Special Article

Transportation Technology Eases the Journey For Perishables Going Abroad

Perishable agricultural products, many of which U.S. farmers could only have dreamed of selling abroad just 10 years ago, now account for about 20 percent—a growing share—of total U.S. food and agricultural exports.

Income growth overseas and accompanying changes in food preferences and diets are most often cited as drivers behind the more-than-decade-long shift in U.S. agricultural exports from bulk commodities (e.g., wheat and soybeans) to nonbulk items (e.g., meats and fruit). While income growth and some policy measures to liberalize trade are key determinants in the rise of perishable shipments, advances in transportation technology are equally important. For U.S. agriculture to benefit from growing overseas demand for, say, fresh asparagus, shippers must be able to deliver perishable products to purchasers thousands of miles away with no substantial loss in freshness and quality.

For many producers, marketing prime-quality perishable products abroad was largely infeasible or prohibitively expensive until new technologies were developed during the last 30 years. Packaging innovations, fruit and vegetable coatings, bioengineering, and other techniques that reduce deterioration of food products have helped shippers extend the marketing reach of U.S. perishable products. In addition, new technologies in transport are gradually opening the ocean trades to a host of perishable products. As a result, U.S. exports of horticultural products now travel much greater distances than before.

Outside North America, markets for U.S. perishable products are concentrated in high-income Asian countries and to a lesser extent in Europe. Beef and pork produced in the U.S. Midwest is chilled or frozen in regional packing houses, moved overland to west coast ports, and shipped by sea to Japan and South Korea. Fresh broccoli goes by ship from California to Japan, and fresh cherries travel the ocean from Washington State. Perishable products as fragile as avocados, lettuce, mangoes, and nectarines are increasingly transported by sea to Asia and Europe from the U.S. and from other suppliers like Mexico and Chile.

Trans-ocean transportation costs are still much higher for many perishable products than for raw agricultural products like cotton or nonperishable products like nuts and raisins. However, new developments in ocean shipping have made it possible to preserve the quality of perishables during transport and still bring down transportation costs. For example, successfully shifting perishable product exports from air to ocean transport can reduce transportation costs by as much as 75 percent.

In addition, satellite technologies, particularly global positioning systems (GPS), which are becoming increasingly available and less expensive, enable shippers to follow their cargo around the world electronically. Sitting at computer terminals, they can monitor quality, reduce risk (and costs) of liability claims, and shorten cargo retrieval time. Profitability of perishable product trade will likely increase further as ocean shipping technologies continue to adapt to the requirements of horticultural products and as shipping lines expand use of these technologies.


Port of Charleston, SC

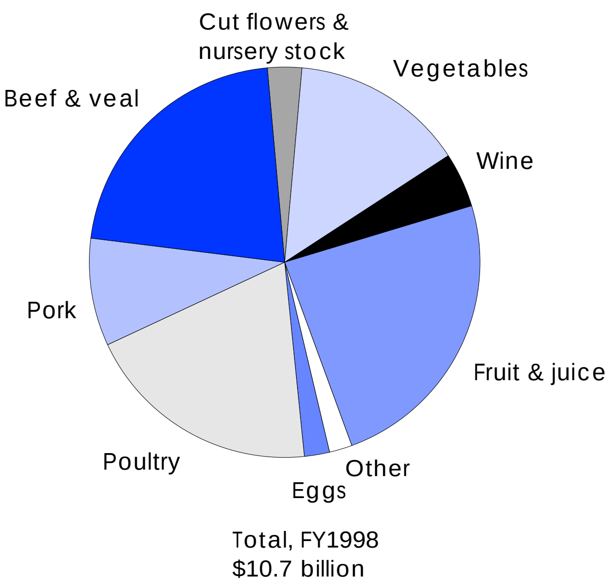
U.S. exports of perishable products increased from $3.5 billion in FY 1989 to $10.7 billion in FY1998. Meats accounted for about half of perishable exports in FY 1998 and fresh fruit and vegetables about one-fourth. Other countries—and U.S. consumers—also benefited from improving transportation technology, as the U.S. imported $11.7 billion of perishable products in FY1998, with horticultural products (including fresh vegetables, fruit and juice, bananas, cut flowers, and nursery stock) accounting for 60 percent.

