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Strategies for Innovative Development of Digital Agriculture Empowered by New-Quality Productivity under Digital Intelligence Context: An Empirical Study Based on Hengzhou Digital Jasmine and Qintang Cloud Adoption Cases

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ABSTRACT

Digital agriculture, as a key driver of rural revitalization and a primary solution to issues related to agriculture, rural areas, and farmers, holds significant importance in leveraging the three core components of new-quality productivity (revolutionary technological breakthroughs, innovative allocation of production factors, and industrial transformation and upgrading) to promote its in-depth development in the digital intelligence era. This study selects two representative digital agriculture cases in Guangxi, integrates collaborative innovation theory, and analyzes the current development status of digital agriculture. Through comparative examination of the unique characteristics and commonalities of these two cases, the research identifies universal challenges hindering digital agriculture progress. It proposes innovative solutions and development pathways to address existing difficulties and foster further growth, constructs new models for digital agriculture advancement, and maximizes the role of digital agriculture as a new-quality productivity engine to accelerate rural revitalization.

KEYWORDS

Digital Intelligence; New-Quality Productivity; Digital Agriculture; Collaborative Innovation

1. INTRODUCTION

1.1. Research Background and Objectives

Agriculture constitutes the bedrock of national development, serving not only as the material foundation for national survival and civilizational progress but also as a critical safeguard for social stability and prosperity. In contemporary society, advancements in science and technology coupled with societal evolution have continuously transformed and elevated agriculture's role. The Report of the 20th National Congress of the Communist Party of China (CPC) explicitly emphasizes the imperative to accelerate the establishment of a new development paradigm and achieve high-quality development as the essential requirement of China's modernization path. It further prioritizes agricultural development in rural areas. Consequently, promoting high-quality agricultural development emerges as an inevitable choice for advancing rural revitalization, building an agricultural powerhouse, and ultimately realizing China's modernization.

Digital agriculture, representing a new agricultural model in the digital intelligence era, leverages informatization and intelligent means to drive agricultural modernization, functioning as a pivotal driver of current rural revitalization efforts. However, this field remains in an exploratory phase both

theoretically and practically, confronting challenges such as digital talent shortages, inadequate digital infrastructure, and funding constraints. How then should China promote innovative development of digital agriculture in this era?

In September 2023, General Secretary Xi Jinping first introduced the concept of "new-quality productivity" during an inspection tour in Heilongjiang Province, defining it as an advanced productive force characterized by innovation-led growth, deviation from traditional economic expansion patterns, and alignment with the new development philosophy through high-tech, high-efficiency, and high-quality attributes. Therefore, advancing high-quality digital agricultural development can harness the empowering effect of new-quality productivity by optimizing the combination of digital agricultural laborers, means of production, and objects of labor through three core elements: revolutionary technological breakthroughs, innovative allocation of production factors, and industrial transformation and upgrading.

This study selects two representative digital agriculture cases in Guangxi that have achieved certain development outcomes. By examining their innovative practices in China's digital agricultural transformation, this research generalizes typical models for transitioning from traditional to digital agriculture. It constructs a theoretical model of new-quality productivity empowering digital agricultural innovation with Chinese characteristics, thereby fostering regional digital development pattern innovations in practice and providing demonstration references for digital agriculture practices across diverse regions. Exploring strategies for new-quality productivity to empower digital agricultural innovation under the digital intelligence context holds significant theoretical and practical value.

1.2. Literature Review

The concept of "new-quality productivity" transcends the scope of traditional productivity, offering advanced theoretical frameworks and profound insights across multidisciplinary fields. When introduced into agriculture, it gives rise to the notion of "new-quality agricultural productivity," symbolizing a fundamental transformation and modernization of agricultural production methods. In the agricultural context, new-quality agricultural productivity refers to the capability of enhancing agricultural efficiency and product quality through cutting-edge scientific technologies, information technologies, and management tools [1]. It represents an innovative productivity underpinned by technological innovation, oriented toward green development, and centered on farmer quality improvement [2]. This concept extends beyond mere improvements in efficiency and quality, profoundly reshaping and optimizing the entire agricultural production chain.

Drawing on Marx's three-factor theory of labor—laborers, means of production, and objects of labor—the construction of new-quality agricultural productivity emphasizes the deep integration and synergistic innovation of these three elements within a digitalized context. Digital new-quality agricultural productivity, as its embodiment in the agricultural sector, refers to a novel agricultural productivity driven by the digitalization of the "trinity" of agricultural productivity factors (laborers, means of production, and objects of labor) to spur technological innovation, thereby achieving leapfrog development and upgrading of traditional agricultural productivity [3].

