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Cold chain infrastructure in Paraguay

Introduction[1]

A cold chain system refers to the sequence of production and logistics processes that enable the production, transportation, storage, and distribution of food, pharmaceuticals, immunobiological, agricultural inputs, cosmetics, and other temperature-sensitive products under controlled temperatures. According to the Food and Agriculture Organization of the United Nations (FAO), a cold chain system includes the stages of pre-cooling, storage, transportation, distribution, retail, and domestic refrigeration (FAO, 2015). When applied to food production,

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This *Fal Bulletin* maps the structure and capacity of the cold chain infrastructure in Paraguay, the availability of refrigerated transport fleets, storage facilities, airport and port infrastructure, and the national vaccine distribution system.

The *Fal Bulletin* was prepared by Rocío Aguayo, Roberto Salinas and Mical Rodríguez Laconich and is a summary of the document "Cold chain logistics: the case of Paraguay and territories along the bioceanic corridor" (in press).

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[1] The introduction was translated and adapted from: Batalha, M. et al. (in press). Economic Commission for Latin America and the Caribbean, developed under the regional project "Transport and trade connectivity in the age of pandemics: Contactless, seamless and collaborative UN solutions".
Unless otherwise noted, the findings in this document rely on primary information gathered from interviews with key actors in the private sector and public institutions.

the goal of a cold chain system is to keep products safe for consumption, preserve their nutritional characteristics, and maintain good organoleptic qualities. In the case of immunobiological and pharmaceuticals, whether for human or veterinary use, the objective is to preserve their immunizing and therapeutic properties. The term "chain" reflects a systemic perspective, in which each activity within the chain is essential to maintaining the products with the desired qualities. Any failure in one of the stages that define and characterize a cold chain system can compromise the final outcome of the controlled refrigeration process.

There are various technologies available for cold generation. These technologies can cool or freeze products at different speeds, using either continuous or batch processes. In general, they are well-known and commercially available technologies. One of the main cost components of any system for generating and maintaining cold is energy. As a result, much of the technological effort has been focused on developing equipment that is more energy-efficient. It is also worth noting that part of the research is not aimed at cold generation and maintenance systems themselves, but rather at the monitoring systems for said equipment that use technologies such as wireless sensor networks (WSN) and radio-frequency identification (RFID).

Temperature-sensitive agri-food and pharmaceutical products generally follow the same storage standards. Storage and transportation temperatures throughout an agri-food chain vary depending on the type of product and the length of time it will be stored. Broadly speaking, temperature ranges can be divided as follows:

- Freezing (at or below -18 °C): mainly used for meat, fish, ice cream, processed foods, etc.;
- Refrigeration (0 to 10 °C): mainly used for seeds, certain fruits and vegetables;
- Cooling (10 to 20 °C): mainly used for some fruits and vegetables.

Table 1 presents another way of classifying cold storage methods by product type and temperature range.

Table 1
Cold storage temperatures for food

Temperature classification		Temperature range	Examples of foods and food products
Low Temperature	Frozen	Less than -10 °C	Tuna
		-40 °C to -18 °C	Seafood, meat, frozen food, ice cream, bread dough.
	Chilled	-18 °C to 10 °C	Dairy products, pastries, vegetables, meat, fresh seafood.
	Constant Temperature	5 °C to 18 °C	Mayonnaise, chocolate, confectioneries, beverage, rice and other grains.

Source: ASEAN-Japan Transport Partnership (2018).

In the case of cold chains for pharmaceuticals and immunobiologicals, the temperature ranges are similar to those used in agri-food chains.

- Freezing (-10 to -20 °C);
- Refrigeration (2 to 8 °C);
- Cooling (8 to 15 °C).

It is worth noting that some types of vaccines require storage in equipment that reaches temperatures as low as -70 °C for long-term storage.

The technical grounds explained in the previous paragraphs help contextualize the relevance and complexity of cold chain systems across different sectors. In light of these considerations, this document presents an exploratory assessment of cold chains for agribusiness products and pharmaceuticals/vaccines in Paraguay with a focus on the departments of Alto Paraguay and Boqueron, both of which are strategically located along the Bioceanic Corridor.[2] Specifically, it covers the following areas:

(i) Assess the installed capacity and operational characteristics of public and private cold storage facilities for agribusiness products and pharmaceutical/immunobiological supplies.

(ii) Describe the broader cold chain infrastructure in Paraguay, including cold storage capabilities at ports and airports, the availability of ultra-low-temperature facilities, and local production of refrigeration equipment.

(iii) Analyze the availability and technical characteristics of refrigerated transportation fleets, used for the domestic and international logistics of temperature-sensitive products.

(iv) Examine the organization and logistics of the national vaccine distribution system, including cold storage, refrigerated transport, and the role of the Ministry of Public Health and Social Welfare (according to its Spanish acronym MSPBS).

(v) Propose public policy recommendations and regional development strategies to strengthen cold chain logistics.

This study adopted a mixed-methods approach to gather information, combining the use of secondary data with semi-structured interviews conducted with key stakeholders in Paraguay's cold chain sector. The interviews were carried out remotely via synchronous online platforms that allowed real-time interaction between interviewers and interviewees. The research design followed a rapid appraisal methodology. This approach is particularly useful for applied research efforts such as the present study, as it seeks to reduce the time and cost of data collection while maintaining analytical rigor. To this end, it maximizes the use of reliable secondary data and qualitative inputs gathered from key stakeholders in the sector or production system under investigation (Kumar, 1993).