A Boost for Ocean Shipping— Containers & Cold Chills

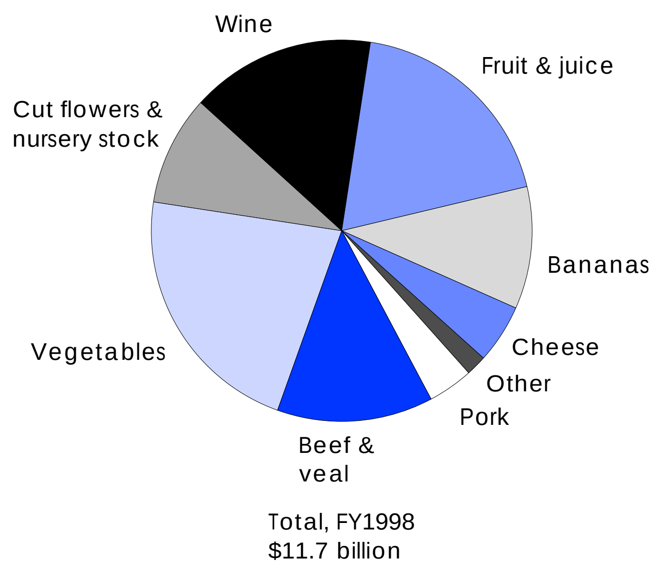
The high cost of loading and unloading is one reason transportation costs tend to decline with distance. The revolution in perishable product shipping technology began with a simple idea called containerization—handling standardized containers filled with cargo, rather than handling the cargo itself. Containerization led to a radical change in global shipping practices known as intermodalism—moving goods by linking two or more modes of travel.

Containerization is recognized as a major contributor to the steady reduction in world transportation costs since the 1950's.

Meats Top List of U.S. Perishable Exports . . .



. . . While Fruit and Vegetables Dominate Imports



Economic Research Service, USDA

For perishable products, however, the increased speed of handling and reduced transport costs that came with containerization were not enough. Ocean transport of cooled and frozen cargo received a substantial boost with development of mobile refrigerated containers called "reefers" in the 1960's.

Reefers, like regular containers, are 20-foot or 40-foot boxes with their own refrigeration units. Reefers can be carried alongside general, nonchilled containers, an advantage that has challenged the competitiveness of conventional, dedicated refrigerated cargo ships that lack this flexibility.

The reefer share of containerized cargo is now about 9 percent and accounts for about 20 million tons of cargo annually. Although deep-freeze and dedicated refrigerated vessels are also important for perishable product trade—especially in carrying palletized chilled hardy fruit such as apples, peaches, pears, grapes, kiwifruit, citrus, and bananas—the reefer container trade is growing more rapidly and is considered better suited to carrying the hardy fruits as well as produce needing more careful handling, like asparagus.

Increasingly efficient and accurate cooling systems have allowed refrigerated carriers to maintain temperatures with great accuracy (plus or minus a quarter degree Celsius) for some time. More recently, however, controlled atmosphere (CA) technologies added refinements that have extended the shelf life of perishable products and thus expanded the types of perishables that can be shipped in reefers without spoilage.

CA technologies allow operators to lower the respiration rate of produce by monitoring and adjusting oxygen, carbon dioxide, and nitrogen levels within a reefer. In this way, CA can slow ripening, retard discoloration, and maintain freshness of supersensitive perishables like lettuce, asparagus, peaches, mangoes, and avocados that would not survive well during ordinary refrigerated ocean transport.

Not all CA systems are the same: some especially sophisticated ones are combined with systems to maintain relative humidity, a crucial factor for some produce such as grapes. In addition, remote reefer monitoring systems can transmit and collect performance information electronically so that physical checks are not required while the reefer is stacked in the hold or on a dock. The remote system may also activate an alarm, helping minimize losses when problems arise at sea or in the container yard.

Transportation & Trade Workshop

USDA's Economic Research Service is sponsoring a workshop to identify research needs and priorities in the transportation sector.

