Containerization in Transporting Agricultural Perishables

JOHN E. CLAYTON
Chief, Transportation Research Branch, Transportation and Facilities Research Division, U. S. Department of Agriculture

CONTAINERIZATION seems to have generated renewed interest, enthusiasm and activity in freight transport. Its use may be extended to all modes of transport, with the addition of many new products; and it may become worldwide. Nearly every issue of the transport press reports expansion of containerization by one firm or another, to products and regions it has not reached before. Rail transport firms are buying more van containers and piggyback trailers. Ocean carriers are planning to buy container ships or convert regular cargo ships for containerized transport to overseas points. Firms already engaged in ocean container service are planning to extend it to other parts of the world. This increased interest, enthusiasm and activity applies to containerized movement of both perishable and nonperishable products.

What causes the increased interest—and investment—in the piggyback-containerization technique? The answer is efficiency—a better transport job—in terms of lower cost, less product losses, and more rapid movement. Cost can be reduced because containerization serves as an effective means of integrating the services of different transport modes and uses more fully the inherent advantages of each mode. Containerization reduces the number of handlings of individual packages which results in less loss and pilferage. It also permits quicker transfer of cargo from one transport mode to another, thus reducing transit time and increasing utilization of transport investment. It has been estimated, for example, that container ships spend only one-fifth as much time in port loading and unloading cargo as do conventional ships. For perishable products, containerization means less exposure to unfavorable temperatures and humidities, and less damage from heat-up or freezing.

After defining containerization and agricultural perishables, this paper will discuss the growth of containerized movements of perishables, outline some things that are necessary for its continued growth, report on containerization research done by the Department of Agriculture and try to indicate how containerization of perishables may affect highway needs.

DEFINITIONS

Containerization includes both trailer-on-flatcar (TOFC) and container-on-flatcar (COFC) movements of agricultural perishables. It also includes land-sea-land and land-air-land or any other combination to transport modes used to move large van containers or truck trailers in through movements from origin to destination. Truck trailers with wheels attached are different in some respects from demountable van containers, which move with bogies and wheels detached on rail cars, ships and other basic transport vehicles. However, they still have the important aspect of containerization—putting many individual cartons or packages in a large container and handling and transporting them as a single unit. Packages are handled individually only when they are put into the container and when they are taken out of it, not every time they are transferred from one transport mode to another.

Paper sponsored by Committee on Intercity Highway Freight Transportation and presented at the 45th Annual Meeting.

Agricultural perishables require a special environment to keep them from spoiling during transport. They include both frozen and nonfrozen products that must be protected by refrigeration, heating or controlled atmosphere. Fruits, vegetables, meat and poultry are examples of perishable products. Grains, fibers, and lumber are not considered perishables for the purposes of this report.

TRAFFIC GROWTH AND SOURCES

Piggybacking, the dominant form of containerization for all kinds of commodities, has grown from a little more than 168,000 carloads in 1955 to an estimated more than a million carloads in 1965. The Association of American Railroads estimates that about 10 percent of all rail piggyback loads are van containers with bogies and wheels detached.

Data are less complete for the number of containerized loads of agricultural perishables transported each year, but no trailers equipped for refrigerated service were among the 1,400 used for piggyback transport in 1955. Piggyback movements of refrigerated cargo seem to have begun about 1958, but exact measures are not available. It is estimated that 25,000 of slightly more than a million piggyback trailers loaded in 1964 were refrigerated.

The Fruit and Vegetable Division of the Consumer and Marketing Service, U.S. Department of Agriculture, collects figures by mode of transport for fruit and vegetable unloads in 41 cities or market areas. Beginning in 1962, this source shows piggyback unloads separately, expressed in rail carlot equivalents. Piggyback unloads grew from 9,207 carlots in 1962 to 15,850 carlots in 1964, a 72 percent increase in two years. For 1963, there were 12,459 carlot equivalents. These data and those for unloads by other modes are given in Table 1. Although incomplete, the data seem good enough to show an upward trend.

Sketchy data from other sources also suggest increasing containerized movements of fresh fruits and vegetables. One witness in ICC Ex Parte 230 reported 1,970 piggyback trailerloads of citrus moved out of Florida in the 1961-62 season. It increased to 6,519 loads in the 1962-63 season. Another witness reported that 596 trailers of fresh vegetables moved out of Florida by piggyback in the 1961-62 season and said the volume of this movement would increase "very substantially" when more TOFC facilities are made available.

