

Transformation and Intelligent Development of Traditional Agriculture in the Era of Digital Economy: Pathways and Strategies

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Abstract: This study aims to explore the transformation and intelligent development pathways of traditional agriculture in the era of the digital economy. Through a systematic review of relevant domestic and international literature combined with theoretical analysis, the study examines four dimensions: value chain restructuring, business model innovation, organizational capability reconstruction, and sustainable development. The results indicate that the digital economy is driving the deep integration of agricultural production, circulation, and consumption, fostering diversified business models, and enhancing the capabilities of agricultural actors while promoting green development. Based on these findings, the study concludes that digitalization and intelligent technologies are crucial directions for improving efficiency and upgrading quality in traditional agriculture. Furthermore, enhancing infrastructure, improving farmers' digital literacy, and developing differentiated growth models will be key tasks in the future.

Keywords: Digital Economy; Traditional Agriculture; Intelligent Development; Value Chain Restructuring; Business Model Innovation

1. Introduction

With the accelerated development of the global digital economy, data, information, and intelligent technologies have gradually become important drivers for industrial upgrading and economic growth. The digital economy not only transforms production and lifestyle patterns but also profoundly reshapes the development trajectories of various traditional industries. As a fundamental sector, agriculture cannot avoid the trend of digitalization and intelligence.

Against this backdrop, the transformation of traditional agriculture has become a common focus for both research and practice.

Traditionally, agriculture has relied on natural conditions and human experience, resulting in limited production efficiency, low resource utilization, and insufficient responsiveness to market demand changes. This has made it difficult for agricultural development to balance output, quality, and income. With population growth and rising consumption levels, agriculture must not only meet quantitative demand but also continuously improve in terms of safety, quality, and sustainability. Therefore, the limitations of traditional agricultural models have become increasingly prominent, creating an urgent need to leverage new technologies and models enabled by the digital economy to achieve transformation and upgrading.

Under the impetus of the digital economy, intelligent agriculture has gradually emerged. Internet of Things (IoT) technologies enable real-time monitoring and feedback of farmland conditions, while artificial intelligence (AI) provides scientific support for pest identification and crop growth prediction. Big data analysis assists farmers in making more precise production and sales decisions, and blockchain plays an important role in product traceability and supply chain management. Through these technological applications, agricultural production is gradually moving toward precision, automation, and informatization [1]. This not only improves production efficiency and resource utilization but also reduces environmental costs to some extent, promoting a shift toward green and sustainable agriculture [2].

Meanwhile, the development of digital platforms and e-commerce has expanded the sales channels for agricultural products, allowing farmers and enterprises to reach

consumers directly, reduce intermediary layers, and enhance market competitiveness [3]. The digital economy creates a more open, transparent, and efficient market environment for agriculture, accelerating the integration of traditional agriculture with modern service and manufacturing sectors. As a result, agriculture is no longer merely a “production-oriented” industry but is gradually evolving into a comprehensive ecosystem encompassing production, processing, circulation, and services [4].

In this context, this study aims to explore the transformation and intelligent development pathways of traditional agriculture in the era of the digital economy, focusing on the driving mechanisms from technological, managerial, and market perspectives. By systematically reviewing relevant research findings and practical cases, this paper seeks not only to reveal the internal logic of agricultural digital transformation but also to provide actionable guidance for agricultural enterprises, cooperatives, and technology service providers. Specifically, this research aims to: (1) construct a systematic analytical framework from an academic perspective to deepen the theoretical understanding of agricultural digitalization and intelligence; and (2) offer practical strategies for agricultural enterprises and technology service providers to facilitate industry upgrading and sustainable production. The following section reviews and analyzes existing studies, providing a foundation for theoretical discussion and pathway design.

2. Literature Review

2.1 Digital Economy and Agricultural Development

In recent years, the rapid development of the digital economy has had an increasingly significant impact on agriculture. Previous studies indicate that the digital economy is not only a new economic form but also a driving force capable of profoundly altering resource allocation methods and industrial operation logic [5]. In agriculture, the digital economy facilitates the efficient flow of data, information, and knowledge, enabling the recombination of production factors. This allows agriculture to gradually move away from sole reliance on land and labor and instead leverage information technologies to

improve overall efficiency.

On one hand, big data and information platforms play an important role in agricultural markets. Market forecasts based on data analysis help farmers and enterprises grasp changes in supply and demand in a timely manner, reducing risks associated with blind production. On the other hand, the widespread adoption of internet platforms and mobile payment systems provides more convenient channels for agricultural product transactions, overcoming the geographical and logistical constraints of traditional agriculture, and significantly improving circulation speed and market coverage. Some studies also emphasize that the digital economy contributes to sustainable agricultural development because it optimizes resource allocation and enhances management efficiency, thereby reducing input costs while increasing output efficiency [6].

