

# **Review of Research on the Development of Cold-Chain Logistics of Agricultural Products in China**

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## **Abstract:**

The growth of cold-chain logistics of agricultural products in China has become a central issue from all walks of life. With the constant growth of the economy and the growth in the standard of living, it has become increasingly prominent as a key link to ensure food safety and enhance the added value of agricultural products. Although the acceleration of urbanization and the trend of consumption upgrading have facilitated the rapid growth of the market needs for cold-chain logistics of agricultural goods, the government has accordingly entered a series of support policies to stimulate the application of modern information technology in cold-chain logistics of farm products, compared to developed nations, a significant disparity exists in terms of infrastructure, technical level, and management system in China. Therefore, it has become urgent to enhance the cold-chain logistics of farm produce in China to strengthen infrastructure construction, enhance the degree of data technology utilization, and facilitate the application of new technologies and models. This paper conducts and analyzes the rising status of cold-chain logistics of agricultural goods nationally and internationally, conducts an in-depth analysis of existing problems by existing scholars, finds out the deep-seated reasons behind it, and points out the direction for the continuous improvement and innovative development of cold-chain logistics of agricultural products in China.

**Keywords:** Cold-Chain Logistics; Literature Review

## **1. Comparison of Development Status of Cold-Chain Logistics of Agricultural Products between China and Foreign Countries**

As one of the most populous countries in the world, China's total consumption of agricultural products is very large. Although the turnover of China's cold-chain industry ranks first in the world, there is a certain disparity in the development level of the cold-chain logistics industry compared with advanced countries. The Chinese cold-chain logistics industry started late. Up to the 20th century, cold-chain logistics management gradually attracted people's attention. Although strategies and investments have achieved initial results in logistics, numerous challenges persist, especially in cold-chain logistics of farm produce. The infrastructure and equipment are imperfect, and backward technical conditions and standards also restrict them. This is primarily evident in the following two dimensions.

### **1.1 Backward cold-chain logistics infrastructure of agricultural products**

Because the traffic in most rural areas of China is relatively backward, some remote areas cannot even build the highway. This isolates these areas from the outside world. Even if there are agricultural products transportation routes, problems exist, such as insufficient equipment. In contrast, the rural automobile transportation capacity is relatively low, accounting for only 20% of the total transportation capacity. According to the statistics of relevant departments, due to the lack of special means of transportation in China, the loss rate of perishable goods accounts for 20% of the total trade before delivery in some areas, resulting in huge direct economic losses. Many agricultural products need fresh maintenance to realize their value, and cold-chain logistics is needed to shorten the transportation cycle. This requires cold-chain logistics companies to maintain leading technology in transportation efficiency and processes. As demonstrated in Table 1.

**Table 1 Comparison of Refrigeration Supply Chain between China and the United States**

Region	Pre-cooling preservation rate	Cold storage capacity	The post-harvest loss rate of fruits and vegetable	Cold storage transportation capacity
Domestic situation	Less than 30%	7 million T	25-30%	6,790 refrigerated trucks and 30,000 insulated cars
American situation	80%	The total amount of 2100T	1-2%	160,000 refrigerated trucks and 60,000 insulated cars

Source: The Cold-Chain Logistics Yearbook of China in 2020.

The above table shows that the Chinese cold-chain logistics of farm goods are mainly carried out at room temperature. Besides limited transportation prices, transportation capacity, road conditions, and fresh product technology, many agricultural products rot during transportation, causing huge losses. In addition, the research and application of the Chinese cold chain of agricultural products is dearth. The fresh-keeping rate of pre-cooling equipment in China is less than 30%, and the refrigeration capacity is less than 1/3 of that in the United States. The problem of insufficient refrigerated trucks is serious.

