



**AgEcon** SEARCH  
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

*The World's Largest Open Access Agricultural & Applied Economics Digital Library*

**This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.**

**Help ensure our sustainability.**

Give to AgEcon Search

AgEcon Search  
<http://ageconsearch.umn.edu>  
[aesearch@umn.edu](mailto:aesearch@umn.edu)

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

# A Market-Driven Investigation of Pallet Trends in Grocery Chains

Diana Twede, Diane Mollenkopf, and Cristina Guzman-Siller

This research project involved a review of literature, personal interviews, and first-hand observations to assess the current role and future trends for pallet usage in the grocery-distribution industry. It explores the grocery retailer's point of view.

Interviews were conducted with eleven experts in the warehousing and material-handling industry and with thirteen high-level managers of grocery chain distribution centers (DCs) across the United States and overseas. Eight geographically diverse grocery DCs were visited for observation. We also visited an automobile manufacturing plant, two overseas distribution centers, and three pallet-manufacturing facilities.

Economic conditions have an impact on the transportation economics of pallets. As fuel prices continue to rise, there is a trend toward maximizing the utilization of space within the trailer, and new regulations reducing a driver's "hours of service" favor the quick unloading afforded by pallets, reinforcing the flow in the supply chain.

The humble wooden pallet plays a vital role in modern grocery distribution as a "sustainable" packaging form for United States and Canada. This research shows that plastic pallets are increasing and serve a clear need, even in a system that is full of "free" wooden pallets. But to focus on wooden pallets alone is a marketing myopia. To serve future supply chains, the industry must redefine the business as material handling, movement, and flow.

The grocery industry is one of the largest users of wooden pallets. This project focuses on how pallets are used at the end of grocery supply chains, from the retailer's distribution center (DC) to the aisles of its stores. It highlights opportunities and threats to the traditional wooden grocery manufacturer's pallet.

There is general agreement that the wooden pallet has withstood the test of time. It is the supply chain's common denominator. There is also agreement about the lack of innovation despite the fact that wooden pallets have not achieved a state of perfection. In the words of one respondent, "We can't live without them, and have to live with their problems."

Over the past fifty years, business management has undergone tremendous transformation. A focus on functional optimization predominated in the mid-20th century. During this time, organizations sought to optimize the performance of each functional area within the firm, such as minimizing costs within the operational areas of purchasing, manufacturing,

and distribution and maximizing revenues generated from the marketing and sales functions. As the 20th century marched toward its conclusion, two important transformations took place.

First, firms began to recognize the systems concept, an analytical framework emphasizing integration across all functional areas within the firm so as to better achieve firm objectives. System integration is the basis for modern supply-chain management (Bowersox, Closs, and Cooper 2007). Integration requires tradeoffs to be recognized and managed across different functional areas of the firm.

For example, purchasing the lowest-priced packaging may ultimately increase distribution costs due to damage incurred in transit or extra handling activities. If the increased costs arising from claims or product write-offs outweigh the savings of the packaging costs, then purchasing objectives may have been optimized at the expense of the other functional activities within the firm. A systems approach advocates analyzing the trade-off between low-cost packaging and increased distribution costs to find the solution that optimizes the total system in terms of both cost and service.

Second, firms began to recognize the importance of coordinating and integrating activities with their suppliers and customers. Rather than merely operating to maximize the profit of a given firm, managers

---

Twede is associate professor and Guzman-Siller is doctoral candidate, School of Packaging, Michigan State University, East Lansing. Mollenkopf is assistant professor, Department of Marketing & Logistics, University of Tennessee, Knoxville.

This research was sponsored by the National Wooden Pallet & Container Association.

are recognizing that the systems approach can be applied in an inter-firm context. This means that suppliers and customers coordinate and plan their activities to reduce costs and eliminate waste across a network of firms in a supply chain, while ultimately enhancing service to the end customer.

