

Digital Economy Empowering the Construction of an Agricultural Powerhouse: A Case Study Analysis

Yan Su, Chen Ma, Mingzhi Xu, Xiyan Tong

School of Economics, Anhui University of Finance and Economics, Bengbu, China

Abstract: The deep integration of the digital economy and agricultural powerhouse construction is a key pathway for agricultural modernization. Based on innovation theory, economic growth theory, and industrial convergence theory, this study constructs a theoretical framework for the digital economy empowering agricultural powerhouse construction. Through case studies of Shouguang (smart agriculture), Lishui (rural e-commerce), and Chengdu (digital agricultural industrial park), it analyzes the digital economy's empowering mechanisms in agricultural production, distribution, and full-chain integration. Results show the digital economy empowers agricultural powerhouse construction via four pathways: resource allocation optimization, production efficiency improvement, sales channel expansion, and industrial integration upgrading, with three differentiated models (production-end, distribution-end, full-chain digitization). Key influencing factors include infrastructure, market entity capacity, policy support, and industrial integration foundation. This study proposes region-specific model selection and full-chain digital integration, providing replicable references for agricultural powerhouse construction.

Keywords: Digital economy; Agricultural powerhouse; Smart agriculture; Industrial integration.

1. Introduction

The construction of an agricultural powerhouse is a major strategic task for comprehensively building a modern socialist country, serving as a core support for consolidating the foundation of national security, promoting common prosperity, and achieving comprehensive rural revitalization. From a historical perspective, China, as a traditional agricultural giant, has accumulated thousands of years of farming civilization and formed a unique agricultural development model. However, during the processes of industrialization and urbanization, traditional agriculture has gradually revealed problems such as fragmented production, low efficiency, tightening resource constraints, and short industrial chains, making it difficult to meet the requirements of high-quality development in the new era. From a realistic perspective, China is currently in a period of accelerating changes unseen in a century. External challenges such as the reshaping of the global food security landscape, intensified geopolitical conflicts, and frequent extreme weather events continue to emerge, making ensuring stable and secure supplies of grain and important agricultural products the bottom-line requirement for building an agricultural powerhouse. At the same time, internal contradictions such as imbalanced urban-rural development, sluggish growth in farmers' incomes, and significant pressure on agricultural sustainability have not yet been fundamentally resolved, necessitating a systemic transformation to reshape the driving forces of agricultural development.

The report of the 20th National Congress of the Communist Party of China explicitly proposed "accelerating the construction of an agricultural powerhouse," incorporating it into the strategic layout of building a modern socialist country through Chinese-style modernization. This marks a critical stage in China's agricultural development, transitioning from a "large agricultural country" to a "strong agricultural country." Building an agricultural powerhouse is not simply about pursuing increased output but aims to achieve agricultural modernization as its core goal, focusing on

improving agricultural production efficiency, ensuring the security of agricultural product supply, promoting steady growth in farmers' incomes, fostering agricultural sustainability and comprehensive rural revitalization, and building an efficient, safe, green, and integrated modern agricultural system. This strategic deployment not only points the way for China's agricultural development but also provides broad application scenarios and practical stages for emerging technologies such as the digital economy to empower traditional industries.

As the core engine driving high-quality economic and social development, the digital economy is penetrating all areas of the economy and society at an irreversible pace, offering a new path to overcome traditional agricultural development bottlenecks and promote the construction of an agricultural powerhouse. Currently, the global digital economy has entered a new stage of accelerated innovation and deep penetration. Digital technologies such as big data, the Internet of Things (IoT), artificial intelligence (AI), and blockchain are continuously iterating and upgrading, driving fundamental changes in production methods, industrial structures, and governance models. In China, the digital economy has become a major component of the national economy. The state has elevated the digital economy to a national strategy, continuously improving digital infrastructure, cultivating digital industry ecosystems, and promoting the deep integration of digital technologies with the real economy, thereby laying a solid foundation for the digital transformation of agriculture and rural areas.

The application of the digital economy in agriculture exhibits full-chain, multi-dimensional characteristics: on the production side, models such as smart agriculture and precision agriculture, through IoT sensors, drones, and intelligent agricultural machinery, achieve refined and standardized agricultural management, significantly improving land productivity and resource utilization efficiency; on the distribution side, new business forms such as rural e-commerce, live-streaming sales, and contract farming break down geographical barriers, achieve precise

matching of production and sales, and broaden channels for increasing farmers' incomes; on the service side, agricultural big data platforms, digital finance, and smart weather services provide full-process support for agricultural production and management, effectively reducing market risks and operating costs. These applications of the digital economy not only address pain points in traditional agriculture such as "relying on the weather for harvests," resource misallocation, and information asymmetry but also inject new momentum into industrial integration and value chain upgrading, becoming a key force in advancing the construction of an agricultural powerhouse.

At the same time, the construction of an agricultural powerhouse also provides unique opportunities and space for the development of the digital economy. The complexity and diversity of agricultural scenarios offer rich testing grounds and application scenarios for digital technology innovation; the expansion of rural markets opens up new growth poles for the digital economy; and the deep integration of agriculture and digital technologies has also given rise to emerging digital industries such as agricultural IoT, agricultural big data, and smart agricultural machinery, further improving the industrial ecosystem of the digital economy. It can be said that the construction of an agricultural powerhouse and the development of the digital economy are not a one-way enabling relationship but an organic whole that mutually promotes and co-evolves. Their deep integration will inject strong momentum into the high-quality development of China's economy and society.