I. Cold chain infrastructure in Paraguay[3]

A. Cold Storage Capacity

Paraguay’s main export product requiring the use of the cold chain is beef, with an annual production of 780,000 tons, of which approximately 390,000 tons are exported frozen or chilled. The largest company in the sector is *Frigorifico Concepcion*, which holds a 25% market share, with an annual production of 240,000 tons and a cold storage capacity of 27,000 m³.

[2] The proposal of the bioceanic corridor finds its origins in the Initiative for the Integration of Regional Infrastructure in South America (IIRSA), which was launched by a group of South American countries in the year 2000. It consists of a road corridor that will connect Brazil, on the Atlantic Ocean, to Chile, on the Pacific Ocean, passing through regions of Paraguay and northern Argentina.

[3] Unless otherwise noted, the findings in this section rely on primary information gathered from interviews with key actors in the private sector and public institutions.

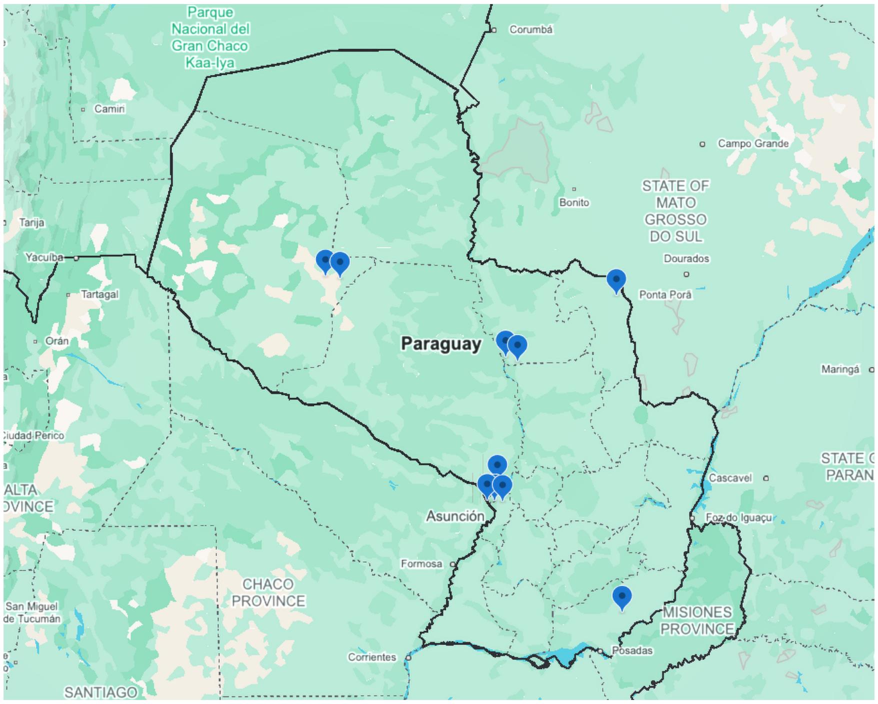
Based on these figures, the total cold storage volume in the beef supply chain can be estimated at around 108,000 m³.

Transport logistics for live cattle, chilled meat, frozen meat, or by-products, are mainly carried out by third-party intermediaries who handle the movement of goods to the points of sale, while cold storage is managed by agents specialized in handling this type of product. Refrigerated containers (reefers) for export are handled by international freight operators, who also coordinate overseas shipments. Chile and Russia are the main importers of Paraguay's chilled and frozen beef, respectively. For the Chilean market, transportation is done via refrigerated trucks over a distance of 2,200 km from the meatpacking plants to the final customers. In the case of frozen meat, the refrigerated containers are transported by truck from the meatpacking plants to ports south of Asuncion, where they are almost directly loaded onto container ships with capacities of up to 400 Twenty-foot Equivalent Units (TEUs). These ships then travel to Argentine or Uruguayan ports (1,600 km) before transshipment to ocean-going vessels. A navigation issue means that production from Concepcion must be trucked 450 km to Asuncion in order to access river shipping, since vessels do not sail upstream to Concepcion. This connection increases transportation costs.

The main slaughterhouses (for beef and pork) are located in the central Chaco region, in Concepcion, and in and around Asuncion. There are around 20 companies exporting both chilled and frozen meat, which are shown in map 1.

Map 1

Location of the main beef and pork meatpacking plants in Paraguay



Source: Prepared by the authors based on data provided by the private sector.

Meat processing companies have the largest cold storage capacities, due to the need to maintain high stocks of frozen meat, especially for exports to the Russian market. In 2020, total frozen meat exports amounted to 163,000 tons, with the main production

and storage centers located in the Central Chaco region, the city of Concepcion, the city of Asuncion, and surrounding municipalities. The distribution of cold storage capacity by region is presented in table 2.

Table 2
Installed cold storage capacity of meatpacking plants in (m^3)

Region	Installed capacity m^3
Asuncion	35 261
Concepcion	27 000
Chaco Central	8 996

Source: Prepared by the authors based on data provided by stakeholders during interviews.