Supply-chain integration is increasingly necessary, given three major changes in physical distribution (Mentzer 2001). First, globalization is leading firms to increasingly seek global sources for their supplies and global markets for their products. Second, competition is based increasingly on issues of time and quality. Getting defect-free products to the customer quickly and reliably is no longer a source of competitive advantage, but merely a requirement to be a player in the market. And third, marketplace uncertainty is increasing. Technology and economic development of markets are changing at a rapid rate; one consequence is that customers become increasingly demanding, with higher expectations from the products they purchase as well as from the retailers from whom they purchase.

The dramatic change in the business environment over the past twenty years has led to a new perspective on competition. Christopher (1992) argues that competition is increasingly supply chain against supply chain. Thus companies can no longer afford to operate in the isolated, functional mode of the mid-20th century. Firms must increasingly acknowledge the role they play within their supply chains and operate in concert with the other organizations within those supply chains. Speed is no longer the sole objective in moving goods through the supply chain.

Synchronization is the key to successful supply-chain flows. It is more important to synchronize the timing of product movement and other related flows throughout the supply chain, rather than moving it quickly from echelon to echelon in the "hurry up and wait" approach spawned by the just-in-time movement (Bowersox, Closs, and Cooper 2007). Estimates and actual demand data shared throughout the supply chain are key to synchronization.

In the grocery industry, this might translate from the old model of a manufacturer rushing an entire promotion's worth of goods to a retailer to the new model of time-sequenced deliveries throughout the promotion. It translates from "push" inventory strategies to "pull." This helps match demand and supply more closely, reducing inventories throughout the

supply chain, and can also translate into smoother production schedules at the manufacturer's location, more efficient transportation, and increased service to the retailers and end customers.

Synchronization and demand-based logistics are beginning to increase in the grocery industry. Supermarket scanner data triggers orders from the DC, and increasingly the data is shared with suppliers to help synchronize their shipments.

### Packaging Logistics

A growing area of supply-chain interest relates to the integration of logistics and packaging decisions. Supply-chain and logistics textbooks (see, for example, Bowersox, Closs, and Cooper 2007) typically address packaging issues briefly in reference to unitization for achieving handling and transportation economies, issues related to product protection and types of packaging containers typically used. Despite the fact that packaging decisions have a significant impact on the efficiency and effectiveness of logistical systems (Saghir and Jonson 2001), packaging and logistical decisions often are made in isolation from each other (Twede 1992). There is relatively little academic research in this area (Saghir and Jonson 2001; Twede and Parsons 1997).

Packaging logistics as a discipline is beginning to emerge, focusing on the "interaction and relationship between the logistical system and the packaging system that add value to the combined, overall, system—the Enterprise" (Saghir 2002, p. 38). This is an important and encouraging development.

### Pallets in Grocery Supply Chains

Wooden pallets revolutionized distribution when they were widely adopted by the grocery industry in the 1950s. They dramatically improved the productivity of material-handling operations, reducing the cost and time to handle goods as well as improving the ergonomics of supply-chain work.

Palletization has been used and developed over the past century, but became more popular after World War II. Prior to 1940, the handling of goods was slow and inefficient. The Office of the Quartermaster General (OGMG) and War Production Board (WPB) adopted efficient state-of-the-art forklift and wooden-pallet material-handling equipment in de-

pots and supply installations in 1941. Pallets made a critical contribution to winning the war, especially in the South Pacific. It would have been impossible to supply the U.S. military forces if logistics operations had been limited to manual labor and hand-loading cargo. By the end of the war the U.S. Army and Navy were using over 75,000 forklifts, three times the number used in all of the U.S. before the war (LeBlanc and Richardson 2003).

After the war, returning soldiers transferred their forklift and pallet skills to commercial supply chains. The demand for pallets grew as lift trucks became more widespread and the pallet manufacturing process was automated.

### The GMA/FMI Common Pool System

During the 1970s, the U.S. grocery industry developed a common pallet pool system, based on standardized "GMA pallet" dimensions of 48" x 40" and a standard construction (GPC 1976a, 1976b, 1976c). Grocery manufacturers and retailers agreed on pallet exchange terms. But the system eventually broke down in a classic "tragedy of the commons" (Hardin 1968; Ostrom 1990), in which "everybody's property is nobody's property" (Gordon 1954).

