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**Zh. S. Raimbekov¹, B. U. Syzdykbayeva¹,
*Zh. B. Rakhmetulina¹, A. A. Rakhmetulina²**

¹ L. N. Gumilyov Eurasian National University, Republic of Kazakhstan, Astana;

²Sarsen Amanzholov East Kazakhstan University,
Republic of Kazakhstan, Ust-Kamenogorsk

*e-mail: rahmetulina_zh@mail.ru

DEVELOPMENT OF DOMESTIC INFRASTRUCTURE FOR THE COLD SUPPLY CHAIN OF PERISHABLE PRODUCTS

The purpose of the work is to analyze the cold supply chain of perishable products (PP) of the agro-industrial complex (AIC) of the country, to assess the volume of production of SPP that requires compliance with the temperature regime; to analyze the transportation of perishable goods of the Republic of Kazakhstan by all modes of transport, to analyze the load capacity of refrigerated vehicles in the country, to identify problems of storage and transportation infrastructure in the supply chains of the PP, to determine the directions of their development, to develop recommendations for improving the efficiency of functioning and development of the infrastructure of the cold chain. The work uses statistical and analytical methods of generalization and comparative analysis, an expert survey.

The paper provides recommendations for business and the state to improve the areas of the cold chain of the PP, namely: it is necessary to create an authorized state body, which will be entrusted with the authority to develop the running chain of food products, to address issues of regulation of the cold chain market; the adoption of new regulatory documents to improve the turnover of the PP; investments in the running chain, training.

Keywords: perishable products; supply chain; logistics infrastructure; vegetable store; food warehouse.

Introduction

In the Republic of Kazakhstan, the last decade has seen an increase in the production of perishable products (PP), which include: fruits, vegetables, potatoes,

poultry products, milk, eggs, yeast. The development of the cold chain infrastructure was not a strategic direction of development to ensure the safe handling and delivery of these products to markets by creating a modern refrigerated storage and delivery system. The logistics of continuous use of the cold chain plays an important role in reducing losses of PP and goods in general, providing farmers with favorable prices and increasing their incomes, maintaining product quality, ensuring public health, thereby affecting the country's food security [1].

Storage of PP requires the use of expensive equipment and qualified personnel for its maintenance [2]. The main reason for the seasonal price growth and volatility of the fruit and vegetable market is the almost complete absence of a continuous technological chain «production – sales» [3], shortage and deterioration of infrastructure [4].

In order to reduce the percentage of losses of Fresh Produce (fresh fruit and vegetable products) in the world practice, there is an unconditional rule of compliance with the so-called «cold chain» in the «production – sales» process [5].

In many countries, the state pays increased attention to these issues and regulates them with special laws and standards; professional associations, together with business, solve topical issues in the field of the cold chain [6].

The key logistics solutions for the effective management of PP are the provision and control of temperature conditions during transportation [7], storage in specialized warehouse complexes, and information support for the cold logistics chain [8].

Currently, there are no regulatory requirements in Kazakhstan to regulate the activities of PP food in the process of storage and transportation, except for immunological medicines. The control and regulation of the cold chain in the technological process depend on the technology and capabilities of each business and enterprise. At the same time, there is no statistical information on containers, refrigerating equipment used in agriculture and the agro-industrial complex, in food production, in trade, in the transport industry. Each area is separately engaged in the process of ensuring the logistics of the cold chain of PP and food. There are no interactions on the development of the cold chain at the level of associations, industries, ministries.

Issues and problems of ensuring the cold chain in the process of production, storage, transportation and trade in order to ensure the safety of products for public health concern many ministries and departments of the country: the Ministry of Agriculture, the Ministry of Trade and Integration, the Ministry of Industry and Construction, the Ministry of Transport, the Ministry of Health, as well as the Ministry of Internal Affairs (registration and control of the technical condition of refrigerated vehicles, containers, insulated vans). However, these ministries, both individually and jointly, do not deal with the problems of cold chain management.

As a result, a whole range of problems to improve the sustainability and efficiency of the management of the supply chains of PP, which means that ensuring food security at the proper level remains unresolved, which requires study and solution.