Technological and Structural Change in the Transportation Sector: Impacts on the Future of U.S. Food and Agriculture Trade

When: *March 17-18, 1999*

Where: *Washington, DC*

For information, contact Bill Coyle (202) 694-5216
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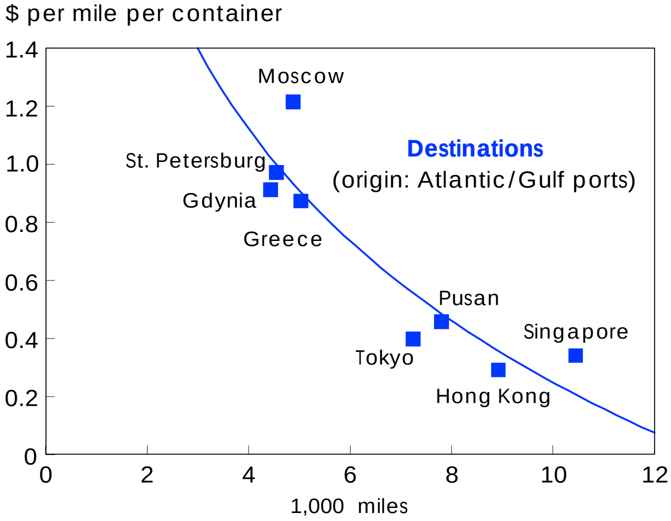
Per-Mile Shipping Costs Decline With Distance for Container Loads of U.S. Frozen Poultry



Source: *Ocean Rate Bulletin*, October 28, 1998, Agricultural Marketing Service, USDA.
Economic Research Service, USDA

Container Ship Technology Keeps Pace

Accompanying advances in containerization has been change in container ship technology. Container vessels are being built larger and larger, making them more competitive with traditional refrigerated vessels. Increasing cargo capacity generally leads to lower per-unit costs.

In the 1970's, container ships on the world's major trade routes were built to carry an average of about 2,500 TEU's (standard containers with exterior dimensions measuring 20 feet by 8 feet by 8 feet). New vessels deployed on major routes are often 5,000-6,000 TEU's. Per-container vessel operating costs are about 50 percent lower for a current 5,000-TEU ship compared with a 2,500-TEU vessel.

The challenge, however, is to increase capacity while maintaining stability and safety—particularly important for ships carrying tall stacks of containers. New hull shapes and ballasting systems improve stability at sea, while bow thrusters make these large vessels more maneuverable in port than their smaller predecessors.

The largest container ship now in service, the *Sovereign Maersk* (built and registered abroad), is estimated by industry analysts to have capacity upwards of 6,600 TEU's, including space for over 800 refrigerated TEU's. The refrigerated capacity alone makes the gigantic *Sovereign Maersk* equivalent to a medium-sized conventional refrigerated carrier. Vessels of this size are expected to become more common—and ships may get even larger. As a result, container ships are expected to increase market penetration at the expense of conventional refrigerated carriers, especially in the major trans-Atlantic and trans-Pacific trades.

At the same time, the conventional refrigerated shipping industry is not standing still. New ship designs allow more rapid loading and discharge, with forklifts moving throughout the holds. Onboard cooling plants have become highly efficient. The industry is concentrating into fewer and larger firms to increase efficiency, and vessel pooling arrangements help companies utilize capacity more effectively. Some refrigerated carriers can now carry loads of containers on deck, and operators are increasingly using their refrigerated vessels to carry other cargoes, such as autos and palletized machinery, on a seasonal basis, which helps even out earnings for carriers.

Although it is likely that container ships will dominate the perishable trade between North America, East Asia, and Europe, conventional refrigerated vessels can serve many smaller ports, especially in the developing world, that are unable to handle large container vessels. Thus, in north-south trade and in certain niche markets, conventional refrigerated ships may have a brighter future, but even here, competition from container vessels is bound to increase as costs decline.

Constraints on Shipping Perishable Products Remain

Despite tremendous progress in adapting shipping technology to the marketing of perishables, there remain significant constraints to the expansion of perishable product trade. Some constraints derive from economic and environmental issues associated with the technologies.