There was a lack of organized pool management and a natural tendency for profit-maximizing firms to "cheat." The quality of pallets deteriorated, creating damage and waste. By 1990, the grocery industry acknowledged that there was a "pallet crisis" (Seifert 1990).

Over the same period, the Canadian grocery industry had developed a more successful common grocery-pallet pool because of better central control. The Canadian Pallet Council (CPC) developed uniform exchange documentation, a quality-control system, and a forum to promote improvements to the system. Members (manufacturers, distributors, retailers, carriers, and third-party logistics providers) pay a fee for the use of the high-quality pallets, and the movements are now managed by internet computer tools. A primary reason that the Canadian system has been more successful than its U.S. counterpart is the leadership role played by the central Council organization (LeBlanc 1992).

### The Current Transaction-Based Systems: Rental and Recycling

The transaction-based systems recommended in 1992 have now developed infrastructures and momentum. Rental and recycling have come to replace most of the exchange systems in the U.S. grocery industry (Witt 1995, 1996, 1999, 2002).

Pallet rental has dramatically increased, due largely to the growth of CHEP, a worldwide private pallet pool provider. CHEP was the first pallet pool rental system, originating after the end of World War II in Australia, where the U.S. military left many pallets behind. The Australian Government created the Commonwealth Handling Equipment Pool (CHEP), to collect the pallets, repair them, and reuse them.

Today, CHEP is the largest private pallet pool company in the world, and its recognizable blue-painted pallets are widely used in Europe, South Africa, and the Americas. In the U.S., the two next-largest competitors, Peco (painted red) and Kamps (painted green), operate in the Midwest and Northeast. The most attractive benefit of rental pallets is their high standard for quality and strength. They are heavy, sturdy, highly standardized pallets, especially well-suited for automated systems.

As an alternative to renting, pallet "recycling" has also increased as pallet manufacturers throughout the U.S. have agreed to cooperate for their mutual financial benefit. This system gives the pallet makers a key role in the grocery-pallet system. These pallets are referred to as "core" or "whitewood" to distinguish them from the painted rental pallets. The core pallets are presumed to conform to the GMA standard, although there is wide recognition that most do not (Pallet-Enterprise 2005).

In the current environment, Ray and Michael developed a simulation that estimated a higher cost for rental systems than for purchased (recycled) systems, by \$1 to \$2 per pallet trip (Ray and Michael 2004). Although the food manufacturer's initial cost for rental pallets may be lower, the cost advantage for purchased pallets comes from the retailer's revenue from selling used pallets.

### Wood Pallets

The wooden-pallet industry in United States consists of about 3,000 companies who build new pal-

lets, repair or recycle them, or provide third-party pallet management and rental. The pallet market divided by material for North America is estimated to be 500 million wood pallets, 8 million plastic pallets, 4 million paper or board pallets, 0.6 million metal pallets, and 4.5 millions others (LeBlanc and Richardson 2003).

Wooden pallets have many advantages. They are made from a ubiquitous, cheap, abundant natural resource in North America. They are adaptable to most material handling and storage systems, fit most lift trucks, and serve as a supply-chain unifier. They are strong, reusable, and recyclable, and there is a good recycling infrastructure. But they also have disadvantages including their heavy weight, damage potential, variable quality, splinters, fire hazard, and lack of sanitation (Twede and Selke 2005).

### Objective

This research explores the current state of wooden pallets in the grocery industry in the context of current supply-chain-management and material-handling trends.

### Research Method

The research began with a review of relevant literature in the fields of supply-chain management, material handling, and packaging.

The qualitative method of case study with a deep-interview, with a semi-structure questionnaire was used; the interviews were conducted by the researchers and complemented with observations made from visits to distribution centers and pallets

suppliers. The interviews focused on two approaches: first, with experts in the fields of warehousing, material handling, and supply-chain management; and second, with grocery DC managers, several of whom we visited to tour their facilities.