The development path of new-quality agricultural productivity can be divided into two dimensions: developmental mechanisms and empowerment integration. At the level of developmental mechanisms, digital technologies are embedded into the three agricultural productivity factors, forming digital agricultural laborers, digital agricultural means of production, and digital agricultural objects of labor, which collectively generate new-quality digital agricultural productivity [4]. At the empowerment integration level, new-quality agricultural productivity optimizes the overall industrial chain from supply to consumption by vertically integrating digital technologies with traditional industrial chains and drives the deep integration of primary, secondary, and tertiary industries

horizontally. This breaks down technological and spatial barriers, enhances industrial symbiosis, and achieves agricultural modernization through internal structural optimization [5].

While theoretical advancements underpin new-quality agricultural productivity, external supporting environments are equally crucial. In terms of agricultural data resources, scholars like Qi Aimin emphasize that agricultural data serves as a critical decision-making foundation for digital means of production and objects of labor. They advocate for standardized government practices to ensure equitable and efficient allocation of agricultural data resources, leveraging data for public benefit [6]. On the legal front, Zhou Haotian et al. argue that a legal system supporting digital agriculture is vital for developing new-quality agricultural productivity. They recommend strengthening anti-monopoly, fair competition review, and anti-unfair competition mechanisms in agricultural data and digital technology markets to maintain fair competition [7].

Regarding digital finance, Liu Xuewen et al. highlight its multifaceted role in agricultural modernization, enhancing agricultural industrial chain resilience while mutually empowering new-quality agricultural productivity to drive agricultural modernization [8]. In agricultural insurance, Li Yongbin et al. suggest that agricultural insurance significantly promotes new-quality agricultural productivity by advancing agricultural technological progress and expanding agricultural scale operations. It increases policy dependence for objects of labor and facilitates agricultural integration [9].

Nationwide, the development of new-quality agricultural productivity varies across regions. At the high-quality agricultural development level, the direct and indirect effects of new-quality productivity are significantly positive in eastern China, while the central, western, and northeastern regions show insignificant direct effects due to relatively backward economies and immature market mechanisms [10]. In terms of development levels, China's digital agriculture exhibits a clear east-west disparity, with significant differences between eastern, central, and western regions. Inter-regional disparities are the main source of overall disparities, though these are gradually narrowing, with the largest gap between eastern and western regions and the smallest between central and western regions [11].

At the provincial level, different provinces face both unique and common challenges in developing new-quality agricultural productivity. Heilongjiang, Jiangsu, and Yunnan all struggle with incomplete agricultural modernization and digital technology application, shortages of agricultural technology and digital talent, short digital agricultural industrial chains, and low industrial integration. Depending on their geographic advantages, Yunnan focuses on integrating advantageous agricultural industries with innovative industries, Jiangsu on empowering the entire industrial chain and reshaping industrial formats, and Heilongjiang, as a major agricultural province, emphasizes digital rural construction and urban-rural integration [1, 11, 12].

In summary, research on new-quality agricultural productivity primarily centers on theoretical exploration, including conceptual definitions, development path establishment, supporting institutional construction, and regional adaptability across China. Practical research remains insufficient. Building on existing studies of digital empowerment in agriculture, this research focuses on how new-quality productivity empowers digital agricultural innovation, examining the deep logic between the two. It identifies key challenges impeding Guangxi's digital agriculture development and proposes effective pathways for new-quality productivity to empower Guangxi's digital agricultural innovation and drive rural revitalization.

1.3. Research Content

Within the grand blueprint of the rural revitalization strategy, digital agriculture serves as a core driving engine with unique innovative and penetrative power, representing a critical path to solving "agriculture, rural areas, and farmers" issues and promoting agricultural modernization. Amid the surging wave of digital intelligence, our team focuses on the empowering role of new-quality

productivity in digital agriculture. Applying collaborative innovation theory, we explore four core research questions:

What are the theoretical connotations of digital intelligence and new-quality productivity empowerment?

What is the logical mechanism of new-quality productivity empowering digital agriculture in the context of digital intelligence?

What challenges does new-quality productivity face in empowering digital agricultural industrial development under digital intelligence?

What strategies can new-quality productivity employ to empower digital agricultural industrial development in the context of digital intelligence?

By addressing these questions, we aim to deeply explore and promote high-quality digital agricultural development.

1.3.1. Logical Mechanism of New-Quality Productivity Empowering Digital Agricultural Innovation in the Context of Digital Intelligence

New-quality productivity empowering digital agriculture in the digital intelligence context refers to comprehensively enhancing the intelligence, automation, and informatization levels of agricultural production through deep integration of digital technologies (such as big data, artificial intelligence, cloud computing, and the Internet of Things) with the agricultural sector, thereby driving agricultural industrial modernization. New-quality productivity comprises five elements: new laborers, new tools, new objects, new infrastructure, technological innovation, and industrial transformation. By embedding these into traditional agricultural productivity factors, it forms digital agricultural laborers, digital agricultural means of production, and digital agricultural objects of labor, generating new-quality digital agricultural productivity.

