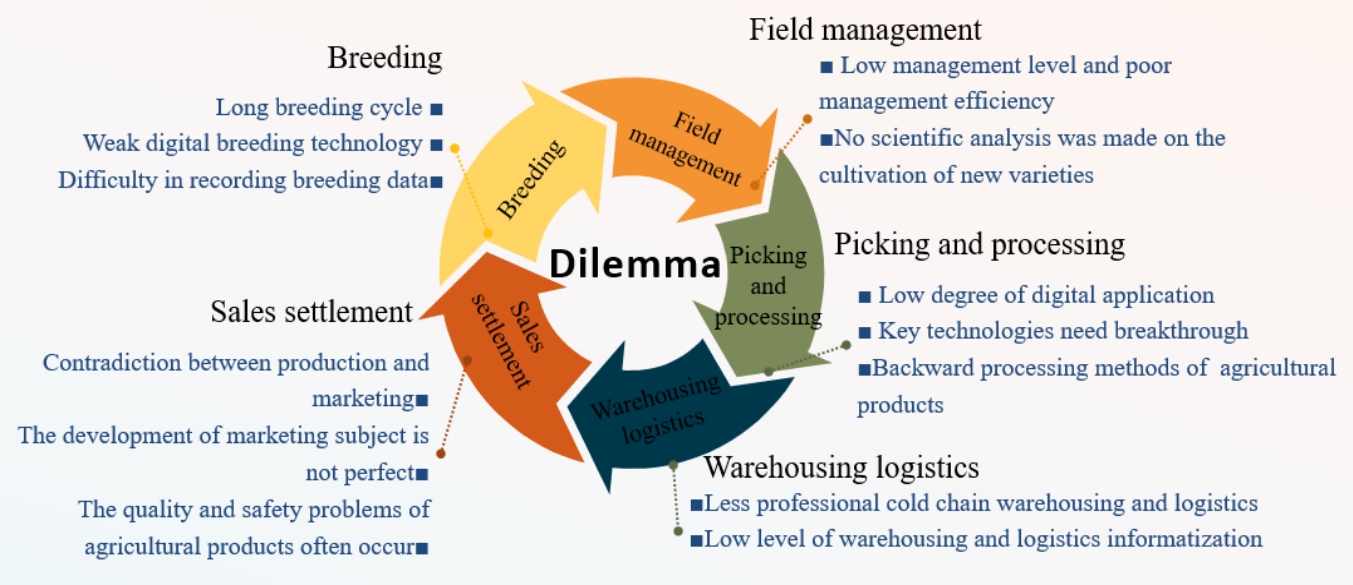

Figure 1. Dilemma faced by digital agricultural development

2.1. Agricultural breeding

Digital breeding is not widely used as the breeding method of major crops in China; instead, the traditional breeding method is still favored. Traditional breeding does not only have a long cycle but also show slow variety improvement progress, leading to a difficulty in meeting the needs of China's economic development. First, the traditional breeding cycle is long, and the yield is low. Due to the genetic background of the breeding material, reproductive barrier, inefficient selection, and other factors, in addition to environmental identification bias, the use of traditional breeding methods such as cycle selection, hybrid breeding, aggregation breeding, backbreeding, and hybrid utilization since the 1970s does not contribute to high yields; thus, the requirements of producers are not met. Second, the digital breeding technology is weak. At the present stage, China's agricultural production is too dependent on foreign breeding resources; moreover, the use of information technology and information breeding technology is weak; there is a lag in gene breeding and molecular breeding technology research, along with relatively backward research facilities and testing means; the digital breeding team is small, with scattered power, short-term behavior, disorderly competition, weak intellectual property protection, etc. Third, the data records of the breeding process are still mainly manual. Taking wheat breeding as an example, there are

still some regions in China that adopt traditional breeding methods; that is, the collection and selection of wheat data through breeding experience. This traditional recording method has errors, which may lead to difficulties in achieving accuracy and scientificity. Therefore, it is not conducive to the development of breeding work. At the same time, the manual recording of data is also tedious, time-consuming, prone to subjectivity, and lacks objectivity.