All interviews and visits took place between June 2005 and February 2006. In all the interviews and visits at least two of the researchers were present. The categories which were study are summarized in Table 1.

### Method of Analysis

A cross-data analysis was performed on the data collected by all the informants to find similarities and differences in their opinions. The backgrounds of the experts and managers, their academic preparation and professional experience, and the environments for the firms were all analyzed to explain the differences in their perceptions.

The actual situation of the pallets system was evaluated based on the experience of the respondents, history analysis, and literature review, and the trends of the market were defined based on new technologies, needs of the distribution channels, and as a solution to the problems described for the experts and managers.

### Results

Pallets are considered to provide efficiency within the distribution environment. No one could envision the future without the ubiquitous wooden pallet. There are no major changes within the material-handling industry that suggest equipment changes

that would force a move away from pallets. Wooden pallets are preferred over plastic platforms for warehouse storage and racking. Thermoformed plastic platforms do not have a bottom deck and so are not able to span a rack; if racks are fitted with deck floors, this is not a problem. None of the cross-dock or direct store-delivery operations require pallets with bottom decks.

The total-cost concept of logistics management (which emphasizes a systems approach) does not seem to be well-understood within the grocery industry. Many grocery chains do not appear to understand the cost of buying pallets, repairing them themselves, or engaging in pallet-exchange arrangements relative to pallet revenue that is realized when white wood pallets are sold. For example, they cannot effectively compare the system-wide economic tradeoffs of either rental pallets or handling and warehousing costs for floor-loading. Thus they are not well-positioned to make decisions concerning the role of pallets within their distribution system.<sup>1</sup>

### Inbound Shipments (Manufacturer to Grocery DC)

Current distribution practices were relatively consistent across most U.S. grocery chains, in that the majority of inbound goods from vendors are received on wooden pallets, either rental pallets or "white wood" pallets that are ultimately sold to recyclers. The percentage for each DC varies from 40 percent to almost 100 percent rental pallets. Some grocery manufacturers charge lower prices for product that is floor-loaded on slipsheets or in clampable units, compared to product on pallets. Manufacturers are reacting to increased transportation rates and wish to increase the cube utilization for each shipment. But many grocery chain DCs opt for the higher-priced palletized shipments in order to enhance product flow and handling efficiency within the warehouse and to reduce damage. Many manufacturers offer an incentive for buying on rental pallets versus "white wood" pallets. But the chains are largely unwilling to pay rental fees for using them downstream to

<sup>1</sup> The DC managers generally made very astute decisions based on their company's measurement and reward system, but many lack a broader organizational approach to measuring and managing costs/revenues, and they focus on functional profit centers vs. system profit management.

ship to the retail stores. Many variations of cross-dock operations were observed, including conveyor sorting of cases, floor order picking in waves, and mixed palletload cross docking. These innovations emphasize flow over storage and require some re-configuration of the warehouse floor space and operational flow, but none of them requires the pallet to have a bottom deck.

### Outbound Shipments (Grocery DC to Retail store)

Most of the chains' DCs ship outbound to retail stores on plastic platforms. Some of the outbound shipments are loaded onto the platforms corresponding to retail-store aisle layout; others need to be further sorted at the retail store. In Europe where inner-city stores are smaller and may not have proper loading docks, orders are typically picked into rolling cages.

At least two chains transport a high percentage of goods transferred to their retail stores without any unitization at all—instead, goods are floor-loaded into the trailers so as to maximize cube utilization. These trailers are dropped at the stores, where store personnel unload the trailers and sort the cartons to retail-aisle carts or pallets.

Only two chains were observed that consistently ship mixed loads to stores on wooden pallets (using the same rental or white wood pallets that they received). One of these is planning to invest in a fleet of plastic platforms this year, and the other would like to but cannot because its wholesaler role makes it impossible to control the reverse logistics required.

