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Research on the Coupling and Coordination Degree of Digital Economy and New Quality Productivity in Agriculture

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Abstract: With the rapid development of the digital economy, the improvement of agricultural productivity is facing unprecedented opportunities and challenges. This paper explores the coupling and coordination degree between the digital economy and the new quality productivity of agriculture, proposes an optimization path based on the coupling and coordination degree theory, focuses on analyzing the profound impact of digital transformation on agricultural production models, and discusses promoting the deep integration of the two through innovation-driven and policy coordination. By constructing a calculation model of coupling coordination degree and conducting empirical analysis, this paper reveals the multiple influences of the digital economy on the improvement of agricultural productivity and its internal mechanism, and puts forward strategic suggestions for improving the coupling coordination degree. Research shows that the integration of the digital economy and the new quality productivity of agriculture needs to rely on the dual-wheel drive of scientific and technological innovation and policy support to promote coordinated regional development and thereby achieve sustainable development of agricultural modernization.

1. Introduction

The rise of the digital economy has brought profound changes to the agricultural sector, especially in enhancing agricultural productivity and promoting agricultural modernization, where digital technology is playing an increasingly important role. However, how to scientifically measure the interactive relationship between the digital economy and agricultural productivity and optimize their coupling coordination degree is a key issue in current research. The coupling coordination degree theory provides us with an effective tool for quantitatively analyzing the coordinated development of the digital economy and agricultural productivity. This paper aims to explore the coupling relationship between the digital economy and the new quality productivity of agriculture, analyze their interaction mechanism, and propose specific strategies to enhance the coupling coordination degree, thereby providing theoretical support and practical guidance for policy-making and industry development.

2. The interaction between the digital economy and the new quality productivity of agriculture

2.1. The driving effect of the digital economy on agricultural productivity

Driven by the digital wave, the interaction between the digital economy and traditional agricultural productivity is becoming increasingly close. Especially in the process of building new agricultural productivity, the digital economy has played an indispensable driving role. The application of digital technology has provided agriculture with more efficient production methods and innovative technical means. It not only breaks through the production limitations of traditional agriculture, but also enhances the overall productivity of agriculture through data, intelligence and informatization means[1]. Specifically, the digital economy has significantly enhanced the production efficiency and resource allocation efficiency of agriculture through means such as information technology, big data, the Internet of Things, and artificial intelligence. For instance, through Internet of Things (iot) technology, various devices and sensors in the agricultural production process can monitor in real time information such as the climate, soil, and crop growth conditions in farmlands, thereby achieving precise agricultural management, accurately adjusting agricultural production plans, minimizing resource waste to the greatest extent, and enhancing the efficiency of agricultural production[2].

The digital economy has promoted the optimal allocation of agricultural production factors. Based on big data, resources such as land, labor and capital in agricultural production can be more scientifically scheduled and allocated. Agricultural enterprises and farmers can make market predictions through data analysis, adjust production strategies in a timely manner, and avoid resource waste or production delays caused by market fluctuations. Meanwhile, the popularization of digital technology has also promoted the transformation of agricultural production methods. The traditional labor-intensive production model has gradually shifted towards a high-tech and high-efficiency intelligent model, significantly enhancing the degree of automation and intelligence in the production process. As a result, agricultural productivity has achieved a qualitative leap. The involvement of the digital economy not only accelerates the process of agricultural industrialization and modernization, but also introduces more flexible and sustainable production methods to the agricultural sector.

2.2. The innovative performance of new quality productivity in the context of the digital economy

Driven by the digital economy, the innovative performance of new quality productivity in agriculture has demonstrated unprecedented vitality and potential. This kind of innovation does not merely rely on the improvement of traditional productive forces. Instead, through multi-dimensional technological empowerment, it has given rise to new production models and economic forms. The digital economy provides rich data support for the innovation of new quality productivity in agriculture, and data has become the core resource for promoting high-quality agricultural development. With the support of digital technology, in agricultural production, whether it is planting, breeding or other links in the agricultural industrial chain, they can all be optimized through precise data analysis and real-time feedback mechanisms, thereby achieving a dual improvement in production efficiency and benefits[3]. For instance, through the promotion of precision agriculture, farmers can rely on real-time data from satellite remote sensing, big data analysis and Internet of Things sensors to precisely adjust irrigation, water and fertilizer management, and pest and disease control, achieving intelligence and automation in the production process, thereby significantly increasing the yield and quality of crops.

