Port Supply Chain Dilemma and Optimization Path of Fresh Agricultural Products in Hainan Free Trade Port

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Abstract: As China's core supply base for tropical fresh agricultural products and a gateway for opening-up, the Hainan Free Trade Port's port supply chain serves as a critical nexus connecting production and sales markets. Current challenges—including limited logistics channels, inadequate cold chain infrastructure, inefficient customs clearance processes, and ineffective coordination mechanisms—have constrained the brand value realization of "Hainan Fresh Products." Leveraging policy advantages of the free trade port and industry research findings, this study proposes targeted optimization strategies across five dimensions: logistics networks, cold chain systems, customs procedures, collaborative frameworks, and policy safeguards. The findings provide theoretical insights and practical support for enhancing supply chain resilience and operational efficiency.

***Keywords*:** Hainan Free Trade Port; fresh agricultural products; port supply chain; cold chain logistics; customs clearance facilitation

1. Introduction

Leveraging its tropical climate and strategic geographical location, Hainan Free Trade Port has become China's key supply base for winter vegetables, tropical fruits, and seafood products during winter, with fresh agricultural exports accounting for 28% of the nation's total tropical fruit exports[1]. As the critical link in "off-island-to-market" distribution and import logistics, the efficiency of port supply chains directly determines product freshness, logistics costs, and market competitiveness.

The policy benefits of zero tariffs and streamlined customs procedures brought by the free trade port initiative have created significant opportunities for upgrading port supply chains. However, inherent limitations of Hainan as an island province, compounded by evolving market supply-demand dynamics, have exacerbated structural supply chain contradictions[2]. As the core hub of the free trade port, Yangpu Port has witnessed sustained growth in imported fresh produce volumes in recent years, yet still faces challenges such as inadequate route coverage and underdeveloped bonded services[3]. This study systematically analyzes the existing bottlenecks in Hainan Free Trade Port's fresh agricultural product supply chain, explores optimization pathways through industry insights, and aims to empower high-quality development of tropical specialty agriculture.

2. Existing Challenges in the Port Supply Chain for Fresh Agricultural Products in Hainan Free Trade Port

2.1 Prominent bottlenecks in logistics channels and elevated comprehensive costs

Hainan's fresh agricultural products face significant dependence on the Qiongzhou Strait maritime transport corridor for island exports, exposing them to "single-path" risks. Firstly, shipping operations in the strait are severely impacted by weather conditions such as dense fog and typhoons, resulting in an average annual suspension of approximately 48 days, which directly leads to stockpiling and spoilage of fresh produce . Secondly, cross-strait transportation costs remain prohibitively high—cold chain freight rates from Haikou to major northern cities exceed inland rail transport costs by over 120%, creating a cost inversion that leaves farmers with "abundant yields but poor harvests" . Although Yangpu Port has launched partial direct routes to Southeast Asia, the limited range of covered products means most specialty agricultural goods still require transshipment, failing to fully leverage the advantages of logistics efficiency and cost-effectiveness.

2.2 The cold chain infrastructure system is weak, with persistently high loss rates

Cold chain infrastructure development lags behind industrial demands: Firstly, field pre-cooling rates stand at merely 60%, significantly lower than the 90% level in developed countries, with some agricultural products lacking initial cooling

treatment . Secondly, there is a capacity gap of 300,000 tons in cold storage facilities, predominantly concentrated around ports, while field cold storage coverage remains below 15%, compromising freshness preservation during the "first mile" phase. Thirdly, outdated cold chain transportation equipment persists, with temperature-and humidity-controlled containers accounting for less than 20% of shipments, resulting in transportation loss rates as high as 25-30%—far exceeding the industry average of 15%.

2.3 Inadequate efficiency in customs clearance procedures and insufficient conversion of policy benefits

The implementation of customs facilitation policies in free trade ports has yielded suboptimal results: Firstly, innovative models such as "two-step declaration" and "consolidated taxation" are adopted by less than 30% of businesses, with some products requiring 3-4 days for clearance—a significant gap compared to the 1-2 day efficiency of domestic advanced ports. Secondly, inconsistent inspection and quarantine standards necessitate repeated testing for imported fresh produce, increasing operational costs for enterprises. Thirdly, bonded processing operations remain underdeveloped, lacking comprehensive services including "bonded sorting, ripening acceleration, and quick-freezing," which prolongs the market availability cycle for fresh goods.

