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Exploration of Modern Agricultural Models Based on Digital Technology

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Abstract

With the rapid development of information technology, digital technology is gradually penetrating into all walks of life at an unprecedented speed, profoundly changing people's production and lifestyle. Agriculture, as the foundational industry of the national economy, cannot remain outside of this technological revolution. The widespread application of digital technology has not only brought unprecedented development opportunities to the agricultural sector but also injected new vitality and momentum into the development of agricultural modernization. This paper aims to delve into the exploration of modern agricultural models based on digital technology, analyzing how digital technology promotes agricultural transformation and upgrading, enhances agricultural production efficiency, and facilitates the development of agricultural modernization, providing useful references and insights for the future development of the agricultural sector. In today's rapidly evolving information technology landscape, digital technology has achieved remarkable results in its application in the agricultural field. From intelligent sensing devices to big data analysis, from cloud computing platforms to artificial intelligence technology, digital technology is penetrating every aspect of agriculture in a comprehensive manner, providing more precise, efficient, and intelligent solutions for agricultural production. The application of these technologies not only improves the efficiency and quality of agricultural production but also reduces production costs and resource waste, laying a solid foundation for the sustainable development of agriculture. Modern agricultural models based on digital technology represent a profound transformation in the agricultural sector. Based on an overview of the current application status of digital technology in agriculture, this paper elaborates in detail on modern agricultural models such as precision agriculture, smart agriculture, vertical agriculture, subscription agriculture, and bio-agriculture, which are based on digital technology. These new models fully utilize the advantages of digital technology, achieving intelligent management, precise operation, and market-oriented operation of the agricultural production process.

Keywords

Digital Technology; Modern Agriculture; Precision Agriculture; Smart Agriculture; Vertical Agriculture.

1. INTRODUCTION

Agriculture, as the foundational industry of the national economy, plays a crucial role in national food security, farmers' livelihoods, and serves as a key indicator for assessing a country's overall economic strength and level of modernization. In the wave of globalization and informatization, the development of agriculture faces unprecedented challenges and opportunities. Traditional agricultural models, despite their significant contributions to the prosperity of human society throughout history, have increasingly prominent issues such as low

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production efficiency, severe resource waste, and intensified environmental pollution, making it difficult to meet the dual high standards of modern society for both the quality and quantity of agricultural products. Therefore, exploring new paths for the modernization of agriculture has become an important issue that must be addressed in the current agricultural sector.

With the rapid development of technology, especially the rise of digital technology, unprecedented opportunities have emerged for innovation in the agricultural field. Digital technology, with its powerful data processing capabilities, precise control technologies, and extensive connectivity, is profoundly changing the agricultural production methods, business models, and industry chains. From intelligent sensing, precise operations, to data analysis and market forecasting, digital technology is permeating every aspect of agriculture, driving agricultural production towards intelligence, precision, and efficiency. This transformation not only holds the promise of solving the problems of traditional agriculture but also enhancing agricultural production efficiency, reducing resource waste, lowering environmental pollution, and better meeting the diverse and personalized market demands for agricultural products.

Modern agricultural models based on digital technology represent a profound revolution in the agricultural sector. They leverage cutting-edge technologies such as the Internet of Things (IoT), big data, cloud computing, and artificial intelligence to achieve intelligent management, precise operations, and market-oriented operations in agricultural production. Through intelligent sensing devices, critical information such as soil moisture, nutrient content, and climatic conditions can be monitored in real-time, providing a scientific basis for agricultural production. Big data analysis allows for precise market demand predictions, optimized planting structures, and improved agricultural product quality. Cloud computing and artificial intelligence enable automated control and intelligent decision-making in the agricultural production process, reducing production costs and enhancing agricultural production efficiency.

Furthermore, modern agricultural models based on digital technology can promote the integration and upgrading of the agricultural industry chain. Digital technology can break the information asymmetry and barriers in traditional agricultural industry chains, achieving close connections and efficient collaboration between upstream and downstream segments. Through digital platforms, the management of agricultural product origins, brand building, and marketing promotion can be realized, enhancing the added value and market competitiveness of agricultural products. At the same time, digital technology can also promote the deep integration of agriculture with industries such as the Internet and e-commerce, forming new economic growth points and industrial ecosystems.