The innovative manifestations of new quality productive forces are also reflected in the profound transformation of agricultural production methods. Under the traditional agricultural model, the production methods are mostly driven by human and natural resources, which are inefficient and greatly affected by the environment. Under the framework of the digital economy, based on technologies such as artificial intelligence, the Internet of Things, and blockchain, all aspects of agricultural production are gradually moving towards a high degree of informatization and automation. This transformation not only enhances the precision and efficiency of production, but also promotes the intelligent upgrade of the industrial chain, driving the leap of agriculture from extensive to intensive and from low efficiency to high efficiency.

2.3. The profound impact of digital transformation on agricultural production models

The profound impact of digital transformation on agricultural production models reflects the structural change from traditional agriculture to modern agriculture. This process not only changed the production mode of agriculture, but also profoundly redefined the development logic and value chain of agriculture. Digital transformation has prompted agriculture to shift from the traditional labor-intensive model to an intelligent one that relies more on technology and information means. In this process, the application of digital technologies such as the Internet of Things, big data and artificial intelligence has made various operations in the agricultural production process more precise and automated. For instance, through intelligent irrigation systems and precise fertilization techniques, agricultural production can be dynamically adjusted based on real-time data to optimize the use of water and fertilizer, thereby enhancing the growth efficiency of crops and the utilization rate of resources[4]. This transformation not only raised the per-unit yield but also effectively reduced resource waste in production, promoting the sustainable utilization of agricultural resources. Digital transformation has facilitated the reshaping of the agricultural industrial chain. In the past, the agricultural industrial chain often suffered from problems such as information asymmetry and poor communication. However, with the introduction of digital technology, the production, processing, circulation and consumption links in agriculture have gradually achieved information sharing and collaborative work. For instance, through blockchain technology, the quality and origin of agricultural products can be traced, and consumers' trust in food safety has significantly increased, thereby optimizing the market supply and demand as well as the price system. This series of changes not only enhanced the overall productivity of agriculture, but also brought new development opportunities to the agricultural economy, promoting the transformation of agriculture from "quantitative growth" to "qualitative improvement". Digital transformation undoubtedly has a profound impact on agriculture and also provides a broad vision and unlimited possibilities for the future development of global agriculture.

3. Application framework of coupling coordination degree theory

3.1. The basic theory and methodology of coupling coordination degree

The coupling coordination degree theory provides an effective tool for measuring the synergy of system elements. Especially in the research on the combination of the digital economy and the new quality productivity of agriculture, its application framework is of great significance. This theory quantifies the coupling relationship among the elements of the system, reveals their interdependence and synergy effects, and emphasizes that the operating state of the system depends on the coordination and interaction among the elements. Methodologically, the coupling coordination degree is often evaluated by combining mathematical models with data analysis. Through the coupling degree formula and the coordination degree index, different weights are set to

comprehensively consider the contribution degrees of each element and assess the overall system coordination state[5]. The coupling degree measures the interaction intensity of subsystems, while the coordination degree reflects whether such interaction effectively promotes the overall development. In practical applications, researchers can quantify the changes in factors and calculate the coupling relationship between the digital economy and agricultural productivity under specific backgrounds through data collection and analysis. The advantage of this method lies in its ability to systematically evaluate and quantify the synergy among different system elements, providing a scientific decision-making basis for policymakers and achieving collaborative optimization and resource allocation among fields.

3.2. Calculation model for the coupling and coordination degree between the digital economy and agricultural productivity

The calculation model of the coupling and coordination degree between the digital economy and agricultural productivity aims to reveal the dynamic process of their coordinated development by quantifying the interrelationship between the two. The core of this model lies in considering both the promoting effect of the digital economy on agricultural productivity and the feedback effect of agricultural development on digital technology. Specifically, the calculation model is usually based on two key indicators: coupling degree and coordination degree. The coupling degree reflects the intensity of the interaction between the digital economy and agricultural productivity. Usually, the weighted comprehensive index method is adopted. Through the standardized processing of various influencing factors, the coupling index is formed. The degree of coordination further measures whether this coupling brings about actual synergy and efficiency enhancement, with a focus on examining the coordination and development synchronicity between the two, which is often represented by the coordination index.