## 1.2 The relatively backward cold-chain logistics infrastructure model of agricultural

## products

With the improvement of marketization, the circulation requirement for contemporary farm products is intensifying. The logistics process of farm products, from the productive activities to the consumption destination, is intricate and multifaceted. However, from farmers to distributors, the circulation mode of many agricultural products is still relatively traditional. The division of markets, supermarkets, and intermediaries in the supply chain leads to excessive additional costs. In some cities, the wholesale market can be divided into two or even multi-level wholesale levels, resulting in logistics costs far higher than production costs. Comparing the main economic indicators of agricultural product logistics at home and abroad, it is found that there is a huge disparity between circulation mode and agricultural products processing and sales mode. As demonstrated in Table 2.

**Table 2 Comparative analysis of main economic indicators of agricultural products logistics between China and developed nations**

	Cost	Loss Rate	Processing Proportion	Processing value-added	Pre-cooling Preservation Rate	Supermarket Sales Proportion
Developed countries	10%	Less than 5%	80%	1:4	80%-100%	80%-95%
China	40%-60%	25%-30%	10%	1: 0.8	about 30%	Less than 30%

Source: The Cold-Chain Logistics Yearbook of China in 2020.

From the comparative analysis of the above table, it is found that there is a huge gap in all aspects of the logistics transportation mode of farm products. Our transportation cost is 4-6 times that of developed countries, and the loss rate is 5-6 times higher. This means that each unit of agricultural product circulation will correspond to higher costs. Regarding the initial processing of farm products in cold-chain logistics transportation, there is a huge loss of our pre-cooling and preservation, serious waste in transportation, low processing proportion, and insufficient processing value-added.

Due to the market supply of agricultural products, it takes

a long process from picking to production and final consumption, which requires reusable storage and transportation tools. At the same time, cold-chain production of agricultural products needs sorting, drying, packaging, anti-corrosion, and other links. However, the deep processing capacity of agricultural products is insufficient, the technical level of additive products is very low, and the backward technical equipment seriously affects the development level of the industry. As a result, it is difficult for China's farm products to change from cold-chain logistics grounded in raw materials to cold-chain logistics founded on agricultural products, seriously affecting the value addition and competitiveness of China's farm produce.

## 2. Analysis of Bottleneck Problems Faced by Cold-Chain Logistics in China

Concerning the gap in the advancement level of cold-chain logistics locally and internationally, many scholars have undertaken thorough explorations into the bottleneck problem of the growth of cold-chain logistics of farm produce in China at present and the underlying factors that contribute to it, from the hardware and software aspects of logistics supply chain infrastructure, transportation mode, standards and regulations, and regulatory measures.

### 2.1 Analysis of infrastructure problems of cold-chain logistics of agricultural products

With the continuous development of the fresh agricultural products market, cold-chain logistics distribution hardware problems are gradually becoming more prominent. It has been discovered that the cold-chain logistics capacity of Chinese farm produce is insufficient, and there are also issues like small inventory, limited machinery and equipment capabilities, and extensive transportation methods.

Yuan (2020) found a huge disparity between the current cold-chain equipment and the market demand by analyzing the logistics distribution of fresh farm produce. Taking Dalian as an example, although Xianyueda has 600 cold-chain transports and advanced GPS positioning and temperature control systems, it remains challenging to fulfill the market demand. Its refrigeration storage equipment is outdated and lacks advanced circulation packaging technology, making it difficult to guarantee fresh agricultural produce throughout the logistics and distribution process. Therefore, it is very important to boost the level of fresh farm products by promoting cold-chain logistics distribution equipment[1]. Through studying the progress of cold-chain logistics and using the methods of data analysis and literature review, Wang (2020) expounded that although the market predicted that cold-chain logistics would develop rapidly. It has not achieved the expected effect in recent years. It has been found that the lack of quantity and low quality of cold storage and refrigerated trucks are the keys to restricting the advancement of cold logistics.