2.2. Field management

The first is low standard management level and poor management benefits. In terms of production management, most farmers have been using traditional management methods. In terms of water management in crop planting, the phenomenon of flood irrigation and watering is common, and the water resources utilization efficiency only reaches 60%. In terms of fertilizer application, in accordance with the habit of fertilization, the lack of scientific guidance and fertilization quality leads to nutrient dosage imbalance and secondary salinity, which may result in an imbalance in the ecosystem, eventually destroying the ecosystem and causing various ecological problems, thus impeding agricultural production. In addition, some agricultural industries implement extensive management; for large areas of weeds in the field, the amount of herbicide used increases, the plots with fewer weeds will be sprayed rarely, and leakages may occur along with other disorders. Second, there is very little scientific analysis of new variety cultivation. The growth characteristics of new varieties have not been analyzed scientifically, which has resulted in a higher rate of mistakes in the formulation of plans for planting. In terms of planting technology, due to the low professional quality of farmers and the lack of knowledge, problems such as extensive technology and random planting according to traditional habits may occur, resulting in mixed varieties and irregular planting, thus seriously affecting production.

2.3. Picking and processing

First, picking and processing are less digital. Most areas use manual operations, in which mechanized and intelligent operations are rare. Although some areas have picking machineries, they need the support of auxiliary personnel; the limited cost savings on labor costs reduce the enthusiasm for investment and brand the machines idle. Taking orchard machinery as an example, in view of its types of power machineries, insufficient research and development investments, the lack of large, modern, and suitable mechanized orchards, and its common small-scale agricultural economic picking mode, it can only rely on the experience of traditional farming to promote the production and management of fruit trees as digital picking management is not easy to implement. Second, the picking efficiency is low, and there is a need for a breakthrough in core technologies. In terms of core technologies, there are problems of hardware “stuck neck” and software lag. In the process of picking agricultural products, machine vision technology, quality automation detection technology, and feedback control are the main problems in the processing automation of agricultural products. At present, in the application of machine vision technology to the field of agricultural harvesting and processing automation in China, there is still a big gap compared with the same period level. Therefore, it is urgent to further carry out in-depth research and improve the automation degree of harvesting and processing agricultural products. Third, the processing mode of agricultural products is backward. Agricultural products processing, preservation, packaging, and other links are still mainly dominated by traditional manual operations and backward information operation technologies; moreover, some manufacturers have weak awareness in environmental protection and safety, unlicensed production, abuse of additives, substandard quality, and other frequently occurring issues, which have brought negative impact on the external environment.

2.4. Warehousing logistics

First, the information level of warehousing logistics is low. At present, the comprehensive coverage of the information network in rural areas has not been fully realized, the information resources of the network have not been effectively integrated, the construction of the rural agricultural products storage and logistics information network system lacks unified planning, and the application of internet technology in rural areas still has decentralized characteristics. The lack of agricultural information infrastructure has affected the development of agricultural information storage and cold chain logistics. Under the influence of "Internet +," some enterprises have begun to pay attention to the construction of an information system for warehousing logistics, but due to the lack of technical personnel, different transportation modes, product storage conditions, and other aspects cannot be unified, which restricts the implementation of an information system standard management for warehousing logistics. Second, the professional agricultural cold chain logistics are less. The transportation and storage of fresh agricultural products need cold chain logistics. Although the storage of some agricultural products has the refrigeration function, the realization of refrigeration transportation is not as good. Most of the agricultural products are damaged in the process of transportation, thus affecting the sales. In warehouse management, there are less application of information warehouse management technology, low mechanization degree of warehouse agricultural products handling, backward inspection and testing technology of warehouse agricultural products, lack of automatic packaging technology, as well as nonunified warehouse management standards.