In the process of model construction, it is first necessary to identify the key factors that affect the coupling relationship, which usually include the technological innovation level of the digital economy, the degree of informatization development, as well as the production efficiency and resource utilization rate of agriculture. Then, by constructing mathematical formulas, the weights and influences of each factor are incorporated into the calculation model. The weights of each index are determined by using multiple regression analysis or the Analytic Hierarchy Process (AHP), and finally the value of the coupling coordination degree is obtained. In practical operation, this model can not only assess the coupling degree between the current digital economy and agricultural productivity, but also predict the future development trend, providing a scientific reference basis for policymakers. By constantly optimizing this calculation model, it is possible to guide the coordinated development of the digital economy and agriculture more precisely and promote their deep integration and common progress.

3.3. Specific steps and index system for measuring coupling coordination degree

The specific steps and index system for measuring the coupling coordination degree aim to precisely assess the interaction and synergy between the digital economy and agricultural productivity through a systematic analytical framework. The measurement process usually begins with data collection and index selection. The key lies in determining multi-dimensional indicators that can reflect the interaction between the two. For the digital economy, common indicators include the level of informatization, technological innovation, the degree of industrial integration, etc. As for agricultural productivity, it includes production efficiency, resource utilization rate, environmental sustainability, etc. The indicator data needs to undergo standardization processing to ensure comparability among different dimensions. This step is crucial as it can eliminate the

dimensional differences among various indicators, thereby providing a consistent basis for subsequent coupling degree calculations.

The core step in calculating the coupling degree is to combine the weights of each index with the actual data through the weighted synthesis method to obtain the coupling degree value. The level of coupling reflects the intensity of the interaction between the digital economy and agricultural productivity. On this basis, the calculation of the degree of coordination further examines the balance and harmony among the various elements within the system. The level of coordination not only indicates the degree of synergy between the two, but also reflects the overall development potential of the system. For the measurement results of the coupling coordination degree, it is necessary to evaluate the effectiveness of the current coupling relationship and the future optimization space through comparative analysis and trend prediction. This process not only provides empirical basis for policy-making, but also offers scientific guidance for further promoting the integrated development of the digital economy and agriculture.

4. Analysis of the Coordination between Digital Economy and New Agricultural Productivity

4.1. Empirical analysis method for coupling coordination degree

The empirical analysis method of coupling coordination degree, as the core tool for exploring the interrelationship between the digital economy and the new quality productivity of agriculture, adopts multi-dimensional and multi-level data analysis means, aiming to reveal the interaction mechanism and development trend of the two through quantitative means. In empirical analysis, it is necessary to construct a complete indicator system covering the key influencing factors of the digital economy and agricultural productivity. For the digital economy, factors such as the level of informatization, technological innovation capabilities, and the degree of industrial integration are usually selected as measurement criteria. As for the new quality productivity in agriculture, the focus is on aspects such as production efficiency, resource allocation, and environmental sustainability. Through the collection and standardization processing of these indicators, the comparability and consistency of the data are ensured, thus laying the foundation for the subsequent calculation of coupling degree and coordination degree. Empirical analysis methods often combine techniques such as regression analysis and multivariate statistical analysis in statistics and econometrics, and process data by establishing mathematical models.

4.2. Evaluation of coupling coordination degree based on data

The evaluation of coupling coordination degree based on data, as an important tool for analyzing the interrelationship between the digital economy and the new quality productivity of agriculture, can accurately reflect the coordination and development potential between the two. The core of this evaluation method lies in quantifying the coupling strength and synergy effect between the digital economy and agricultural productivity through scientific data processing and model construction. The collection and processing of data is the first step in the entire evaluation process. Researchers need to ensure that the selected indicators can comprehensively and deeply reflect the key elements of the digital economy and agricultural productivity. For instance, in terms of the digital economy, it may involve the application of information technology, the penetration rate of the Internet, and the infiltration of intelligent agricultural technologies, etc. The new quality productivity of agriculture focuses on production efficiency, resource utilization rate and ecological benefits, etc. By standardizing data, the differences between different dimensions can be eliminated, ensuring the fairness and comparability of various indicators.