Due to the long construction period of cold storage, large investment, low universality, the long manufacturing period, and the high price of refrigerated trucks, the growth speed of cold-chain facilities in China is far below expectations. This shortage of infrastructure restricts the evolution of cold-chain logistics, making it impossible for government management departments to formulate standards beyond the current conditions to enforce management, further aggravating the difficulty of improving cold-chain infrastructure[2]. Wang (2023) investigated

the present circumstances of cold logistics in China and found that although there is a great demand and a good development foundation, the extent of integration between refrigeration technology and general logistics still needs to be improved. It is suggested that improvement should be made in four aspects: the research of refrigeration preservation technology, the construction of three-level nodes of cold-chain logistics, the investment and use of refrigerated trucks, and refrigeration packaging technology. In particular, it emphasizes the importance of increasing the research on cold storage and preservation technology of fresh farm products and the necessity of building a national core cold-chain logistics facility, a production and marketing cold-chain collection and distribution center, and supplementing the flaws of cold-chain logistics facilities at both ends of production and marketing[3].

The Chinese cold-chain logistics of fresh farm produce are facing multiple challenges, such as equipment shortage, backward technology, and insufficient infrastructure. To improve the level of fresh agricultural products, satisfy market demands, and facilitate the rapid expansion of the cold-chain logistics sector, we urgently need to boost and enhance cold-chain logistics distribution equipment. In addition, we should also strengthen the research and application of cold storage and preservation technology and expedite the construction and upgrading of cold-chain logistics infrastructure.

### 2.2 Analysis of the transportation mode of cold-chain logistics of agricultural products

In the transportation of cold-chain logistics, the three-peak links of loss include “the first kilometer,” “the last kilometer,” and the moment of chain breakage during transportation. These three key links significantly affect the transportation efficiency of farm goods in the whole cold-chain logistics transportation.

1) The problem of “the first kilometer”. The initial key step of the cold chain of farm goods refers to a series of meticulous treatment measures, including but not limited to pre-cooling, careful grading, preliminary processing, proper packaging, and safe storage, to guarantee the level of agricultural goods and extend their freshness. In this process, due to the lack of unified standards and norms, the temperature of goods often gets out of control[4-5]. Xie (2022) pointed out that due to the particularity of cold-chain logistics, professional cold storage equipment and cold storage are needed for storage, which undoubtedly increases operating costs. In the initial stage, if the temperature is not properly controlled, it may lead to the corruption of food or drugs or the reduction of drug efficacy, which will bring huge losses to enterprises[4]. Zhao (2020) studied the cold-chain logistics of farm products

under the background of agricultural structure adjustment and residents' consumption level improvement and found that the cold-chain logistics of agricultural products have made remarkable progress in refrigerated transportation, cold storage construction, and application of new technologies. Meanwhile, driven by the national Belt and Road Initiative and the Internet trend, rural e-commerce and fresh e-commerce have grown fast, highlighting the importance of "the first kilometer" in the circulation of farm goods[5].

The initial key step of the cold chain of agricultural goods is very important to guarantee farm produce's prime mass and freshness. However, due to the lack of uniform standards, the problem of temperature out of control frequently occurs, which increases operating costs and enterprise risks. Under the background of the tune-up of agricultural structure and the improvement of inhabitants' consumption level, the cold-chain logistics of agricultural products have made remarkable progress, highlighting the importance of "the first kilometer" in the circulation of farm produce.

2) The problem of "the last kilometer". This stage mainly involves the distribution and service of consumers. In this link, the planning of distribution routes, the layout of terminal nodes, and the quality of service personnel may also lead to the loss of cold-chain logistics.

