

Supply Chain and Logistics Optimization Strategy of Fresh Agricultural Products in the Internet Era

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Abstract. This study investigates logistics and retail optimization strategies for fresh agricultural products in the internet era, establishing an efficient and sustainable digital supply chain system. Based on the systematic summary of previous research and cases, this paper points out the problems in the current supply chain operation system of fresh agricultural products and proposes solutions. Through literature review, case studies, quantitative analysis, and system simulation, it examines existing challenges, including data silos, high loss rates, and cold chain disruptions, while exploring digital technology applications, a collaborative optimization framework encompassing production, warehousing, transportation, and sales, providing theoretical foundations and practical guidance for industry transformation. This research demonstrates that the application of technologies such as IoT and blockchain can significantly reduce product loss rates in supply chain transportation, enhance operational efficiency, and improve consumer shopping experiences. Future research will focus on advancing smart cold chain systems and supply chain finance to drive the sustainable development of fresh agricultural products toward greater efficiency, transparency, and universal applicability.

Keywords: Agricultural Products, Supply Chain, Optimization Strategy, Logistics.

1. Introduction

Fresh agricultural products are perishable, have a short shelf life and are difficult to transport. The loss of traditional supply chain transportation is high. At present, the loss rate of production and circulation of fresh agricultural products in China is as high as 18%-25%, much higher than the average level of 5%-8% in developed countries.

With the rapid advancement of internet technology, the deep integration of digital technologies with traditional agriculture has introduced innovative solutions to address current shortcomings in fresh produce supply chains. The application of Internet of Things (IoT), artificial intelligence, and blockchain technology is progressively transforming conventional distribution models for agricultural products, enabling precise supply-demand matching while achieving full-process visibility and digital transformation throughout the supply chain.

IoT and blockchain technologies jointly establish a full-process visual supervision system from origin to consumer terminals. By networking sensors across massive systems, IoT enables real-time monitoring of temperature, humidity, and other influencing factors during cold chain transportation, ensuring optimal transport conditions and reducing losses. Meanwhile, big data and Artificial Intelligence (AI) are being applied to optimize logistics solutions, such as route planning and demand forecasting, thereby reducing transportation time and energy consumption. Smart warehousing systems predict demand to minimize inventory buildup and spoilage, significantly lowering cargo loss rates while boosting logistics efficiency. E-commerce platforms eliminate middlemen and information barriers, allowing farmers at the source to access broader markets and substantially increase income. The "Hema Village" model exemplifies this approach, where Hema directly purchases agricultural products from village collectives, enhancing farmers' average income while promoting standardized and branded agricultural development [1].

At the policy level, there has been strong support for the digital transformation of agricultural product distribution systems. Since 2020, the Central No.1 Document has repeatedly emphasized the



development of contract farming and digital production chains. These industrial policies have boosted market confidence and accelerated the widespread adoption of digital technologies in agriculture.

Wang Minhao emphasizes the critical need for supply chain optimization in fresh agricultural products [2]. He argues that data-driven approaches are key to enhancing responsiveness and precision in e-commerce supply chains, with big data prediction models and warehouse optimization effectively reducing inventory loss rates and logistics costs. Ruan Junhu and Han Jiliang propose that an integrated planning model combining order management, e-commerce, wholesale, and retail operations is essential [3]. Their research demonstrates through algorithms that collaborative decision-making can significantly improve overall supply chain efficiency.

The prevailing industry consensus identifies four key trends in supply chain evolution: transparency enhancement, traceability implementation, financial innovation adoption, and sustainable operations. Transparent and traceable systems strengthen product quality control while boosting consumer trust. When unexpected supply chain disruptions occur, digital technologies enable predictive risk assessment and contingency planning. Financial innovation addresses financing challenges in agricultural production. Ultimately, the development of intelligent information systems drives sustainable supply chain management.

2. Analysis of Fresh Agricultural Products Supply Chain and Logistics Retail Status in the Internet Era

2.1. Analysis of Defects in the Traditional Supply Chain

Data connectivity remains inadequate, with data silos being a prominent issue [4]. The fresh produce supply chain involves multiple interconnected stages, yet data exchange between these segments remains inefficient, information transparency is lacking, and overall coordination efficiency suffers [5]. For instance, a major fresh produce supply chain company has long faced challenges, including supplier reconciliation delays of up to 15 days and a 20% order error rate at the retail level.