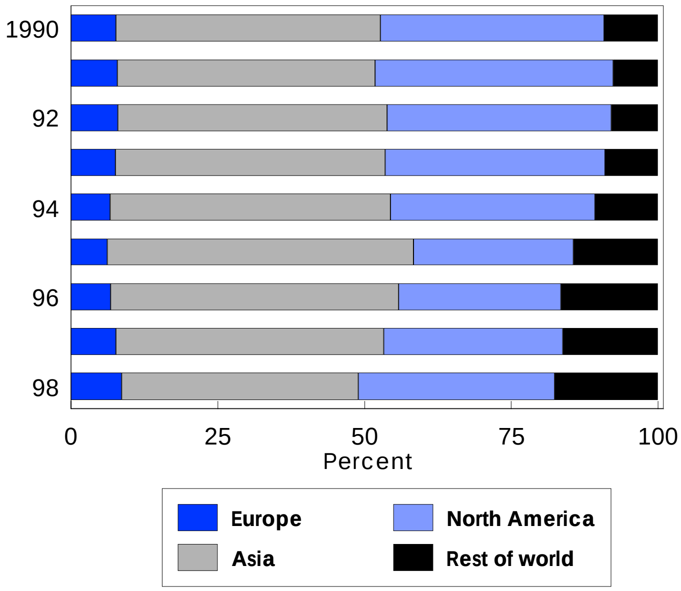
New Technology May Protect the Planet As Well As Produce

Controlled atmosphere (CA) technology, now used primarily in shipping highly sensitive perishables, may develop as one substitute for chemical treatment of agricultural products during shipping. A number of companies are working collaboratively with USDA to investigate more environmentally friendly technologies to eradicate insects that harm fruit, vegetables, feed, and wood products.

For example, methyl bromide is a broad-spectrum pesticide, used primarily as a soil fumigant but also as a fumigant for commodities entering or leaving the U.S. Because of concerns about methyl bromide's high toxicity and ozone-damaging properties, production and importation of the pesticide is scheduled to be phased out by January 1, 2005 under terms of the Montreal Protocol, an international treaty to protect the earth from ozone-depleting substances. However, the treaty exempts preshipment and quarantine uses of methyl bromide.

EPA, working closely with USDA, state agriculture departments, and other stakeholders, will define preshipment and quarantine uses that will be exempted from the phaseout. CA systems that kill insects with low temperatures and a mixture of naturally occurring gases could become one of several effective substitutes for methyl bromide treatment.

Asia Is Still the Leading Market for U.S. Perishable Exports



1998 forecast.
Economic Research Service, USDA

First, CA technologies, particularly some of the more complex systems, are expensive for carriers to adopt and install, especially at a time when shipping rates are low and exporters are still undecided whether a potentially higher price in foreign markets justifies the premium they pay for shipping via CA. Although continued technological refinements and developments and increasing competition among manufacturers of CA systems are bringing investment costs down, much of the CA reefer trade is seasonal (timed, for example, to the fruit harvest) and therefore particularly vulnerable to income swings. The reefer business can be very profitable because of the high value of the cargo, but some industry analysts believe that the CA reefer trade, while continuing to grow, will remain a niche market.

Some questions also remain as to how international environmental agreements and national environmental regulations will affect the availability of economical and environmentally friendly refrigerants for reefer systems. Chlorofluorocarbon compounds (CFC's), the predominant refrigerants used in reefer containers, are being phased out under the terms of the 1990 Montreal Protocol international treaty because of their damaging effect on the ozone layer.

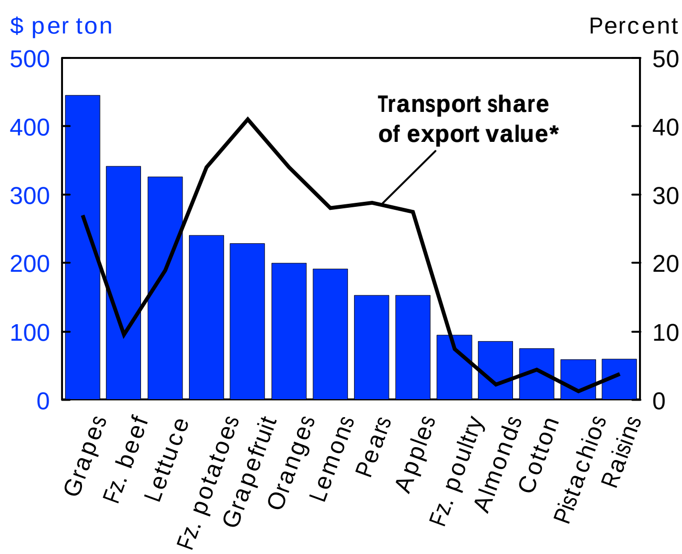
The most popular replacements for CFC's are hydrochlorofluorocarbons compounds (HCFC's), which have limited ozone depletion potential. However, HCFC's are expected to be phased out in favor of hydroflourocarbons (HFC's), which have zero ozone depletion potential but some global warming potential. The Kyoto Agreement on climate change, while not presently ratified, suggests the possibility of bans or caps on these "greenhouse" gases. If proposed restrictions on HFC's become a reality, refrigerated shipping will face serious challenges in finding acceptable substitutes.