Yang (2016) studied "the last kilometer" management of urban cold-chain logistics and found that reasonable network layout, optimization of distribution path, maximum use of vehicles, and selection of appropriate means of transportation can reduce logistics costs and meet the requirements of safety, timeliness, and accuracy. Therefore, "the last kilometer" management of urban cold-chain logistics should ensure basic safety and low-cost standards[6]. He also pointed out that unreasonable distribution route planning may lead to too long distribution time and more difficult temperature control. The unscientific layout of terminal nodes may lead to an increase in distribution distance and increase the distribution cost. The uneven quality of service personnel may also affect the quality of service and may even cause the loss or mismatch of goods[6]. Chen (2017) explored "the last kilometer" distribution status of fresh e-commerce in China. Data analysis found that there were problems such as scarcity of cold-chain resources, uneven distribution of infrastructure, and lack of systematic standards, which led to high loss and high cost of fresh distribution. At the same time, "the last kilometer" distribution also faces challenges regarding timeliness, convenience, information traceability, and degree of sharing [7]. Zhang (2015) believed that although "the last kilometer" problem of logistics was often narrowly understood as a problem at the end of distribu-

tion, it had a wider social attribute. The emergence and complexity of this problem involve many levels, including seven aspects: strategic planning of self-pick-up points, the efficiency of distribution route, optimization of cargo stowage, coordination of various modes of transportation, appropriate choice of transportation tools, coordination among stakeholders and continuous improvement of customer service quality[8].

To sum up, "the first kilometer" and "the last kilometer" in cold-chain logistics are not only the key to ensuring product quality, reducing loss, and improving customer satisfaction but also the research direction that needs to be paid attention to in the future. To overcome these two problems, the industry needs to formulate stricter and unified operating standards and norms, facilitate the innovation and upgrading of cold-chain equipment and technology, optimize the distribution network, and improve the professionalism of service personnel.

3) The chain breakage problem of cold-chain logistics. The chain breakage in the cold-chain logistics of fresh farm products essentially refers to the fact that in the total cold-chain logistics operation process. Because of the lack of cold-chain logistics nodes or equipment and the failure of enterprises and staff involved to follow the strict standards of cold-chain logistics, fresh farm goods are exposed to normal temperature or high-temperature environments at a certain key link or node called chain breakage. In short, cold-chain logistics is discontinuous for various reasons, making it impossible for fresh agricultural products to sustain a constant low-temperature environment throughout the circulation process[9].

Cold-chain logistics of farm goods is a complex system covering many links from production to consumption, including pre-cooling, warehousing, transportation, distribution, retail, and other key links, which are closely linked to guarantee the freshness and quality of farm goods in the whole supply chain [10-11]. The normal operation of this system is very important for ensuring food quality and safety and reducing loss. However, in actual operation, for various reasons, the chain breakage of cold-chain logistics occurs from time to time, which greatly influences the level of farm products and food safety.

In the cold-chain logistics system of fresh farm produce, pre-cooling at the origin is regarded as the most vulnerable link, followed by urban distribution, transportation, warehousing, consumption, and retail. The analysis of the reasons mainly lies in the farmers' lack of understanding of the importance and operational knowledge of pre-cooling, the small and scattered scale of farmers' operation, and the low degree of organization, which leads to the frequent breakage of the cold chain in the initial stage. In addition, the inefficiency of receiving goods, the interruption



of refrigeration by car owners to save costs, the imbalance of cold storage structure, the lack of popularization of cold-chain knowledge among consumers, and the mismatch of fresh-keeping equipment used in supermarkets and small stores have also aggravated the risk of cold-chain logistics breakage to varying degrees. Therefore, in building and managing the cold-chain logistics system, we should not only focus on strengthening the weak links but also comprehensively plug the loopholes to guarantee the whole chain's efficiency, stability, and safety [10].