The main product for domestic consumption that requires a cold chain is dairy. The company Lactolanda is the market leader, with a 50% market share and a cold storage volume of 56,000 m^3. Based on this figure, the total installed cold storage capacity in the dairy sector is estimated at around 112,000 m^3. Milk production is dominated by large producer cooperatives. There are about eight companies that produce and market dairy products. The business model is based on the management of dairy basins made up of small and medium-sized producers who supply milk, while reception, storage, production, distribution, and marketing are handled by the industry. The entire cold chain is managed by the industry itself using its own facilities and vehicles. In terms of milk production areas or dairy basins, the main collection and production centers are located in the Central-West part of the Eastern region, particularly in the departments of Caaguazú and Alto Paraná. There is also a major basin in the Central Chaco, in the Mennonite colony area, with reception and production centers located along the bioceanic corridor, where the company Trebol stands out with a 27% market share.

On a smaller scale than beef and dairy, there is also an annual production of approximately 20,000 tons of exported processed meats and about 150,000 tons of poultry production, both of which require the use of the cold chain. For these two sectors, the installed cold storage capacity is estimated at around 23,000 m^3.

Although pork is not a traditional export product, it has been developing rapidly and finding export markets, in addition to local consumption, which is also significant. Poultry production has shown growth in terms of exports, although the main market remains the domestic one. The primary market for both products is the metropolitan area of Asuncion, which means that a large part of the production and commercialization chain is located on the outskirts of Asuncion, with access to the main export ports on the Paraguay River.

Based on the sectors identified as the main users of cold storage facilities, along with estimates derived from leading industry actors and interviews with suppliers and logistics operators, an estimation exercise was conducted to assess the installed static cold storage capacity in Paraguay. Table 3 presents the estimated distribution of total cold storage capacity by sector.

Table 3
Estimated Cold Storage Capacity in Paraguay (m^3)

Sector	Capacity in m^3
Meat	108 000
Dairy	112 500
Processed meat	12 000
Poultry	18 000
Retail	21 000
Logistics Operators	30 000
Fruits and Vegetables (FLV)	12 000
Other	15 000
Total	328 500

Source: Prepared by the authors based on interviews with production agents.

The national figure presented at the end of table 3 (Total: 328,500 m^3) was derived from interviews with key stakeholders from the main sectors that utilize cold storage infrastructure. While this estimate provides a solid starting point, it is ideal to validate it using an alternative method or secondary data source. The Global Cold Chain Alliance (GCCA, 2020) report includes an indicator titled *Refrigerated Warehouse Capacity (m^3 per urban resident)*. The initial intention was to multiply this value by Paraguay's urban population to estimate the country's total refrigerated capacity, using the formula:

$$\text{National cold storage capacity} = \text{Refrigerated Warehouse Capacity } (m^3 \text{ per urban resident}) \times \text{Total urban population}$$

While the GCCA reports values for other countries in Latin America, it does not provide data for Paraguay, making it impossible to apply this method directly.

To address this limitation and reproduce the formula, the research team developed a method to estimate Paraguay's refrigerated capacity per urban resident based on its Logistics Performance Index (LPI), reported by the World Bank.[4] Before proceeding with the estimation, it was necessary to verify whether LPI scores and refrigerated storage capacity are statistically related across countries. In other words, to corroborate if a country with better logistics performance tends to have higher cold storage capacity.

Data on *Refrigerated Warehouse Capacity (m^3 per urban resident)* and *LPI (2018)* were collected for seven Latin American countries represented in the GCCA 2020) report. These data are presented in table 4. The selected countries vary in both logistics performance and cold chain infrastructure, making them a meaningful reference group for constructing a regression model to estimate Paraguay's expected value.

A non-parametric Spearman correlation test was conducted to assess the degree of association between the two variables. The results, presented in figure 1, show a strong and statistically significant positive correlation (Spearman's rho = 0.757; p-value < 0.05). This suggests that countries with higher logistics performance tend to have higher cold storage capacity per capita.

[4] https://lpi-worldbank-org.translate.goog/2018?_x_tr_sl=en&_x_tr_tl=es&_x_tr_hl=es&_x_tr_pto=tc

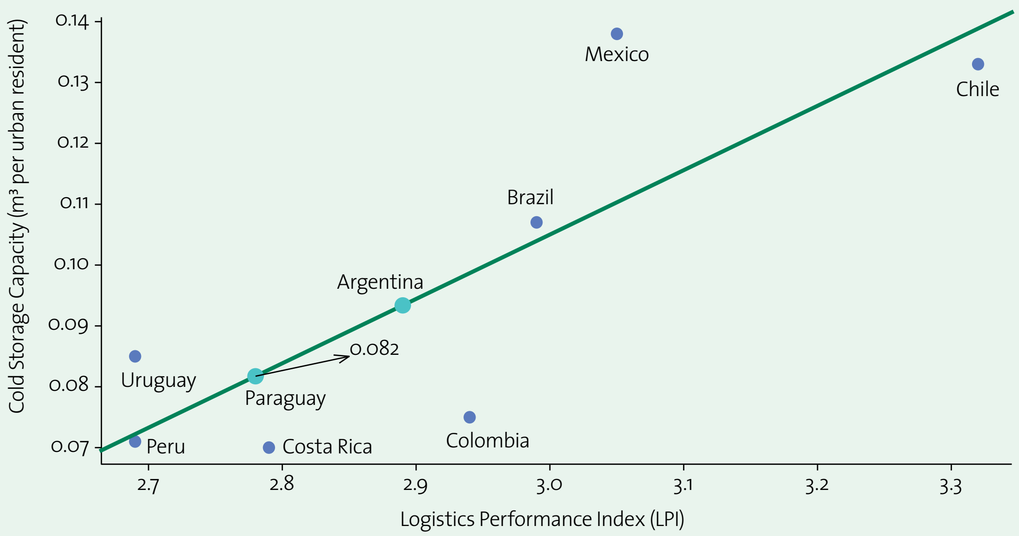
Table 4
Variables used to calculate correlation