This logical mechanism is rooted in the practical needs of agricultural green development and industrial transformation. It is driven by technological support, organizational leadership, policy guidance, and financial assurance, ultimately aiming to realize the practical values of farmer prosperity, agricultural strength, and rural revitalization.

At the practical level, agricultural green development and industrial transformation focus on the realistic needs of digital agriculture. The green development concept requires reducing resource consumption and environmental pollution in agricultural production, which digital intelligence technologies enable through precise management and intelligent decision-making. Industrial transformation demands a shift from traditional low-efficiency, low-value-added models to high-efficiency, high-value-added ones, with digital intelligence serving as the core driver. Its deep integration with new formats (digital agricultural ecosystems, agriculture + internet), new models (precision agriculture, contract farming), and new technologies (Internet of Things, big data, artificial intelligence, smart agricultural machinery) empowers industrial transformation.

At the driving level, technological support, organizational leadership, policy guidance, and financial assurance jointly constitute the four driving forces of digital agriculture. Technological support is the foundation, providing advanced information technology tools and intelligent platforms for efficient data processing and analysis. Organizational leadership is the core, integrating government, enterprises, research institutions, and farmer cooperatives through multi-level, diversified systems to foster collaboration. Policy guidance is the direction, with governments formulating scientific measures such as fiscal subsidies, tax incentives, and land use guarantees to create a favorable policy environment. Financial assurance is the key, ensuring funding through government investment, social capital, and financial markets to support digital agriculture projects.

At the practical value level, digital agriculture ultimately aims to achieve farmer prosperity, agricultural strength, and rural revitalization. Farmers benefit directly from increased productivity

and income through digital intelligence. Agricultural strength is the core, requiring qualitative leaps in competitiveness and international influence. Rural revitalization is the vision, promoting infrastructure, industrial diversification, and governance modernization to underpin rural revitalization strategies.

In conclusion, the logical mechanism of digital agriculture development is deeply embedded in the urgent needs of agricultural green development and industrial transformation, reflecting the internal logic and inevitable trend of modern agricultural development. Its driving forces—technological support, organizational leadership, policy guidance, and financial assurance—collectively form a robust system, serving the ultimate goals of farmer prosperity, agricultural strength, and rural revitalization.

1.3.2. Propulsion Mechanism of New Quality Productivity Empowering Innovative Development of Digital Agriculture

As an important representative of new quality productivity, digital agriculture shoulders the crucial responsibility of promoting agricultural modernization and aiding rural revitalization. In light of the characteristics of new quality productivity, it is imperative to construct a propulsion mechanism integrating three dimensions: new business formats, new models, and iterative new technologies, thereby unleashing new momentum for the innovative development of digital agriculture empowered by new quality productivity.

(1) Strengthening Business Format Innovation and Building New Business Formats of Digital Agriculture

To transform traditional digital agriculture into a new type, the first step is to enhance business format innovation. The new digital industrial formats driven by new quality productivity should leverage intelligent technologies such as the Internet of Things (IoT), big data, cloud technology, and artificial intelligence (AI) to establish an agricultural digital ecosystem. This ecosystem should cover the entire agricultural industry chain, including production, processing, and sales, enabling comprehensive perception, dynamic transmission, intelligent processing, and automatic control of agricultural information, and promoting the digital transformation of the entire traditional digital agriculture industry. In terms of market expansion, digital agriculture should deepen its integration with the Internet, accelerate the formation of new business formats such as agricultural e-commerce, agricultural crowdfunding, and agricultural big data services, broaden the sales scope of traditional digital agriculture, and enhance its market competitiveness.

(2) Strengthening Model Innovation and Establishing New Models of Digital Agriculture

Currently, the production and operation modes of digital agriculture in China are still dominated by traditional agricultural methods, with new methods playing a supplementary role. Therefore, it is necessary to innovate the production and operation modes of traditional digital agriculture and give full play to the important role of new quality productivity in promoting the formation of new production and operation modes in the agricultural industry. To strengthen the innovation of digital agriculture models, the precision agriculture model can be adopted. By utilizing digital technologies such as IoT and big data, this model enables real-time monitoring of the agricultural production environment and precise management of fertilization, irrigation, pest control, etc., based on the growth needs of crops. This improves agricultural production efficiency and resource utilization, forming a green, efficient, and high-quality development model. Additionally, the order agriculture model can be employed. For instance, "Cloud Adoption" and "Digital Jasmine" have established e-commerce or sales platforms and achieved certain results. Adopting the order agriculture model can broaden the channels of e-commerce platforms, fully realize the direct connection between agricultural products and the market, enhance the ability to collect market information, customize production according to market demand, increase the sales volume of agricultural products, and promote agricultural development.

