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Fragile Global Chain: How Frozen Berries Are Becoming a Matter of National Security

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Abstract

In the more interdependent and volatile world, frozen food products, especially frozen berries are becoming very important aspects of food security across the globe. Historically considered as auxiliary commodities, the products have currently become strategic in the international trade and national food reserves, especially to the import-dependent countries. This paper discusses the meaning of frozen food in the wider perspective of agri-food systems with regard to the international trade systems as the foundation of food security and food affordability across countries. Studied in the context of current geopolitical conflicts, as well as disruption of trade, and stress on the environment via war in Ukraine, sanctions on Russia, and with the shortage of containers following instability in the Red Sea the research distinguishes the weak points within the global food chains. One of the focuses is on the position of small and medium-sized enterprises (SMEs) to secure regional food system resilience and supply continuity. It achieves this by basing its premises on literature provided by FAO, WTO, WFP and peer-reviewed journals thus providing the structural risks of the food supply chains as well as policy solutions should there be a need to strengthen the food supply chains. The article contends that frozen food as grains and vegetable oils are to be understood now as one of the fundamental pillars of the food system resilience, and such needs to be responded to with geopolitical, economic, and institutional action coordination.

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Introduction

Even though food insecurity today can be attributed to agricultural production or national autarky still, in the 21 st century, it is closely intertwined with global trade, geopolitical stability, changes in climatic conditions and international supply chains. Whole grains and vegetable oil have long been in the spotlight when it comes to the subject of strategic food commodities, yet frozen food products (frozen berries, to be specific) are coming to be in the debate of food system resilience. Products previously considered niche or luxury have been once a staple of global diets, economic prosperity and population healthcare systems of most countries, especially those with small farming seasons or climatic limitations.

A number of factors are interacting to move frozen foods as a convenience good to strategic commodities. To start with, world population, urbanization

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and changing dietary patterns have promoted a year-round demand of nutritionally rich produce, which can be stored, transported and reached with minimum wastage of spoilage. These types of berries, strawberry, raspberry, currants, cranberry and sour cherry are frozen in their first stage; hence they are important in nutrition strategy, school lunch schemes and emergency food stores as they are rich in vitamins, anti oxidants and contain high fibre content.

Second, the effectiveness and extendability of the global cold chain logistics means that nations could be dependent on imported frozen products rather than on harvest and thus, prolongs shelf life. This however has resulted in a weakness. The fragility of global supply chains, and especially part of it that includes time- and temperature-sensitive products, has become evident due to the COVID-19 pandemic, the war in Ukraine, sanctions imposed on large exporters, such as Russia, and trade disputes between European countries. Logistical bottlenecks such as port congestion, lack of shipping containers and clogged transport arteries such as the Suez Canal have revealed the systematic risk to the supply of frozen food products and products thereof across continents due to a geopolitical or climatic shock.

Third, frozen berries are manufactured in certain climatic regions Eastern Europe (Poland, Ukraine, Serbia), North America (Canada, the U.S.), and South America, at least, Chile, that is, the world market is dependent on a narrow subset of producers. The supply of frozen fruits to the global market is undermined when these areas are affected by conflicts, drought, high inflation rates, and shortages of labor. Considering the war in Ukraine, both grains and processed frozen produce exports were disturbed, impacting sequentially the Middle Eastern and African importers.

Small and medium-sized enterprises (SMEs) participate in this equation very importantly. This is because these producers, processors and distributors constitute the core of local agri-food networks and play a huge role in the global provision of frozen berries. Nevertheless, SMEs are also some of the weakest when it comes to economic shocks, variability in climate, and changes in policy. Their capacity to keep their doors open with the help of collaborative frameworks, citizen involvement, and versatile trade policies will play a crucial role in being able to withstand any further shocks in the future.

The article aims to explore the connection of the elements of international trade, geopolitical conflict, and complexity of a supply chain by using the example of frozen berry products. Relying on the data provided by the Food and Agricultural Organization (FAO), the World Food Programme (WFP), the World Trade Organization (WTO), and recent articles in the Nature Food, Global Food Security and Food Policy Journal, the paper will present the argument that the frozen berries are gaining geoeconomic relevance to grains and oilseeds. In this way, they should be covered by both the national and international food system resilience strategies, and specific investments should be made in cold chain networks, diversified trade flows, and safeguarding the small producers.