2.5. Sales settlement

With the accelerating pace of agricultural modernization in China, the consumption of agricultural products also shows the momentum. From the perspective of market demand, consumers do not only pay attention to the price of agricultural products but also their quality, appearance, brand, and nutrition. There are still many problems in the current marketing of agricultural products in China. First of all, the contradiction between the production and sales of agricultural products is becoming more prominent. On one hand, farmers have a large backlog of agricultural products to sell, while urban consumers complain that they would not eat cheap fruits and vegetables. The issue of "unsalable, difficult to sell, and expensive" has not been solved. Secondly, the main body of marketing is flawed. The marketing subjects in the agricultural market are mainly farmers, individual distributors, and wholesalers, which are scattered and small in scale. In the face of an unpredictable market, the scattered and weak farmers have some "functional defects" in entering the market due to their difficulty in obtaining timely and accurate market information. In the circulation of agricultural products from producers to consumers, after a number of links when farmers are able to grasp the market information, they are already lagging behind. Finally, quality and safety issues concerning agricultural products often occur. The quality of agricultural products is not only related to the health and safety of consumers, but also affects the future development of China's agricultural economy. The lack of a strict and complete standard system as well as market supervision in agricultural production, processing, circulation, quality inspection, identification management, and other links results in a flood of problems with the products and a decline of brand value.

3. Differences between traditional agriculture and digital agriculture

3.1. Economic characteristics

First, in terms of industrial production, traditional agriculture is dominated by the agricultural production and processing industry, and it is easily affected by the climate, region, and season. The products mainly serve the needs of daily life. Digital agriculture is dominated by the digital industry, which includes the information technology production industry, information technology utilization industry, e-commerce industry, and so on. Digital agriculture will run digital science and technology as well as information

technology through the whole process of agricultural development. It will be used to improve the energy level and efficiency of agriculture as well as fully realize the transformation of agricultural digitalization. Second, in terms of economic expression form, traditional agricultural economy is a product-oriented and scale-oriented economy that pursues the specialization, automation, and standardization of agriculture. It enhances competitiveness through the cost advantages of agricultural products, and its main competitors are oriented to different cities. Digital agricultural economy is knowledge-oriented, intelligent, digital, and green. Looking at the global market and creating advantages through technological innovation, it is a customer-oriented and service-oriented economy. Third, in terms of driving force, traditional agriculture takes the factor input of capital, labor, land, and other means of production as the driving force. Its development mode is single and greatly limited. On the other hand, digital agriculture drives the innovative development of the industry with digital technology, breaks the barriers between traditional industries through the progress of digital technology, promotes the integrated development of primary, secondary, and tertiary industries, as well as realizes cross-industry and cross-regional cooperation.