2.4 Inadequate supply chain coordination mechanisms and delayed information alignment

Multiple stakeholders face collaborative barriers: Firstly, information asymmetry in production and sales persists. Farmers' reliance on traditional procurement channels coupled with the absence of market early-warning mechanisms often leads to concentrated product surpluses and sales stagnation. Secondly, insufficient coordination between ports and logistics providers results in inefficient handling processes—including loading/unloading, warehousing, and transportation—when vessels arrive, with average port stay times reaching 8-12 hours. Thirdly, low digitalization levels are evident, as no unified supply chain information platform has been established. Features such as product traceability and temperature/humidity monitoring remain absent, making it challenging to meet food safety traceability requirements.

3. Optimization Path of Port Supply Chain for Fresh Agricultural Products in Hainan Free Trade Port

3.1 Establishing a multimodal transport network to alleviate logistics channel bottlenecks

Establish a "port + route + hub" logistics system: First, increase the frequency of direct flights to Southeast Asia, with a focus on expanding direct routes to production areas such as Thailand, Vietnam, and Indonesia; launch a "Tropical Fruit Dedicated Route" and a "Seafood Express Line," reducing maritime transit time to 2–4 days; Second, optimize transportation operations in the Qiongzhou Strait by implementing "reservation-based transit" and "priority passage" mechanisms, advance preparatory work for cross-strait shipping channels, and establish a multimodal transport network integrating maritime, rail, and road transport; Third, establish distribution hubs in key consumption markets to reduce unit logistics costs through bulk transportation, keeping island outbound freight rates below 0.5 yuan per jin[4].

3.2 Upgrade cold chain facility systems to reduce end-to-end losses

Optimize the end-to-end cold chain system integrating "field pre-cooling + port cold storage + cold chain logistics": First, increase investment in field cold chain infrastructure by constructing small-scale pre-cooling facilities and mobile cooling equipment to achieve a field pre-cooling rate exceeding 85%. Second, expand intelligent cold storage clusters at ports with an additional capacity of 400,000 tons, complemented by value-added services including sorting, ripening, and processing. Third, implement "constant temperature/humidity containers + real-time monitoring" systems using recyclable packaging materials to reduce transportation loss rates below 10%.

3.3 Optimize customs clearance supervision procedures to unleash policy dividends

Deepening the "streamlining administration, delegating powers, and improving services" reform: First, comprehensively implement the "two-step declaration" and "consolidated taxation" models, establish a green customs clearance channel for fresh agricultural products, and reduce average clearance time to 1-2 days; Second, unify inspection and quarantine standards, establish mutual recognition mechanisms for inspection results with Southeast Asian production areas, and minimize redundant testing; Third, leverage Yangpu Bonded Port Area to provide bonded processing services for fresh products, shortening market launch cycles by 3-5 days and reducing processing costs by 30%; Fourth, build a "single window" digital platform to achieve "one-stop online services and seamless customs clearance."

3.4 Establish a collaborative governance mechanism to break down information barriers

Establishing a collaborative framework of "government + enterprises + industry associations": First, develop a supply chain information platform to integrate production, logistics, and sales data, providing farmers with market alerts and price monitoring services. Second, establish the Hainan Fresh Food Supply Chain Alliance by engaging multiple stakeholders to create a shared-interest mechanism and implement the "contract farming + port distribution" model. Third, utilize blockchain technology to build a full-chain traceability system that includes origin data, temperature/humidity records, and inspection/carantine information, thereby enhancing product credibility.

3.5 Improve the policy support system and strengthen supporting capabilities

Establish a comprehensive safeguard mechanism through four key measures: First, establish a dedicated support fund for cold chain infrastructure development, route subsidies, and corporate financing interest subsidies. Second, optimize tax policies by implementing zero tariffs on imported cold chain equipment and preservation technologies, while offering value-added tax incentives to processing enterprises. Third, collaborate with local universities to launch logistics management and cold chain technology programs to cultivate interdisciplinary professionals. Fourth, develop emergency transportation plans to ensure supply chain stability during typhoons, pandemics, and other emergencies.

4. Conclusion

Optimizing the port supply chain for fresh agricultural products in Hainan Free Trade Port is crucial for unlocking the port's opening-up dividends and driving high-quality development of tropical specialty agriculture. Current supply chain challenges—including logistics bottlenecks, inadequate cold chain infrastructure, inefficient customs clearance, and insufficient coordination—stem from lagging facility development and insufficient institutional innovation. By establishing multimodal transport networks, upgrading cold chain systems, streamlining customs procedures, creating collaborative mechanisms, and enhancing policy support, we can effectively boost supply chain resilience and efficiency, reduce logistics costs and loss rates, and strengthen the market competitiveness of "Hainan Fresh Products".

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