Existing studies have mostly focused on the one-way logic of "digital economy empowering the construction of an agricultural powerhouse," extensively exploring the role of digital technologies in promoting agricultural productivity, industrial structure, and farmers' incomes, and have generated relatively rich research results. These studies generally believe that the digital economy can effectively overcome traditional agricultural development bottlenecks, promote agricultural modernization, and provide technical support and industrial momentum for building an agricultural powerhouse by optimizing resource allocation, improving production efficiency, and expanding sales channels. However, existing research pays insufficient attention to the "reverse impact of agricultural powerhouse construction on the development of the digital economy," rarely systematically exploring the two-way interactive relationship and practical pathways between them. On the one hand, most studies treat agricultural powerhouse construction as the application scenario and target of digital economy empowerment, neglecting the positive pulling effect of agricultural powerhouse construction on digital economy development in terms of demand-driven traction, scenario expansion, and institutional improvement. On the other hand, existing research mostly employs quantitative empirical methods, and there is a relative shortage of multi-case comparative studies on how the construction of an agricultural powerhouse drives the development of the digital economy, with no clear analytical framework yet formed for the internal transmission mechanisms of their interaction.

Specifically, current research has three obvious gaps: first, at the theoretical level, a complete theoretical framework for the impact of agricultural powerhouse construction on the development of the digital economy has not yet been constructed, and the internal logic and pathways of their interaction lack systematic explanation; second, at the

empirical level, there is a lack of in-depth analysis of typical regions and typical cases, making it difficult to intuitively demonstrate the actual outcomes and practical models of agricultural powerhouse construction on the development of the digital economy; third, at the practical level, policy recommendations on how to rely on agricultural powerhouse construction to cultivate new growth points of the digital economy and improve the synergistic development mechanism between the two are still insufficiently specific, making it difficult to effectively guide local practice. Filling these research gaps will not only enrich theoretical research in the interdisciplinary field of agricultural economics and digital economy but also provide important practical references for promoting the deep integration of agricultural powerhouse construction and the digital economy in China.

(1). Research on the Construction of an Agricultural Powerhouse

Scholars have conducted extensive research on the connotation, characteristics, and realization paths of building an agricultural powerhouse. In terms of defining the connotation, scholars generally agree that building an agricultural powerhouse is a comprehensive concept covering core dimensions such as food security, industrial competitiveness, sustainable development, and increasing farmers' incomes. Some scholars summarize the characteristics of an agricultural powerhouse as "one foundation, three strengths, one high, and one sufficiency": ensuring the stable and secure supply of grain and important agricultural products as the foundation; strong innovation capacity, competitiveness, and sustainability in agricultural industrial and supply chains; a high level of agricultural modernization; and sufficient resilience and security in agriculture and its related industrial and supply chains. In terms of realization paths, existing research mostly emphasizes strengthening agricultural science and technology support, promoting industrial integration, improving agricultural support and protection systems, and cultivating new types of agricultural business entities, believing that technological and institutional innovation are the core driving forces for building an agricultural powerhouse.

(2). Research on the Digital Economy Empowering Agricultural Development

The integration of the digital economy and agriculture is a hot topic in current research. A large number of studies have confirmed that the digital economy can significantly improve agricultural production efficiency, optimize resource allocation, and broaden channels for increasing farmers' incomes. In terms of production efficiency, digital models such as smart agriculture and precision agriculture, through technologies such as precision irrigation, intelligent pest and disease identification, and yield prediction, effectively reduce production costs, minimize resource waste, and improve the quality and yield of agricultural products. In terms of distribution efficiency, new business forms such as rural e-commerce and live-streaming sales break down geographical restrictions, achieve the matching of production and sales of agricultural products, and reduce distribution costs. In terms of industrial integration, the digital economy promotes the deep integration of agriculture with processing, cultural tourism, services, and other industries, giving rise to new business forms such as rural tourism and agricultural product processing e-commerce, thereby extending the agricultural industrial chain and increasing added value.

In summary, existing research provides a solid theoretical

foundation for this paper but still has obvious shortcomings: first, a one-way research perspective, focusing more on the enabling role of the digital economy on agriculture while neglecting the reverse traction of agricultural powerhouse construction on the digital economy; second, a lack of diversity in research methods, with a predominance of quantitative empirical studies and a relative shortage of case studies and mechanism analyses, making it difficult to reveal the complex logic of their interaction; third, fragmented research content, lacking a systematic framework and pathway analysis of the impact of agricultural powerhouse construction on the development of the digital economy. This paper, based on these research gaps, adopts a two-way interactive perspective, focusing on the positive impact of agricultural powerhouse construction on the development of the digital economy, extracting practical models through multi-case analysis, and providing theoretical support and practical guidance for their synergistic development.

(3). Introduction to the Internal Mechanisms

The positive impact of agricultural powerhouse construction on the digital economy is not direct but drives its penetration in rural areas through three core transmission mechanisms. First, the resource allocation optimization mechanism: aiming at intensive use of agricultural factors, it breaks the inefficient circulation of traditional factors, prompting big data, IoT and other digital technologies to intervene in factor scheduling, thus spawning agricultural data-related digital formats and expanding the digital economy's industrial boundaries. Second, the production efficiency improvement mechanism: its goals for intelligent and refined agricultural production promote the large-scale application of digital technologies and equipment, stimulating the R&D, manufacturing and operation of agricultural digital industries and boosting the digital economy's technological iteration. Third, the sales channel widening mechanism: focusing on agricultural product circulation and farmers' income growth, it promotes digital circulation systems such as rural e-commerce and smart cold chains, driving digital services to rural areas and expanding the digital economy's sinking market. These three interconnected mechanisms form the internal logic for agricultural powerhouse construction to promote the digital economy.