Materials and methods

The theoretical and methodological basis of the research is the publications of Kazakhstani and foreign scientists in the field of supply chain management and the functioning of the logistics infrastructure of agriculture. Abstract-logical method, comparative analysis, systematization, questionnaire survey were used in the process of work. The survey was conducted in 2023.

Questionnaires on the study of the storage and distribution infrastructure of agricultural PP and supply chains contained the following set of questions:

1) general information (region, field of activity, work experience, type of business);

2) assessment of the functioning of the infrastructure (availability, degree of deterioration, level and frequency of use, location from the point of production, competence of employees, problems in operation);

3) the state of functioning of supply chain logistics (sales channels, communication stability, degree of compliance with temperature conditions, distance of delivery to the consumer, percentage of losses, organization and management of purchases, joint activities with other participants; factors affecting the supply chain; problems and efficiency of work in supply chain logistics);

4) development prospects (measures to improve supply chain performance, types of support, training needs, willingness to use innovative technologies).

The respondents' field of activity is shown in Figure 1.

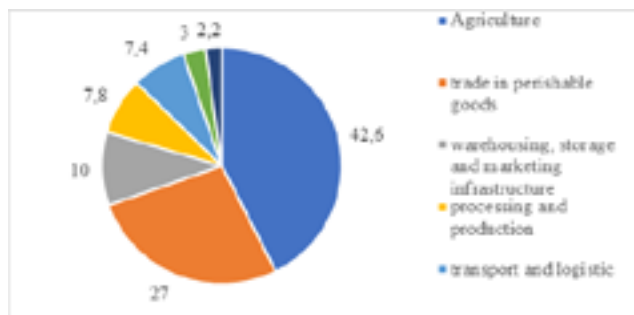


Figure 1 – The field of activity of the survey respondents, in %
Note: compiled by the authors

Results and discussion

Based on the processing and analysis of the survey data, we have identified the following main results in the functioning and development of the logistics infrastructure and supply chains of the PP.

A) According to the state of infrastructure development:

- the condition of the logistics infrastructure: excellent – 8.3 %, good – 46.3 %, satisfactory – 17.4 %, worn-out – 11.6 %, no infrastructure – 16.0 %;
- the use of logistics infrastructure: constantly – 46.1 %, sometimes – 31.3 %, not used – 22.6 %;
- more than half (51.5 %) of the logistics infrastructure is located at a close distance (up to 50 km) to the place of consumption of production;
- infrastructure utilization: 25 % of objects are loaded by 50 %, 46% by 50-70 %, and 12 % by 90–100 %;
- employees of 72.2 % of facilities have the skills and competencies of the logistics infrastructure to implement best practices, 15.7 % are insufficient, and 11.9 % do not have;
- problems hindering the high-quality provision of the cold supply chain of fresh products: expensive equipment for cold chains (75.6 %); a large number of intermediaries (77.4 %); large deterioration of the existing infrastructure (56.2 %).

B) On the issue of supply chain logistics:

- compliance (monitoring) of the temperature regime in the cold supply chains of perishable products: 60 % of respondents – comply; 27 % – partially comply; 6.8 % – do not comply, of which 31 % – during collection, 38 % – during transportation of products;
- organization and management of purchases of perishable products: 25.1 % – do not plan, 33 % – partially plan, 42 % – plan;
- carry out joint work with manufacturers, distributors, logistics and transport operators on forecasting, planning, procurement, production, warehousing, price management – 19.3 %; do not carry out – 58.9 %; partially – 21.6 %;
- problems faced in the logistics of SPP supplies: non-transparency of tariffs for storage services (77 %); low level of use of digital and innovative technologies in storage and delivery (64.5 %); violation of delivery deadlines to the market – 32 %, shortage of warehouses and equipment – 26 %, lack of interest of participants in the supply of fresh products in joint and/or integrated problem solving – 31 %; outdated technologies and equipment in warehouses – 23%;
- The lack of skills and competence of the logistics infrastructure to implement best practices is observed in 32 % of respondents; 26 % require improvement, 42 % of respondents have sufficient skills.