### 2.3 The cold-chain logistics standards and regulations and regulatory measures and other issues

#### 1) Standard construction of cold-chain logistics system for agricultural products

The cold-chain logistics of agricultural products is a comprehensive field covering a series of technical operation norms and institutional standards, from food safety to environmental temperature control to packaging, transportation, and storage. Although the government has launched a series of technical norms and guiding principles in the cold-chain logistics industry, these norms and standards do not fully cover all aspects of agricultural product logistics. It even includes problems such as imperfect standard systems, insufficient supervision mechanisms, and low standardization levels[10]. What is more serious is that some existing standards are imperfect, making it difficult to effectively implement them in actual operation. This leads to the chain breakage of cold-chain logistics[12]. Yuan (2020) analyzed the cold-chain logistics distribution of local farm products in Dalian and pointed out that the cold-chain logistics distribution of fresh farm products was still in its infancy, with imperfect standards and quality problems. Due to the high delivery cost of cold-chain trucks, over 80% of fresh agricultural products are transported by regular trucks, so it is necessary to formulate stricter cold-chain logistics distribution standards to improve the quality of fresh farm goods[1]. Li (2018) found that although relevant policies and standards have begun to take shape, the standard system is not perfect, the binding force is not strong, and there are obstacles to implementation [11]. Shi (2021) studied the standard system of cold-chain logistics and found that there were many centralized management departments of standards, a lack of unified top-level design, and the coordination and cohesion between standards formulated by different departments needed to be improved. These problems have affected the standardized transportation growth and increased enterprises' operational difficulty. Thus, she called for strengthening communication and cooperation between departments and establishing a unified standard

system to stimulate the healthy advancement of the cold-chain logistics industry[13].

Standardization plays an important supporting and guiding role in standardizing the management of the logistics industry and promoting the high-quality advancement of cold-chain logistics. However, due to the relatively low degree of organization of farm goods production, the small and scattered agricultural production mode leads to the dispersion of agricultural product logistics. Farm products need to transform processing, packaging, transportation, organization, loading and unloading, storage, and other links in the logistics process, which makes the standardization process of farm goods cold-chain logistics face many challenges[12-13]. Chen (2023) pointed out that implementing a standardization system helps improve the service quality of cold-chain logistics, ensuring the food safety of agricultural products and meeting the needs of high-quality development, which is an effective way to upgrade the cold-chain logistics industry[14].

Although normalizing cold-chain logistics of agricultural products faces multiple challenges, such as scattered agricultural production modes and complicated logistics links, its advantages in promoting technological transformation, improving efficiency, ensuring food safety, and promoting industry upgrading cannot be ignored. In addressing issues in standardization transversion, it is necessary to strengthen the leading role of leading enterprises, improve the standardization awareness of employees, and keep an eye on the effect of the whole cold chain. With the modernization of the national governance system and governance capacity, cold-chain logistics standardization will become the crux of facilitating the high-quality growth of the industry.

#### 2) Regulations and supervision of agricultural cold-chain logistics system

In the cold-chain industry of farm products, the phenomenon of "emphasizing construction and neglecting supervision" is not uncommon. The legal guarantee system of fresh cold-chain logistics is not perfect, and the national legal construction in this respect is still in the primary stage. This leads to the lack of a unified and clear legal basis in the industry, leading to much confusion and restrictions. Although the government and enterprises participate together in formulating fresh cold-chain distribution standards, it is difficult to unify the standards due to differences and contradictions among various departments. This situation affects the quality improvement of distribution services, hinders the healthy development of the whole industry, influences the sound growth of cold-chain logistics of farm products, and restricts its progress to a higher quality level[10-13,15].

Rao (2020) studied the legal and management issues of

cold-chain logistics of fresh agricultural products and discovered that the lack of a sound legal basis and effective coordination mechanism led to chaotic and inefficient industry development, resulting in huge losses[15]. Li (2018) pointed out that the regulatory authorities' lack of supervision on refrigerated trucks and temperature control in road transportation led to the ineffective implementation of industry standards. She took the delivery vehicles of community vegetable direct-sale stores in Urumqi as an example to emphasize the traffic safety hazards it brought[11]. Through the research on the traceability management platform of cold-chain food in China, Li (2021) found that several provincial traceability platforms have been established, and data docking has been realized. However, problems remain, such as difficulties in cross-regional platform docking and inconsistent system coding. In addition, the available platform does not overlap the total information management process, just targeting imported cold chain food, which threatens the authenticity and integrity of the data and cannot realize real-time whole process monitoring, creating a latent threat to the healthy and green rounding of cold-chain food[16].