2. Policy Background and Theoretical Hypotheses

2.1. Policy Background

The report of the 20th National Congress of the Communist Party of China first explicitly proposed to "accelerate the construction of an agricultural powerhouse." This major strategic deployment, based on Chinese-style modernization, focuses on coordinated urban-rural development and national stability, serving as the core for the "three rural" work in the new era and guiding China's agricultural and rural modernization. Agriculture is the foundation of national stability; a strong country requires a strong agriculture. As a key to rural revitalization and a strategic choice to address modernization shortcomings, ensure national security and consolidate common prosperity, the construction of an agricultural powerhouse aims at efficient resource use, high-quality production, industrial integration and affluent farmers, building a modern agricultural system.

To implement the major strategy of accelerating the construction of an agricultural powerhouse, the central

government has successively introduced a series of supporting policies, forming a comprehensive and multi-level policy support system: the "14th Five-Year Plan for Promoting Agricultural and Rural Modernization" explicitly proposes to "empower agricultural and rural modernization through digitization," promoting the deep integration of digital technologies with the entire chain of agricultural production, management, circulation, and services; the "Digital Rural Development Action Plan" focuses on the digital transformation of agriculture, deploying key tasks such as smart agriculture construction, improvement of rural digital infrastructure, and upgrading of rural e-commerce; policies such as the "Opinions on Accelerating the Construction of the Rural Express Logistics System" and the "14th Five-Year Plan for Digital Economy Development" further refine the application paths of digital technologies in agricultural factor allocation, agricultural product circulation, and industrial integration, explicitly supporting the R&D of agricultural digital equipment, the construction of digital platforms, and the cultivation of digital talents, providing solid policy guarantees for the digital economy to empower the construction of an agricultural powerhouse.

Currently, China's agriculture has entered a critical stage of transitioning from a scale-quantity type to a quality-efficiency type. The level of agricultural modernization is continuously improving, yet deep structural contradictions still exist: first, low efficiency of factor allocation, with mismatches and poor circulation of core production factors such as land, labor, capital, and technology, constraining the large-scale and intensive development of agriculture; second, relatively extensive production models, with high labor input, high consumption of agricultural inputs, low production efficiency, and insufficient stability of agricultural product quality in traditional agriculture, making it difficult to meet the requirements of high efficiency and high-quality products for building an agricultural powerhouse; third, an incomplete industrial system, with short agricultural industrial chains, low added value, insufficient depth of integration with processing, cultural tourism, services, and other industries, and weak industrial competitiveness; fourth, the urban-rural digital divide has not yet been fully bridged, with insufficient rural digital infrastructure and a shortage of digital talents, limiting the deep application of digital technologies in agriculture.

2.2. Theoretical Hypotheses

As the core carrier of the new technological revolution and industrial transformation, the digital economy, relying on data elements' characteristics and the empowerment of digital technologies like big data, IoT and AI, has become a key driver to solve agricultural development pain points, boost high-quality agricultural development and support agricultural powerhouse construction. By penetrating the entire agricultural chain, it reconstructs factor allocation, production, circulation and industrial patterns, forming a full-chain enabling pathway. Based on this background and needs, combined with the digital economy's enabling logic, this paper puts forward three theoretical hypotheses to support subsequent empirical research and path optimization.

Hypothesis 1: The digital economy optimizes the allocation of agricultural production factors, alleviates factor mismatch, improves factor utilization efficiency, and thus provides factor security for the construction of an agricultural powerhouse.

The foundation of building an agricultural powerhouse is the efficient use of agricultural resources, while the prominent shortcoming of traditional agriculture is the fragmented allocation and supply-demand mismatch of factors. The digital economy, by building an agricultural factor information sharing platform, integrating information on land transfer, labor supply, capital allocation, technology promotion, etc., achieves precise matching and intelligent scheduling of factor supply and demand through big data, AI, and other technologies, breaking down geographical restrictions and information barriers, promoting the efficient circulation of labor, land, capital and other factors, releasing the marginal output efficiency of factors, promoting agriculture from "factor constraint" to "factor empowerment," and consolidating the foundation for large-scale and intensive development for the construction of an agricultural powerhouse.

Hypothesis 2: The digital economy promotes the digital transformation of the entire agricultural production process, optimizes production models, reduces production costs, improves product quality, and thus lays a solid production foundation for the construction of an agricultural powerhouse.

High efficiency and high-quality products are the core requirements for building an agricultural powerhouse, and traditional extensive production models are unable to meet this demand. New production models spawned by the digital economy, such as smart agriculture and precision agriculture, achieve refined control, standardized operations, and intelligent decision-making throughout the entire agricultural production process—from sowing, fertilizing, and irrigation to harvesting, sorting, and warehousing—through IoT sensing devices, intelligent farming equipment, and big data analysis systems. This effectively reduces labor and agricultural input consumption, minimizes resource waste, improves the stability of agricultural product quality, builds a high-yield, high-quality, efficient, ecological, and safe agricultural production system, and consolidates the production support and food security bottom line for the construction of an agricultural powerhouse.

Hypothesis 3: The digital economy promotes the deep integration of agriculture with related industries, extends industrial chains, increases added value, cultivates new business forms, and thus injects lasting momentum into the construction of an agricultural powerhouse.

Building a modern agricultural industrial system is a key task in constructing an agricultural powerhouse, while traditional agriculture has a single industrial structure, short industrial chains, and low added value. As a core link that breaks down industrial boundaries and promotes industrial coordination, the digital economy, through the cross-industrial flow of data elements and cross-border technology empowerment, promotes the deep penetration and cross-border integration of agriculture with industries such as deep processing of agricultural products, rural cultural tourism, modern logistics, and digital services, giving rise to new business forms and models such as rural e-commerce, live-streaming economy, and leisure agriculture. This extends agricultural industrial chains, enriches industrial forms, increases industrial added value, and promotes the transformation of agricultural industrial structure from "single production orientation" to "three-industry integration, value orientation," solving problems such as low industrial levels, insufficient added value, and uneven urban-rural development, injecting lasting momentum into the

construction of an agricultural powerhouse.