C) Prospects for the development of supply chain infrastructure and logistics:

- support the adoption of measures to develop sustainable supply chains of perishable products: the adoption of the Law «On Perishable Products» against fraud in the trade of perishable agricultural products, as well as the development of measures to maintain the cold chain in order to ensure food security – 58.3 % of respondents; the development of quality management standards for supply chain management – 41.0 %;

- support the provision of conditions and services in one place – 10.5 %, the introduction of an automated management system for the need for goods, stocks and resources (SCM, ERP, WMS, TMS, etc.) – 10.0 %;

- the use of innovative technologies: 6.8 % use, 14.5 % are ready to use, 50.4 % do not use, 28.1 % plan. Of these, 20 % are ready to use blockchain to increase the stability and efficiency of supply chains, 27.7 % are ready to use radio frequency identifiers (RFID), 17.7 % are ready to use digital platforms in commerce, and 14.1% are ready to use information technology;

- plan to use marketplaces in the future – 43.6 %, smart contracts – 36.4 %, digital platforms – 36.4 %, Internet of Things (IoT) – 20.4 %, blockchain – 17.9 %.

Considering the problem of creating a modern cold supply chain for PP as the main element of the food market infrastructure, it is necessary to represent the volumes of produced and consumed, the volumes of stored and transported agricultural raw materials and finished food and fish products. Such information is not available everywhere.

According to [9], the annual output of fresh crop production (vegetables, potatoes, fruits and berries) over the past 2-3 years is 12–14 million tons. Of these, 4 – 4.5 million tons (1/3 part) are used for sale, 2.5 – 3 million tons for storage, 2.5 – 4.0 million tons for processing.

The services of enterprises of auxiliary transport activities for storage also show a decrease in the number of places and the capacity of one-time storage of food products, vegetables and fruits. There has been a sharp increase (by 4 times) in the capacity of warehouses for storing food products to 1022.3 thousand square meters (Table 1).

Revenues from auxiliary transport activities of enterprises show that storage and warehousing services increased by 155.0 % – from 17.69 billion tenge to 27.44 – billion tenge (Figure 2). Refrigerated cargo storage services decreased from 1.14 – billion tenge in 2016 to 0.26 billion tenge in 2021, and in 2022 increased to 1.85 – billion tenge (7 times) or by 62 % compared to 2016.

Table 1 – Number, capacity and income per unit of one-time storage places from the services of enterprises of auxiliary transport activities of the Republic of Kazakhstan

Warehouse performance indicators	Purpose of warehouses	2018	2019	2020	2021	2022	2022 to 2021, %
Number of one-time storage places, units.	food storage warehouses	210	205	211	198	126	63,6
	warehouses for storing vegetables and fruits	23	22	19	18	13	56,5
One-time storage capacity	warehouses for storing food products, thousand sq.m.	301,5	299,4	303,3	244,5	1022,3	339,1
	warehouses for storing vegetables and fruits, thousand sq.m.	74,1	73,2	73,4	69,2	61,3	82,7
Revenue per unit of one-time storage space, billion tenge	warehouses for storing food products, billion tenge. per unit	0,021	0,024	0,021	0,014	0,142	10.1 times
	warehouses for storing vegetables and fruits, billion tenge. per unit	0,089	0,088	0,084	0,104	0,217	2.1 times
Note: Compiled and calculated based on data [9]							