In this view, frozen berries are not only a food staple, but a geopolitical good one whose supply between and among nations is a part and parcel of the healthy citizens, the stable nations and the propagation of peace internationally.It is a strategic reality that needs to be identified and planned in the context of a world in which multidimensional risk is growing with relation to food systems.

International Trade and Food Supply Chain Security

Food security in the contemporary world does not necessarily mean that enough food should be produced in the locality. It is also about how countries can be able to get food all over the world when they require it. This is achievable through international trade. Food can cover thousands of kilometers between farms to tables through effective logistics networks, bilateral trade agreements and international regulatory rules. This interdependence has enabled countries to vary in their diet, cut shortage during the seasons and stabilize food prices. Major beneficiaries of this system include frozen food items and in particular frozen berries.

The Growing Role of Frozen Food in Cross-Border Supply Chains

Frozen foods have been vital in the international food business. They have a long shelf surveying and are of high nutritional value and have low chances of

getting spoiled that makes them suitable as exports. Nations having favorable climatic situations and technology engage into mass production of berries and freeze them, and sell to far away areas unable to produce the same commercially. The main exporters of frozen berries are Poland, Ukraine, Serbia, Canada and Chile, which sell to the markets of Asia, the Middle East, Western Europe and Africa.

As an illustration, raspberries growing in the Polish fields during summer and frozen may be kept in store, transported in refrigerated containers and used in schools and hospitals in Gulf states during the year. It is not a luxury yet this flow of goods is a necessity to countries that lack agricultural capacity. It contributes to the stabilization of food supply and nutrition of millions of people and in large cities, in particular, where fresh products are either not available or too expensive.

Food Security Depends on Trade Access

International trade makes sure there is no concentration of food in certain places but in other parts of the world. This system however only functions when there is openness and functionality of trade routes. Once, even if a key exporter or axis of transportation becomes unreachable, the impact will be experienced even beyond national boundaries. In the case of frozen berries this would be especially alarming due to the geographic focus of production and concentration among only a few exporting countries. Supply can easily be affected by any disturbance in the zones whether it occurs as a result of war, climatic shock, or even a collapse of economies.

These vulnerabilities have become apparent in the last few years through various disruptions. War in Ukraine not only affected grains, but also recruited a chill on export of frozen fruits. Poland is one of the biggest producers of berries in Europe which has been experiencing strikes and blockades of its cross-border trade. Geopolitical tensions related to Russia in the form of trade embargo have also affected conventional directions of food transfers. The occurrences demonstrate the impact of political decisions and regional strains in relation to the global outcomes which are significant when it comes to the commodity like frozen berries that can not easily be replaced.

Cold Chain Logistics and Maritime Trade Infrastructure

The cold chain is a special form of trade infrastructure, on which frozen food is reliant. These include the refrigerated trucks, refrigerated warehouses, shipping containers and refrigerated ports. Lapse in this chain anywhere may lead to spoilage and wastage. A worldwide poor supply of refrigerated containers, overcrowded ports and increases in the amount of inspection are leading to delays that result in food waste and lower food safety and shelf life.

Global transport of frozen foods depends on major shipping routes e.g. the Suez Canal and the Red Sea regions. When such routes are cut off or when subjected to military confrontation like the effect in the last few years there would be a drastic slowdown in the movement of goods. The small producers make financial losses, the importing countries have to pay higher prices, and even the vulnerable population has restricted access to nutrition rich food.

Table 1 demonstrates the scale of international trade in frozen berries and emphasizes which countries are central to global supply. It also helps identify which regions are most vulnerable to disruptions.

Trade Policy and Regulatory Challenges

Policies also influence international trade in addition to infrastructure and logistics. With sanctions, trade and import bans, the provision of food can be halted in one night. In the periods of wars or political disagreements, nations can be willing to defend their local markets by reserving the export or introducing tariffs. These measures may be particularly harmful in the case of frozen food owing to the perceptibility of the products and the fact that there are few alternative sources.

To use an example, when Poland introduced such limitations in the presence of agri-food imports of Ukraine under the influence of domestic politics, it did not simply produce a bilateral conflict. It had a growing influence on Central and Eastern Europe,

Table 1: Global Trade in Frozen Berries by Country and Region (2015 to 2023)

Country/Region	*Export volume*	*Import volume*	*Top trade partners*	*Annual growth rate (%)*	*Share of global market*
USA	120,000	45,000	Canada, Mexico	4.5	18
Germany	10,000	80,000	Poland, Netherlands	2.1	12

who must depend on stable cross-border supply as its regional processors and buyers. Likewise, the Russian fertilizer ban created a dent to international farming activities, which, by extension, influenced the production of berries in various parts of the world.