(3) Strengthening Technological Innovation and Iterating New Technologies of Digital Agriculture

Technological innovation is the core driving force of new quality productivity. Therefore, empowering the innovative development of digital agriculture with new quality productivity should focus on adopting new technologies and their iterative updates. Through IoT technology, agriculture can utilize sensors, wireless communication, and other technical means to transmit various information in the agricultural production process to the cloud or terminal devices in real time, realizing intelligent perception and remote monitoring of the agricultural production environment. Big data technology collects, stores, analyzes, and mines the vast amounts of data generated during agricultural production, revealing patterns and trends in agricultural production and providing a scientific basis for agricultural production decision-making. At the same time, AI technology utilizes machine learning, deep learning, and other means to provide intelligent optimization and decision support for the agricultural production process, such as predicting the occurrence trends of crop diseases and pests through intelligent algorithms and formulating prevention and control measures. Furthermore, the research, development, and application of intelligent agricultural machinery and equipment technologies, including driverless tractors, intelligent irrigation systems, and plant protection drones, have significantly improved the automation level and operation accuracy of agricultural production.

In summary, the empowerment of digital agriculture's innovative development by new quality productivity is embodied in the three dimensions of new business formats, new models, and new technologies. By strengthening business format innovation, model innovation, and technological innovation, we can build new business formats, reconstruct new models, and iterate new technologies of digital agriculture to promote its innovative development, enhance agricultural production efficiency and resource utilization, promote the transformation, upgrading, and sustainable development of the agricultural industry, and aid rural revitalization.

1.3.3. Theoretical Basis for Constructing the Theoretical Model of New Quality Productivity Empowering Innovative Development of Digital Agriculture

(1) Collaborative Innovation Theory

Proposed by American scholar Peter Gloor in the 20th century, collaborative innovation theory emphasizes the coordination and cooperation among various elements through integration and interaction, ultimately promoting the innovative development of organizations. It is a large-span integrated innovation organization model that takes knowledge value-added as the core and is carried out by enterprises, governments, knowledge production institutions (universities, research institutions), intermediaries, and users to achieve major technological innovations.

With the goal of knowledge value-added, this theory emphasizes breaking down barriers among innovation entities such as enterprises, governments, knowledge production institutions, and intermediaries to achieve coordinated cooperation in talent, capital, information, technology, and other aspects. It aims to build a dynamic system of interaction, complementarity, exchange, innovation, and development both internally and externally among various entities. By integrating resources among entities, it accelerates technological innovation and the industrialization of scientific and technological achievements, achieves innovation goals, and enhances social benefits.

Collaborative innovation theory mainly has two characteristics: (1) Holism: Collaborative innovation requires that innovation entities such as governments, enterprises, and knowledge production institutions organically integrate their resources, and the methods, goals, and functions of each element in the system exhibit unified holism. (2) Dynamism: It can be divided into external dynamism, internal dynamism, and the dynamism of the innovation process. Changes in the external environment require collaborative innovation entities to continuously adjust their strategic directions and operating modes, enhancing their ability to resist external risks. Due to the non-linear relationship of system superposition among innovation entities in the innovation system, the fluidity of the internal system

enables the optimal allocation of innovation resources and improves their utilization efficiency. During the innovation process, the continuous evolution of innovation stages and the iterative updating and upgrading of innovation achievements enhance the sustainability and development of innovation activities.

(2) Rationality Analysis of Applying Collaborative Innovation Theory to the Innovative Development of Digital Agriculture Empowered by New Quality Productivity

New quality productivity drives agricultural technological revolutions and factor allocation innovations through digital technologies (big data, AI, etc.), achieving production efficiency improvements and green transformations. This process requires multi-stakeholder collaboration: governments provide policy guidance and institutional guarantees, enterprises invest in technological capital to promote application innovation, scientific research institutions provide intellectual support, and farmers participate in practice through technical training. The dynamic evolution characteristic requires entities to continuously track technological frontiers, strengthen cross-domain cooperation, and enterprises need to establish market response mechanisms to optimize product services. Collaborative innovation breaks through the bottlenecks of digital agriculture development through technology-industry-institution integration, forms a sustainable innovation ecosystem, and aids rural revitalization. This model not only aligns with the requirements of new development concepts but also achieves dual improvements in efficiency and quality through systematic resource integration, possessing both theoretical and practical rationality.