2. CURRENT APPLICATIONS OF DIGITAL TECHNOLOGY IN AGRICULTURE

2.1. Remote Sensing Technology and Geographic Information Systems

The application of remote sensing technology and geographic information systems (GIS) in agriculture enables visualization, digital design, and information management of agricultural production processes. Remote sensing technology allows for real-time monitoring of crop growth and development, soil moisture, pest and disease occurrences, and other critical factors, providing accurate data support for agricultural production. GIS can assist agricultural producers in rational land use, optimizing planting structures, and enhancing agricultural production efficiency. How digital technology drives agricultural transformation and upgrading, boosts agricultural production efficiency, and promotes agricultural modernization is explored through in-depth research on the current applications, new models, and deep integration strategies of digital technology in the agricultural sector.

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2.2. Internet of Things Technology

The application of the Internet of Things (IoT) technology in agriculture has achieved intelligence and automation in agricultural production processes. Through IoT technology, agricultural producers can monitor real-time environmental parameters in farmland, such as temperature, humidity, and light intensity, and autonomously adjust irrigation, fertilization, and other agricultural activities based on monitoring results. IoT technology also enables traceability of agricultural products, improving food safety standards.

2.3. Big Data and Artificial Intelligence Technology

The application of big data and artificial intelligence (AI) technology in agriculture provides precise and efficient decision support for agricultural production. Big data technology enables the mining and analysis of agricultural production data, revealing patterns and growth trends in agricultural production, and providing a scientific basis for agricultural production. AI technology can use machine learning methods to intelligently process and analyze agricultural production data, providing more intelligent decision support for agricultural production.

3. MODERN AGRICULTURAL MODELS BASED ON DIGITAL TECHNOLOGY

3.1. Precision Agriculture

Precision agriculture is one of the modern agricultural models based on digital technology. It utilizes remote sensing technology, geographic information systems, IoT technology, and other means to monitor farmland environmental parameters and crop growth conditions in real-time, providing precise data support for agricultural production. Through precision agriculture, agricultural producers can formulate scientific planting plans and schemes for irrigation, fertilization, and other agricultural activities based on farmland environmental parameters and crop growth conditions, thereby improving agricultural production efficiency and enhancing the quality of agricultural products.

In precision agriculture, advanced equipment such as drones and intelligent agricultural machinery has also been widely used. Drones can be employed for precise fertilization and pesticide spraying in farmland, improving agricultural production efficiency while reducing the use of chemical pesticides. Intelligent agricultural machinery can automatically adjust operating parameters based on farmland environmental parameters and crop growth conditions, realizing the intelligence and automation of agricultural production.

3.2. Intelligent Agriculture

Intelligent agriculture is a modern agricultural model based on artificial intelligence technology. It uses big data, artificial intelligence, and other corresponding technical means to mine and analyze agricultural production data, discovering patterns and trends in the agricultural production process, and providing more intelligent decision support for agricultural production. Through intelligent agriculture, agricultural producers can monitor farmland environmental parameters and crop growth conditions in real-time and automatically adjust irrigation, fertilization, and other agricultural activity plans based on monitoring results.

In intelligent agriculture, machine learning algorithms are widely used in the processing and analysis of agricultural production data. Through machine learning algorithms, agricultural production data can be intelligently classified, predicted, and used for decision support.

3.3. Vertical Agriculture

Vertical agriculture is a production model that uses indoor vertical space for food cultivation. It employs hydroponics or aeroponics to grow crops in circulating water or fine mist containing nutrients, water, and oxygen. By adjusting indoor environmental parameters, crops can be

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grown year-round without interruption. Vertical agriculture not only maximizes the use of planting space, reduces water usage and land resource consumption, but also improves crop yield and quality.

Vertical agriculture has been widely applied in urban agriculture, rooftop gardens, and vertical farms. In some developed countries, vertical agriculture has become an important food production method, providing fresh vegetables and fruits to urban residents. In China, vertical agriculture is also gradually gaining attention, with some enterprises beginning to experiment with building vertical farms in urban centers to utilize indoor space for food production and alleviate urban food supply pressures.

3.4. Adoptive Agriculture (or Subscription Farming)

Adoptive agriculture (or subscription farming) is a new agricultural sales model based on consumers' prepaid production costs. By establishing a contractual relationship between consumers and producers, it eliminates intermediate links in the circulation of agricultural products, allowing consumers to directly obtain green organic food from the farmland to the table. At the same time, producers can better sell their agricultural products, reducing the risk of unsold goods.