The problem is also posed by regulatory inconsistencies. The requirements and rules of food safety, certification and labelling vary by country. In the small and medium producers, cost can be high and time consuming to comply with such standards to export to the international market.

The Human Dimension of Trade-Dependent Food Security

Essentially, it is not economics but people that food trade is all about. The results of failure of supply chains are witnessed in school cafeterias, home kitchens, refugee camps and in the healthcare systems. Children lack the vital vitamins. Expectant mothers do not have access to fruits rich with iron. Food aid initiatives cause additional expenses to the humanitarian organizations. In this respect frozen berries are not simply a traded good.

To have a strong trade system, it is important to invest in the infrastructure of cold chain, encourage cooperation among trading partners, and maintain trade open even at the time of crisis. It includes the understanding of the strategic role of frozen food in national security planning and stands behind small producers maintaining the functional state of such systems.

Frozen Food Products as a Pillar of Global Food Security

Frozen food is no longer a luxury or convenience. With the changing world that grows more and more under the influence of climate change, the tensions, both geopolitical and environmental, the process of urbanization, and supply chain instability, frozen food has become a pillar of food security. The top foods that fall under this category are frozen fruits, especially berries (strawberries, raspberries, sour cherries, currants, and cranberries). Not only are such fruits appreciated in terms of their nutritional value but also they help in stabilization of diets, economies as well as health sector programs in both the developed and developing regions.

Nutritional Value and Public Health Significance

Frozen Berries contain a high amount of nutritious essential vitamins, antioxidants, fibre, and micronutrients. Frozen berries have turned out to be an imperative source of nourishment in lots of regions of the world, particularly those that experience restricted entry to fresh products either because of climatic challenges or financial hindrances. They are usually picked at peak ripeness and flash frozen, meaning that most of their nutritional value is preserved and overall it is usually better and safer than off-season fresh vegetables.

The products find application in schools feeding, hospital nutrition and in disaster response. They prevent malnutrition and enhance food variety in low-income contexts. The health-loving people in high-income countries, with an increasing number of consumers using berries all year round as an added benefit, are the customers of these.

Strategic Advantages of Frozen Over Fresh Produce

Frozen goods are products with major strengths that are important to modern food planning. They do not have seasonal restrictions like fresh fruits, as well as local climate circumstances, or transportation time. This enables governments, Non-governmental organizations and food distributors to design reliable nutrition programs in the long run and warehoused emergency reserves.

Well-preserved frozen berries have a storage life of months, depending on the right environment, and this saves a lot of food waste and lowers the overall collective cost of commodity storage due to its low perish ability. They are further less prone to eventualities in the market as they can be relocated in large profiles and not on an urgent basis hence making supply chains flexible and responsive.

Moreover, the emergence of natural calamities and wars around the world has caused a scenario whereby frozen food has been employed to offer emergency protection. Frozen berries in most cases find their way into food baskets given to displaced people and constitute a great process in stabilizing food in war-torn regions.

Global Trade Networks and Geographic Production Hubs

Berries that are frozen are mainly manufactured in areas that have pleasant growing conditions, efficient harvesting systems and excellent cold chain facilities. The Eastern Europe region and Poland and Ukraine, in particular, are leaders of supply on a global scale. There is also the donor North America with contributions by Canada as well as the United States. Chile is a country of counter-seasonal output which has been supplying a critical amount of exports to the Northern Hemisphere in winters.

These berries are exported to other continents to bring supplies to cities in Asia, Middle East, and Africa where it is impossible to grow them. In most of these areas, the frozen berries are the only viable avenue of getting a year round supply of nutritious fruits.

Geopolitics Crisis and Supply Chain Disruptions

The twenty-first century is about the events that are far beyond food security in the twenty-first century. Posing threats to food supply chains globally are now some of the worst threats such as geopolitical conflicts, economic sanction, trade disputes, and climate-related disasters. Berries and other frozen food products are especially sensitive as they require the maintenance of the cold chain of transportation, particular storage, and transboundary collaboration. With these shocks increasingly occurring with more frequency and unpredictability the ability to have resilient food systems is more vital than ever before.