Country	Cold storage capacity per capita m³	LPI 2018	Ranking
Chile	0.133	3.32	34
Mexico	0.138	3.05	51
Brazil	0.107	2.99	56
Colombia	0.075	2.94	58
Argentina	Not available	2.89	61
Costa Rica	0.07	2.79	73
Paraguay	Not available	2.78	74
Uruguay	0.085	2.69	85
Peru	0.071	2.69	83

Source: Prepared by the authors based on data from the World Bank (2018) and GCCA (2020).

Based on this relationship, a simple linear regression model was fitted to predict cold storage capacity per capita as a function of LPI. By applying Paraguay's LPI score for 2018 (2.78) to the regression line, the model produced an estimated value of 0.082 m³ per urban resident. This result is displayed in figure 1, where Paraguay appears near the trend line.

Figure 1
Correlation between per capita cold storage capacity and Logistics Performance Index (LPI)
(Cold storage capacity m³ per urban resident and LPI)



Source: Prepared by the authors.

The estimated value of 0.082 per urban resident was used to calculate Paraguay's total cold storage capacity, applying the following formula:

Refrigerated Warehouse Capacity (m³ per urban resident) or 0.082 × Total urban population = National cold storage capacity.

According to the National Institute of Statistics (INE, 2022), Paraguay's urban population in 2021 was 4,625,061.

Applying the formula:

$$0.082 \times 4{,}625{,}061 = 379{,}255 m^3$$

This estimate is reasonably close to the interview-based figure of 328,500 m³ presented earlier in table 3, suggesting that the data collected through interviews yielded a reliable result.

Moreover, having an estimated per capita value enabled the study to project cold storage capacity at the departmental level, including for Boqueron and Alto Paraguay, which are focal areas of this research. The same formula was applied:

Estimated departmental capacity = Refrigerated Warehouse Capacity (m^3 per urban resident) or 0.082 x Urban population of each department

Table 5 presents the estimated cold storage capacity for all 17 departments of Paraguay and the capital district (Asuncion), based on 2021 urban population figures from INE (2022b). The results show that Boqueron and Alto Paraguay (the territories along the bicoeanic corridor, a major infrastructure project in the country) have estimated refrigerated capacities of 2,216 m^3 and 826 m^3, respectively, well below the national departmental average of 20,570 m^3.

Table 5
Cold storage capacity by department

Department	Urban population	Rural population	Total population	Refrigerated warehouse capacity (m^3)
Asuncion	521 101	0	521 101	42 730
Concepcion	99 064	159 589	258 653	8 123
San Pedro	82 783	357 552	440 335	6 788
Cordillera	107 814	207 431	315 245	8 841
Guaira	93 886	136 227	230 112	7 699
Caaguazu	230 837	339 131	569 967	18 929
Caazapá	40 847	153 664	194 512	3 349
Itapua	276 292	348 804	625 096	22 656
Misiones	69 695	60 091	129 787	5 715
Paraguari	89 033	171 298	260 331	7 301
Alto Paraná	608 988	233 319	842 307	49 937
Central	1 954 343	289 449	2 243 792	160 256
Ñeembucu	60 637	30 137	90 774	4 972
Amambay	110 948	63 773	174 721	9 098
Canindeyu	88 573	150 813	239 386	7 263
Presidente Hayes	43 506	86 752	130 258	3 567
Boqueron	27 028	41 052	68 080	2 216
Alto Paraguay	10 071	8 510	18 581	826
Country Total	4 625 061	2 727 977	7 353 038	379 255

Source: Prepared by the authors.

While this indicator is based on a national-level regression and may underestimate or overestimate the capacity of individual departments, it nonetheless suggests that infrastructure in Boqueron and Alto Paraguay as of 2022 may be insufficient to meet the anticipated growth in demand following the implementation of the Bioceanic Corridor.

The general overview presented in the section provides the foundation for analyzing other key components of Paraguay's cold chain, starting with refrigerated transport capacity which is discussed next.

B. Availability and Characteristics of Refrigerated Transportation Fleets

The agency responsible for the registration of motor vehicles in Paraguay is the National Transport Authority (DINATRAN),[5] under the supervision of the Ministry of Public Works and Communications (MOPC). The refrigerated transport fleet in Paraguay can be divided into two categories: (i) providers of national freight services and (ii) providers of international

[5] https://www.dinatran.gov.py/autoridades.html

freight service. According to a 2018 report by DINATRAN, there were 291 transport companies authorized to operate internationally, owning a total of 568 trucks and 9,533 trailers. Of these, 547 vehicles had some form of refrigeration capacity, either as refrigerated box trucks or refrigerated semi-trailers. On the other hand, during the same year there were a total of 2,624 refrigerated vehicles used for domestic transportation.