2. BASIC SITUATION OF TYPICAL DIGITAL AGRICULTURE DEVELOPMENT IN GUANGXI REGION

2.1. Case Analysis of Hengzhou Digital Jasmine

Hengzhou City, known as the "Hometown of Jasmine in China" and the "World Capital of Jasmine," had a jasmine planting area of approximately 1.28 million mu in 2022, benefiting about 340,000 flower farmers. Its annual jasmine (tea) production accounts for over 60% of the world's total output. The comprehensive output value of Hengzhou's jasmine industry increased from 12.2 billion yuan in 2019 to 15.27 billion yuan in 2022, making it the most valuable agricultural product brand in Guangxi. In recent years, Hengzhou City has taken the opportunity of digital village pilot construction to promote the informationization of the entire jasmine industry chain and create the "Digital Jasmine" 2.0 version, enhancing the digital level of the entire industry chain. Main measures include building a "Jasmine+" industrial cluster, utilizing smart devices to adjust the planting environment, installing intelligent control equipment, applying satellite remote sensing monitoring technology, etc., to achieve precise management, improve production efficiency and product quality, increase farmers' income, and promote industrial upgrading.

2.2. Case Analysis of Qintang Cloud Adoption

To solve the problems of traditional rice planting in Qintang District, Guigang City, Guangxi, and explore the development of smart agriculture, in 2022, the district innovated the "Qintang Digital Agriculture Adoption" model, built a digital village construction and management cloud platform, and established a risk-sharing and benefit-sharing model between farmers and consumers. Main measures include constructing a "Cloud Adoption" smart application scenario, establishing a digital supervision system, building an e-commerce public service and logistics service system, promoting industrial integration, etc., to realize the full-process digital supervision of agricultural products, improve production transparency and product quality, broaden sales channels, and promote local economic development.

3. EXISTING ISSUES IN THE DRIVING EFFECTS OF NEW QUALITY PRODUCTIVITY ON THE INNOVATIVE DEVELOPMENT OF DIGITAL AGRICULTURE

3.1. Disconnection between Policy Support and Grassroots Implementation

Li Caihua and Chen Kaidi (2024) pointed out that in the process of exploring agricultural digital industrialization models and the application of digital agricultural technologies, there is also a lack of effective policy guidance and support, leading to non-optimal resource allocation, poor promotion effects and economic benefits of digital agricultural products, limiting the potential and scale of digital agriculture development, and hindering its progress. In the promotion of the "Cloud Adoption" model and the "Digital Jasmine" platform, the support and implementation of grassroots governments are particularly important. However, currently, some grassroots cadres have insufficient understanding of the importance of new quality productivity and digital agriculture, and policy formulation is unclear or has gaps. For the "Cloud Adoption" model, the Qintang government has not yet issued relevant supporting policy documents. For the "Digital Jasmine" platform, the Hengzhou government has only issued policies on jasmine planting, processing, sales, and investment promotion, such as jasmine planting subsidy programs, tax incentives, land acquisition for investment promotion, and tax incentives for enterprise settlement. However, it has not yet issued policy documents specifically for the construction and development of the "Digital Jasmine" platform. This has resulted in limited support for the "Cloud Adoption" model and the "Digital Jasmine" platform. At the same time, grassroots governments have not fully utilized the policies, leading to a disconnection between policy formulation and implementation, which in turn has restricted the smooth progress of digital agriculture projects such as the "Cloud Adoption" model and the "Digital Jasmine" platform. Although the government has provided certain financial support, it lacks a sense of main responsibility and often "only provides funds but does not contribute effort," failing to form an effective collaborative development mechanism with platform enterprises.

3.2. Mismatch between Technical Equipment and Application Scenarios

Lou Man (2024) pointed out that digital agriculture is the introduction of disruptive technologies and requires continuous innovation support. Despite significant progress in digital agricultural technology, some technical challenges remain to be solved. For example, the stability, accuracy, and durability of agricultural IoT devices need to be further improved; the application of big data analysis algorithms in the agricultural field is not yet mature enough to fully explore and utilize the value of agricultural data; and there is a disconnect between agricultural technology research and development and practical application, making it difficult to widely promote the technology. In the practice of the "Cloud Adoption" model and the "Digital Jasmine" platform, the accuracy and applicability of technical equipment need to be improved. For instance, the cameras in the "Cloud Adoption" model can only provide distant views, unable to meet consumers' needs to observe crop growth up close. The mini-program has deficiencies in order processing and logistics information tracking. For example, the order system lacks an order reminder notification function, causing operators to fail to ship in a timely manner; after shipment, consumers can only receive shipment notifications on the mini-program side and cannot view detailed logistics information such as courier tracking numbers. The intelligent irrigation system equipment in the Digital Jasmine platform also has certain technical defects. Through a questionnaire survey of 67 flower farmers, the vast majority reported that the intelligent irrigation system could not supply sufficient water during peak water usage periods, and the water price was relatively expensive, with high equipment maintenance costs. Some flower farmers indicated that scanning QR codes for water was less convenient than traditional pumping irrigation. The unreasonable setting and consideration of water supply and water prices have greatly affected the effectiveness of the intelligent irrigation system. The electronic scale has not yet uploaded

the transaction coding and identity authentication data of all flower farmers and purchasers, and it is not as convenient as traditional transactions, resulting in fewer transactions using the electronic scale by flower farmers and purchasers. The majority still choose to use traditional scales or weighbridges for transactions.