The Russia Ukraine Conflict and Its Ripple Effects

The war between Russia and Ukraine has also greatly affected the world's food systems. Besides producing large amounts of grains, Ukraine is a large provider of frozen vegetables and fruits. Ukrainian agricultural exports are unable to enter into the global markets since the onset of the conflict due to ports in the Black Sea being blocked or closed.

Russia, however, is one of the biggest suppliers of fertilizers. The effect of sanctions put in place by the western countries broke down exports of fertilizer, which meant that farmers across the globe had to suffer more input prices. Increased fertilizer costs decrease agricultural productions in the long run which offsets fresh and frozen produce making it costly and scarcer.

The impulses do not remain in Europe. The North Africa and the Middle East countries that largely depend on Ukrainian and Russian goods and especially foodstuff have had their food prices jump drastically. In a good number of these areas, the frozen berries are included in key nutrition plans. When the chain disruption occurs, it reduces or stops the access to these products.

Trade Barriers and Border Conflicts in Eastern Europe

Besides the war, new trade barriers have emerged in Eastern Europe due to political wrangles. Poland has frequently turned off Ukrainian agricultural products because of the internal farmer protest and infrastructure snags. Such restrictions involve frozen food items that are delivered by land or rail transporting them in Poland to other countries in the European Union.

Long delays on perishable goods have been caused by border blockades, slow inspections and random strikes. It does not only cause producers to lose money but leads to more products that are spoiled and a lack of availability in the market.

In the case of a small berry producer in Ukraine, where many producers work in the framework of cooperatives or small commodity export companies, such distractions result in long-term financial stress.

Red Sea Instability and Maritime Trade Vulnerabilities

Food products in a frozen state usually move along vital sea routes thousands of kilometers in refrigerator boxes. Most of the routes used to carry agri-food products between Europe and Asia and Africa are the Red Sea, the Suez Canal and the Strait of Hormuz.

Recent unsteadiness in the Red Sea region which brought about aggressive military action and a threat of piracy has detained many shipping companies to divert routes to longer and costly routes. Those longer routes add on to the transport costs and time. This may cause frozen berries to have a shorter shelf life, increased insurance expenses and pricing in retail outlets as well.

It is compounded by the fact that not enough refrigerated containers are available. In the recent years global supply chain crunch, there was a lack of cold storage containers where the frozen products at ports waited or were stuck in transit. Products also run a risk of being of poor quality even when they come in after a long period of time.

Climate Change and Environmental Disruptions

Due to climate-related shocks, stressed out food systems are becoming even more troubled. The expansion in production of berries in the major exporting nations has led to droughts, heatwaves and unexpected frosts impacting production of berries. As an illustration, an extreme drought in certain areas of Poland and Serbia contributed to poor businesses and diminishing quantities of exports. Meanwhile, fluctuation in weather in Chile and Canada has affected production across seasons.

Such changes do not only diminish quantity among the environmental changes. They also interfere with quality, where farmers have to dispose of huge quantities of produce, or have to sell it unprofitably. During frozen berries, the factories are also using a lot of energy on freezing as well as

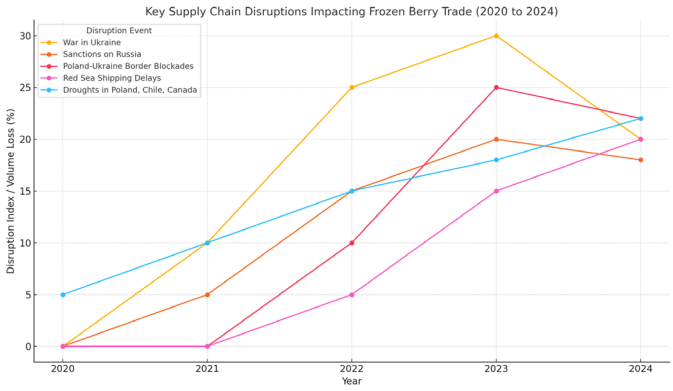

Figure 1: Key supply chain disruptions on the frozen berry trade from 2020 to 2024

storage. The whole supply chain is less sustainable and pricey once there is an increase in energy prices when there is some climate or conflict shock.

The line Figure 1 showing the impact of key supply chain disruptions on the frozen berry trade from 2020 to 2024. Each line represents a major disruption, with the Y-axis showing estimated volume loss or disruption severity.