Adoptive agriculture not only increases the added value of agricultural products but also promotes the development of rural tourism, cultural exchanges, and other aspects. By integrating and packaging specialty agricultural products, tourist attractions, and unique homestays, adoptive agriculture provides consumers with more personalized choices. This not only meets consumer demand but also brings more economic benefits to rural areas.

3.5. Biological Agriculture

Biological agriculture is a new agricultural model that utilizes biotechnology and production processes for crop cultivation. It uses microbial, plant, and animal biological resources, and applies them in areas such as biological breeding, biological pesticides, biological fertilizers, biological feeds, biological vaccines, and preparations to improve crop yield and quality.

Biological agriculture has broad development prospects. Compared with traditional agricultural models, biological agriculture has significant advantages in increasing crop yield, improving crop quality, and protecting the environment. Through the technology of biological agriculture, the disease resistance, insect resistance, and stress resistance of crops are improved, thereby reducing the use of chemical pesticides and fertilizers and lowering agricultural production's pollution to the environment.

4. STRATEGIES AND SUGGESTIONS FOR PROMOTING THE DEEP INTEGRATION OF DIGITAL TECHNOLOGY AND AGRICULTURE

4.1. Strengthening Agricultural Infrastructure Construction

Agricultural infrastructure construction is the foundation for the popularization and application of agricultural digital technology. We need to enhance network coverage, power supply, and water conservancy facilities in rural areas, providing robust support for the application of digital technology in agriculture. Simultaneously, the construction of agricultural IoT facilities should be strengthened to boost the capabilities of agricultural data collection, transmission, and processing.

4.2. Promoting the Fusion of Digital Technology and Agricultural Knowledge

The fusion of digital technology and agricultural knowledge is crucial for advancing the application of digital technology in agriculture. We must enhance farmers' digital skills training, thereby significantly improving their digital literacy and information technology application

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abilities. Additionally, the promotion of agricultural scientific and technological knowledge is necessary to facilitate the deep integration of digital technology and agricultural science and technology, driving the development of intelligent and automated agricultural production.

4.3. Advancing the Construction of Agricultural Digital Platforms

Agricultural digital platforms serve as important carriers for the application of digital technology in agriculture. We need to strengthen the construction of agricultural big data platforms, agricultural e-commerce platforms, and agricultural IoT application platforms, promoting the sharing and openness of agricultural data and facilitating the application and promotion of agricultural digital technology. Furthermore, the supervision and management of digital platforms should be enhanced to ensure the security of agricultural data and user privacy.

4.4. Policy Support and Incentive Mechanisms

The government should introduce relevant policies, offering tax reductions, funding subsidies, and other incentives to agricultural enterprises and farmers adopting digital technology, thereby reducing their transformation costs and stimulating their enthusiasm for applying digital technology. Additionally, an innovation incentive mechanism should be established to encourage agricultural technological innovation and the commercialization of research results, promoting the widespread application and deep integration of digital technology in agriculture.

4.5. Strengthening International Cooperation and Exchange

International cooperation and exchange are crucial pathways for promoting the application of digital technology in agriculture. We need to actively participate in international agricultural digitization projects, learning from advanced agricultural digitization technologies and experiences from abroad. Meanwhile, activities such as international forums on agricultural digitization should be held to strengthen exchanges and cooperation with international peers, jointly promoting the widespread application and deep integration of digital technology in agriculture.

4.6. Enhancing Agricultural Data Security and User Privacy Protection

As digital technology is widely applied in agriculture, the issues of agricultural data security and privacy protection have become increasingly prominent. We need to strengthen the security management of agricultural data, establishing an agricultural data security guarantee system to ensure the integrity, availability, and confidentiality of agricultural data. Furthermore, the protection of farmers' data privacy should be enhanced, clarifying the usage rights and scope of farmers' data to prevent its misuse or leakage.

5. CASE STUDIES

5.1. Case Study on Precision Agriculture

Taking a certain farm as an example, this farm adopts precision agriculture technology, utilizing drones for precise fertilization and pesticide spraying in farmland. Through intelligent sensors and cameras mounted on drones, real-time monitoring of farmland environmental parameters and crop growth conditions is conducted. Based on the monitoring results, the farm has formulated scientific planting plans and schemes for agricultural production activities such as irrigation and fertilization. After a year of practice, the farm's crop yield increased by 20%, and the usage of chemical pesticides decreased by 30%.