Thermoformed plastic platforms are preferred for outbound shipments to stores for several reasons. Most grocery loads (especially mixed loads) are light, so a heavy-duty wooden pallet is not needed. The true four-way-entry plastic platforms are more readily handled with the hand jacks found in the retail receiving environment, enabling loads to be "pinwheeled" in the delivery vehicle. Plastic platforms are more visually suitable for display within the retail environment, and do not scratch the floors as readily as do their wooden counterparts, and they are light weight (20–25 lbs) and more ergonomic and safe for retail workers to lift; current plastic rental pallets are heavier (65 lbs) and wooden rental block pallets are the heaviest,

**Table 1. Summary of Research Interviews and Observations.**

Interviews and observations	Number
Warehousing & material handling experts	6
Academic experts	4
U.S. grocery DC managers	11
Grocery DC site visits	8
International DC managers	2
Grocery DC site visits	2
Non-grocery industry observations	2
Pallet facility observations	3

up to 80 lbs. The plastic pallets nest for easy return and can be easily cleaned. The initial investment in a "fleet" of thermoformed plastic platforms is significant, but they have been found to have remarkable longevity and a lower rate of pilferage than do wooden pallets

### Quality

Quality issues are a concern when white wood (or "core") pallets are used. The "GMA pallet" is the industry standard, but very few grocery chains actually believe that their vendors' white wood pallets meet GMA standards. Some chains make a regular practice of charging back for defective pallets. Quality issues are generally not a concern with respect to rental pallets, which have raised the standard for pallet quality in recent years (although managers report that the quality of wooden rental pallets has gone down lately, due to the aging of the pallets themselves as the U.S. rental industry matures). Rental pallets are more standard, which is especially preferred for automated palletizing, storage and retrieval, depalletizing, and handling operations.

### Trends

#### Supply-Chain Management

Progressive supply chains seek systemic ways to increase productivity and velocity, and to reduce errors and costs. The emphasis is on flow rather than storage. System-wide metrics and financial measures are slower to catch on, but will further support the growing focus on system-wide supply chain efficiency and effectiveness. There are a few leading-edge chains moving in this direction already. Third-party logistics providers are offering to a set of manufacturers the service of picking store-level orders which could be delivered directly to a chain's stores, bypassing the chain's DC. Currently these orders are cross-docked by the DC.

Economic conditions have a significant impact on the use of pallets. Many grocery chains are evaluating the transportation economics of pallets. As fuel prices continue to rise, vendors are beginning to pressure the retail chains to accept slip-sheet loads so as to maximize the space utilization within the trailer. Several chains reported that they currently

pay higher transport prices for inbound freight because they request their products be shipped on pallets. On the other hand, new regulations reducing a driver's "hours of service" favor the quick unloading afforded by pallets, especially in parts of the country where a single truck and driver make multiple stops. These changing economic conditions will be increasingly evaluated for system-wide impact, further supporting the supply-chain approach. For example, floor-loaded trailers may help reduce transportation costs, but what trade-offs are incurred at either the DC or the retail level in terms of increased labor and handling costs? Only the leading-edge firms are currently addressing these issues at a system-wide level.

As retailers become more focused on in-store merchandising displays, half-pallets and quarter-pallets are being developed so that store-ready displays can be created by the vendors and shipped to retail display with a minimum amount of intermediate handling. The (mostly plastic) half- and quarter-pallets are shipped on wooden "slave" pallets to facilitate handling through the distribution system. This merchandising approach reinforces the need for flow and efficiency through the supply chain. Some large vendors have begun to offer mixed "rainbow" loads from orders "pulled" from each of a chain's retail stores; these mixed loads are simply cross-docked ("one-touch") by the DC.