Institutional Fragility and the Need for Preparedness

Most of the frozen food small and medium-sized enterprises are not well institutionalized to withstand such compounding shocks. They also find it hard to receive emergency funds, alternative trading options, or specialized computer applications that can analyze the market and exchange information in real-time. This means that any slight disturbance can result in tremendous operational and financial losses.

International agencies and governments should work together in creating cushions into the food trade system. Some of these are a coordinated response to diplomacy to ensure borders remain open during times of crisis, financial safety net to small produce and investing alternative logistics routes that avoid vulnerable chokepoints.

A Growing Recognition of Frozen Food in National Security Planning

What used to be likened to one of the privileges of a consumer is now gaining relevance in the national interest. With the emergence of frozen berries into

the school menu as well as hospital diets and food aid in humanitarian emergencies, not only the health of the population but also political stability may be at stake.

Governments must begin to treat frozen food as a strategic commodity and include it in national food security strategies. This involves stockpiling, domestic production support, and securing trade partnerships with reliable suppliers. The private sector also plays a role by investing in technology that increases resilience, from blockchain-based supply tracking to renewable energy-powered cold storage systems.

This visual emphasizes how frozen berry exports are concentrated among a few key countries and reflects their strategic role in the global trade system (Figure 2).

Frozen Berries and Economic Security for Producers

Frozen berries industry benefits thousands of small-scale and medium-sized businesses and particularly in rural Europe and South America. Farmers in Poland or cooperatives in Ukraine can find a way to grow berries as a solid income with increasing export. These business ventures are economically successful and they help in community development, employment and stability of the rural areas.

Nonetheless, producers are experiencing a greater threat of climate change, labor shortage, and trade shocks. The late frost, drought and uncertain rain falls have already cut the yields in some of the

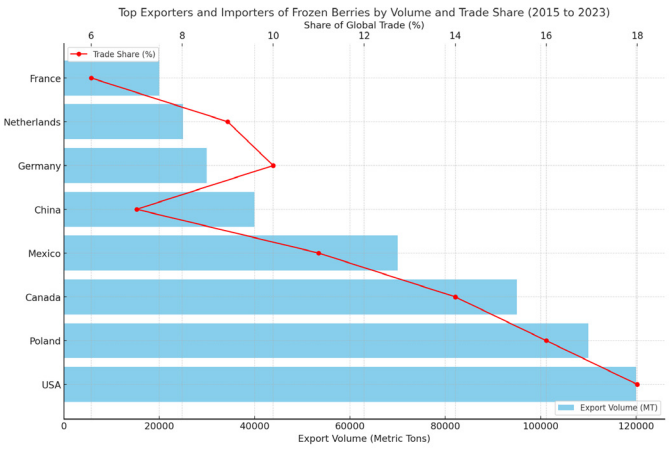

Figure 2: Top Exporters and Importers of Frozen Berries by Volume and Trade Share (2015 to 2023) Share of Global Trade (%)

major regions. Increase in the cost of energy and inflation has an impact on the freezing and storage processes. Such businesses are exposed to death when they cannot get access to markets reliably.

The national and international authorities should realize that it is not just an issue of economic growth to support the frozen berry industry but it is also a matter of international food security. Through investment into such infrastructure as cold storage facilities, collaborative networks and export infrastructure, nations can not only preserve livelihoods but also food security.

The Changing Status of Frozen Food in Food Policy

Frozen food has little place in national policies on food security, and discussions on this are majorly on grains, pulses and oils. However, with the expanded need of frozen berries in terms of both their relevance to the overall health of the population and economy, as well as emergency feeding systems, there has been an increasing agreement that berries should be regarded as a core value in national and international food security systems.

A number of governments are also starting to adopt frozen food stores and food policies. Global agencies like the World Food Programme too have been tapping more of the frozen items in logistic strategies to mobilise quickly amidst the crisis. Nevertheless, policies are disjointed. They require the world to have standardization, trade agreements that secure the movement of cold-chain products during the crisis, and subsidies that enable small producers to access modern technologies of freezing.

The reframing of frozen food as a strategic necessity not a commercial luxury is crucial. As global supply chains become more complex and fragile, frozen berries offer a rare example of a product that supports resilience across every level of the food system.

Geoeconomic Shocks and the Strategic Role of Small and Medium Enterprises

Today, sudden changes in the global economy of food systems are not only influenced by physical

developments or events such as drought or conflicts. Geoeconomic shocks that affect production and distribution of food include inflation, energy price spikes, currency fluctuations, trade barriers and breakdowns in supply chains. Although such impacts may not cause a big dent on the multinational companies that have the financial freedom to either absorb or adjust to the change, it is the small and medium sized enterprises that are most vulnerable.