3.3. Rupture in Capital Investment and Support Guarantees

In the process of empowering the innovative development of digital agriculture with new quality productivity, insufficient funds and high costs have become significant constraints. Hengzhou City faces significant challenges of insufficient funds in promoting the digital transformation of the jasmine industry. Firstly, the water equipment in the fields is inadequate, and the capital chain is broken, preventing farmers from timely maintaining and updating equipment, which affects the irrigation efficiency and yield of jasmine. In particular, high-end equipment required for smart agriculture, such as QR code scanning for water use and integrated water and fertilizer systems, is costly, and farmers cannot afford them on their own. Additionally, although the government has provided certain subsidy policies, such as subsidies for newly planted jasmine and high subsidies for contiguous planting, these subsidies are still insufficient to fully cover the huge funds needed for digital transformation. The expiration of cooperation between the government and Huiyun Information Technology Co., Ltd., and irrigation equipment maintenance companies has also resulted in a lack of stable funding sources for subsequent equipment maintenance and updates. Farmers have to continue relying on natural rainfall or inefficient manual irrigation methods, restricting the improvement of production efficiency. The digital transformation of the jasmine industry is a long-term and complex process that requires a large amount of continuous capital investment to support technological research and development, equipment procurement, system upgrades, and talent cultivation. Taking the digital management pilot base of the Hengzhou Modern Agricultural Industrial Park's jasmine production as an example, although digital management has brought significant yield increases and quality improvements, its high costs have deterred many flower farmers and small and medium-sized enterprises. The introduction of modern equipment such as smart greenhouses, AI yield measurement devices, and integrated water and fertilizer irrigation systems requires not only high initial investments but also considerable subsequent operation and maintenance costs. These costs undoubtedly impose a heavy burden on the transition from traditional agriculture to digital agriculture. However, the current financial situation of Hengzhou City is not yet sufficient to support this enormous funding demand, resulting in severe constraints on the progress and effectiveness of digital transformation.

3.4. Lack of Farmer Participation and Benefit Guarantees

In the promotion of the "Cloud Adoption" model and the "Digital Jasmine" platform, the issue of farmer participation and benefit guarantees has become prominent. On the one hand, some farmers have a relatively indifferent attitude towards participating in digital agriculture, with low willingness to engage in farming, and some are unwilling to abandon traditional farming methods, lacking enthusiasm for participation, leading to obstruction from farmers whose interests are damaged during the promotion of digital agriculture projects. On the other hand, during the land transfer process implemented in the "Cloud Adoption" model, some farmers adopt a wait-and-see attitude, worrying about issues such as low rent after transfer and lack of livelihood security. At the same time, problems such as information asymmetry and uneven benefit distribution in the land transfer process have exacerbated farmers' resistance. In the promotion of the "Digital Jasmine" platform, on the production side, a few flower farmers still express unwillingness to accept the installation of intelligent irrigation systems and are reluctant to have water pipes laid through their land, leading to contradictions and misunderstandings regarding land use rights for pipe laying. The benefit guarantee mechanism for farmers in digital agriculture is still imperfect. Once disputes or losses occur, it is difficult to obtain effective guarantees. On the transaction side, most flower farmers and purchasers have low

willingness to use the electronic scale developed by Guangxi Huiyun Information Technology Co., Ltd., for transactions, with low participation in online transactions, and they still mainly rely on traditional offline transactions.