Tables 6 and 7 present the number of refrigerated or reefer vehicles used for the national and international transport of temperature-sensitive goods.

Table 6
Fleet of domestic freight services

Refrigerated box truck		Refrigerated semi-trailer		Refrigerated trailer	
Type	Quantity	Type	Quantity	Type	Quantity
2 Axles	2 352	1 Axle	2	2 Axles	1
3 Axles	164	2 Axles	12	3 Axles	3
4 Axles	44	3 Axles	46		
Total	2 560	Total	60	Total	4

Source: Prepared by the authors based on data from DINATRAN (2020).

Table 7
Fleet of international freight services

Refrigerated box truck		Refrigerated semi-trailer	
Type	Quantity	Type	Quantity
2 Axles	11	1 Axle	1
3 Axles	9	2 Axles	147
4 Axles	1	3 Axles	378
Total	21	Total	526

Source: Prepared by the authors based on data from DINATRAN (2020).

Regarding the provision of transport for refrigerated and frozen products at the time of this study (2022), there are no indications that current vehicle capacity limits the transport of refrigerated or frozen goods in Paraguay. According to interviewed stakeholders, national companies operate with adequate quality and safety standards, as they conduct international transport operations in compliance with the regulations of Brazil, Argentina, Chile, and Uruguay. Furthermore, there are enough refrigeration equipment suppliers to support any future expansion of land and river transport fleets.

Nuestra Señora del Asuncion (NSA) the largest logistics company in the country, operates two major logistics centers in the Metropolitan Area of Asuncion. Both centers are equipped with cold storage chambers of 8,000 m³ and a fleet of trucks for general cargo transport. Additionally, it owns a fleet of 60 refrigerated trucks with a capacity of 5 tons and another 60 trucks with a capacity of 25 tons for long-distance transportation. The trucks' cold chambers can operate at 2 to 8 °C for chilled products and at -20 °C for frozen goods. Frozen products, primarily frozen beef, are typically exported through inland waterways (IWW) in refrigerated containers (reefers). NSA is one of the main carriers of refrigerated meat to Chile and Brazil.

While transportation plays a central role in maintaining cold chains, the infrastructure at export and import hubs is also important. Therefore, the next section examines the storage capacity at ports and airports.

C. Cold Chain Infrastructure at Export and Import Hubs

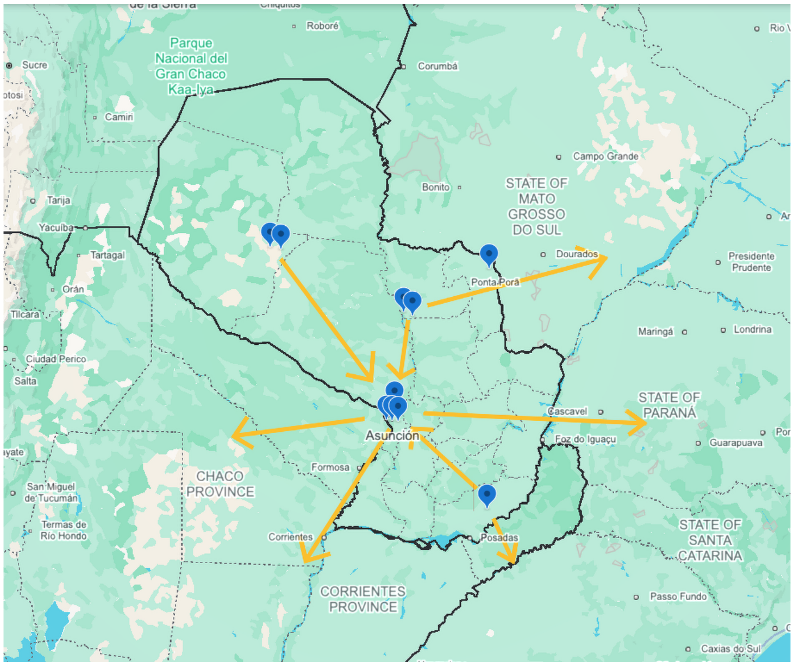
1. Cold Storage Capacity at Major Export Ports

The main river export ports are located in the city of Asuncion and surrounding municipalities, particularly in the port zone of Villeta, about 40 km downstream from Asuncion. Therefore, the main export corridors for frozen and refrigerated products are as follows:

River export is the most important in terms of volume. Between 75% and 80% of the country's foreign trade is transported via the Paraguay–Paraná Waterway. The port complex of Villeta alone handles approximately one-third of the total volume of foreign trade in tons.

For instance, of the nearly 60,000 TEUs exported in 2020, 11% corresponded to reefer container exports of frozen meat. It is worth noting that none of the ports has cold storage infrastructure for temperature-sensitive products.

Map 2
Main Corridors for Frozen and Refrigerated Products



Source: Prepared by the authors based on data provided by the private sector.

2. Cold storage capacity in Paraguayan airports

In Paraguay, the two main airports with cargo handling terminals are located in the Central Department (Silvio Pettirossi International Airport) and in the Alto Paraná Department (Guaraní International Airport). At both airports, the volume of refrigerated cargo is relatively low. Small volumes of refrigerated meat for export, as well as imported medicines and flowers, are handled at these airports without the need for long-term on-site cold storage.