Small and medium producers, processors and exporters form the backbone of the international supply chains in the frozen food industry especially in the case of frozen berries. Such enterprises have become part and parcel of the local communities and are normally the key linkages between small farmers and the international markets. Their survival is vital towards the sustainment of agricultural jobs, rural livelihoods, and supplying high-nutrition food products continuously to international markets.

Inflation and the Rising Cost of Food Production

Overall, in recent years, a lot of farming businesses have not coped with increasing expenses. The cost of fuel, fertilizers, packaging requirements, cold store installations and workforce is on the increase. Efforts to scale back costs particularly through laying-off are becoming difficult as small and medium sized firms (SMIs) usually work under low margins. To people engaged in the chain of frozen berries production, these increases in costs can be fatal.

One of the overhead costs is electricity to be used at the freezing and storage plants. Small producers tend to be unable to resist production reduction or even shut down in countries where the prices of energy have risen as a result of global shortages in oil gas or cut in national subsidies. Such increases in cost ultimately take the form of increased prices to the consumers and decrease the availability of frozen fruits in low income areas.

Currency Volatility and Export Risk

Most of the important exporters of frozen berries are based in cake countries with weak or floating currencies. To give an example, Ukrainian, Serbian and Chilean producers usually sell them to European Union, North America or Middle East markets, with payment being received in euros or US dollars. With sudden shifts in currency values, exports and imports costs may alter radically.

The small and medium enterprises can have no access to sophisticated financial tools such as hedging tools or foreign currency backup. Consequently, any slight fluctuations in exchange rates will culminate to severe losses or loss of competitiveness in international markets. When such firms fail to execute contracts or offer steady prices this causes imbalance in the chain of supply.

Limited Access to Capital and Credit

Many small and medium-sized frozen berry companies, unlike the big agribusiness, do not have easy access to financing. It is hard to get loans on agriculture projects, especially projects that need costly cold storage or export quality processing. The banks can find such businesses with considerable risks, especially in economically troubled or politically volatile areas.

At no investment, these producers are not able to modernize their plants, renovate freezing devices or increase storage. The high-income markets also restrict their ability to export to them since they cannot comply with the requirements of the market. This will result in a reliance on middlemen who recover more profit making sustainability and resilience of the producers smaller.

Impact of Geoeconomic Shocks on Frozen Berry SMEs in Key Exporting Countries

This visual help illustrates where SMEs are most vulnerable and which external shocks are the most damaging to their operations and food security contributions (Figure 3).

The Adaptive Role of Local Enterprises in Food System Resilience

Nevertheless, these are some of the challenges that affect small and medium-sized enterprises and

their role in creating resilient food systems. They are usually able to react quicker than bigger institutions because of their flexibility, neighborhoods and adaptability.

Most people have come up with imaginative coping mechanisms. In Poland and Ukraine, the cooperation of the berry sector is also trying to gather resources and invest in the communal freezing and storage capabilities. Digital tools are also being implemented in Chile and Canada to communicate and reach foreign buyers without having to deal with the expensive middle persons. This has meant that some have gone to the level of collaborating with humanitarian organs as well as government institutions to take the frozen berries to the schools and hospitals thus establishing new markets as they tend to the social needs.

These reactions are indicative of the huge importance of involving SMEs in the global trading continuity as well as locally in food security. Putting resources in their sustainability and development is not just an economic policy. It is a plan on food security.

Policy Imperatives and Global Coordination

To support small and medium-sized enterprises in the frozen berry sector, governments and global organizations must take deliberate steps. These may include:

- Targeted financial support such as subsidized energy costs and low-interest loans
- Public investment in cooperative cold storage and logistics hubs
- Trade agreements that protect SME access to markets even during global crises
- Technical assistance to help meet international food safety and certification standards
- Inclusion of SME voices in international trade and food policy decision making

Properly supported, such enterprises will be able to act as the source of stability; they can ensure food supply on the domestic market as well as export processes in the shock of geoeconomic impact.