3.5. Limitations in Consumer Awareness and Acceptance

Li Caihua and Chen Kaidi (2024) believe that due to the "hollowing out" of rural areas, there is a shortage of young and middle-aged rural populations, and the aging population is severe. The elderly have relatively low education levels, slow acceptance of information and intelligence, and low adaptability, which have seriously affected the promotion of digital agriculture development. As an emerging agricultural consumption model, the "Cloud Adoption" model has a relatively narrow audience range and low market acceptance. On the one hand, the consumer group is limited. Although young consumer groups show a certain interest in the "Cloud Adoption" model, most consumer groups still prefer to accept traditional agricultural planting products and hold a wait-and-see or skeptical attitude towards the "Cloud Adoption" model. This has resulted in the actual number of adopters of the "Cloud Adoption" model being much lower than the number of followers. On the other hand, the "Cloud Adoption" model currently lacks effective means to retain consumer groups. Consumers often lose interest after one consumption and lack "repeat customers," which limits the long-term development of the "Cloud Adoption" model. In the market promotion process, the "Cloud Adoption" model has also failed to clearly define its target groups, resulting in a lack of targeted promotion and difficulty in attracting more potential consumers. During the promotion of the "Digital Jasmine" platform, the vast majority of flower farmers only use the mini-program developed by Guangxi Xiangru Yimo Tea Industry Co., Ltd., to view real-time transaction prices in the core market, and their acceptance of other digital agricultural products is low. Many flower farmers have not even heard of electronic scales and only know traditional offline transaction methods. Staff from Guangxi Xiangru Yimo Tea Industry Co., Ltd., mentioned that for pest control lamps and AI pest and disease automatic identification technology, the number of people who understand and use them is even smaller. Only a few flower farmers occasionally upload photos of jasmine pests and diseases through their mobile phones, and the vast majority still use traditional pest and disease control methods.

4. STRATEGIES FOR NEW QUALITY PRODUCTIVITY EMPOWERING INNOVATIVE DEVELOPMENT OF DIGITAL AGRICULTURE

4.1. Policy Support and Implementation

Strengthen the training of grassroots cadres to enhance their understanding of the importance of new quality productivity and digital agriculture and cultivate forward-looking and innovative thinking. Improve the policy system, and the government should issue specific and clear support policies, especially in the areas of the "Cloud Adoption" model and the construction of the "Digital Jasmine" platform, clarifying the direction, standards, and procedures of policy support and filling policy gaps. At the same time, it is necessary to strengthen the operational guidance of policies to ensure that grassroots governments have clear criteria and bases during implementation. Building a service-oriented government does not mean completely letting go; it is also necessary to strengthen the government's sense of main responsibility, establish an effective collaborative development mechanism with platform enterprises, form a close cooperative relationship, not only provide financial support but also actively participate and contribute efforts to jointly promote the implementation of digital agriculture projects and create a mutually beneficial and win-win development situation. Strengthening policy publicity and interpretation to ensure that grassroots governments can fully understand and utilize policies and avoid the disconnection between policy formulation and implementation. Finally, establish a supervision and feedback mechanism for policy implementation to ensure that policies are effectively implemented at the grassroots level.

4.2. Matching of Technical Equipment and Application Scenarios

Increase investment in technological research and development to develop high-precision technical equipment, improve the accuracy of cameras in the "Cloud Adoption" model to meet consumers' needs to observe crop growth up close, and optimize the order processing and logistics information tracking functions of the mini-program. At the same time, encourage technical researchers to go deep into the front lines of agricultural production to understand actual needs and develop more accurate and intelligent technical equipment. It is not only necessary to develop new facilities but also to improve existing digital equipment. For example, for the technical defects of the intelligent irrigation system in the "Digital Jasmine" platform, carry out improvements and optimizations, reasonably set water supply and water prices, reduce equipment maintenance costs, and improve the effectiveness of use. Improve the functions of the electronic scale to ensure the accuracy and completeness of its data upload, enhance the convenience of transactions, and increase the willingness of flower farmers and purchasers to use the electronic scale for online transactions. Optimize the functional design of the "Cloud Adoption" model and the "Digital Jasmine" platform based on the actual needs of farmers and consumers to improve user experience. For other high-cost digital equipment such as intelligent irrigation, policy subsidies, technological innovation, and other means should be utilized to reduce the purchase and maintenance costs of technical equipment and increase farmers' willingness to use them.

4.3. Capital Turnover

Establish a sound capital chain and form a sound mechanism for capital investment, management, and utilization to ensure efficient use of funds and avoid waste and misappropriation. Strengthen cooperation with financial institutions to provide diversified financing channels for agricultural technology promotion and support more farmers and enterprises to participate in technological innovation and application. Establish special funds for agricultural projects to attract more merchants and leading enterprises to invest. Establish special funds for agricultural technology promotion to stimulate new agricultural technology research and development and provide research resources for scientific research teams. Introduce a market competition mechanism to encourage different agricultural technology service providers to participate in competition, thereby improving service quality and reducing service costs. Strengthen the supervision of agricultural technology promotion funds, establish a strict auditing system, and ensure that the flow and use of funds align with predetermined goals. Increase incentives for regions and units that have achieved remarkable results in agricultural technology promotion to encourage more entities to actively invest in agricultural technology promotion work. At the same time, through policy guidance, encourage social capital to participate in the later operations and maintenance of agricultural technology promotion projects to form a sustainable development model. Build a risk assessment system for agricultural technology promotion funds to predict possible financial risks in advance and formulate corresponding countermeasures. Regularly evaluate and provide feedback on the effectiveness of fund utilization and adjust the direction and scale of fund investment in a timely manner based on actual conditions to adapt to changing agricultural technology promotion needs.