4.3. Reliability and limitations of the analysis results

When conducting the coordination analysis between the digital economy and the new quality productivity of agriculture, the reliability and limitations of the analysis results are important factors that cannot be ignored. Although the evaluation of coupling coordination degree provides us with a profound insight into the interaction between the two, its reliability is often influenced by multiple factors such as data quality, indicator selection, and model construction. The accuracy, completeness and timeliness of the data directly determine the credibility of the analysis results. If the statistical data used are biased or incomplete, it may lead to misleading analysis conclusions and thereby affect the effectiveness of policy recommendations. The selection of indicators and the setting of weights are equally highly subjective. Different researchers may choose different indicator systems or weight allocations based on their own research backgrounds and preferences. Such differences will undoubtedly affect the calculation results of coupling coordination and the interpretation of the relationship between the two.

On the other hand, the limitations of the model cannot be ignored either. Although the current analytical methods provide a relatively comprehensive perspective through multi-dimensional comprehensive evaluation, essentially they are still simplified quantitative processing of complex systems and are difficult to fully cover all potential variables and dynamic interactions. Especially in the context of the rapidly developing digital economy, the complexity of technological progress and market changes poses challenges to the adaptability of existing models. Future research needs to continuously improve this theoretical framework through more detailed data collection, more comprehensive indicator systems and more advanced analysis models, thereby enhancing the accuracy and applicability of its analysis results.

5. Optimization Path for the Coupling and Coordination Degree of Digital Economy and Agricultural Productivity

5.1. Strategic suggestions for enhancing coupling coordination degree

Strategic suggestions for enhancing the coupling and coordination between the digital economy and agricultural productivity should focus on optimizing the two-way promotion mechanism of technological integration and innovation-driven development. Driven by the digital economy, the enhancement of agricultural productivity not only relies on the introduction of technology but also requires the strengthening of digital transformation in the agricultural sector through an innovation-driven mechanism. Therefore, policymakers should increase investment in the construction of agricultural information infrastructure, especially in remote areas. By popularizing Internet technology and intelligent equipment, they should promote the digitalization, automation and precision of the agricultural production process. By integrating big data, cloud computing and other technologies, a complete agricultural information service platform is constructed to ensure that farmers can obtain various types of data needed for production in real time, thereby achieving refined management and enhancing overall production efficiency. Optimizing resource allocation and promoting the deep integration of agricultural production factors and digital economy factors is also a key strategy to enhance the coupling and coordination degree. The government can guide the cooperation between agricultural enterprises and digital technology enterprises through policy incentives, and encourage collaborative innovation between the two sides in research and development, technology application and industrial upgrading. For instance, agricultural enterprises can leverage the resource sharing and platform advantages brought by the digital economy to enhance the intelligence level of agricultural production. They can also optimize crop planting, irrigation, fertilization and other links through intelligent equipment, thereby effectively increasing

agricultural productivity.

Strengthening cross-industry cooperation and policy coordination is also an important way to enhance the degree of coupling coordination. The government should promote the coordination of policies on digital economy and agricultural development through multi-departmental collaboration, avoid acting independently, and facilitate seamless integration between the digital economy and agricultural productivity, providing a solid support for achieving sustainable development.

5.2. The development model of digital agriculture driven by innovation

The innovation-driven digital agriculture development model, as a key path to enhance the coupling and coordination between the digital economy and agricultural productivity, emphasizes the formation of sustainable agricultural growth momentum through the dual promotion of technological innovation and model innovation. Under this model, digital technology not only serves as a tool to enhance agricultural production efficiency, but also promotes a fundamental transformation of agricultural production methods by deeply integrating into the agricultural industrial chain. Data-driven precision agriculture has become a core element. Through technologies such as big data, the Internet of Things, and cloud computing, every link in agricultural production can be monitored and dynamically adjusted in real time. For instance, based on information such as meteorological data and soil data, farmers can accurately predict the growth cycle of crops, optimize irrigation and fertilization plans, maximize resource utilization efficiency and reduce production costs. The introduction of intelligent and automated technologies has also brought revolutionary changes to agriculture. The application of intelligent agricultural machinery, unmanned aerial vehicles (UAVs), and automated picking systems and other equipment has gradually transformed the traditional labor-intensive agricultural production mode towards intelligence and automation, thereby achieving efficient and refined production processes. This transformation not only enhanced crop yields and quality, but also promoted the improvement of the agricultural ecological environment, reducing resource waste and environmental pollution. More importantly, the innovation-driven digital agriculture model emphasizes industrial collaboration and cross-border integration. Agricultural enterprises, technology companies, financial institutions and other parties cooperate, leveraging digital platforms and innovative mechanisms to achieve resource sharing and complementary advantages, and promote the overall leap of agricultural modernization. This model not only enhances the endogenous driving force of agricultural productivity, but also provides an innovative demonstration for the deep integration of the digital economy and agriculture, thereby promoting sustainable agricultural development.