Conversations with fresh fruit and vegetable shippers and the railroads that serve the producing areas show support for the growing piggyback-containerization movements. Several individual railroads keep separate statistics for piggyback and container movements, but putting these figures together in a complete national record has not been undertaken.

TABLE 1

FRESH FRUIT AND VEGETABLE UNLOADS FOR 41 CITIES, IN RAIL CARLOT EQUIVALENTS, BY TRANSPORT MODE, 1956-1964

Year	Piggyback	Rail	Rail and Piggyback	Truck	Total
1964	15,850	304,686	320,536	592,353	912,889
1963	12,459	313,002	325,461	593,353	918,814
1962	9,207	331,617	340,824	589,354	930,178
1961	?	–	355,899	588,933	944,832
1960	?	–	381,662	587,545	969,207
1959	?	–	390,306	629,136	1,019,442
1958	?	–	395,879	621,594	1,017,473
1957	?	–	426,072	596,205	1,022,277
1956	?	–	433,680	502,554	936,234

Figures showing growth in container-piggyback movements of meat and poultry are even fewer than those for fruits and vegetables. Nevertheless, nearly all figures show an increase in this type of movement, but specific data are not good enough to quote. One opinion expressed was that 75 percent of the meat movements from the midwest to the east go by piggyback (1). Another source said Georgia poultry processors would make a record number—over 100 carloads—of piggyback shipments in July 1965 (2). Confidential figures supplied by a few railroads also suggest an increase in container-piggyback movements of meat and packing house products, but they do not show clearly the size of the increase.

Another growth index of containerization of perishables is the number of refrigerated piggyback trailers and demountable van containers suitable for transporting perishable cargo. From zero in 1955, this number grew to almost 7,000 refrigerated TOFC trailers and more than 2,000 demountable van containers by 1965.

Where did containerized perishables traffic come from? Is it a substitute for rail car or over-the-road truck movements, or is its growth self-generated? Surely some perishables that now go by piggyback formerly made the trip to market in refrigerated rail cars. Some shifts from over-the-road trucks seem likely, and piggybacking itself probably caused some perishables to go to market that otherwise would have stayed on the farm. The data in Table 1 suggest that the growth from 1962 to 1963 may have been a shift from former rail car movements, and that from 1963 to 1964 may have come from both rail and truck. But it would be dangerous to hold to this conclusion. "The data do not clearly show" seems to be the best answer to the question.

REQUIREMENTS FOR SUCCESS

Although still a small part of the total movement of agricultural perishables, containerization has grown rapidly in recent years. Most signs seem to indicate an even brighter future for this coordinated transport technique. However, a few basic requirements must be met. Equipment used must be able to do the job and the system must be managed in a way that will reduce the total cost of marketing agricultural perishables.

Equipment

In the last few years there has been much progress in developing equipment for containerized perishables transport, but much work remains to be done. Special attention needs to be turned toward equipment that will enable perishables to make the long trips to overseas markets, and toward developing equipment that will be more versatile and get the job done at less cost than equipment now in existence.

Perishable agricultural products have one common characteristic. Most are organisms which live and breathe pretty much the same as people. They inhale oxygen and exhale carbon dioxide. However, their "shelf life" after harvest is relatively short. This means that many perishables must go through the marketing system in equipment that will maintain a special environment to prolong their shelf life, and allow time for effective distribution and consumption at the end of the transport journey.

Containers used to transport agricultural perishables must be able to maintain the environment required by the product. Temperature must be kept at proper levels. Air must be circulated through nonfrozen loads to remove heat of respiration, field heat, and ambient heat that penetrates the walls of the van. Humidity must be controlle to keep the products from drying out excessively and to prevent too much moisture from accumulating on them. These requirements become more important as the journey increases in length. They are crucial on the long trips to many overseas markets.

Air exchange is another essential feature for containers transporting perishables long distances. All fresh fruits and vegetables produce carbon dioxide, ethylene and other volatiles in their natural respiratory process. Too much of these gases may adversely affect the product. Carbon dioxide may cause physiological injury or delay ripening. Ethylene may accelerate ripening. The air in the van must be exchanged periodically to avoid adverse effects on the product.

Containers must be versatile. Their refrigeration and air distribution systems shoulc be suitable for both frozen and nonfrozen perishables, and they must be light enough and have enough cube to make them suitable for hauling dry cargo. These features will increase the utilization rate of the vans and lower the capital cost per unit of cargo because the capital invested in the van will be doing a bigger job. In addition, containers used for perishables must be adaptable to highway, rail, water, and perhaps air transport to enable them to fit into a fully integrated system for both domestic and overseas transport. Adaptability for full transport integration also should up usage rates and help reduce transit time.