The existence of small and medium frozen berry enterprises is equally demanding with inflation,

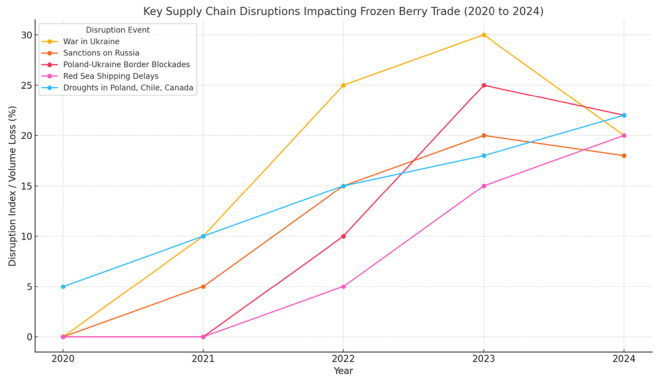

Figure 3: Key Supply Chain Disruptions Impacting Frozen Berry Trade (2020 to 2024)

currency shocks and instability of trade. However, they are absolutely essential because of their involvement in ensuring food security between countries. They do not only matter in terms of business sustenance but also the strategic aspect of global food security. Empowering these actors is investing in a more stable, inclusive, and resilient global food system.

Policy Recommendations and Food Resilience Frameworks

The frozen food products are also becoming essential to keeping nutrition and food security around the globe throughout the year. With the international food system increasingly unstable, owing to war, climate upheaval and financial shocks, it is no longer optional to intervene appropriately and to plan across the board resilience. They are necessary. Different stakeholders including governments, trade organizations, private actors, and the civil society can also play their part to create an efficient and yet equitable, sustainable, and shock-resistant food system.

This chapter summarizes major policy suggestions and proposes a framework, based on present reality, projecting potential future challenges, and giving high priority to safeguarding the consumer and the small-scale producers. These suggestions are based on prominent international reports from the FAO, WFP, and WTO, along with more recent scholarly analyses of food trade arrangements.

Table 2: National-Level Food Resilience Framework for Frozen Berry Supply Chains

Policy Area	*Action*	*Stakeholders*	*Timeframe*	*Expected Outcome*
Cold Chain	Solar-powered storage hubs	Local govt, private sector	Medium	Less spoilage, lower energy cost
Trade Policy	Fast-track lanes for perishables	Customs, trade ministries	Immediate	Fewer border delays
Transport	Upgrade rural roads, cold trucks	Transport ministry, logistics firms	Long	Better delivery, rural access
Climate Response	Support drought-resilient farming	Agri. services, farmers	Medium	Stable production
Risk Forecasting	Early warning systems	Weather agencies, food security units	Medium	Timely response to disruptions
Regional Cooperation	Strengthen food trade pacts	Foreign affairs, trade blocs	Long	Supply diversification
Finance	Subsidize cold transport, offer insurance	Finance ministry, insurers	Immediate	Reduced trader risk
Data & Monitoring	Real-time supply chain dashboard	Stats offices, tech firms	Medium	Smarter decisions, quick response

Strengthening Trade Reliability for Frozen Products

Frozen foods like berries depend on trade channels that are stable and secure. Trade continuity must be prioritized by policymakers when faced with geopolitical tensions and logistical bottlenecks.

Recommendations include

- Expanding bilateral and regional trade agreements that recognize frozen food as an essential commodity
- Creating fast-track clearance programs for temperature-sensitive shipments at borders
- Encouraging trade diplomacy to keep agri-food corridors open during political crises
- Establishing joint emergency trade protocols between neighboring states

Nations should strive to recognize each other's food quality and safety standards. This will eliminate delays resulting from inspection and enable fast transportation of frozen products across international boundaries.

Investing in Cold Chain Infrastructure and Technology

Food systems that are resilient need good logistics. Cold chain facilities must be improved and modernized to avoid spoilage, minimize waste, and address increasing demand for frozen foods in urban and rural markets.

Key investment areas include

- Public-private partnerships to finance cold storage facilities in high-risk regions
- Mobile refrigeration units for smallholder cooperatives
- Solar-powered or renewable-energy-based cold chains to reduce operational costs
- Digital tracking systems for real-time monitoring of temperature and transit conditions

By investing in infrastructure development in regions of constrained capacity, governments can both enhance domestic food availability and export potential.

Empowering Small and Medium Agricultural Enterprises

Small and medium-scale enterprises are at the forefront of frozen foods production, especially for berries. They are, however, faced with financial, regulatory, and market access limitations. Policy must be altered to actively prefer and incorporate these actors in resilience planning.