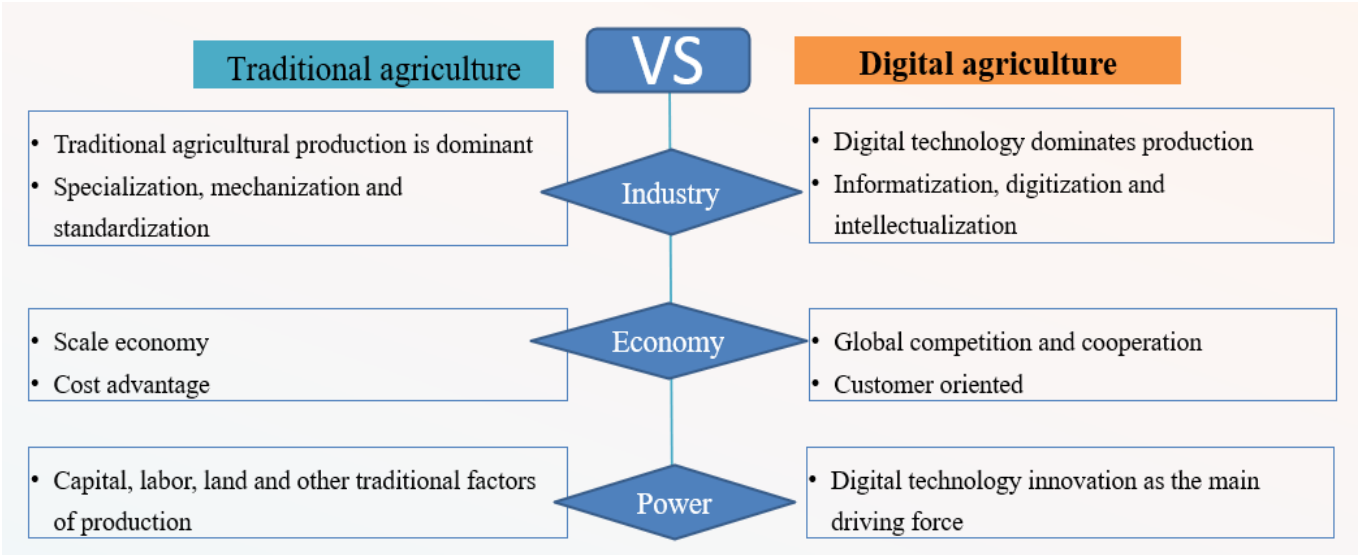

Figure 2. Comparing the economic characteristics of traditional agriculture and digital agriculture

3.2. Governance model

First of all, in terms of governance subjects and means, the traditional agricultural governance model is dominated by people, and relying on long-term accumulated experience, its production efficiency is low, and it is difficult to guarantee the product quality. Under the governance of digital agriculture, the transformation from "people" to "AI" occurs. This means that agriculture no longer focuses on artificial governance, but relies on artificial intelligence means, such as the internet and big data, to make production decisions. Secondly, in terms of governance form, traditional agriculture has the characteristics of localization, decentralization, fragmentation, and certain diversification. Its business organization is mainly small farmers, small-scale, weak strength, and low level intensification. In digital agriculture, priority is given to integrated, systematic, and precise management. It includes modern information technology and agriculture as well as the application of agricultural breeding, field management, picking and processing, storage and transportation, logistics, sales settlement, agricultural resources, and agricultural production process and upgrading on the digital level to optimize the allocation of agricultural resources and promote the process of agricultural modernization. Finally, at the level of organizational structure and mechanism of governance, the traditional agricultural governance model is given priority to with the hierarchical structure, the lack of information transmission between the upper, middle, and downstream subjects in the

process of agricultural production, the low level of industrial structure, and the serious convergence phenomenon lead to poor industrial operation and issues in making timely adjustment according to the changes of the market. The organizational structure and governance mechanism of digital agriculture mainly focus on cross-level network structure and multi-department collaborative governance. The decision-making services of the whole agricultural industrial chain before, during, and after will be connected through data to form an integrated operation, in order to better guide the whole process of agricultural production, establish the agricultural product network integration system, and realize the interconnection between leading enterprises, sellers, and farmers at all levels in the country.

Classify	Traditional agricultural governance	Digital agricultural governance
Governance subject	Person	AI
Governance means	Mainly manual treatment	Artificial intelligence
Governance form	Localization、decentralization、fragmentation	Integrated,、systematic 、accurate
organizational structure	Hierarchical structure	Cross level network architecture

Figure 3. Difference between traditional agriculture and digital agriculture in terms of governance model

4. Digital outlook of agricultural production process

Strengthening the basic research and establishing a model algorithm are the bases of realizing digital agriculture. Its digital connotations can be manifested as the number of agricultural breeding, agricultural field management, agricultural picking and processing, agricultural warehousing logistics, and agricultural sales settlement.