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5.2. Case Study on Smart Agriculture

Taking a certain smart farm as an example, this farm employs smart agriculture technology, leveraging big data and artificial intelligence for mining and analysis of agricultural production data. Through machine learning algorithms, the farm predicts crop yields and quality and formulates scientific planting plans and sales strategies. Additionally, the farm utilizes intelligent agricultural machinery for automated operations, improving the efficiency of agricultural production. After a year of practice, the farm's agricultural product sales increased by 30%, and agricultural production costs decreased by 20%.

5.3. Case Study on Vertical Agriculture

Taking a certain vertical farm as an example, this farm adopts vertical agriculture technology, constructing vertical farms in the city center. By adjusting indoor environmental parameters, the farm achieves year-round uninterrupted planting of crops. Simultaneously, the farm utilizes IoT technology to monitor farmland environmental parameters and crop growth conditions in real-time, and automatically adjusts irrigation, fertilization, and other agricultural production activity plans based on monitoring results. After a year of practice, the farm's crop yield increased by 50%, providing fresh vegetables and fruits to city residents.

5.4. Case Study on Subscription Agriculture

Taking a certain subscription agriculture project as an example, this project establishes a contractual relationship between consumers and producers, bypassing the middle links in agricultural product circulation. Consumers can directly obtain green organic food from the farmland to the table, while producers can better sell their agricultural products. The project integrates local specialty agricultural products, tourist attractions, and specialty homestays, providing consumers with personalized solutions. After a year of practice, the project's agricultural product sales increased by 40%, bringing more economic benefits to rural areas.

5.5. Case Study on Biological Agriculture

Taking a certain biological agriculture enterprise as an example, this enterprise utilizes biotechnology and production processes for crop cultivation. Through the application of biological breeding and biological pesticides, the enterprise enhances crops' resistance to diseases, pests, and adverse conditions. At the same time, the enterprise reduces the usage of chemical pesticides and fertilizers, lowering the degree of environmental pollution caused by agricultural production. After a year of practice, the enterprise's crop yield increased by 30%, and the quality of agricultural products was significantly improved.

6. CONCLUSION

The modern agricultural models based on digital technology have provided renewed opportunities for the development of agricultural modernization. The increasing application of new agricultural models such as precision agriculture, smart agriculture, vertical agriculture, subscription agriculture, and biological agriculture has not only improved agricultural production efficiency and agricultural product quality but also promoted sustainable agricultural development and rural revitalization. To promote the deep integration of digital technology and agriculture, we need to strengthen agricultural infrastructure construction, facilitate the integration of digital technology and agricultural knowledge, promote the construction of agricultural digital platforms, provide policy support and incentive mechanisms, enhance international cooperation and exchanges, and strengthen agricultural data security and privacy protection.

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REFERENCES

[1] Li Yuan. Construction of Agricultural and Rural Modernization Infrastructure System in China at a New Stage of Development [J]. Journal of Qiu Shi, 2024, 51(02): 81-89.

[2] Chen Mengqiang. Research on the Application of "Digital Intelligence Empowerment" in the High-Quality Development of Modern Agriculture in Zhaoqing [J]. China Management Informationization, 2023, 26(15): 97-100.

[3] Wang Shuxia. Trends and Promotion Pathways of Digital Agriculture [J]. Agricultural Engineering Technology, 2021, 41(06): 36-37.

[4] Tu Shengwei, Zhang Chen. Basic Characteristics and Construction Paths of Modern Agricultural Industry Systems from the Perspective of a Comprehensive Agriculture Concept [J]. Zhongzhou Academic Journal, 2024, (07): 29-37.

[5] Luo Jiaxin. Data Breakthrough, Intelligent Matrix, Digital Empowerment: Digital Media Assists in the Development of Chinese-Style Agricultural Modernization [J]. Agricultural Machinery, 2023, (09): 83-36+89.

[6] Ding Yulong, Zhang Wangli, Zhao Yajuan. An Empirical Test of the Impact of the Digital Economy on Agricultural and Rural Modernization in China [J]. Agricultural Machinery, 2024, 40(16): 16-21.

[7] Liu Xiaofeng, Piao Zonggen. The Internal Logic, Dilemmas, and Solutions for the Digital Economy Empowering Agricultural Modernization [J]. Journal of Xi'an University of Finance and Economics, 2024, 37(05): 55-66.

[8] He Lilong, Chen Shuxing. Research on the Construction of Agricultural Power and Agricultural and Rural Modernization [J]. Review of Political Economy, 2024, 15(03): 159-184.