Research on the Development Path and Policies of the Digital Economy in Agriculture

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Abstract: Against the backdrop of digital transformation, the agricultural digital economy is showing promising development trends, yet it also faces numerous challenges that hinder its high-quality growth. To align with the requirements of agricultural digital transformation in the new era, it is necessary to accelerate the construction of digital infrastructure, create a favorable industrial environment, enhance the overall quality of the workforce, and implement a comprehensive approach to elevate the development level of the agricultural digital economy, thereby driving the high-quality development of modern agriculture. This article focuses on the development of the agricultural digital economy, summarizes relevant policies and practical pathways, and aims to provide references for related theories and practices.

Keywords: Development path; Agriculture; Digital economy; Policy

1. Introduction

According to the requirements of the national 14th Five-Year Plan, digital agriculture has become an inevitable path for the modernization and transformation of agriculture. By introducing digital economy concepts into the agricultural sector and deeply integrating digital technologies with the agricultural industry, it is possible to comprehensively reconstruct agricultural production and management processes, thereby promoting green and sustainable agricultural development. Unlike traditional agricultural economies, the agricultural digital economy covers the entire agricultural production process, relying on technologies such as artificial intelligence, the Internet of Things, and big data to assist farmers in real-time, efficient data acquisition, providing data support for making optimal decisions. However, despite the promising prospects for the development of the agricultural digital economy, numerous challenges remain that require further refinement and improvement.

2. Challenges faced by the agricultural digital economy

2.1. Incomplete digital infrastructure

In some remote mountainous areas and rural regions with relatively low overall economic levels, broadband network infrastructure is inadequate, and new communication technologies such as 5G and high-speed fiber optics have not yet been fully deployed or popularized. Many farm fields still face issues with insufficient signal coverage. In core production areas such as livestock farms and large-scale planting bases, the density of IoT device deployment is relatively low, and data collection on agricultural production environments—including weather conditions, soil moisture levels, and crop growth—is incomplete, making real-time transmission and sharing of such data difficult. Smart sensing devices suitable for complex field environments are scarce due to high costs, making large-scale adoption challenging. Agricultural producers often opt for low-cost digital tools, such as portable data collection terminals and lightweight farm management apps, resulting in agricultural production data that cannot be standardized or structured for collection and integration [1].

2.2. Low technical literacy among farmers

Farmers are a crucial force in the development of the agricultural digital economy, and enhancing their technical literacy is of utmost importance. However, the current rural labor force is predominantly composed of middle-aged and elderly individuals who are unfamiliar with operating computers and smartphones and cannot collect and process agricultural technology knowledge and market data. Commonly used agricultural apps and online payment tools are difficult to operate, making it challenging for farmers to participate in online sales on a large scale. Additionally, most farmers have low acceptance of new technologies and a superficial understanding of how to apply cutting-edge technologies, leading to negative emotions such as resistance and reluctance.

2.3. Incomplete policy and institutional framework

Although the state has implemented digital rural policies from a macro perspective, there is a lack of detailed planning for the agricultural digital economy sector. There is no systematic, forward-looking national strategic plan, and development goals and implementation pathways remain unclear. Interdepartmental collaboration is low, with significant departmental barriers, resulting in limited synergies between policy formulation and implementation. This prevents the formation of a policy synergy, hindering the implementation of policies [2]. Significant differences exist in the agricultural foundations and characteristics of different regions, yet policy considerations for regional differences are insufficient, and regional policy coordination and collaboration are inadequate, hindering the high-quality development of the agricultural digital economy.

3. Development pathways for the agricultural digital economy

3.1. Continuously deepening the construction of information infrastructure

The development of the agricultural digital economy relies on a robust information infrastructure. Through forward-looking and systematic planning, a secure, intelligent, and efficient digital foundation should be established to drive the digital transformation and upgrading of the agricultural supply chain. According to the Ministry of Agriculture and Rural Affairs' "2023 National Digital Agriculture Development Report" and the Ministry of Industry and Information Technology's Communications Industry Statistical Bulletin, the current status and development goals of China's agricultural digital infrastructure are outlined in **Table 1**.