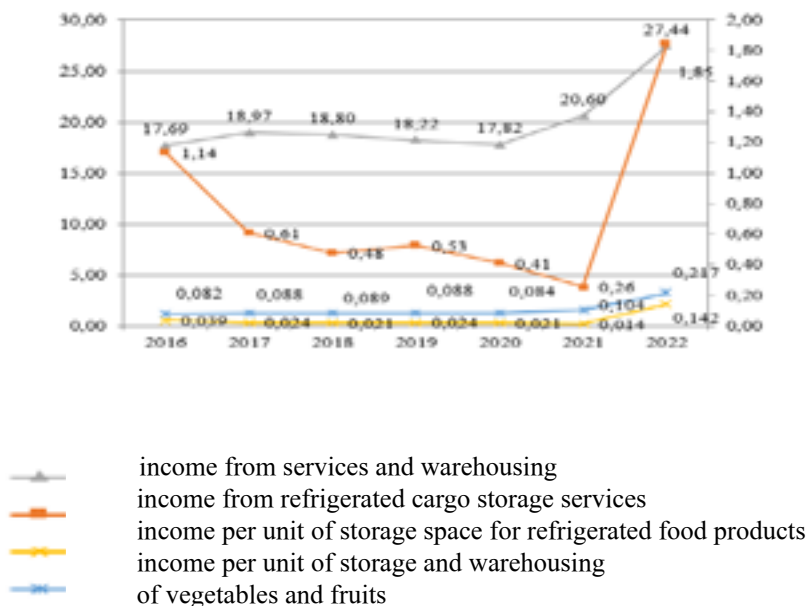


Figure 2 – Revenues from auxiliary transport activities of enterprises for 2016-2022*, billion tenge.

Note: Developed by the authors based on the materials [9]

Income per unit of one-time storage of food products and storage and warehousing services in 2019-2021 decreased, but in 2022, compared to 2021, they increased by 10.1 and 2.1 times, respectively. This suggests that this type of business has growth potential. Moreover, vegetable and fruit storage services are 2-4 times more efficient than refrigerated food storage services.

There is an acute shortage of high-quality cold formulations: an insufficient number of modern structures with equipment that can provide various temperature options. The main reason is the high cost of creating logistics facilities and the lack of government support.

Only the consolidation of the industry, namely, the union of manufacturers, retailers, suppliers of logistics services, equipment and technologies, can solve the problem of guaranteeing the freshness and quality of perishable goods for the consumer [10].

In our opinion, regulatory documents should be developed and adopted to prevent fraud in the trade of perishable agricultural products, as well as measures to maintain the cold chain.

Warehouses and storages should be located not only in the places of production, as is happening now, but also in places closer to the main consumers, depending on the quality and quantity of products. This allows you to reduce spring costs and increase prices out of season. This issue requires a more in-depth study for each range of PP.

An analysis of income from auxiliary transport activities showed that income per unit of places for one-time storage and warehousing of fruits and vegetables is higher than income from food storage services. This can be explained by the fact that with long-term storage of fruits and vegetables (6-7 months), costs increase and, accordingly, high prices for products.

Summarizing the results of the analysis of the state of the logistics infrastructure and logistics of the supply chains of the PP, we have formulated the following problems that hinder the development and improvement of the efficiency of the logistics infrastructure of storage, delivery and packaging industry:

- insufficient development and shortage of a network of storage, packaging and delivery infrastructure to attract additional storage volumes and ensure continuous delivery to consumers;
- insufficient development of modern transport and logistics services;
- insufficient level of development of the “soft infrastructure”, digitalization and automation for managing the processes of production, storage, transportation, data and document exchange between the participants in the process;
- an acute shortage of large-capacity refrigerators for international transportation.
- the absence of a tariff setting system for storage services and other regulated services;
- frequent violation of delivery deadlines, heavy wear and shortage of warehouses and freezing equipment, the competence of specialists require constant improvement;
- low level of integration in joint planning, organization and supply chain management.

Conclusions

So, today in Kazakhstan there are no organizations responsible for solving the problems of the cold chain and monitoring the effectiveness of their functioning. The problems of lack of transparency and traceability of the supply chain should be solved by organizing the vertical integration of farmers - producers of PP, using innovative technologies: the Internet of Things, blockchain, remote temperature

control technologies. It is necessary to develop local wholesale markets, aggregation centers and processing centers; invest in cold chain infrastructure; provide integrated cold chain solutions, including the development of auxiliary infrastructure.