3. Research Design

3.1. Variable Description

(1). Core Explanatory Variable: Digital Economy

The digital economy in this paper refers to an economic form with data resources as key production factors, modern information networks as the main carrier, and the integrated application of information and communication technologies and the digital transformation of all factors as important driving forces. In the agricultural field, the digital economy is reflected in the penetration and application of digital technologies throughout the entire chain of agricultural production, management, circulation, and services, including various forms such as agricultural IoT, big data, e-commerce platforms, and smart agricultural management systems.

(2). Explained Variable: Construction of an Agricultural Powerhouse

The construction of an agricultural powerhouse takes the realization of agricultural modernization as its core goal, focusing on improving agricultural production efficiency, ensuring the security of agricultural product supply, promoting steady growth in farmers' incomes, fostering agricultural sustainability and comprehensive rural revitalization, and building an efficient, safe, green, and integrated modern agricultural system.

3.2. Theoretical Foundations

(1). Innovation Theory: Schumpeter's innovation theory emphasizes that technological innovation is the fundamental driver of economic development. The digital economy, through technological innovation and diffusion, promotes the optimization and reorganization of agricultural production factors, giving rise to new production models such as smart agriculture and precision agriculture, breaking through the technological boundaries of traditional agriculture, and injecting innovation momentum into high-quality agricultural development.

(2). Economic Growth Theory: New economic growth theory incorporates knowledge, technology, and human capital into economic growth models, considering technological progress as the core driving factor of long-term economic growth. The digital economy, by improving agricultural total factor productivity and optimizing resource allocation efficiency, pushes the agricultural production function upward, achieving sustained growth of the agricultural economy.

Industrial Integration Theory: Industrial integration theory points out that technological innovation can break down industrial boundaries and promote cross-industry integration. The digital economy promotes the deep integration of digital technologies with the agricultural industry, giving rise to new business forms such as "agriculture + e-commerce," "agriculture + big data," and "agriculture + IoT," extending agricultural industrial chains, increasing value chains, and expanding the space for agricultural development.

3.3. Mechanism Analysis

The digital economy, with data as the core production factor and relying on the deep integration of new-generation information technologies with all aspects of agricultural production and management, breaks through the development bottlenecks of traditional agriculture and promotes high-

quality agricultural development through multi-dimensional effects. The specific mechanism pathways are as follows:

First, resource allocation optimization effect. The digital economy uses big data, IoT and AI to build an intelligent scheduling system for agricultural factors, realizing precise matching and efficient circulation of land, labor and other core factors. It solves the pain points of fragmented allocation and low utilization in traditional agriculture, maximizes factor output efficiency, and supports agricultural powerhouse construction by promoting agriculture from "factor constraint" to "factor empowerment", breaking bottlenecks like low land use efficiency.

Second, production efficiency improvement effect. Digital technologies spawn smart and precision agriculture, realizing refined control and intelligent decision-making in the whole production process. This reduces labor and input costs, minimizes resource waste, improves product quality stability, promotes agriculture from "extensive" to "intensive" production, and provides core production support for agricultural powerhouse construction by enhancing production capacity and ensuring product supply and quality.

Third, sales channel widening effect. The digital economy breaks circulation barriers through rural e-commerce, live-streaming and traceability systems, building a direct origin-to-consumer circulation model. It alleviates information asymmetry, broadens sales channels, reduces costs, increases product brand value, drives farmers' income growth, and consolidates the livelihood foundation for agricultural powerhouse construction, helping transform China's agriculture from a "large producer" to a "brand powerhouse".

Fourth, industrial integration upgrading effect. The digital economy promotes the integration of agriculture with deep processing, rural tourism and other industries, spawning new forms like rural e-commerce and leisure agriculture. It extends industrial chains, enriches forms, enhances industrial added value and competitiveness, promotes the industrial structure transformation, and injects lasting momentum into agricultural powerhouse construction by fostering industrial clusters and improving rural infrastructure.

3.4. Data Sources

The case data in this paper mainly come from: (1) public materials, including government work reports, corporate annual reports, industry white papers, news reports, and academic literature ; (2) field research data, obtaining practical data and operational conditions of case subjects through interviews and questionnaires; (3) third-party data, including e-commerce platform transaction data and statistics from the Ministry of Agriculture and Rural Affairs, to ensure the authenticity and reliability of the case analysis.

3.5. Research Methods

To systematically analyze the positive impact of agricultural powerhouse construction on digital economy development, this study adopts three research methods based on the research theme and core logic. First, the literature review method: it systematically combs domestic and foreign academic literature, policy documents, and research reports on agricultural powerhouse construction, digital economy, and industrial integration, summarizes existing research findings, theoretical consensus, and gaps, clarifies the intrinsic correlation between the two, and lays a solid theoretical foundation for mechanism analysis and theoretical deduction. Second, the case analysis method: typical regions

with remarkable agricultural modernization and mature agricultural digitalization practices in China are selected as cases. Based on their agricultural powerhouse construction practices, it deeply analyzes the implementation paths and effects of the three core mechanisms (resource allocation optimization, production efficiency improvement, and sales channel widening), and verifies the positive promotion effect through multi-case comparison, enhancing the practical persuasiveness of the conclusions. Third, the inductive-deductive method: based on existing theories and literature, it deduces the internal mechanisms and theoretical hypotheses of agricultural powerhouse construction's impact on the digital economy; combined with case practice experience, it summarizes the general laws and practical models of their interaction, and further extracts targeted and operable policy recommendations, realizing the organic integration of theoretical analysis and practical verification.