5.3. Policy design for promoting coordinated regional development

Policy design for promoting coordinated regional development is one of the core strategies for enhancing the coupling and coordination between the digital economy and agricultural productivity. Under the background of the digital economy, the development differences among regions often determine the efficiency of resource allocation and the speed of technology promotion. Therefore, policy design should focus on narrowing regional gaps and promoting the efficient flow of resources, technologies and information to achieve more balanced regional coordinated development. The government should increase investment in digital infrastructure in rural areas, especially in remote regions. By improving Internet access, popularizing intelligent devices and providing technical training, it should ensure that these areas can fully enjoy the technological dividends brought by the digital economy. These regions simultaneously implement differentiated policy incentives, encouraging local governments to formulate digital agricultural development plans that are in line with local realities based on their own development characteristics, and form

agricultural digitalization models with local characteristics. To promote coordinated regional development, it is also necessary to accelerate the integration and upgrading of the agricultural industrial chain. Policies should encourage agricultural enterprises in various regions to cooperate with digital technology enterprises, promote technology and resource sharing, especially in the construction of data platforms, processing and circulation of agricultural products, and facilitate cross-regional joint innovation and the development of industrial clusters. Policies should also focus on promoting the connection between the upstream and downstream of the industrial chain, enhancing the overall coordination of agricultural production, processing, logistics, sales and other links, so as to improve the comprehensive competitiveness of agriculture in the entire region.

6. Conclusions

This paper, through the application of the coupling coordination degree theory, conducts an in-depth analysis of the interaction and synergy between the digital economy and the new quality productivity of agriculture. Research has found that digital transformation has significantly enhanced agricultural production efficiency and also laid the foundation for intelligent and precise management of the agricultural industrial chain. The optimization paths proposed in this paper include strengthening the development model of digital agriculture driven by innovation and policy design to promote coordinated regional development. It also points out that the deep integration of the digital economy and agriculture needs to be promoted through both technological innovation and policy coordination. Future research can further improve the coupling coordination degree model and explore more detailed regional development strategies to achieve the sustainable and coordinated development of the digital economy and agricultural productivity.

References

[1] Deng Yiwen, He Ying, Ma LAN, et al. Research on the Coupling and Coordination Degree of Digital Economy and High-Quality Development of Textile Industry: A Case Study of Xuzhou City [J] Business Watch,2022(1):55-59.
[2] Guo Liping, Wang Liangchao. Research on the Coupling and Coordination Degree of New Quality Productivity and High-Quality Development of the Digital Economy: Based on Panel Data of 30 Provinces (Autonomous Regions and Municipalities) in China [J] Journal of Jinling Institute of Technology (Social Science Edition),2024,38(3):1-10.
[3] Wu Yuhuan, Zhou Rongzhu, Zhu Ning. Research on the Coupling and Coordination of Digital Villages and Agricultural Production Efficiency [J]. Journal of Technology Economics and Management,2022(10):87-92.
[4] Peng Guotai. Analysis of the Coupling and Coordination Degree of Digital Economy, New Urbanization and Agricultural Modernization in Hebei Province [J]. Anhui Agricultural Sciences,2023,51(20):215-219.
[5] Ma Guiyong, Luo Jian, Tang Yaozong. Analysis of Influencing Factors of Coupling and Coordination Degree between Digital Economy and Rural Revitalization [J]. Times Economy and Trade,2024,21(2):10-14.