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*Ж. С. Раимбеков¹, Б. У. Сыздықбаева¹, *Ж. Б. Рахметулина¹,
А. А. Рахметулина²*

¹Л. Н. Гумилев атындағы Еуразия ұлттық университеті,
Қазақстан Республикасы, Астана қ.;

²С. Аманжолов атындағы Шығыс Қазақстан университеті,
Қазақстан Республикасы, Өскемен қ.;

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ТЕЗ БҰЗЫЛАТЫН ӨНІМДІ ЖЕТКІЗУДІҢ СУЫҚ ТІЗБЕГІНІҢ ОТАНДЫҚ ИНФРАҚҰРЫЛЫМЫН ДАМУ

Жұмыстың мақсаты—еліміздің агроөнеркәсіптік кешенінің (АӨК) тез бұзылатын өнімді (ТБӨ) жеткізудің суық тізбегіне талдау жүргізу, температуралық режимді сақтауды талап ететін ТБӨ өндірісінің көлеміне баға беру; көліктің барлық түрлерімен ҚР тез бұзылатын жүктерді тасымалдауға талдау жүргізу, елдегі тоңазытқыш көлік құралдарының жүк көтергіштігін талдау, ТБӨ жеткізу тізбектерінде сақтау және тасымалдау инфрақұрылымының проблемаларын анықтау, олардың даму бағыттарын анықтау, суық тізбек инфрақұрылымының жұмыс істеуі мен дамуының тиімділігін арттыру бойынша ұсыныстар әзірлеу. Жұмыста жалпылау мен салыстырмалы талдаудың статистикалық және аналитикалық әдістері, сараптамалық сауалнама қолданылды.

Жұмыста бизнес пен мемлекет үшін ТБӨ суық тізбегі салаларын жақсарту бойынша ұсынымдар берілді, атап айтқанда: тамақ өнімдерінің жүріс тізбегін дамыту, суық тізбек нарығын реттеу мәселелерін шешу бойынша өкілеттіктер жүктелетін уәкілетті мемлекеттік орган құру қажет; ТБӨ айналымын жақсарту бойынша жаңа нормативтік құжаттарды қабылдау; жүріс тізбегіне инвестициялар тарту, кадрлар даярлау.

Кілтті сөздер: тез бұзылатын өнімдер; жеткізу тізбегі; логистикалық инфрақұрылым; көкөніс қоймасы; азық-түлік қоймасы.

*Ж. С. Раимбеков¹, Б. У. Сыздықбаева¹, *Ж. Б. Рахметулина¹,
А. А. Рахметулина²*

¹Восточно-Казахстанский университет имени С. Аманжолова,
Республика Казахстан, г. Усть-Каменогорск;

²Евразийский национальный университет имени Л. Н. Гумилева,
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РАЗВИТИЕ ОТЕЧЕСТВЕННОЙ ИНФРАСТРУКТУРЫ ХОЛОДОВОЙ ЦЕПИ ПОСТАВОК СКОРОПОРТЯЩЕЙСЯ ПРОДУКЦИИ

Цель работы – провести анализ холодовой цепи поставок скоропортящейся продукции (СПП) агропромышленного комплекса (АПК) страны, дать оценку объема производства СПП, требующего соблюдения температурного режима; провести анализ перевозок скоропортящихся грузов РК всеми видами транспорта, проанализировать грузоподъемность холодильных транспортных средств в стране, выявить проблемы инфраструктуры хранения и транспортировки в цепях поставок СПП, определить направления их развития, разработать рекомендации по повышению эффективности функционирования и развития инфраструктуры холодовой цепи. В работе использованы статистические и аналитические методы обобщения и сравнительного анализа, экспертный опрос.

В работе даны рекомендации для бизнеса и государства по улучшению сфер холодовой цепи СПП, а именно: необходимо создать уполномоченный государственный орган, на который будут возложены полномочия по развитию холодовой цепи пищевых продуктов, по решению вопросов регулирования рынка холодовой цепи; принятию новых нормативных документов по улучшению оборота СПП; инвестиций в холодовую цепь, подготовки кадров.

Ключевые слова: скоропортящаяся продукция; цепочка поставок; логистическая инфраструктура; овощехранилище; склад продовольственной продукции.

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«Toraighyrov University» баспасынан басылып шығарылған

Торайғыров университеті

140008, Павлодар қ., Ломов к., 64, 137 каб.

«Toraighyrov University» баспасы

Торайғыров университеті

140008, Павлодар қ., Ломов к., 64, 137 каб.

8 (7182) 67-36-69

e-mail: kereku@tou.edu.kz

www.vestnik.tou.edu.kz

www.vestnik-economic.tou.edu.kz