Table 1. Current status and development goals of agricultural digital infrastructure (2023–2027)

Indicators	Current status in 2023	Target for 2025	Target for 2027	Pathway
5G network coverage in administrative villages	62%	85%	100%	Increase the special fund for telecommunications services in administrative villages
IoT device coverage rate	18%	40%	65%	Promote low-cost sensors
Proportion of smart agricultural machinery	12%	25%	40%	Purchase subsidies + equipment sharing model
Cold chain digital monitoring rate	35%	60%	85%	Establish a regional logistics platform

Vigorously implement the rural broadband network upgrade project, accelerate the rollout of high-speed fiber-optic networks to villages and households, and achieve full coverage of 5G networks. Promote the application of advanced information technologies such as low-frequency 5G and satellite internet, and explore cost-effective network coverage solutions. In agricultural core production areas such as livestock farms and large-scale planting zones, accelerate the deployment of 5G private networks to meet the demand for low-latency, high-concurrency data transmission; vigorously promote the construction of IoT coverage in farmland, and in fields such as soil moisture monitoring or weather monitoring, promote the construction of LPWAN low-power wide-area networks to expand the coverage of communication networks [3].

Establish an intelligent IoT sensing system to efficiently collect and process agricultural production data. Under the leadership of relevant departments, increase funding for research and development and popularize agricultural smart sensors, such as lightweight crop phenotyping collection devices and soil parameter sensors. Focus on developing multifunctional integrated smart terminals that combine image recognition, environmental monitoring, and other functions to reduce the difficulty and cost of deploying agricultural smart terminals. Promote the application of satellite remote sensing and drone remote sensing equipment to establish an integrated data collection system; accelerate the popularization and application of intelligent agricultural machinery operation monitoring terminals to monitor data such as fertilizer application rates, seed sowing rates, and fuel consumption in real-time, supporting the digital processing of the entire agricultural production process [4].

Establish a regional digital platform to facilitate collaboration among departments such as meteorology, land resources, markets, and water conservancy, achieving comprehensive collection of agricultural production data and agricultural-related data across the entire supply chain, and establishing an interconnected regional agricultural resource database; design standardized API interfaces, strengthen application development across different scenarios, and enhance data filtering, cleaning, and analysis capabilities. In areas such as processing plants and farms, deploy edge computing gateways on a large scale to process local data in real-time, providing precise data support for equipment fault diagnosis, pest and disease early warning, and soil moisture analysis, and effectively improving the system's data response speed.

Accelerate the digitalization of cold chain logistics, upgrade and renovate existing cold chain infrastructure at production sites, and focus on building cold storage facilities and pre-cooling facilities, providing environmental temperature and humidity control equipment for agricultural operators; Promote the implementation of RFID tagging systems to achieve seamless tracking and recording of agricultural product information throughout the supply chain; establish county-level smart cold chain logistics warehousing and distribution centers, implement a shared delivery model, and achieve comprehensive monitoring and control of the logistics delivery process.

Based on collected data, dynamically optimize logistics routes to provide a robust infrastructure foundation for the sustained and stable growth of the agricultural digital economy [5].

3.2. Deepen digital talent cultivation

In the context of agricultural digital economic development, continuously deepening digital talent cultivation is of critical importance. Encourage higher education institutions to establish majors in agricultural big data, agricultural IoT, etc., to promote the deep integration of agricultural knowledge and digital technology, and focus on cultivating composite talents with a solid foundation and strong practical abilities. Appropriately increase project practice, internships, and training in course design to support students' participation in agricultural production on the front lines, and focus on enhancing students' problem-solving abilities and digital literacy [6].