4. Case Studies

4.1. Case 1: Shouguang Digital Agriculture Demonstration Base, Shandong – Digital Technology Empowering Smart Agricultural Production

(1). Case Background

Shouguang, located in the north-central part of the Shandong Peninsula, is an important vegetable production base and distribution center in China, known as the "Hometown of Vegetables in China". On average, over 17,000 kilograms of vegetables are sold from Shouguang to all parts of the country every minute, forming a whole-industry chain system "from a seed to a good dish". As a benchmark for China's vegetable industry, Shouguang has long been a national leader in facility agriculture scale, variety development, and standardized production. However, traditional vegetable cultivation relies heavily on manual experience, facing problems such as low production efficiency, insufficient resource utilization, and difficulties in quality control. The irrational use of fertilizers and pesticides increases production costs and puts pressure on the ecological environment; the imperfect quality and safety traceability system affects consumer trust. The digital wave has provided a new path for Shouguang to solve these bottlenecks. In recent years, relying on technologies such as IoT, big data, and AI, Shouguang has built a smart vegetable industry base, promoted the digital transformation of the entire agricultural production process, and become a typical example of the digital economy empowering the production side. It was selected as a typical case of smart agriculture by the Ministry of Agriculture and Rural Affairs in 2025.

(2). Practical Applications of the Digital Economy

First, building an agricultural IoT system to achieve precise environmental monitoring and intelligent control. The Shouguang Smart Vegetable Industry Base deploys sensors, intelligent irrigation equipment, and temperature control systems inside vegetable greenhouses to build a real-time monitoring network covering temperature, humidity, light, soil nutrients, and other factors. In Sunjiayi Street, growers can use a mobile phone and an APP to monitor the temperature, humidity, and light intensity inside the greenhouse, and the AI early warning system pushes information on water and fertilizer regulation and pest and disease control. Currently, newly built greenhouses in Shouguang have been upgraded to the seventh-generation

smart IoT “cloud greenhouses,” with an IoT application rate of over 85%, and about 16,000 greenhouses have achieved intelligent management. The seventh-generation smart glass greenhouse integrates more than 120 patents, reduces energy consumption by 50%, and achieves production efficiency three to four times that of ordinary greenhouses. The contribution rate of scientific and technological progress to agricultural growth has jumped to 70%, realizing the transformation from traditional facility agriculture to smart agriculture.

Second, relying on big data platforms to analyze growth data, achieving standardized planting and precise input. Shouguang has built a data analysis and decision support system covering the entire planting cycle, cooperating with more than 40 scientific research institutions and universities to develop the “Shouguang Vegetable Industry Internet Platform.” The platform integrates the planting experience of more than 290 “local experts” and develops the AIMP agricultural big model, transforming the traditional “diagnosing diseases by leaf observation” experience into digital instructions. In the smart greenhouses of Changle County, AI image recognition can accurately identify over 90% of pests and diseases, increasing fertilizer utilization by more than 30%, saving water by 50%, and increasing seedling survival rates from 80% to 95%. Shandong’s facility planting IoT AI intelligent control technology increases water and fertilizer utilization by 40.4%, yields by 15.5% to 31.7%, and reduces carbon emission intensity by 16.7%.

Third, establishing an agricultural product quality and safety traceability system to ensure fully credible traceability. Shouguang has built a full-chain quality and safety supervision platform covering “from field to table.” Through an AI recognition system, it monitors farming activities in real time and issues automatic warnings, achieving GIS positioning of 157,000 greenhouses, more than 1,900 wholesale markets, and more than 1,600 agricultural supply stores. Consumers can scan the QR code to view full-process information such as vegetable variety, planting base, fertilizer and pesticide use, and test reports. The traceability platform conducts over 150,000 vegetable sample inspections annually, gathers more than 10 million pieces of data from the entire industrial chain, and maintains a pass rate of over 99%, making Shouguang one of the first national agricultural product quality and safety counties. Some parks are also exploring blockchain certification technology to build a completely credible agricultural product (track record).

(3). Empowering Outcomes

Digital technology has significantly improved the production efficiency and input-output benefits of Shouguang vegetables. IoT intelligent control has increased output per unit area by more than 20%, labor productivity by 30% to 50%, water resource utilization by 30%, and significantly reduced the use of fertilizers and pesticides. The agricultural product quality traceability system has effectively enhanced brand value, with the selling price of smart-produced vegetables about 15% higher than ordinary vegetables. In 2024, the online retail sales of agricultural products in Shouguang City reached 730 million yuan, a year-on-year increase of 31.5%. Smart agriculture has driven a revolutionary change in production operations, moving from “growing vegetables by experience” to “growing vegetables by data,” greatly lowering the threshold for agricultural production. Shouguang has deeply implemented the strategy of strengthening agriculture with digital technology,

comprehensively promoting the digital upgrading of the entire industrial chain of production, processing, circulation, and services, providing a replicable “Shouguang model” for the transformation and upgrading of modern agriculture across the country.

4.2. Case 2: Lishui, Zhejiang – E-commerce Platforms Broadening Distribution Channels for Agricultural Products

(1). Case Background

Lishui, located in the mountainous area of southwestern Zhejiang, is known as “nine-tenths mountains, half water, half farmland.” It has an excellent ecological environment and produces a wealth of high-quality agricultural products such as tea, edible fungi, bamboo shoots, She herbal medicines, and honey. However, due to structural bottlenecks such as lagging transportation infrastructure and information asymmetry, the sales channels for agricultural products are narrow, and a large number of high-quality agricultural products remain “hidden in the deep mountains and unknown to the world,” making it difficult for farmers to increase their incomes. In Jingning She Autonomous County, more than 700 mountains over 1,000 meters above sea level crisscross the area, and administrative villages with a permanent population of less than 300 account for nearly 80% of the total. The problems of “difficult express delivery into villages and difficult mountain goods out of villages” are prominent. Against the backdrop of the digital economy, Lishui seized the opportunity to promote agriculture through e-commerce, making the development of rural e-commerce a key measure to solve the predicament of mountainous development, and gradually formed a “Lishui rural e-commerce model” with distinctive mountain characteristics, becoming a typical example of the digital economy empowering agricultural distribution.