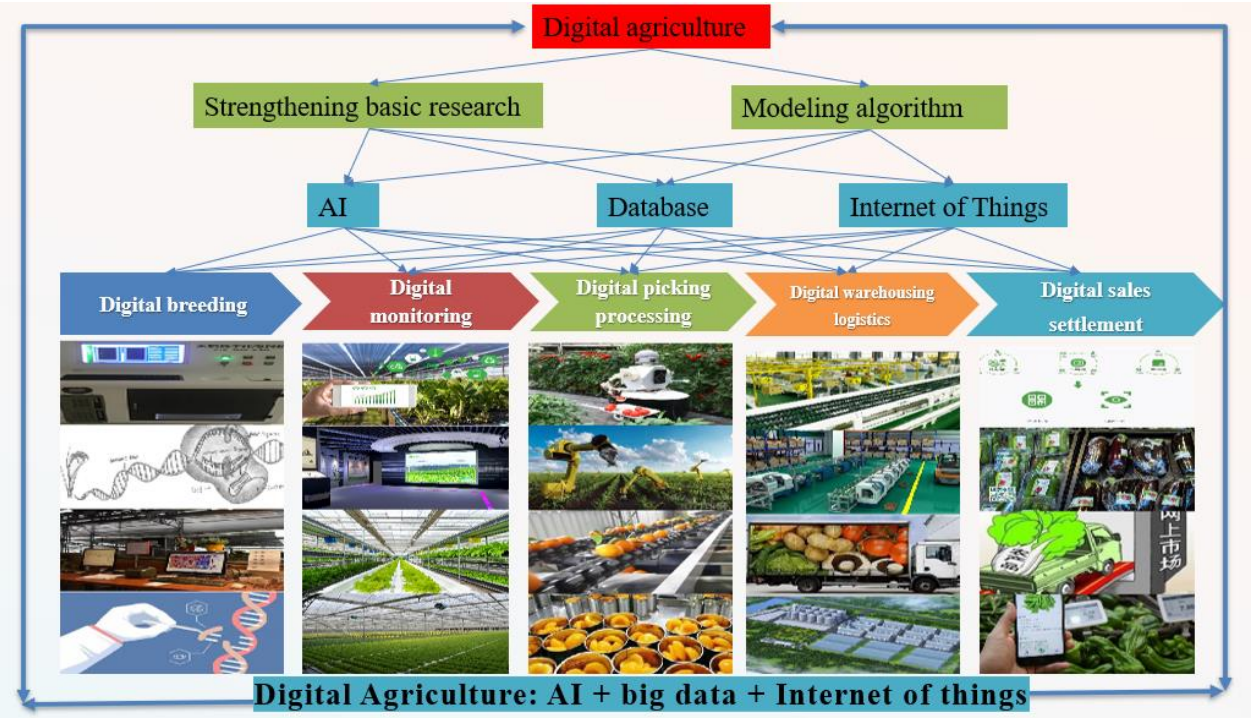

Figure 4. Schematic diagram of digital agriculture

4.1. Digitalization of agricultural breeding

Digital breeding uses digital analysis tools to analyze the product temperature conditions required from sowing to seedling and determine the appropriate sowing period; it also uses information data design software to provide detailed information for hybrid breeding and parental selection; image scanning and processing technology are used to diagnose diseases, monitor germination, and obtain crop phenotype data; agricultural information germplasm resource database can be constructed using biosensor technology, information technology, and Internet of Things. The purpose of digital breeding is to create efficient links from parental selection, material allocation, test management, data collection, genetic analysis, to industrial application, and at the same time for crop access, variety rights law enforcement to provide technical support, and speed up the transformation from "experience breeding" to "accurate breeding," as the main means to achieve the purpose of intelligent breeding. The digitization of data collection and analysis process and the reliance on intelligent products and equipment can reduce labor intensity and input cost, improve breeding efficiency, as well as accelerate the digitization of germplasm resources management, so as to achieve resource saving and cost reduction. This is the fundamental way to build a modern crop breeding platform.

4.2. Digitalization of agricultural field management

In the field management stage, digital tools through robots, drones, or satellite images, combined with visual recognition technology can be used detect the moisture of soil, seedling, insects, and disaster; Internet of Things and AI technology can be used to realize big data calculation and management to achieve the purpose of reducing field management cost and improve efficiency. In that way, the application prospect is very broad. It is possible to set up agricultural monitoring stations, land sensors, 360-degree high-definition cameras, micro meteorological stations, remote photo measuring lights, and other intelligent devices to obtain remote crop image data and crop growth. The regional crop growth process data files obtained with the pest monitoring and warning system in combination with artificial intelligence aerial and sensors can be used to automatically control temperature, light, and ventilation, determine the growth status of crops, and detect the types and quantity of pests. Output plant protection schemes can be implemented to provide scientific and technological guarantee for pest control. At the same time, digital tools can be used for cluster analysis and calculation for different soils, screening of seeds and seedling test sites, judging future meteorological conditions, recommending the optimal sowing period and best nutrient demand for crops, as well as predicting diseases and pests. The digitalization of field management has achieved remote care of crop growth for 24 hours, achieved a breakthrough of 20 mu to 60-100 mu, and improved the work efficiency by 3-5 times. "Agricultural Eye" (the agricultural intelligent monitoring system developed by large climate agriculture) and AIPaaS (artificial intelligence platform-as-a-service) are some of the successful applications of digital field management in China.