The cold-chain industry of farm goods has obvious shortcomings in legal protection, standard formulation, supervision, and implementation. These problems not only affect the healthy advancement of the industry but also may cause the decline of the level of farm products and the increase of security risks.

### **3. Analysis of the Development Trend of Cold-Chain Logistics of Agricultural Products**

#### **3.1 Innovation of circulation mode to improve infrastructure shortage**

The emerging cold-chain logistics technology has been extensively used in fruit and vegetable products in the past few years. The evolution of this cold-chain logistics technology and the innovation of online circulation mode have profoundly changed the supply and transportation modes of fruit and vegetable products.

Wu (2023) believed that the cold-chain logistics technology of fruits and vegetables has evolved from the traditional mode of "cold storage-refrigerated transportation" to a whole chain cold-chain system including "pre-cooling at the place of origin-low temperature storage-low heat packaging-low heat loading and unloading-refrigerated transportation and distribution-refrigerated sales." This change improves the level and safety of fruits, vegetables, and farm produce and meets consumers' demand for freshness, safety, and diversification[17]. Wang (2023) analyzed the circulation mode of fresh agricultural products

and compared the effects of the traditional wholesale and retail mode with the current online direct selling mode. He pointed out that online direct selling can deliver farm goods to consumers faster, reduce the loss in circulation, and improve the utilization rate of farm products[3].

The transformation of cold-chain logistics mode and the rise of online direct selling mode not only optimize the circulation efficiency of fruits and vegetables and agricultural goods but also extraordinarily enhance consumers' shopping experience. In the future, with the continuous progress of technology and continuous innovation of mode, it can effectively reduce intermediate links, save storage space and capacity, greatly alleviate the problem of insufficient cold-chain logistics infrastructure, and make the supply chain of fresh farm products more efficient, safe, and reliable.

#### **3.2 Blockchain technology to build an information ecosystem**

With distributed ledger technology's continuous maturity and application expansion, its role in the cold-chain logistics industry has become increasingly prominent. Some students have conducted thorough research on this and proposed building an ecological management system of cold-chain logistics information based on blockchain. Applying blockchain technology can solve the information barriers, insufficient safety supervision, and traceability problems faced by the current cold-chain logistics industry and produce new chances for the sector's development.

Wang (2021) studied the information ecological management of the cold-chain logistics industry, adopted blockchain technology as a solution, and reached the conclusion of building a new information ecological management system for cold-chain logistics, aiming at breaking the information barrier and improving safety, efficiency, and traceability of cold-chain logistics to meet the challenges and opportunities of industry development. She also pointed out that with the development of blockchain technology. However, the cold-chain logistics information environment in China has not yet been formed, resulting in loopholes in consumer rights protection. We can build a brand-new blockchain cold-chain logistics information management system with the help of blockchain technology. This system will greatly enhance the security of the cold-chain logistics network, promote information exchange and cooperation between nodes, and then promote multiple node enterprises to jointly create a perfect ecological environment[18]. In addition, Li (2021) analyzed the advancement status of the cold-chain logistics market in China during the epidemic era and the pain points of the food cold-chain logistics news traceability system. He believed that the food cold-chain logistics traceability sys-

tem enabled by blockchain technology could extremely define the duties of all participants, significantly facilitate the level of cold-chain food and the openness of logistics information, guarantee the safety and hygiene of cold-chain food, and strongly facilitate the cooperation and docking of cross-regional platforms. This will not only help the country to strengthen epidemic prevention and control in the field of cold-chain food but also greatly reduce the risk of chain breakage in the cold-chain logistics industry and finally realize the two-way traceability and efficient reuse of cold-chain food information[16].