Cold chain logistics coverage is insufficient. Fresh agricultural products have high requirements on temperature, humidity and transportation time, but the current cold chain infrastructure in China is still weak [6]. Traditional logistics mode has a slow time limit, an unreasonable distribution path and non-standard cold chain management, resulting in a large loss of agricultural products in the process of transportation [7].

Finally, the delivery force is insufficient for the last kilometer. The urban terminal distribution network is uneven in coverage and the rural stations are sparse, which makes it difficult to guarantee the delivery time.

Small farmers have difficulty connecting with the market. At present, China's agricultural production integration is still not high enough; there are a large number of individual small farmers, and agricultural production is still small-scale and decentralized, which limits the modernization process of agricultural products circulation.

2.2. Application of Digital Technology in the Supply Chain

IoT technology enables end-to-end monitoring. By deploying temperature sensors at critical points like cold chain vehicles and warehouses, it provides real-time tracking and recording of environmental conditions. A company implemented sensor systems to collect temperature data in real time. When abnormal fluctuations were detected, the system immediately triggered alerts, significantly improving quality control of cold chain products and reducing complaint rates by 80%.

Blockchain technology ensures traceability and credibility. With its decentralized and highly tamper-resistant nature, blockchain provides robust encryption capabilities, making it an ideal solution for product traceability. Lvwei Smart Agriculture Platform assigns a unique traceability code to each

product. Consumers can monitor the entire production process of fresh produce through this code, significantly enhancing consumer trust.

An artificial intelligence algorithm optimizes the decision-making process. The algorithm can make comprehensive judgments and analysis on historical production and sales data, weather factors, holiday factors, etc., and make adjustments at any time to realize demand prediction and intelligent scheduling.

2.3. Model Innovation and Multi-link Coordination

The integration of production and sales improves the added value. The integration of production and sales opens up the circulation channels of goods in production, transportation and sales. Enterprises such as Hema and Daily Fresh have begun to explore the initial stage of this model. Under this model, the supply chain cost is reduced by about 30%, and the loss rate is reduced by 30%.

3. Supply Chain Optimization Strategy of Fresh Agricultural Products in the Internet Era

3.1. Direct Sourcing and Supply Chain Integration

In view of the current problems in the operation of the fresh agricultural products supply chain, it can optimize and improve from three aspects: direct procurement from producing areas and supply chain integration, upgrading the cold chain logistics system, and digital collaboration transformation and information sharing.

Direct procurement from production areas and supply chain integration streamlines redundant processes, enhancing logistics efficiency and product quality. The contract farming model, driven by market demand through clearly defined procurement agreements, reduces operational uncertainties. For instance, Hema Fresh's collaboration with Jiangsu Haimen in goat farming is projected to achieve annual sales exceeding 15,000 heads. This partnership not only ensures stable sales channels for farmers but also guarantees consistent quality supplies for enterprises.

Directly connecting with the origin of agricultural products and placing orders at the source. In recent years, many e-commerce platforms have directly sourced specialty agricultural products from their origins. For example, Dingdong Maicai's "Xunwei China" program procures specialty agricultural products nationwide, such as placing orders for Yellow River Estuary hairy crabs in Dongying's origin area and introducing air transportation in logistics methods, thereby enhancing market responsiveness.

By streamlining supply chains, reducing intermediaries, and implementing community-based direct sales, it can enhance transportation efficiency. The "Supply Chain + Community Leaders" model, for instance, enables same-day delivery while rapidly expanding market reach, creating mutual benefits for both consumers and farmers [8].

3.2. Upgrade of Cold Chain Logistics System

The unique nature of fresh produce necessitates stringent preservation standards, which imposes high demands on cold chain logistics infrastructure. An effective logistics system should minimize transportation losses, ensure product quality, and maximize distribution coverage. This requires establishing integrated cold chain supply hubs, developing specialized logistics services, and building smart, information-driven systems that combine multiple transportation modes.