(2). Practical Applications of the Digital Economy

First, building an agricultural product e-commerce public service platform and establishing a government-led e-commerce service system. The Lishui Municipal Postal Administration, together with multiple departments, issued the “Implementation Plan for Promoting the High-Quality Development of Rural E-commerce Express Delivery in Lishui,” systematically deploying the construction of e-commerce express delivery comprehensive service circles. Longquan City’s Supply and Marketing Cooperative created the “Supply and Marketing e-City” platform, building a county-level agricultural “production, supply, sales, credit” full-link digital public service platform, forming a full agricultural chain service for 19 townships, driving online sales of the seven major industries of “bamboo, tea, mushrooms, vegetables, medicinal herbs, fruits, and bees” to increase by 30 million yuan, boosting the incomes of more than 200 farming households, with an average income increase of over 7,000 yuan per household.

Second, cultivating e-commerce entities and developing new sales models such as live-streaming and short video marketing. In 2025, Jingning County launched the “Hundred Villages, Thousand Livestreams, Ten Thousand Households” campaign, forming agricultural assistance live-streaming teams. Lvcaoyuan Village’s village-broadcasting company created 16 themed live-streaming rooms, bringing together more than 60 young practitioners and providing e-commerce live-streaming training to over 400 people. Jingning explored a digital human live-streaming model to lower operational

thresholds. At the same time, it innovated an integrated model of “passenger, freight, postal services + e-commerce live-streaming,” investing 35 urban-rural buses and 8 postal delivery vehicles to build a logistics network covering 21 townships and 127 administrative villages, increasing logistics efficiency by 40% and reducing costs by 30% .

Third, establishing a standardization system and regional public brands to enhance brand recognition. Lishui focuses on creating regional public brands such as “Lishui Shanshan” and “Lishui Xiangcha,” unifying quality standards and packaging specifications. Longquan’s “Supply and Marketing e-City” provides supporting services such as agricultural product laboratory SC certification and brand service station entry. Qingtian County’s “Village Production, Society Sales” service platform effectively solves the pain points of difficult agricultural product sales, lack of supply sources, and difficulty in tasting fresh products. Suichang County’s “Zheli Rural Customization” platform experience was showcased at the World Internet Conference.

Fourth, relying on big data to analyze market demand and promoting “production according to sales.” Longquan’s “Supply and Marketing e-City” uses full-link data collection to provide farmers with real-time business guidance, achieving a shift from “producing first and then finding a market” to “analyzing the market first and then organizing production”. Jingning coordinated 75 vehicles, built 2 mobile fresh-keeping warehouses, and created 4 “mountain goods out of mountains” service points to unblock production and sales bottlenecks.

(3). Empowering Outcomes

E-commerce channels have effectively broken down the circulation barriers for Lishui’s agricultural products. The “Hundred Villages, Thousand Livestreams” campaign has held 18 live-streaming events, increasing the incomes of farmers in 10 townships by more than 220,000 yuan, with a maximum income of 2,850 yuan per household. The village-broadcasting company achieved sales of 5 million yuan, helping more than 400 farming households solve sales problems and boosting incomes by over 2 million yuan. Jingning’s “passenger, freight, postal services + e-commerce live-streaming” model drove online sales of agricultural products to exceed 8 million yuan. Jinyun’s “mobile convenient co-wealth vehicle” live-streaming project has cumulatively driven agricultural product sales of over 10 million yuan. Live-streaming has brought Lishui’s agricultural products to the whole country, achieving premium sales for special products such as dried bamboo shoots, She herbal medicines, and deep mountain honey. The e-commerce industry has driven the development of supporting industries such as packaging, logistics, and warehousing, creating a large number of rural jobs and attracting young people to return to their hometowns to start businesses. In 2025, the “Mountain Broadcasting Youth Training Camp” launched 9 sessions, focusing on customized training for AI tools in e-commerce talent development. Lishui, adhering to the overall ideas of digital assistance to agriculture, live-streaming enrichment of farmers, and brand promotion of agriculture, continues to promote the quality and efficiency improvement of rural e-commerce, contributing “Lishui experience” to the comprehensive revitalization of rural areas and the construction of a demonstration zone for common prosperity.

4.3. Case 3: Chengdu Digital Agriculture Industrial Park, Sichuan – Full-Chain Digitization Promoting Industrial Integration and Upgrading

(1). Case Background

Chengdu, located in the hinterland of the Western Sichuan Plain, is an important production, processing, and distribution center for agricultural products in western China, with a relatively strong agricultural industrial base. However, traditional agriculture has short industrial chains and low added value, and there are structural barriers in the connection between agriculture and processing, cultural tourism, services, and other industries. Seizing the strategic opportunity of the national push for agricultural digital transformation, Chengdu has built a development model centered on “full-chain digitization” for its agricultural industrial parks, striving to promote the systematic penetration and deep integration of digital technologies in all links of the agricultural industrial chain, becoming a typical example of full-chain integrated digitization for the digital economy to empower the construction of an agricultural powerhouse.

(2). Practical Applications of the Digital Economy

First, building a digital agriculture comprehensive management platform to achieve full-chain data integration and unified control. The industrial park has built a digital agriculture comprehensive management platform covering the entire chain of “production—processing—circulation—services.” Relying on sensor networks, drone remote sensing, intelligent monitoring, and other equipment, it collects real-time data on soil moisture, meteorological environment, crop growth, pests and diseases, and more. The platform constructs a unified data resource pool, using machine learning for dynamic monitoring, trend prediction, and intelligent early warning, providing data-driven decision support for agricultural production and management. This practice aligns with the goal of building a national agricultural and rural big data platform proposed in the “National Smart Agriculture Action Plan (2024-2028)”.

