Development Economics of China
2026, VOL. 10, NO. 3, 52-54
DOI: 10.47297/wspdecWSP2515-797310.20261003

Construction and Optimization of Agricultural Supply Chain Ecosystem

Xiuqing Wang

Tianjin Agricultural College, Tianjin, 300384, China

ABSTRACT
The global agricultural supply chain currently faces systemic challenges such as severe information asymmetry, low circulation efficiency, and persistent difficulties in ensuring product quality and safety. These multi-dimensional issues not only hinder the healthy development of market mechanisms but also significantly affect the overall growth of the agricultural industry and the stability of farmers' income. As the backbone of rural economies, the inefficiency of traditional supply chains often results in high post-harvest losses and diminished value addition. This paper aims to construct a robust and efficient agricultural supply chain ecosystem to address these structural challenges and promote holistic, sustainable agricultural development. By integrating digital technologies and ecological management principles, the proposed ecosystem can enhance circulation efficiency, ensure end-to-end quality and safety, and support industrial upgrading. Ultimately, this framework contributes to the realization of agricultural modernization and provides a strategic pathway for rural revitalization and income growth among primary producers.

KEYWORDS
Agricultural supply chain; Supply chain ecosystem; Efficiency; Quality and safety; Sustainable development

1 Introduction

Introduction In the context of 21st-century globalization and the rapid acceleration of the digital economy, the construction and optimization of agricultural supply chain ecosystems have emerged as critical research topics. As global food systems face pressure from population growth and climate change, the traditional linear supply chain model is proving inadequate. With significant advances in digital technology and growing consumer scrutiny regarding food safety, provenance, and environmental sustainability, supply chain management in agriculture is undergoing a rapid and fundamental evolution. The core challenge for modern researchers and policymakers is determining how to build an efficient, sustainable, and secure agricultural supply chain ecosystem—a task that has become a focal point at the complex intersection of agricultural economics, industrial engineering, and digital ecology [1].

Building and optimizing such ecosystems is far more than a simple technical upgrade; it is a complex socio-economic problem that requires a multi-stakeholder approach. The process involves a highly fragmented series of stages, including production, processing, storage, specialized transportation (such as cold chain logistics), and final distribution to the end consumer. Each stage requires a holistic planning approach to mitigate risks and maximize value creation. Furthermore, environmental and social considerations have become critical benchmarks for success. For instance, stakeholders must reconcile the tension between maintaining high agricultural output and quality while minimizing the environmental footprint of intensive farming and logistics. Simultaneously, the system must balance meeting sophisticated consumer demands with protecting the fundamental interests and livelihoods of smallholder farmers.

Previous studies have explored these issues from different perspectives. Some focus on supply chain management, investigating how improvements in coordination and processes can enhance efficiency and effectiveness. Others adopt an ecological perspective, examining how sustainable agricultural practices and traceability technologies can support a resilient supply chain [2,3]. These studies provide valuable theoretical and practical guidance for understanding and addressing the challenges in constructing and optimizing agricultural supply chain ecosystems.

2 Definition and Characteristics of Agricultural Supply Chain Ecosystems

An agricultural supply chain ecosystem is a complex network composed of interconnected enterprises, value chains, information flows, capital flows, and logistics flows. It integrates producers, processors, distributors, retailers, service providers, consumers, and regulatory authorities into a closely linked organic whole. Enterprises and stakeholders within the ecosystem coordinate closely through value creation, information interaction, resource complementation, and interest sharing to achieve overall system efficiency and maximize collective value.

The ecosystem exhibits self-organization, self-regulation, and adaptability, enabling enterprises and participants to respond to market changes, policy adjustments, and external risks in a timely manner. Self-organization allows the system to form a stable operation order spontaneously without excessive external intervention. Self-regulation helps balance supply and demand, restrain vicious competition, and maintain stable operation. Adaptability supports continuous evolution and upgrading as technology and markets develop. Information sharing allows all nodes to monitor real-time supply chain dynamics, grasp production, circulation, and demand status, and adjust operation strategies accordingly. Additionally, the ecosystem is open and collaborative, facilitating resource sharing, technology exchange, and business

integration across different enterprises and sectors. It maintains material, energy, and information interaction with the external environment to continuously absorb new opportunities and enhance vitality. These characteristics work together to significantly enhance the operational efficiency, risk resilience, and long-term sustainability of the agricultural supply chain.