Systems Management

Proper equipment alone cannot assure the maximum contribution of containerization to improved transport of agricultural perishables. The transport system also must be managed effectively. Expensive refrigerated vans must keep moving to get maximum benefit from the dollars invested—in lower transport costs, shorter transit times, and longer shelf life at final destination. Perishables must be moved as rapidly as possible through truck terminals, rail yards, and over ocean piers. When destined for overseas markets, they should be placed on board ship at the last domestic port of call and transferred to the inland transport mode at the first foreign port of call.

To keep cost per unit of product transported as low as possible, the vans also must be kept loaded in both directions. In addition to having versatile vans that will do several transport jobs well, marketing and product-flow analyses will have to be undertaken to keep empty mileage as low as possible.

Transport of perishables, like that for other products, will be helped by standardization of many parts of the system. Piggyback trailers, van bodies, rail flatcars, handling and tiedown equipment and techniques are but a few areas where standardization can help the free interchange of all types of equipment. In the evolution of containerization, vehicles meant for one transport environment were combined with those meant for another environment. Limited interchangeablility resulted when one type of carrier adopted a particular form of refrigerated vehicle for its needs with not enough consideration of how it might be used to fit the needs of the other modes. Most piggyback trailers, for example, cannot be handled on container ships because of the type and location of their refrigeration units and because they are not adapted to ships' handling gear. Containerization can be more fully exploited by placing greater emphasis on interchangeablility and coordination in future development of equipment and systems.

Reduction of institutional barriers is another systems-management improvement which can help bring about the full benefits of perishables containerization. This is particularly true for overseas shipments where differences in weight limits, clearance restrictions, and lighting requirements among the various countries restrict the free movement of many types of vans. Customs regulations and other factors which require inspection and extensive documentation of international shipments also add to the burden and delay of shipments.

Also, all modes of transport will have to coordinate arrivals and departures to minimize waits by containers at transhipment points. Moreover, any cost savings containerization may bring to perishables transport must be shared with farmers, shippers, and consumers in lower transport rates and consumer prices.

USDA CONTAINERIZATION RESEARCH

Private business firms in recent years have done research to help adapt containerization to perishables transport. Transport and refrigeration equipment manufacturers and carriers of different types are taking a harder look at the requirements of containerized transport systems. This research is producing lighter, more versatile vans and improved refrigeration systems. The U. S. Department of Agriculture has worked with private business firms in bringing these improvements about. An outline of some of the research the Department has done, always with the cooperation and help of industry, shows the benefits of containerization and indicates something about the USDA program and its hopes for the future.

USDA research produced a method for rating the thermal efficiency of refrigerated containers and trailers. Research also has studied air circulation in the vehicles and the way perishables are stacked inside transport vehicles. We have looked into piggy-back movements of perishables in this country and have made suggestions which enable transport firms to do a better job in transporting perishables.

Most current containerization research seeks to apply this technique in doing a better job of transporting perishables to overseas markets. The USDA effort has increased during the last two years and now there is a modest program under way which hopefully will produce significant improvements before long.

A few years ago a containerized test shipment of grapefruit from Florida to Switzerland showed that this method could bring much lower spoilage losses than the conventional method of movement in the holds of ships. Such losses for the containerized movement were about one percent compared to 15 percent normally experienced under the conventional method. Economies also were indicated by reducing from about 10 to 2 the number of handlings of individual boxes required during the trip.

Later, USDA and the Department of Defense made a six-month test of containerization in moving perishable food products to overseas points. This test showed that many problems must be solved before containerization can be effective in overseas transport. The whole overseas movement system needs to be studied and improved. Transport equipment and techniques are not the only things which must be made more efficient. These findings have guided us in developing a containerization research program and we are working to bring about improvements.

Over a year ago we observed two containerized shipments of fresh beef from St. Louis, Missouri, to Paris, France. The beef in one van arrived in fair condition, but that in the other van arrived in poor condition. However, a number of factors kept these shipments from being what might be called a typical containerized movement, so we drew no definite conclusions. Nevertheless, this research did lead us to make these recommendations: (a) fresh beef destined for overseas markets should be thoroughly chilled within 48 hours after slaughter, and should be stored and transported at internal meat temperatures of 29 to 31 deg F to maintain its quality; (b) it should move through the marketing channels as rapidly as possible; and (c) it should be free of bruises.