Support strategies may include

- Subsidized access to energy for freezing and storage
- Simplified export compliance processes for small producers
- Creation of cooperative financial institutions and microcredit schemes for rural enterprises
- Digital platforms that allow direct connection to international buyers

Through supporting these businesses, governments provide long-term continuity of supply chains and safeguard rural livelihoods.

Enhancing Food Security Governance and Institutional Coordination

Fragmented institutional responses tend to undermine food system resilience. National food agencies, trade ministries, disaster response agencies, and private sector entities need to work together through common frameworks.

Proposed policy tools include

- National Food Security Councils with private sector and farmer representation
- Integrated Food Security Risk Dashboards that use satellite and market data to detect early warnings
- Dedicated agencies to manage strategic frozen food reserves for emergencies
- Public food procurement systems that prioritize small frozen berry suppliers

This type of coordination allows governments to act quickly during a crisis and protect vulnerable groups from price spikes or shortages.

Integrating Frozen Food into National Food Security Strategies

Food security planning in most countries has historically been focused on grain and oilseed inventories. That must change. As frozen foods become integral to school lunches, urban food supplies, and public health preparedness, they must be part of national food security planning (Table 2).

Governments should

- Maintain strategic frozen food reserves alongside dry commodities
- Include frozen foods in public procurement for schools and hospitals
- Develop seasonal import planning based on projected climate and trade risks
- Classify frozen berries and vegetables as essential for customs and logistics

Recognizing frozen food as a public good shifts the mindset from commercial commodity to strategic asset.

Promoting Global Collaboration for Equitable Food Access

Global food resilience requires global cooperation. No single country can safeguard food security alone. Exporting countries must coordinate with import-dependent nations to ensure fair, consistent, and ethical access to frozen food.

International efforts should include

- A global forum under FAO or WTO dedicated to cold-chain food trade security
- Data sharing platforms on trade disruptions and food inventories
- Joint investment in South-South partnerships for cold chain technology
- Humanitarian food programs that integrate frozen produce into crisis response

These collaborations can prevent export bans based on panic and establish equitable distribution of scarce foodstuffs.

Policy settings must be changed to suit the new landscape of global food trade. Frozen fruits, once seen as complementary, are now securely

embedded in nutritional security, rural livelihoods, and international partnerships. Trade negotiations, energy subsidies, and food reserve management--resilience begins when all actors are counted, all threats are mapped, and all voices are heard.

Governments and institutions that act today to stand up for the frozen food system will be in a stronger position to handle crises in the future, protect their citizens, and build a food system that works for people and the planet.

Conclusion

Geopolitical tensions, variations in climate, economic upheavals, and changing trade partnerships are putting real strains on the global food system to unprecedented levels. In this elaborate environment, frozen food items especially frozen berries have become silent but vital sources of food security, food stability or balance, as well as international relations. These products were previously thought of as supplementary or seasonal but now they are taking a center stage in guaranteeing that the people of the globe are enjoying nutritious and nutrient-enriched foods regardless of seasons.

Frozen berries are not only agricultural products. They are military resources. They are essential and at the same time exposed to collapse due to their long shelf life, nutritional value, and reliance on global supply chains. Caused by the war in Ukraine, restrictions on major suppliers, crop failures due to climate change, and Eastern European blockades on trade, have demonstrated how vulnerable frozen food systems are to these external shocks. Such outages are not unrealistic, as they are traded in the form of increase in prices, dip in supply, and aggravation of the food security in the importing countries as well as exporting countries.

Due to these increasing threats, the international community needs to reconsider food security policy in a more engaging and resilient perspective. This implies the understanding that frozen products are the significant elements of the national and international food strategies. It entails the investment in cold chain networks and investment in small and medium enterprises, and international cooperation, and incorporation of frozen foods in the institutional purchases and emergency stocks. In addition, frozen berry supply chain strengthening brings more than food security; it safeguards livelihoods, enhances rural growth and strengthens the right to food in the world. To become productive contributors to the global food system, small producers, particularly in Eastern Europe and Latin America have to be enabled and empowered by access to funds, training, and guaranteed market access.

It is impossible to consider food security anymore without ignoring trade patterns, technological base, and geopolitics. Since the issue of frozen berries enters the national security discourse, governments and institutions should interact across sectors and borders. It is only by joining our efforts that we can anticipate defending these frail supply chains and guarantee that nutrition, dignity, and access can still be shielded in a world which is growing progressively hostile and unpredictable.

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