Deepen school-enterprise cooperation, invite experts and scholars to guide course development, and cultivate composite talents that fully meet market development needs. Organize agricultural practitioners to actively participate in digital training. For farmers with lower educational levels and older age groups, adopt methods such as on-site demonstrations and short video tutorials to focus on improving farmers' digital technology application literacy. For new professional farmers with a certain foundation in agricultural knowledge, organize advanced training activities centered on topics such as intelligent agricultural system management and big data analysis. Develop online learning platforms and combine online and offline training models to overcome spatial and temporal constraints, enabling farmers to learn agricultural knowledge and skills anytime and anywhere. Farmers are encouraged to obtain agricultural digital skills certificates, with those who pass the assessment receiving special subsidies. The improvement of farmers' digital skills is also incorporated into the criteria for recognizing new professional farmers. A Pioneer Award is established to recognize and reward farmers who excel in agricultural digital production and management, creating county-level digital benchmarks [7].

3.3. Strengthening market regulation and control

Understanding the characteristics of the agricultural digital economy, a modern regulatory system is established to balance risk prevention and innovation incentives. Establish an agricultural SaaS platform, formulate differentiated access lists, and improve the quality and security of regulatory data; promulgate and implement the "Agricultural Data Transaction Management Measures," which define data property rights and revenue distribution mechanisms, to support agricultural data collection and processing. Establish a sandbox regulatory mechanism, set up regulatory pilot zones in smart farm scenarios, encourage agricultural production and operation enterprises to adopt new business models, and dynamically adjust and improve regulatory details. Establish a comprehensive traceability system, introduce blockchain technology to collect data on agricultural production records, logistics temperature control, and product quality inspection, store it on the blockchain to prevent data tampering and theft; implement AI video inspection + blockchain evidence storage for green products and regional specialty products to ensure product patent security and prohibit counterfeit and substandard products in the market.

4. Policy research on agricultural digital economy development

4.1. Existing policies

Under the backdrop of agricultural digital economy development, the state has issued the "Digital Rural Development Action Plan (2022–2025)" to accelerate the construction of 5G communication network infrastructure support; the "Guidelines for Agricultural Machinery Purchase Subsidies (2023 Revision)" to

include autonomous driving terminals in the scope of agricultural machinery purchase subsidies, with the highest subsidy reaching 30%; The Implementation Plan for the Farmer Digital Literacy Enhancement Project focuses on organizing new professional farmers to participate in specialized training, with a target of training 5 million people over three years. Despite the issuance of a series of policy frameworks by the state, issues have emerged, including a focus on hardware over maintenance, insufficient coverage of small-scale farmers, inadequate coverage of data services and software systems, and homogenization of training content. In terms of policy implementation, at the county level, there is a fragmented and uncoordinated execution status, failing to leverage interdepartmental collaboration; incentive subsidies are limited to hardware procurement, with insufficient funding support for subsequent software services, leading to a large number of idle devices.

4.2. Policy improvements

While existing agricultural digital economy policies have achieved some results, there is still significant room for improvement. Current policies focus primarily on short-term projects and lack long-term strategic planning. It is necessary to develop a medium- to long-term plan for the agricultural digital economy based on actual conditions, establish goals, tasks, and safeguards for each phase, and establish a coordinated, coherent, and comprehensive policy framework. The agricultural digital economy involves multiple departments. To address issues such as policy overlap and unclear responsibilities, a cross-departmental policy coordination mechanism should be established to facilitate information transmission and sharing, thereby enhancing the effectiveness of policy implementation. Additionally, efforts should be intensified to develop core technologies for the agricultural digital economy. For agricultural digital economy projects, funding should be prioritized to guide social capital investment, and differentiated support policies should be formulated to promote balanced and high-quality development of the agricultural digital economy.

5. Conclusion

In summary, under the backdrop of the development of the agricultural digital economy, relevant departments should increase efforts in information infrastructure construction, enhance funding to improve the facility system, strengthen digital talent cultivation and market regulation, and promote interdepartmental collaboration to optimize and improve supporting policies. This will enhance the vitality of the agricultural digital economy and drive the modernization and transformation of agriculture.

Disclosure statement

The author declares no conflict of interest.

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