Hydrocarbons, such as propane or butane, are a possibility, but these are flammable. Ammonia systems using cooled brine, which were common before the adoption of Freon (a CFC) in the late 1970's, may be adapted to address environmental concerns. Although new ammonia-brine systems are attractive, ammonia is hazardous and brine is quite corrosive and difficult to pump. Ammonia systems that use carbon dioxide as a secondary refrigerant may hold greater long-term promise.

Perhaps most critical to expansion of perishable trade are infrastructure linkages to make ocean shipping of perishable products not only technologically feasible but also profitable for all the players. Reefer container trade requires that ports on both ends provide sufficient crane capacity, adequate storage space, and ready access to highway and rail systems designed for container traffic. Efficient inspection and customs services by government agencies, as well as port-to-market distribution systems, are critical since most fresh produce must arrive on store shelves within 24 hours of unloading.

How many ports worldwide currently have the necessary infrastructure and the necessary links to internal markets to handle large volumes of reefer container trade? Although there are many "containerports," container traffic and traffic growth are clearly concentrated around the largest few. Of the top 100 containerports in 1997, 10 accounted for more than 45 percent of all container throughput.

Shipping Costs From California to Japan Vary By Commodity



Rates for June 1998. Shares based on export unit values for January-August 1998. Destination for apples and pears is Hong Kong.
*F.o.b. value of commodity.
Source: Agricultural Marketing Service, USDA
Economic Research Service, USDA

Special Article

Impatience Begets Innovation

Malcolm McLean, founder of Sea-Land, the largest U.S.-based ocean carrier, made a major contribution to the technology of perishable product shipping. In 1937, he waited on a dock in Hoboken, New Jersey with a ship-bound truckload of North Carolina cotton. For hours he observed the complicated, labor-intensive process of goods being unloaded from trucks, moved onto the ship, and juggled into their proper places in the hold. As the story goes, he wondered why his truck trailer could not simply be lifted up and placed on the deck of the ship without its contents being touched.

McLean made his idea a reality in 1956 when he purchased a small tanker company, adapted the ships to carry trailers, and launched the Ideal X from Port Newark in the New York harbor. When he later converted from conventional truck trailers to specially engineered steel boxes that could be stacked several deep inside the hold, he had launched the era of the cargo container. In 1966, one of his new container ships crossed the Atlantic to Rotterdam, launching the first trans-Atlantic and later trans-Pacific containerized shipping service.

By far the largest throughput is handled at ports in Hong Kong and Singapore (each with 10 percent of 1997 container throughput), followed by Kaohsiung in Taiwan and Rotterdam in the Netherlands, each with less than half the volume of the largest two ports. In the U.S., the five leading container ports (Long Beach, Los Angeles, New York/New Jersey, San Juan, and Oakland) together accounted for 9 percent of world container throughput. Although these figures mean little in terms of the ability of other ports to respond to growing consumer demand for perishable products, they do suggest a challenge to the diversification of perishable product trade beyond major, high-income markets.

What lies behind the rapid growth in U.S. exports of perishable products over the past 10 years? The general decline in trade barriers, such as tariffs and import quotas, and worldwide income growth play major roles. But the contribution made by advances in transportation technology, particularly in ocean shipping, tends to be ignored. These advances have extended the marketing reach of U.S. perishable high-value products to distant markets by reducing delivery times, maintaining product quality, and reducing costs.

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