2.2 Main Practices of Agricultural Digital Transformation

At the practical level, research on agricultural digital transformation has shown diversified exploration directions. From crop management to the supply chain system, digital penetration has become increasingly deep.

In production, IoT technologies are widely applied for real-time monitoring of farmland conditions [7]. For example, sensors collect multidimensional data such as soil moisture, temperature, and light intensity, which are analyzed centrally through cloud platforms to provide scientific guidance for precision fertilization, irrigation, and planting. This not only increases resource utilization but also effectively reduces environmental burdens.

In production management, the popularization of agricultural management software and intelligent systems enables automated farm operations [8]. AI-based decision support systems, for instance, can generate optimized plans for farmers using historical data and real-time monitoring results, thereby reducing losses caused by insufficient experience.

In supply chain and distribution, the rise of e-commerce platforms has significantly shortened the time from farm to table. The

introduction of blockchain technology further enhances traceability, increasing transparency in food safety management [9]. Meanwhile, the digital transformation of rural logistics infrastructure and cold chain technology continues to improve the transport efficiency and quality assurance of perishable products. Overall, practices in agricultural digital transformation indicate that digital tools are not only a means to improve productivity but also a key force for reconstructing the entire agricultural industry chain.

2.3 Application of Intelligent Technologies in Agriculture

Research and application of intelligent technologies are essential for agricultural modernization. Existing literature shows that AI, cloud computing, blockchain, and IoT are gradually penetrating all stages of agricultural production [10].

AI is primarily applied in pest and disease identification, yield prediction, and crop health monitoring. Deep learning-based image recognition can quickly diagnose plant diseases, providing data support for precise prevention and control [11]. AI-driven predictive models analyze climate, soil, and historical yield data to enhance the scientific basis for agricultural decision-making [12].

The development of drones and remote sensing technologies further expands agricultural monitoring capabilities. Drones can cover large areas of farmland in a short time, capturing high-resolution images to help farmers detect pest infestations or water shortages, enabling targeted interventions [13]. The combination of remote sensing and geographic information systems (GIS) also facilitates macro-level management of large-scale agricultural production.

Cloud computing and blockchain applications in agriculture have also received widespread attention. Cloud platforms enable more efficient storage and processing of agricultural big data, advancing informatization [8]. Blockchain, with its decentralized and tamper-proof features, provides reliable support for agricultural product traceability and supply chain management, enhancing consumer trust [14]. In general, the application of intelligent

technologies not only improves production efficiency and food safety but also provides new opportunities for extending and upgrading the agricultural industry value chain.

2.4 Limitations of Existing Research and Future Directions

Despite rich contributions, existing studies on the relationship between the digital economy and agriculture have several limitations. First, most research focuses on the application of individual technologies and lacks a systematic study of the overall integration pathways between digital economy and agriculture. Such fragmented research makes it difficult to reveal the deeper logic and sustainability mechanisms behind agricultural digital transformation. Second, current literature pays little attention to differences among agricultural actors. Smallholders, due to limited capital and technical resources, often struggle to afford high-cost digital equipment, whereas large agricultural enterprises possess stronger technological and financial advantages. This disparity leads to uneven digital transformation, which remains insufficiently explored in research.

Moreover, the analysis of agricultural organization, business models, and value chain restructuring is still weak. How to achieve a transformation from “production-oriented” to “value-oriented” agriculture under the digital economy requires further exploration. Some scholars suggest that future research should adopt an interdisciplinary perspective, integrating economics, management, information science, and agricultural science to build a multidimensional analytical framework. Additionally, more attention should be given to the social impacts of digital transformation, such as rural employment structure, income distribution, and urban-rural gaps. Only with a comprehensive perspective can agriculture achieve genuine transformation and intelligent development in the digital economy era.

3. Theoretical Analysis

3.1 Value Chain Restructuring Perspective

Driven by the digital economy, the agricultural

value chain is undergoing deep restructuring. Traditional agricultural value chains often exhibit a disconnection between production and consumption, with delayed information flow leading to supply-demand mismatches and inefficiencies. The introduction of digital platforms significantly shortens the hierarchical structure of the value chain, enabling real-time information exchange across different stages. For example, data analytics tools on e-commerce platforms can feedback consumer preferences and purchasing habits to the production stage, helping farmers scientifically plan crop structures and avoid overproduction and resource waste. The application of blockchain technology further enhances value chain transparency by establishing traceable systems that ensure product quality and safety, strengthen consumer trust, and increase the added value of agricultural products. Consequently, the agricultural value chain is shifting from a “production-driven” model to a “demand-driven” model, gradually evolving toward efficiency, transparency, and data-driven operations.