3 Literature Review on Construction and Optimization of Agricultural Supply Chain Ecosystems

3.1 Smart Supply Chains

Recent studies on smart agricultural supply chains focus on their development trends, evolution logic, and operational models. Digital technologies enable diversified supply channels, real-time information flow, and rapid demand response across procurement, storage, production, transportation, and sales, benefiting farmers, logistics providers, retailers, and consumers while achieving Pareto-efficient resource allocation.

The transformation to smart supply chains is driven by both data and market factors: data-driven approaches link consumer, supplier, and producer data to form a closed-loop data system, generate accurate insights through analysis and mining, and optimize the decision-making and operation of the ecosystem. While market-driven approaches prioritize consumer demand orientation, take personalized and diversified needs as the guidance, and efficiently deliver value across the chain. Common models in current research include chain-dominant, platform-based, ecosystem-based, and smart supply chain models. Among them, smart supply chains typically adopt a pull-based operation mode driven by terminal demand, rather than the traditional push-based mode dominated by production, which can better avoid overcapacity and inventory backlog. However, existing research mainly emphasizes system construction and technology application, but often lacks a complete macro-level perspective on long-term development trends, dynamic operation mechanisms, practical challenges and landing implementation pathways.

3.2 E-Commerce Supply Chains

The rise of e-commerce platforms has broken the geographical and channel limitations of traditional agricultural product circulation, greatly expanded sales channels, promoted the large-scale operation, standardized production and quality improvement of agricultural products, and provided new momentum for the transformation of agricultural supply chains. Omnichannel integration in e-commerce supply chains further supports standardized, intensive and efficient operations, which is driven by consumer-centric processes and service-oriented organizational models.

Technologies such as Radio-Frequency Identification (RFID), barcode scanning, and IoT-based traceability systems have been widely applied in agricultural e-commerce supply chains, enabling automatic identification, real-time monitoring, data recording and full-chain quality control of agricultural products [4]. These technologies effectively reduce information asymmetry between producers and consumers, shorten circulation links and transportation time, minimize loss and damage in the circulation process, help the market establish a fair and reasonable "quality-for-price" mechanism, and support efficient coordination and resource sharing across channels.

At present, traceability systems are increasingly applied in single- and dual-channel fresh produce supply chains [5], which is of great significance to ensure the safety and freshness of products. Relevant research mainly focuses on three directions: loss reduction in circulation, basic system principles and real-time functional optimization [6,7], providing a theoretical basis for the construction and application of traceability systems in agricultural e-commerce.

3.3 Omnichannel Supply Chains

In the context of digital consumption, delivering safe, high-quality and fresh agricultural products to consumers quickly and conveniently has become the core goal of supply chain construction. However, in practice, many agricultural product supply chains still have the problems of weak channel integration, fragmented information islands, inefficient demand response, high comprehensive operation costs and frequent quality and safety risks. Therefore, strengthening the deep integration of omnichannel supply chains has become an important direction of current research.

It is worth noting that research on omnichannel integration specially targeting the agricultural field is still limited. Most studies focus on the manufacturing or retail sectors, and there is a lack of targeted exploration for the characteristics of agricultural products such as perishability, seasonality and decentralized production. Full integration of agricultural omnichannel supply chains involves the coordinated connection of multiple channels such as physical stores, mobile apps, social platforms and community group-buying, as well as the synchronous and efficient operation of information flow, logistics flow and business processes.

Compared with traditional single-chain structures, omnichannel supply chains facilitate full data sharing, more seamless alignment with real consumer demand, closer integration of production and sales, and significantly lower transaction costs. It supports the construction of a consumer-centric, data-driven and highly flexible supply network, which provides an important reference for the high-quality development of agricultural supply chain ecosystems.