The cold storage infrastructure at both airports is described below:

- Silvio Pettirossi International Airport: Located in the capital city, Asuncion, it has a cold room of 60 m³ with three compartments at different temperatures: -5 °C, -10 °C, and -15 °C.
- Guaraní International Airport: Located in Ciudad del Este, it has two cold rooms of 69 m³ each, with cooling capacity down to -5 °C. At the time of this study in 2022, both were idle.

D. Infrastructure for Ultra-Low Temperatures (-70 °C)

Equipment designed to store products at extremely low temperatures (-70 °C) has very limited use in industrial refrigeration for food storage, and even in the storage of pharmaceuticals and vaccines. It is uncommon to store food, agricultural inputs, pharmaceutical ingredients, medicines, or vaccines at such low temperatures. Typically, small-scale facilities (often already in use) are found in research laboratories at universities, pharmaceutical companies, and some hospitals and clinics. In Paraguay, no physical infrastructure was identified as capable of storing products at -70 °C. Equipment designed to store products at -70 °C is generally scarce across the region. For instance, within the sub-region comprising Argentina, Brazil, and Chile, ultra freezers are found only at the University Hospital of UFMS in Mato Grosso do Sul and at the Federal University of Goiás.

While the use of ultra-cold storage remains limited, it highlights the need for local technological capacity and equipment manufacturing, which is discussed next.

E. Local Manufacturing of Cold Chain Equipment

Broadly speaking, industrial cold chain equipment manufacturers are concentrated in the more developed regions of the country. In Paraguay, they are in the Central Department, mainly in Asuncion and surrounding areas. However, the location of these companies does not appear to be a limiting factor for the production, distribution, and installation of refrigeration equipment in other regions. Companies are able to offer their equipment and services throughout the national territory. It is also worth noting that the supply of industrial refrigeration equipment was not identified by logistics operators and experts interviewed as a bottleneck to the development of the cold chain in the regions analyzed.

Although Paraguay does not have an association exclusively for cold storage service providers or manufacturers, there is an association that brings together a group of affiliated companies offering cold storage, mechanical ventilation, and air conditioning services. This association is the Paraguayan Chamber of Air Conditioning, Refrigeration and Mechanical Ventilation (CAPAREV). CAPAREV includes the main companies that assemble refrigeration equipment and cold rooms in the country. According to interviews with sector stakeholders, Tecnimet is the market leader in Paraguay in this field. The company is responsible for installing cold rooms for major beef processing plants, dairy producers, pharmaceutical companies, supermarkets, and regional markets. Tecnimet manufactures its cold rooms using its own modular or dismantlable insulating panels. It also produces polystyrene and polyurethane panels in thicknesses ranging from 50 to 250 mm and operates continuous production machinery with the capacity to produce up to 1,500 m² of panels per day.

In addition to industrial applications, cold chain infrastructure also plays a crucial role in supporting public health efforts, particularly for vaccine storage and distribution which is the subject of the next section.

F. Characteristics of the Cold Chain for Pharmaceuticals and Immunobiologicals

The lack of available data on the cold chain for pharmaceuticals and immunobiologicals in Paraguay, whether at the macro level (industry), meso-level (value chain), or micro level (individual companies), makes it difficult to conduct a comprehensive or in-depth analysis of the country's installed capacity in this sector. This scarcity of information underscores the need for further investigation and systematization of the cold chain infrastructure and logistics that supports the national health system.

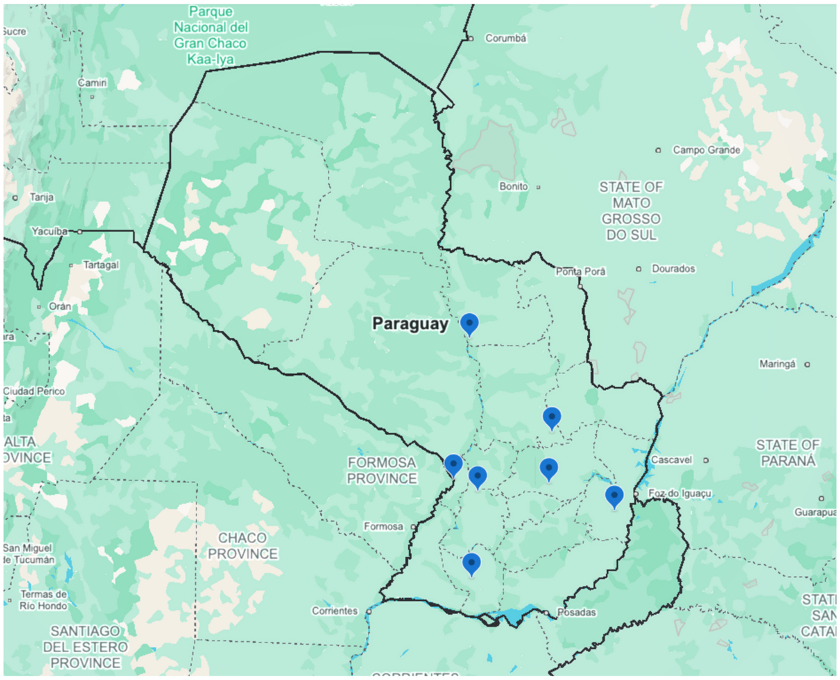
As of 2021, the national vaccination system in Paraguay was coordinated by the Ministry of Public Health and Social Welfare (MSPBS) and is known as the Expanded Program on Immunization (Programa Ampliado de Inmunizaciones–PAI). According to Law 2310/03, it is the responsibility of the Paraguayan State, through the PAI, to provide the population with appropriate protection against vaccine-preventable diseases. This includes the acquisition and free provision of vaccines included in the regular immunization schedule as well as those recommended by the Pan American Health Organization (PAHO) and the World Health Organization (WHO). To fulfill this mandate, the PAI is in charge of the following activities:

- Planning, programming, and budgeting;
- Institutional and intersectoral organization and coordination;
- Training;
- Acquisition and supply of vaccines, syringes, and related materials;
- Cold chain management and safe vaccination;
- Adequate Information systems;
- Epidemiological surveillance;
- Promotion and social communication;
- Supervision;
- Monitoring and evaluation;
- Research;
- Introduction of new vaccines.

Thus, the MSPBS was and is responsible for all stages of the COVID-19 vaccination rollout. As of 2022, the PAI operated 12 cold storage centers equipped with refrigerated chambers. On average, these chambers have a capacity of 37.5 m^3 and can be set to operate at temperatures ranging from 8 °C to -20 °C. Generally, around 1.5 million vaccine doses are stored per cold chamber, operating at approximately 60% of their full capacity, meaning that each cold chamber can hold up to 2.5 million doses. Four of these chambers are located in the capital city, while the remaining eight are distributed among regional centers throughout the country, as illustrated in map 3. At present, the western Chaco region is served by the Regional Center in Concepcion, although a new facility is planned for the city of Mariscal Estigarribia, in the Paraguayan Chaco.

Map 3

Location of PAI storage and distribution centers



Source: Ministry of Public Health and Social Welfare (2021).

By mid-November 2021, the PAI had acquired 7 million doses of COVID-19 vaccines to be administered across 1,600 vaccination sites nationwide. Its installed storage capacity is therefore considered sufficient to meet demand. In addition, the PAI has three refrigerated trucks with a capacity of 8 tons each, and according to 2021 data, transportation from the headquarters in Asuncion to any regional center takes no more than 72 hours. As of November 23, 2021, a total of 5,838,507 doses of the COVID-19 vaccine had been administered, as detailed in table 8.

Table 8

Number of COVID-19 vaccine doses administered in Paraguay as of November 23, 2021

Vaccine	Doses			Total
	1ª	2ª	3ª	
AstraZeneca	717 153	463 304	36 141	1 216 598
Coronavac	20 882	18 971		39 853
Covaxin	101 495	93 215		194 170
Hayat Vax	124 864	119 958		244 822
Moderna	202 875	185 730	6	388 611
Pfizer	1 566 665	1 256 757	32 024	2 855 446
Sinopharm	10 785	2 007		12 792
Sputnik-V	492 814	392 861		885 675
Total	3 237 533	2 532 803	68 171	5 838 507

Source: Prepared by the authors based on data from Ministry of Public Health and Social Welfare.

Although storage centers are located near the country's main urban areas, no significant issues were observed regarding storage or distribution capacity that could have compromised the national vaccination schedule. To prevent new waves of infection in the country, the government has been carrying out promotion and awareness campaigns highlighting the benefits of vaccination for both individuals and society as a whole.

G. Main public policies for the cold chain in Paraguay

No credit lines specifically for the installation of cold chains (whether for storage or transportation) were identified in public or private banking. As of the time of this study (2022), the needs of this sector are met through general industrial financing lines available to the industrial and service sectors. The Paraguayan government has sought to complement the private financial sector to reach all areas of the economy by using a range of mechanisms, namely: the Livestock Fund (*Fondo Ganadero*),[6] the Development Finance Agency (*Agencia F inanciera de Desarrollo*–AFD),[7] and the Agricultural Credit and Housing Institution (*Crédito Agrícola de Habilitación*–CAH).[8] The Livestock Fund is a state entity that finances livestock-related activities. Loans are accompanied by free technical assistance, provided through field visits by specialists in veterinary medicine or agricultural engineering, who guide producers in achieving maximum production efficiency with the financed resources.

The Development Finance Agency is a second-tier bank that offers loans through first-tier entities of the national financial system, known as Intermediary Financial Institutions. The agency defines credit lines for specific sectors. These funds may be used exclusively for:

- Rural development projects;
- Loans to micro, small, and medium-sized enterprises (MSMEs);
- Creation and development of businesses, with a focus on small, and medium-sized enterprises;
- Export of goods and services and import of medium- and long-term capital goods, especially for MSMEs;

6 https://www.mef.gov.py/sites/default/files/2025-06/27-04-fondo-ganadero_1.pdf
7 https://www.afd.gov.py/productos
8 https://www.cah.gov.py/productos

- Tourism development projects;
- Basic infrastructure investment projects carried out by the private sector or through alliances with the private sector;
- Housing and urban development programs, and other actions aimed at reducing the housing deficit.