Second, promoting the integration of agriculture with the processing industry and achieving customized product upgrades based on data insights. The park integrates multi-source data from e-commerce platforms and supermarket channels to accurately capture consumption trends. Based on consumer preference analysis, one company developed low-sugar, high-fiber functional fruit and vegetable processed products, successfully opening up a blue ocean market. This “production according to sales” smart processing model avoids product homogeneity and significantly increases the added value and market competitiveness of agricultural products.

Third, promoting the integration of agriculture with the cultural tourism industry and creating digital agriculture experience projects. Relying on the comprehensive management platform, the park has developed immersive digital agriculture experience projects, combining AR/VR interaction, smart farm live displays, and farming culture to form a composite model of “agriculture + technology + tourism.” At the same time, it has developed new business forms such as rural tourism, farming study tours, and agricultural science popularization, expanding the space for agricultural development and achieving cross-border integration of “agriculture as the foundation, tourism as the promoter, and digitization as the enabler” .

Fourth, building an agricultural technology service platform to enhance farmers' digital capabilities. The platform brings together agricultural experts and information technology personnel to provide both online and offline comprehensive services. Online services include smart agriculture equipment operation tutorials, standardized technical solutions, intelligent pest and disease identification, and market prices. Offline services include training courses and expert guidance to help farmers solve practical problems and fundamentally improve their digital literacy.

(3). Empowering Outcomes

Full-chain digitization has increased the agricultural product processing conversion rate in the Chengdu Digital Agriculture Industrial Park by more than 40%, significantly enhancing the added value of the industrial chain. The information barriers between production and processing are broken down, and customized products enter high-value-added niche markets. The integrated development of agriculture and cultural tourism has driven an average annual increase of 25% in rural tourism income, promoting the development of related businesses such as catering, accommodation, and specialty product sales. The digital service system has effectively improved farmers' management capabilities and market competitiveness. Farmers in the park can independently use digital equipment, analyze data, and connect with online channels, forming an integrated development pattern of information sharing, resource complementarity, and value co-creation. Research shows that agricultural and rural digitization increases farmers' incomes by improving production efficiency, reducing transaction costs, and expanding market channels. The practice in the Chengdu park demonstrates the amplifying effect of full-chain digitization. The park provides a replicable "full-chain integrated digitization" model for the western region and the whole country, contributing to the "three-chain integration" development of the agricultural industry chain, innovation chain, and value chain.

5. Cross-Case Comparison and Discussion

5.1. Common Characteristics of the Cases

Through an in-depth comparison of the three typical empowerment practices in Shouguang, Lishui, and Chengdu, several common characteristics of the digital economy empowering the construction of an agricultural powerhouse can be distilled.

First, technology empowerment is the core pathway. All three cases use digital technologies such as big data, IoT, cloud computing, and e-commerce platforms as basic tools, promoting the comprehensive digital transformation of agricultural production, distribution, and management through technological penetration. The core mechanisms of Shouguang's smart greenhouse IoT, Lishui's e-commerce public service platform, and Chengdu's full-chain comprehensive management platform lie in the "information penetration" and "resource allocation optimization" capabilities of digital technology. The development of the digital economy promotes the activation of data elements and achieves the comprehensive digital transformation of agriculture through industrial chain collaboration, a theoretical judgment fully confirmed in the three cases.

Second, full-chain empowerment is the key direction. Although the three cases start at different points, they all aim

for the overall optimization of the agricultural industrial chain. Shouguang focuses on the production end, Lishui on the distribution end, and Chengdu on full-chain integration. However, the role of the digital economy transcends a single link, extending to upstream and downstream links of the industrial chain. Research shows that the digital economy has a significant positive impact on the resilience of the agricultural industrial chain, achieved through pathways such as optimizing the allocation of innovation factors, promoting agricultural industrial agglomeration, and guiding industrial structure upgrading. The digital economy is not just "patching" shortcomings but "reshaping" the resilience and competitiveness of the entire industrial chain.

Third, government guidance is combined with market drive. All three cases reflect the dual-wheel linkage of active government involvement and the release of market vitality. Local policy guidance and basic investment in Shouguang create conditions for the promotion of smart agriculture; explorations of the PPP model and the construction of public service platforms in Lishui provide institutional guarantees; the construction of the industrial park in Chengdu receives government planning support and funding guidance, while business entities within the park carry out diversified innovations driven by market mechanisms. The collaborative pattern of the government "setting the stage" and enterprises "playing the leading role" leverages the advantages of the government in infrastructure and institutional supply while unleashing the decisive role of the market in resource allocation.

5.2. Differentiated Characteristics of the Cases

The three cases have formed differentiated empowerment models based on their respective resource endowments, industrial foundations, and development stages.

The Shouguang case focuses on production-end digitization, using smart agricultural technology to improve production efficiency and product quality. As the hometown of vegetables in China, with an annual output of 4.5 million tons and an annual transaction volume of about 9 million tons, Shouguang has a high degree of scale and specialization, making it suitable for the digital pathway "starting from the land." The outcomes of a more than 20% increase in output per unit area and a 30% increase in water resource utilization rate show that in areas with good production foundations and a high degree of scale, the "production-end digitization" model can efficiently unleash the factor substitution effect of digital technology.

The Lishui case focuses on distribution-end digitization, using e-commerce platforms to solve the problem of agricultural products accessing the market. Located in mountainous areas, Lishui has a clear information gap between high-quality agricultural products and external markets, a typical dilemma of "having good products but no good market." Lishui chose to "break through from the channel," opening a "cloud corridor" from the deep mountains to the national market in the information space. The outcomes of an average annual increase of over 30% in online sales of agricultural products and an average increase of over 2,000 yuan per farming household show that in mountainous areas with restricted circulation conditions, the "distribution-end digitization" model can achieve rapid value chain extension at a relatively low marginal cost.