4.3. Digitalization of agricultural picking and processing

Centering on "intelligent perception – intelligent diagnosis – intelligent decision-making," the digitalization of agricultural picking and processing relies on navigation technology to identify complex terrains and lays a foundation for the development of the orchard tourism economy. In the 2021 China International Intelligent Industry Expo, the "Hilly and Mountain Unmanned Orchard Management Platform" received warm response from the majority of orchards and fruit farmers. The digital picking management platform uses agricultural remote sensing, AI identification, data mining, intelligent agricultural machinery, and other information technology based on the construction of three-dimensional digital map base, three-dimensional model data, environmental data, crop physiological data, land attribute data, intelligent agricultural machinery data, and multi-source reconstruction farm orchard plot level digital map to realize

unified data, standard, and management. For each space, data information such as planting scale and the number of trees and fruit trees can be intelligently obtained; combining with attributes such as the age of fruit trees in the plot, the yield of each fruit tree can be speculated in advance to realize the clustering and versatility of the three-dimensional orchard data. At the same time, by relying on intelligent sensing, mode recognition, navigation and positioning, path planning, and automatic obstacle avoidance technical support in combination with 3D digital map, efficient collaborative unmanned to unmanned spraying robot, unmanned weeding robot, unmanned picking robot, and other intelligent agricultural machineries, it is possible to realize all intelligent agricultural machinery data interconnection, operation planning, and unified scheduling, so as to conduct large range, high precision, and high efficiency independent operation tasks.

4.4. Digitalization of agricultural warehousing logistics

The digital value of transporting agricultural products is to effectively record the production, transaction, logistics, and sales of agriculture, as well as to monitor and evaluate the whole process of agricultural production, so as to realize the effectiveness of the supply chain, reduce the sales cost, and improve the retail efficiency. In order to shorten the supply chain distribution path, Alibaba has established 17 distribution warehouses across the country. Alibaba's platforms, including RT-Mart, Hema, Taobao, Tmall, Kaala, and Alipay, are all ready to enter the digital operation and realize the "digital + agriculture + commodity" mode. In regard to warehousing logistics, mechanical replacement, combined with modern high-tech equipment, equipped with 10,000 tons of capacity refrigeration storage and advanced refrigeration system, realizes automatic and intelligent control to achieve remote monitoring in unattended situations and promote the transformation as well as upgrading of traditional food production to modern production. Digitalization of the supply end and sales end through data technology can be seen in the following situations: each product has an ID card from one link to another (from picking, transportation, to store sales, and finally distribution to consumers). Data are used to refine purchase preferences and push for the next day, so as to ensure sufficient quantity and fresh goods.

4.5. Digitalization of agricultural sales settlement

The digitalization of transactions and settlement can promote the standardization and transformation of farmers' markets, prevent various problems during transactions, and shoulder the supervision responsibility of food safety in the market. The emergence of the pandemic has promoted the digital process of trading platforms, which has become the new favorite of agricultural sales. At present, some domestic agricultural batch markets have begun to implement the electronic settlement market of farmers' circulation and jointly promote the construction of the electronic settlement system of agricultural products trading and information technology. Market regulators can solve the issue of remote management banks through mobile application. Many links of Shouguang Vegetable Industry chain in Shandong Province have been informatized and digitalized, but the individual accounts of farmers have not been established. The digitalization of sales settlement is convenient for the automatic generation of account information, and it solves the problems of difficult accounting, management, and reconciliation in the traditional methods. By establishing the digital certification system and traceability system, consumers can scan the code to understand the whole process from production to sales; the price index system and service system can guide the production and sales of farmers and supply chain service system. Farmers in producing areas and sales enterprises can expand financing channels through supply chain, bank acceptance bill discount, warehouse receipt pledge, etc., so as to solve the problems of financing difficulty, expensive financing, and slow financing.