At present, some leading enterprises in related industries are increasing their efforts to build comprehensive supply chain centers integrating warehousing, processing and distribution functions. The supply chain operation center established by Hema in southwest China can radiate 60 Hema stores in municipalities and provinces such as Chongqing, Sichuan, Shaanxi and Guizhou, greatly improving the processing and circulation efficiency of fresh products.

Third-party logistics providers play a vital role in the supply chain, delivering specialized and integrated cold chain transportation solutions. Cainiao has developed a comprehensive service model combining "direct procurement from production bases, air-ground intermodal transport, and priority delivery". By establishing cold chain distribution centers at key hub cities, the company ensures prioritized transshipment and distribution of fresh produce.

By integrating multiple transportation modes and implementing intelligent upgrades to supply chain systems, it adapts solutions to local conditions. The approach flexibly combines road, rail, waterway, and air transport according to specific routes. Through an information management platform connected with networked sensors embedded in the cold chain system, it monitors real-time product location and temperature/humidity status, thereby enhancing the efficiency and reliability of cross-border logistics.

3.3. Digital Collaboration and Information Sharing

The development and application of big data, the Internet of Things (IoT), and artificial intelligence have significantly enhanced the intelligence, informatization, and precision of fresh agricultural product supply chains [9]. Enterprises now make data-driven decisions and achieve precise market alignment. Hema uses big data algorithms to classify different locations in the city and open stores of different sizes according to the surrounding population density. At the same time, it combines online ordering and offline shopping, and uses Internet technology to participate in the operation of the supply chain [10].

Digitalization and intelligent systems enable full transparency and visualization throughout the supply chain. Shouheng Group utilizes WeChat Mini Programs to facilitate online order processing, enhancing operational efficiency while achieving precise supply-demand matching. The company implements transparent supply chain management through a digital control center that provides real-time monitoring of cold storage facilities and container statuses.

Develop intelligent supply chain warehousing and distribution management systems. For instance, Hema's Southwest Supply Chain Hub utilizes smart systems to optimize sorting, processing, and delivery operations. Its central kitchen factory is managed through Alibaba Cloud's Digital Intelligence Factory System, which controls processes from production workflows to finished goods storage. Cainiao leverages AI-powered technologies that analyze cargo characteristics and demand patterns to dynamically coordinate logistics elements, including personnel, vehicles, and cargo, thereby enhancing overall operational efficiency.

4. Conclusion

The Internet era has deeply influenced the mode and ecology of the traditional supply chain of fresh agricultural products, making it develop in the direction of digital intelligence and information, improving the core problems such as high loss and low efficiency in the traditional supply chain, and reshaping the whole supply chain system from production to consumption terminal.

The first priority lies in technological advancement and operational innovation, primarily manifested through supply chain integration, innovative order models, digital-physical upgrades for cold chain logistics systems, and full-chain digitization. By adopting direct procurement from production bases and expanding order-based procurement models, intermediaries are eliminated to reduce distribution costs. Demand-driven production ensures smoother farmer-market connections and stable income streams. Industry leaders are establishing integrated supply chain hubs that provide specialized cold chain customization services and multimodal transport solutions. Leveraging big data analytics for precise demand forecasting and marketing decisions, coupled with intelligent management platforms optimizing resource allocation in warehousing and distribution processes, these initiatives significantly enhance overall operational efficiency.

Overall, the aforementioned approach delivers multiple benefits for supply chain optimization: reducing losses and costs, enhancing quality and customer experience, boosting farmers' income, and strengthening supply chain resilience. In the future, fresh agricultural product supply chains will further evolve towards digital intelligence, green development, and globalization. The deep integration of technologies like IoT and AI will continue to enhance supply chain efficiency and smart capabilities. Sustainable operations necessitate promoting green and low-carbon supply chains, while improved cold chain systems will establish material foundations for cross-border and global fresh agricultural product distribution. Internet technologies drive systematic innovation and improvements in models, facilities, and management of fresh agricultural supply chains, successfully building a more efficient, transparent, and risk-resistant modern supply chain system. This ultimately achieves a win-win scenario for farmers, consumers, enterprises, and society.

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