A USDA transport researcher got the idea that the cost of getting fresh fruit to overseas markets might be lowered if the fruit were shipped in ventilated containers during the cool months of the year instead of shipping it under refrigeration. Refrigeration cost would be avoided and the dry cargo vans could be loaded with nonperishable freight on the return trip. To test the idea, two containerloads of fresh grapefruit were shipped from Florida to points in Europe. Ventilation kept fruit temperatures within an acceptable range and the grapefruit arrived in excellent condition.

In another test, containerized transport delivered chilled orange juice in glass jars from Florida to Germany in good condition. Scarcely a glass jar was broken during the $2\frac{1}{2}$-week trip. This test showed that containerization can help deliver perishable farm products long distances in good condition.

Also, containerization can help reduce the cost of transporting agricultural perishables, but research has not yet developed measures of the cost of using this technique. Future efforts will seek measures to compare the cost of containerized transport with the conventional method of transporting perishable products.

Another aspect of research is what is called "a multi-purpose van container concept," and it is a big step toward effective containerized transport of agricultural perishables. It should help fulfill several of the requirements for success already outlined.

The van container in the concept or system can be used to carry freight by highway, rail, water, and perhaps air in moving perishables from farm to market. It also can be used to haul frozen and nonfrozen perishables—and dry cargo. When used for dry freight, the van would have its tare weight reduced and its payload increased by these features:

1. Both the wheeled chassis and the refrigeration plant, including compressor and condenser, are separate from the container;
2. Plastic or other lightweight material will be used for the shell; and
3. Insulation will be thinner than in most present vans.

A distinctive feature of the van is its refrigeration and air distribution system. Air circulates laterally across cooling coils in the ceiling and down through false walls on each side. For nonfrozen perishable loads, the air then moves upward through the floor and the load and returns to the ceiling to cross the cooling coils again and repeats the same cycle. For frozen loads, the return air openings in the ceiling are closed and refrigerated air circulates laterally down one side wall, under the floor, upward through the other side wall, and back across the cooling coils in the ceiling.

The 40-ft version of the van has eight cooling coils in the ceiling, two in each 10-ft section. Air is circulated by eight blowers, one on each side of each 10-ft section. With this coil and blower arrangement, and removable partitions, the van can be divided into four 10-ft compartments each of which can be kept at a different temperature, making it possible to ship in the same container products which require different temperatures.

The present concept of the container meets the standards recommended by the American Standards Association. It includes lengths of 10, 20 and 40 ft and height and width of 8 ft. Recent talks with transport firms and trailer manufacturers, however, show some preference for a height of 8½ ft. By removing the wheeled chassis, the van can meet the clearance requirements for piggyback shipments on most European railroads. Sliding tandem axles on the chassis would give the van the flexibility needed to meet varying axle load limits in the United States and abroad.

USDA has a contract with the research division of General American Transportation Corporation to do engineering research and prepare working designs for the conainers and supporting equipment. After this step is completed, we hope a private firm will buy a prototype container which would be used to do research to develop information about the physical and economic feasibility of the van container system.

PERISHABLES CONTAINERIZATION AND HIGHWAY NEEDS

Containerized movements of agricultural perishables in the future will include some traffic that otherwise would move in over-the-road truck service, but data are too few for quantitative forecasts of the size of this traffic. Figures that are available, however, suggest it will be very small in relation to the total use of highways. Estimates for 1964 put vehicle-miles for all truck-trailer combinations that might move in piggyback service at less than 5 percent of total vehicle-miles (3). Only a small part of this 5 percent would be perishables. Therefore, it seems likely that the impact of perishables containerization on the future demand for highways will be slight.

CONCLUSIONS

Piggyback-containerization movements of perishables offer great opportunities to improve the transport of farm perishables from farm to market and from processing plants to consumer outlets. This type of transport service has grown rapidly in the past few years and should have significant growth in the near future. But we need better data to measure accurately the size of its recent growth and to make meaningful estimates of its future role in transporting agricultural perishables. Also, for containerization to contribute its full benefit to perishables transport, both technological and management improvements still must be made.

REFERENCES

1. Transport Topics. Col. 1, p. 21, Oct. 4, 1965.
2. Poultry and Eggs Weekly. Col. 2, p. 11, July 17, 1965.
3. Supplementary Report of the Highway Cost Allocation Study. House Document No. 124, p. 56, 89th Congress, 1st Session, March 24, 1965.