The Development Finance Agency financial products include:

- PRODESI: Loans for real estate development companies;
- PROPYMES: Financing for small and medium-sized enterprises;
- PROREGADIO: Financing for livestock and silvopastoral investment projects;
- PROCRECER: Financing for general investment projects.

The Agricultural Credit and Housing products include:

- Instruments to finance productive projects and/or acquisition of equipment, adoption of technological innovations, and/or infrastructure;
- Financial products prioritized by the Ministry of Agriculture and Livestock;
- Credit instruments for micro-entrepreneurs.

II. Conclusions and recommendations

The cold chain is not perceived as a constraint to the production of refrigerated and frozen products at the time of this study (2022). Similarly, it does not appear to pose an obstacle to a potential increase in production or to the development of new products in any region of the country. Paraguay has a solid electrical grid, and the establishment of companies in new production areas has been facilitated by grid expansions. Additionally, the National Electricity Administration (*Administración Nacional de Electricidad*–ANDE) offers differentiated rates that benefit the industrial sector, with prices as low as USD 0.04/KWh. From a technological standpoint, there is an adequate number of cold chain suppliers, and no supply issues have been identified regarding equipment or inputs for the industrial sector. Most suppliers are foreign companies, primarily from Argentina and Brazil, with extensive experience in refrigeration systems.

The Ministry of Public Health and Social Welfare (MSPBS), through its Expanded Immunization Program (*Programa Ampliado de Inmunizaciones*–PAI), has sufficient capacity to store and distribute all vaccines included in the national immunization schedule, including the COVID-19 vaccines. The MSPBS's management of the logistics chain is robust and reliable, and the risk of system failure is relatively low. The main challenge faced by Paraguay's COVID-19 vaccination plan in 2021-2020 was related to the supply of doses from international providers. Therefore, it is necessary to create alternatives to ensure secure vaccine supply across countries and regions of the continent.

No credit lines specifically for the cold chain were identified in public or private banking system. In general, industries have access to adequate financing for the installation, repair, or expansion of cold storage units or refrigeration equipment. Additionally, there are tax incentives for industrial investments. However, financing remains a challenge for small and medium-sized producers, especially in the strawberry, tomato, banana, and pineapple value chains.

Although there is a significant level of cooperativism, the issue may lie in the guarantees for credit access. It is recommended that the Ministry of Agriculture and Livestock (MAG), together with the Ministry of Industry and Commerce (MIC), design specific credit lines for refrigeration infrastructure, especially for small and medium-sized producers. This financing could be offered through the National Development Bank.

It was also observed that there is little culture of using refrigeration for many products that require temperature preservation and control. Post-harvest losses are estimated to reach up to 30%, especially for temperature-sensitive products. It is advisable to conduct awareness campaigns for producers and develop financial tools to facilitate the acquisition of refrigeration facilities. If the 30,000 tons of bananas exported in 2022 were handled using refrigerated chambers, about 30,000 m³ of storage would be needed to process this production. Table 9 details a summary of the main problems, proposals, and strategies for improving the cold chain in Paraguayan territories.

Table 9

Identified challenges, proposed solutions and strategies, and key stakeholders

Identified challenges	Proposal	Strategies	Key stakeholders
Lack of cold chain development for small businesses	Establish cooling spaces for small farmers through farmer cooperatives	Encourage the installation of refrigerated chambers in up to three regions of the country through financing and technical assistance for production cooperatives	Ministry of Agriculture, Ministry of Industry
Credit lines for agribusiness that do not target cold chain development	Develop credit lines for the cold chain	Identify needs and development conditions for the cold chain	Ministry of Agriculture, Ministry of Industry, National Development Bank, Development Finance Agency
Lack of statistics or records providing a complete and organized picture of the cold chain in the country	Centralize existing records into a unified database for analysis. Designate INTN as the institution responsible for certification and licensing of refrigerated chambers	Establish a unified registry led by the National Institute of Technology, Standardization and Metrology (INTN)	Ministry of Agriculture, Ministry of Industry, National Institute of Technology, Standardization and Metrology
Low availability of training courses on the cold chain	Create specialized training courses for the cold chain	Conduct feasibility studies to create human resource training courses focused on the cold chain	Ministry of Agricul ture, Ministry of Industry

Source: Prepared by the authors.

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IV. Publications of interest

Boletín Fal 409

Mejor infraestructura para una mayor integración económica en América Latina y el Caribe

Sebastián Herreros
Miryam Saade Hazin

El presente *Boletín FAL* analiza los avances y desafíos de la integración económica en América Latina y el Caribe, con énfasis en el rol del comercio intrarregional y la infraestructura logística y de transporte. Asimismo, identifica los principales obstáculos y oportunidades, y presenta recomendaciones estratégicas para fortalecer la integración regional y mejorar la competitividad y sostenibilidad de la región.

Available in: Spanish

Fal Bulletin 408

The role of trade and transport infrastructure in food security in Latin America and the Caribbean

Sebastián Herreros
Miryam Saade Hazin

This *FAL Bulletin* analyses the role of trade and transport infrastructure in food security in Latin America and the Caribbean. It identifies the main challenges and opportunities for ensuring equitable and sustainable access to food in the region. It also includes strategic recommendations to strengthen the contribution of trade, especially intraregional trade, to regional food security.

Available in: English Spanish