3.2 Business Model Innovation Perspective

In the context of the digital economy, agricultural business models are increasingly diversified and innovative. On one hand, traditional sales systems dependent on intermediaries are gradually being replaced by emerging models such as e-commerce platforms, live streaming sales, and community group buying, promoting “direct-from-farm” and “point-to-point” transactions. On the other hand, the rise of agricultural service platforms provides farmers with comprehensive services including financial support, insurance coverage, and technical consulting, transforming agriculture from a single production activity into a complex industrial system. Cross-industry integrated business models are also emerging. For instance, combining agriculture with leisure tourism, dining, and experiential consumption not only expands the market value of agricultural products but also adds cultural and experiential attributes to agriculture. Essentially, these innovative models leverage the digital economy to reduce transaction costs, enhance market matching efficiency, and strengthen the overall competitiveness of the agricultural industry through platformization and ecosystem development.

3.3 Organizational Capability Reconstruction Perspective

Agricultural digital transformation relies not only on external technological empowerment but also on the reconstruction of internal organizational capabilities. For smallholders, limited capital and technical capacity often place them at a relative disadvantage in the digitalization process. Cooperatives and leading agricultural enterprises play a bridging role by integrating resources, sharing technology platforms, and establishing training mechanisms to help smallholders participate in digital development pathways. For large agricultural enterprises, organizational capability reconstruction is reflected in the digital upgrading of internal management, including intelligent production management systems, visualized supply chain scheduling, and enhanced data analysis capabilities. This capability reconstruction enables agricultural actors to respond agilely and innovate continuously in complex and dynamic market environments, thereby improving overall adaptability and resilience.

3.4 Sustainable Development Perspective

Agricultural digital transformation emphasizes not only efficiency and profitability but also ecological sustainability. The application of intelligent agricultural technologies promotes the adoption of green production methods. For example, precision fertilization and irrigation techniques reduce input waste and effectively lower environmental pollution; sensor- and AI-based agricultural environment monitoring systems can adjust water and soil resource usage in real time, improving resource efficiency. The use of drones and remote sensing technologies in large-scale farmland management also provides technical support for energy saving and emissions reduction. Meanwhile, agricultural circular utilization models are emerging, such as converting crop residues into bioenergy or organic fertilizers, achieving the reuse of agricultural waste. These intelligent and green production methods not only optimize resource allocation but also enhance the sustainability of agriculture, laying a foundation for long-term stable development.

4. Conclusion

This study systematically explores the transformation and intelligent development

pathways of traditional agriculture in the era of the digital economy from four perspectives: value chain restructuring, business model innovation, organizational capability reconstruction, and sustainable development. The findings indicate that the deep involvement of the digital economy is gradually reshaping the operational logic of traditional agriculture and injecting new vitality into its development. First, in terms of the value chain, the application of technologies such as big data, blockchain, and IoT has enabled closer integration of production, circulation, and consumption, optimizing resource allocation and improving market responsiveness. Second, regarding business models, the rise of e-commerce, social platforms, and agricultural service platforms has broken traditional channel limitations, allowing agricultural products to quickly reach the market and promoting extension and diversification of the industry chain. Third, in terms of organizational capability, agricultural actors face higher technical and managerial requirements in the digital context. Smallholders enhance competitiveness through cooperative mechanisms, while large enterprises achieve intelligent management through data-driven approaches, collectively improving industry adaptability and risk resilience. Finally, from a sustainable development perspective, digitalization and intelligent applications enhance the efficiency of agricultural resource utilization, promote green and refined development, and provide a foundation for the long-term healthy growth of the industry. It should be noted that agricultural digital transformation still faces several challenges, such as uneven infrastructure, insufficient digital literacy among farmers, and data security concerns. Future research should adopt an interdisciplinary perspective to systematically explore the mechanisms of agricultural digital development and propose differentiated pathways for different types of actors. Additionally, drawing on international experiences while integrating local practices can help develop more actionable models for agricultural digitalization. Overall, the digital economy provides new opportunities for the transformation and intelligent development of traditional agriculture. By continuously optimizing the value chain, innovating business models,

reconstructing organizational capabilities, and promoting green production, agriculture can achieve improvements in efficiency and quality, moving toward a more intelligent, efficient, and sustainable development path.

Future research should deepen in three directions: (1) strengthen interdisciplinary studies by integrating theories and methods from economics, management, information science, and agricultural science to build a systematic analytical framework; (2) focus on the differentiated needs of various agricultural actors and propose more targeted digital and intelligent transformation pathways; and (3) actively draw on international experience and combine it with local practices to explore development models suited to regional characteristics.

The digital economy is bringing entirely new development opportunities for traditional agriculture. Through the continuous optimization of value chains, business model innovation, organizational capability reconstruction, and promotion of sustainable development, agriculture can not only improve production efficiency and quality but also balance social and ecological benefits, achieving high-quality and sustainable comprehensive upgrading in the era of the digital economy.

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