4.4. Farmer Participation and Benefit Guarantees

Strengthen publicity and training for farmers to enhance their awareness and participation enthusiasm in digital agriculture and guide them to transform traditional farming methods. Improve the land transfer mechanism to guarantee farmers' rental income and livelihood security after land transfer, reduce their wait-and-see attitude and resistance, and strengthen technical training to help them master new technologies. When carrying out agricultural technology extension work, it is recommended that village cadres take the lead, and extension personnel provide on-site agricultural technical guidance to establish pilot projects that stimulate farmers' interest in participation and create

a good atmosphere for agricultural technology extension. Establish and improve a farmer benefit guarantee mechanism to clarify solutions and safeguard measures in case of disputes or losses. Strengthen communication and coordination with farmers to resolve contradictions and misunderstandings regarding land use rights for the installation of intelligent irrigation systems and pipe laying. Establish an incentive mechanism to reward and support farmers who actively participate in digital agriculture projects and stimulate their enthusiasm.

4.5. Consumer Awareness and Acceptance

Further clarify the target groups of the "Cloud Adoption" model, accurately position the target consumer groups of the "Cloud Adoption" model and the "Digital Jasmine" platform, strengthen targeted publicity and promotion, and improve market acceptance. Innovate marketing methods, utilize new media, social media, and other channels, and adopt diversified marketing methods to enhance the popularity and market acceptance of digital agricultural products. Optimize product functions, improve service quality, and other means to enhance consumers' experience, increase the attractiveness of the "Cloud Adoption" model to consumer groups, increase "repeat customers," and promote the long-term development of the model. Flower farmers are also considered consumers of the "Digital Jasmine" platform. During the promotion of the "Digital Jasmine" platform, strengthen the training and guidance of flower farmers to enhance their acceptance of other digital agricultural products and promote the use of electronic scales, pest control lamps, and AI pest and disease automatic identification technology.

4.6. Infrastructure Construction

Strengthen the integration of technological research and development with actual application scenarios, deeply understand the actual needs of agricultural production, and develop technical equipment that meets user needs. Accelerate the upgrading of technical equipment in the agricultural field to improve the intelligence level of agricultural production. In light of the actual conditions of Qintang District and Hengzhou City, increase investment in infrastructure construction, improve the research and development technology of monitoring equipment, enhance agricultural production conditions, upgrade farmland infrastructure and equipment, and provide support for the development of smart agriculture. Encourage social capital to participate in agricultural infrastructure construction to form a diversified investment mechanism. For smallholder farmers in Hengzhou City, the government can provide certain support policies to help them purchase irrigation equipment, strengthen rural infrastructure construction, and improve the yield and quality of jasmine. Strengthen technological research and development and application to promote the intelligence and modernization of agricultural infrastructure.

4.7. Interactivity among Multi-Stakeholders

Establish an information interaction platform to form an information interaction and communication mechanism among platform parties, governments, farmers, consumers, and other stakeholders to promptly understand the development status and needs of all parties. Strengthen the cooperation mechanism between platform parties and farmers to form a close community of shared interests and jointly promote the development of digital agriculture to achieve information sharing and collaborative operations. Improve the interaction and feedback mechanism between platform parties and consumers to meet consumers' personalized needs. In the "Cloud Adoption" model, strengthen communication between the platform party and Guangxi Mobile Branch to update and optimize the functions of the mini-program in a timely manner. During the promotion of the "Digital Jasmine" platform, enhance the application of data results in the planting and production of ordinary flower farmers outside the park, organize technical personnel to provide production guidance and training to flower farmers, and narrow the information flow gap between flower farmers and the government.

4.8. Improvement of Farmers' Technological Literacy

Strengthen science and technology education in rural areas to improve farmers' technological literacy and skill levels. Through policy support and incentive mechanisms, strengthen the attraction of young and middle-aged rural labor, encourage them to return to rural areas to engage in agricultural production, provide talent support for the development of smart agriculture, and enhance the overall quality of agricultural production personnel. For the elderly in rural areas, carry out targeted training to improve their ability to accept and learn new technologies and help them adapt to the changes brought about by smart agriculture. Strengthen publicity and education for farmers to enhance their awareness and understanding of emerging agricultural business models such as the "Cloud Adoption" model and increase their enthusiasm and initiative for participation. Publicize and promote successful cases of digital agriculture to enhance farmers' confidence in and acceptance of new technologies.

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