4 Proposed Solutions

The construction and optimization of agricultural supply chain ecosystems can be approached from several perspectives:

First, establishing an integrated information-sharing platform is crucial. Such a system enables real-time communication across the supply chain, improving transparency, coordination, and reducing information delays and asymmetry. It connects producers, processors, logistics providers, retailers, and consumers on one unified system, making production plans, inventory levels, logistics status, and market demand visible to all eligible participants. Big data and artificial intelligence can further support data analysis and decision-making, such as demand forecasting, risk early warning, and intelligent scheduling, to enhance the overall operational efficiency of the ecosystem. Second, optimizing the logistics network is essential. Proper planning of distribution nodes and transport routes can lower costs, shorten delivery times, and improve reliability. Reasonable layout of warehouses, cold chain facilities, and distribution centers helps reduce unnecessary loading/unloading and long-distance transit. Multimodal transport combining road, rail, and waterway options can enhance efficiency and flexibility, especially for cross-regional and large-volume transportation of agricultural products, thus reducing circulation loss and improving product freshness. Third, ensuring quality and safety throughout the supply chain is key to stability. Implementing a comprehensive management system and monitoring production, processing, storage, and transportation stages ensures compliance with standards and regulations. Full-process supervision helps eliminate potential risks and prevent unqualified products from entering the market. Technologies such as IoT and blockchain can enable full traceability and strengthen trust in product quality [8], allowing consumers and regulators to verify source, process, and circulation information quickly and accurately.

Finally, fostering collaboration across enterprises and departments enhances ecosystem performance. Cooperative mechanisms and third-party support can facilitate resource integration, information sharing, and risk management. Closer cooperation between upstream and downstream entities helps stabilize supply relationships, balance benefit distribution, and improve the resilience of the whole chain against market fluctuations and emergencies.

In summary, an effective agricultural supply chain ecosystem requires coordinated efforts in information sharing, logistics optimization, quality assurance, and collaboration to improve efficiency and sustainability.

5 Conclusion

Building and optimizing agricultural supply chain ecosystems is a complex process involving production, processing, distribution, and sales. Environmental, economic, and social factors must be considered to ensure stability and long-term sustainability. Coordination across all stages is critical to enhance overall efficiency. Optimization is an ongoing process that should adapt to market changes and technological advances. Methods such as information systems, management practices, and engineering solutions can improve transparency, flexibility, and responsiveness. With continuous technology iteration and demand upgrading, the agricultural supply chain ecosystem needs dynamic adjustment rather than static solidification, so as to maintain high efficiency in different market environments. Farmer participation is also essential, as their engagement and protection directly affect supply chain stability. Policies and implementation strategies should consider farmers' interests to encourage active collaboration. Supporting smallholder farmers with digital tools, training, and fair benefit-sharing mechanisms will help them better integrate into the modern supply chain and share the value-added gains. Finally, this field requires interdisciplinary research, integrating insights from economics, supply chain management, and ecology, to better address challenges and support the development of resilient and efficient agricultural supply chains. Future studies can further combine digital technology, institutional economics and circular agriculture theory to explore more standardized, replicable and scalable construction paths, so as to provide stronger theoretical support and practical guidance for global agricultural modernization, food security and rural revitalization.

About the Author

Xiuqing Wang holds a master's degree and specializes in agricultural product marketing.

References

[1] Marchese A, Tomarchio O. A Blockchain-Based System for Agri-Food Supply Chain Traceability Management. SN Computer Science. 2022, 3:279.

[2] Demestichas K, Peppes N, Alexakis T, Adamopoulou E. Blockchain in Agriculture Traceability Systems: A Review. Applied Sciences. 2020,10(12): 4113.

[3] Bosona T, Gebresenbet G. The Role of Blockchain Technology in Promoting Traceability Systems in Agri-Food Production and Supply Chains. Sensors. 2023,23(11):5342.

[4] Ha OK, Song YS, Chung KY, Lee KD, Park D. Relation Model Describing the Effects of Introducing RFID in the Supply Chain: Evidence from the Food and Beverage Industry in Republic of Korea. Personal and Ubiquitous Computing. 2014,18:553–561.

[5] Tagarakis AC, Benos L, Kateris D, et al. Bridging Gaps in Traceability Systems for Fresh Produce Supply Chains: Overview and IoT Integration. Applied Sciences. 2021,11(16):7596.

[6] Bottani E, Bertolini M, Rizzi A, Romagnoli G. Monitoring Fresh Food Supply Chain Through RFID. International Journal of RF Technologies. 2017, 8(1-2):33–55.

[7] Menanno M, Savino MM, Accorsi R. Digitalization of Fresh Chestnut Fruit Supply Chain Using RFID. Applied Sciences. 2023,13(8):5086.

[8] Arvana M, Rocha AD, Barata J. Agri-Food Value Chain Traceability Using Blockchain Technology: Portuguese Hams' Production Scenario. Foods. 2023,12(23):4246.