The Chengdu case focuses on full-chain integrated digitization, using full-industry-chain digitization to promote

industrial upgrading and integrated development. Located on the Western Sichuan Plain with a good foundation for industrial integration, Chengdu chose the “full-chain integration” route, using a comprehensive management platform covering all links as a lever to promote the deep integration of agriculture with processing, cultural tourism, and service industries. The outcomes of a more than 40% increase in the agricultural product processing conversion rate and an average annual increase of 25% in rural tourism income show that in areas with a good industrial foundation and conditions for multi-format integration, the “full-chain integrated digitization” model can achieve a systematic leap in the industrial chain.

These three differentiated pathways demonstrate that there is no “one-size-fits-all” model for the digital economy to empower the construction of an agricultural powerhouse. Localities should choose appropriate entry points and development paths based on their own resource endowments, achieving a stepwise leap from “following” to “running alongside” to “leading.”

5.3. Extraction of Key Influencing Factors

Cross-case comparison identifies four key factors influencing the digital economy’s effectiveness in empowering agricultural powerhouse construction.

First, infrastructure security. The completeness of rural digital infrastructure (network, logistics, storage) directly determines the feasibility and coverage of digital technology applications. With the rural Internet penetration rate reaching 65.6% by 2024, continuous investment is needed to build a secure, ubiquitous, and efficient digital infrastructure base for agriculture and rural areas.

Second, market entity capacity building. Farmers’ and agricultural enterprises’ digital literacy is the micro-foundation for empowerment. Case experiences show continuous training and technical support are crucial. The Ministry of Agriculture and Rural Affairs trains nearly 40 million farmers annually in mobile phone skills, and efforts should continue to address the “digital divide” of “having equipment but not knowing how to use it”.

Third, policy and institutional support. Fiscal funds are irreplaceable for digital agricultural infrastructure, R&D, and public service platforms. In 2025, new digital agriculture bases received provincial subsidies, and the “2025 Key Points for Digital Rural Development” sets a 90%+ 5G coverage target for administrative villages, providing clear policy guidance.

Fourth, industrial integration foundation. A stronger integration foundation between agriculture and other industries brings more significant digital empowerment spillovers. Cases of Shouguang, Lishui, and Chengdu show that digital applications thrive on industrial interaction and division of labor. As a core feature of agricultural powerhouse construction, a sound industrial chain relies on digital technology for “chain value addition”.

6. Research Conclusions and Policy Recommendations

6.1. Research Conclusions

Based on the analytical framework of innovation theory, economic growth theory, and industrial integration theory, this paper systematically explores the differentiated pathways and synergistic effects of the digital economy empowering

agricultural powerhouse construction through in-depth analysis of three typical cases (Shouguang, Shandong; Lishui, Zhejiang; Chengdu, Sichuan), drawing the following main conclusions.

First, the digital economy effectively empowers agricultural powerhouse construction through multiple pathways. On the production side, it realizes refined and intelligent agriculture via IoT, big data, and AI; on the distribution side, e-commerce platforms break information and spatial barriers to enhance circulation efficiency and market competitiveness; at the full-chain level, data flows drive the integration of agriculture with processing, cultural tourism, and services, promoting the industrial chain’s transformation from “chain-like” to “network-like” and “ecosystem”, with more significant empowering effects in the digital-real integration stage.

Second, digital empowerment models for agricultural powerhouse construction are diverse, requiring localities to choose differentiated paths based on resource endowments. Shouguang’s “production-end digitization” suits large-scale and specialized areas; Lishui’s “distribution-end digitization” fits mountainous areas with circulation constraints; Chengdu’s “full-chain integrated digitization” is applicable to regions with sound industrial integration foundations. The key is to identify local strengths and weaknesses to select an appropriate starting point.

Third, four key factors affect empowerment effectiveness: infrastructure (hard foundation), market entity capacity (soft core), policies and institutions (stabilizer), and industrial integration foundation (catalyst). These mutually coupled factors form the systemic ecological conditions for digital empowerment. Promoting agricultural powerhouse construction requires their coordinated advancement to achieve hardware-software synergy, technology-capability alignment, policy-market linkage, and chain-space integration.

6.2. Policy Recommendations

First, consolidate the hardware foundation by upgrading rural digital infrastructure. Increase investment in rural network, logistics, and storage infrastructure, and promote the popularization and upgrading of agricultural IoT, big data platforms, and 5G networks in rural areas, aiming to exceed 90% 5G coverage in administrative villages and raise agricultural production informatization by the end of the “14th Five-Year Plan”. Infrastructure construction should align with land spatial and agricultural industrial planning, catering to current digital transformation needs while reserving space for future technological innovation.

Second, bridge the “digital divide” by enhancing the digital capabilities of agricultural entities. Establish a multi-level digital talent training system to strengthen training for farmers, cooperatives, and family farms, covering smart equipment operation, data analysis, e-commerce application, as well as market, brand, and innovation awareness. Cultivate emerging entities such as rural e-commerce and smart agriculture, and leverage the demonstration effect of “Star Villages” and “Star Farmers” initiatives to optimize the human capital structure of the agricultural labor force.

Third, promote in-depth integration of digital technology with the entire agricultural chain to enhance industrial value. Encourage the full-chain deployment of digital technologies in agricultural production, processing, circulation, and services, breaking information and coordination barriers to

transform the industrial chain from a linear to a networked collaborative system. Foster diversified integration formats such as customized, experiential, and smart agriculture, and promote differentiated experiences of typical regions through demonstration-driven approaches to advance smart agriculture development on a broader scale.

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