Generally, applying cold-chain logistics technology in fruits, vegetables, and agricultural products is a complex system involving many links and technologies. Only by continuously exploring, optimizing, and applying relevant systems can we better meet consumers' demand for high-quality fruit and vegetable goods and facilitate the high-level advancement of the cold-chain logistics industry of fruit and vegetable products in China.

## References

- [1] Yuan Wentao. Study on cold-chain logistics distribution of fresh agricultural products [J]. *Modern Marketing*, 2020, 10: 152-153.
- [2] Wang Chunyan, Dong Shasha, Wei Xiaoxia, et al. Analysis of the development status and countermeasures of cold-chain logistics of agricultural products in China [J]. *China Fruit and Vegetable*, 2020, 40(11): 8-11.
- [3] Wang Youzhen. China's cold-chain logistics development status and trends [J]. *Logistics Science and Technology*, 2023, 46(13):125-126.
- [4] Xie Ruirui. Discussion on the development of "the first kilometer" of cold-chain logistics of fresh agricultural products in China [J]. *Commercial Economic Research*, 2022, 2(4).
- [5] Zhao Jiaoyun. Cold-chain of agricultural products "the first kilometer" broke [J]. *Logistics Technology and Application*, 2020(S01):34-35.
- [6] Yang Haojun. Research on the obstacles of the "last mile" of urban cold-chain logistics [J]. *Business Economic Research*, 2016 (17): 93-94.
- [7] Chen Yaoting, Huang Heliang. The "last mile" crowdsourcing distribution mode of fresh e-commerce in China [J]. *China circulation economy*, 2017, 31(2): 10-19.
- [8] Zhang Jin, Chen Yiyu. Summary of the research on the "last mile" of logistics [J]. *China Circulation Economy*, 2015, 29(4): 23-32.
- [9] Yang Luming, Ma Xiaoya. Study on the causes of chain breakage of cold-chain logistics of fresh agricultural products and the ways to avoid it [J]. *Qinghai Social Sciences*, 2015 (6): 66-70.
- [10] Zhang Xicai, Huo Di. Study on the weak links of cold-chain logistics of fresh agricultural products in China and countermeasures [J]. *Agricultural Economics and Management*, 2021, (03): 93-102.
- [11] Li Hong, Zhao Shanshan. Problems, causes and solutions of cold-chain logistics of fruits and vegetables [J]. *Xinjiang Finance and Economics*, 2018 (5): 7.
- [12] Zhang Xicai. China agricultural cold-chain logistics economic characteristics, difficulties and countermeasures [J]. *Modern economic discussion*, 2019 (12): 6. doi: CNKI: Sun: jjt.0.2019-12-016.
- [13] Shi Yanlei, Wang Wei, Li Yamin. Current situation of cold-chain transportation standardization in China and development policy suggestions [J]. *Transportation Research*, 2021, 007(001): 41-49.
- [14] Chen Zhenyu, Chen Xiaorong, Luo Linyan, et al. Cold-chain logistics standardization of agricultural products leads the high-quality development of the industry [J]. *Quality and Market*, 2023(11):4-6.
- [15] Rao Peijun. Study on cold-chain logistics distribution of fresh agricultural products [J]. *Guangdong Sericulture*, 2020,54 (11): 2. doi: 10.3969/j.issn.2095-1205.2020.11.58.
- [16] Li Hang, Dong Rui. Construction of food cold-chain logistics traceability system based on blockchain technology in post-epidemic era [J]. *Food and Machinery*, 2021, 37(5): 6.
- [17] Wu Jingqiong, Zheng Lu, Ba Xueqin, et al. Research progress of cold-chain logistics technology of fruits and vegetables and agricultural products [J]. *Journal of Beijing Jiaotong University: Social Science Edition*, 2023, 22(3):119-135.
- [18] Wang Na. Discussion on information ecological management of cold-chain logistics under the framework of blockchain [J]. *Business Economic Research*, 2021(21): 5.