5. Ensuring the sustainable development of agriculture through digital agriculture

Digital agriculture can fully and effectively mobilize resources, turn "oil agriculture" into "green agriculture," promote the path of sustainable development, and contribute to the realization of carbon peak and carbon neutrality. Agricultural digitization is the essence to ensuring green and sustainable development. In the process of modern agricultural development, it is crucial to pay attention to the development and utilization of agricultural science and technology as well as embrace the concept of green development as the driving force. In fact, with the support of agricultural science and technology, traditional agriculture has realized transformation and upgrading, breaking through the bottleneck of previous development. The application of digital tools in agricultural pollution control, excellent variety breeding, agricultural irrigation system, organic fertilizer use, and resource recycling meets the needs of agricultural industrialization, and it is in line with the promotion of modern agricultural technology, which has always been running at high levels. In addition, with the maturity and large-scale application of modern agricultural technology, the emergence of agricultural science and technology innovation industrial park, high-efficiency technology demonstration zone, and agricultural biotechnology research foundation has further promoted the application and development of agricultural technology as well as green agriculture.

Disclosure statement

The authors declare no conflict of interest.

References

[1] Chen Y, Zhang Y, 2021, The Transformation Path of "Traditional Agriculture" to "Modern Agriculture" in China. Proceedings of Chongqing University of Technology (Social Sciences), 35(08): 105-117.

[2] Man C, 2021, Development to from Traditional Agriculture to Modern Agriculture. Guangdong Silkworm Industry, 55(08): 39-40.

[3] Wu J, Cheng Z, Huang X, 2021, Effect Research on "Internet +" Driving the Innovation and Development of Traditional Agriculture. Jiangxi Social Sciences, 41(08): 37-49.

[4] Qi X, 2017, Agricultural Industrialization, Agricultural Industrialization and Agricultural Modernization and Analysis. Journal of Xinyang Normal University (Philosophy and Social Sciences Edition), 37(04): 28-32.

[5] Liu M, 2007, Exploring on the Road of Agricultural Modernization with Chinese Characteristics. Journal of Hunan Agricultural University (Social Science Edition), 2007(06): 1-8.

[6] Chen T, 2018, Research on American Agricultural Industrialization Development and Ecological Transformation. Asia-Pacific Economy, 2018(05): 80-87, 151.

[7] Xiao Z, 2011, Agricultural Industrialization and Agricultural Development Model with Chinese Characteristics. Journal of the National Academy of Administration, 2011(05): 47-51.

[8] Ji R, Zhang L, 2021, Modernization the Governance Level and Capacity of Agricultural Industrialization. Environmental Protection, 49(01): 16-19.

[9] Cao Z, 2011, Research on Institutional Innovation in the Development of Agricultural Industrialization, Hunan Agricultural University.

[10] Ahmad N, Ribarsky J, 2018, 16th Conference of the International Association of Official Statisticians (IAOS), September 19-21, 2011: Towards a Framework for Measuring the Digital Economy. IAOS, OECD Headquarters, Paris, France, 19-21.

[11] Ma J, 2018, Digital Economy: Promoting the High-Quality Development of the Real Economy. New Economy Weekly, 2018(6): 10-12.

[12] Fu G, Li Q, Ma K, 2021, How the Hainan Free Trade Port Industry Can Change Lanes and Overtake in the Digital Economy. Hainan Today, 2021(05): 50-52.

[13] Yu H, 2006, He Yong. Digital Agriculture and Its Development Status. Agricultural Mechanization Research, 2006(02): 14-15, 19.

[14] Yi J, Li X, Yang X, et al., 2021, Agricultural Digital Transformation from the Perspective of Innovation Ecosystem Theory: Driver Factors, Strategic Framework and Implementation Path. Agricultural Economic Issues, 2021(07): 101-116.

[15] Yang Y, Wang F, Liu X, 2007, A Strategic Discussion on Digital Agriculture Driving China's Agricultural Modernization. Agricultural Mechanization Research, 2007(12): 246-247, 250.

[16] Liu H, 2019, Accelerate the Digital Transformation of Modern Agriculture Driven by Precision Agriculture. Agricultural Resources and Division of China, 40(01): 1-6, 73.