#### Rental Pallets

Third-party services are increasing in supply-chain management, and in line with this trend, rental pallets owned and managed by third-party providers are increasingly being accepted by the grocery industry. This trend is expected to continue as more grocery chains realize that pallet management is not their core business. There is growing concern amongst grocery chains about the lack of competition within the rental-pallet industry. This is a double-edged sword, as critical mass is required for any rental-pallet organization to provide a high level of service at reasonable cost. This suggests that the industry needs few players to maintain cost efficiency and high service. However, monopolistic and oligopolistic industries can be under suspicion of taking advantage of their customers. Rental-pallet organizations need to be aware of this in managing their customer relationships—with the manufactur-

ers and the retail chains—when they demonstrate the cost/benefit tradeoffs of using rental pallets.

Wooden pallets are expected to remain in use in the United States for the foreseeable future, as the relative costs of wood vs. plastic still favors wood. This is not the case overseas, however. For example, plastic pallets and containers are much more prevalent in Asia due to the relative cost tradeoffs of wood vs. plastic, including the raw-material supply and phytosanitary issues. Wooden pallets in North America are a "sustainable" good, and the wooden-pallet industry is wise to promote this fact with visible support of the forest industry in its efforts to manage plantation forests to maintain an assured source of wood as a plentiful natural resource.

### Conclusion

The total-cost concept of logistics management (which emphasizes a systems approach) does not seem to be well-applied by the grocery industry to pallet use. Many grocery chains do not appear to understand the system-wide cost of buying pallets, repairing them themselves, or engaging in pallet recycling or rental arrangements.

The retailers put these costs in different accounts, with little incentive for integration. The DC managers seemed to be making very astute decisions based on their company's measurement and reward system. But many seemed to lack a broader organizational approach to measuring and managing costs/revenues, and they focus on functional profit centers versus system-profit management.

The more progressive grocery-supply chains seek systemic ways to increase productivity and velocity and to reduce errors and costs. Their emphasis is on flow rather than on storage. System-wide metrics and financial measures are beginning to follow, to further support the growing focus on system-wide supply-chain efficiency and effectiveness. In the future, they will be better prepared to evaluate pallet-related costs.

Pallets are considered to provide efficiency. No respondent could envision the future without the ubiquitous wooden pallet. The material-handling industry does not expect any major changes that would force a move away from pallets. But plastic pallets are gaining ground, even in an era of rapidly rising plastics prices. In many cases they offer true

value, as they clearly do for the retailers in this study. As the need to span racks and support stacks is replaced by flow-through systems, plastic-pallet value will grow.

Store-ready palletloads are increasingly being cross-docked. These range from merchandising displays to custom-mixed rainbow loads which may soon be delivered directly to a chain's stores, bypassing the chain's DC entirely. These new merchandising and distribution approaches reinforce the need for flow and efficiency through the supply chain.

The grocery industry seems to welcome competition to a single rental company. There are many other efficient ways to reuse and recycle pallets, but the best form of competition is still expected to be a true shared industry pool system like that used in Canada and Europe.

While the current transaction-based recycling system successfully competes with the rental companies, a shared industry pool system would have an overall lower cost. The 1992 FMI/GMA study and the CPC estimate that a true common pool system would dramatically reduce costs for the grocery industry as a whole. In a common pool system:

- The quality of pallets in a true cooperative pool would be higher. The recycling system works but has no mechanism to discourage cheating on quality, and deteriorating quality is a primary driver of cost. Low quality results in more labor and costs for repair and replacement.
- The transaction costs and hassles would be lower using today's information technology for a network-based credit/debit system rather than fragmented transactions among hundreds of regional participants.
- The pallet-manufacturing, grocery-manufacturing, and retail industries would have a forum to negotiate their common platform concerns.

The concept of a shared grocery-industry pallet pool is more viable today than ever. Key factors have changed since 1992. The industry has seen the advantages of the rental-pool pallets and of adherence to a standard. There are new seamless

information technology options for controlling pallet logistics. American industry is now cultivating a "sustainable" image, and a shared pool would conserve resources. Finally, the addition of plastic pallets and/or reusable produce containers (RPCs) might just be incentive enough for the competitive grocery and pallet industries to undertake such a collective action. This is a good time to revisit the issue, as the Swedish grocery industry has recently done, developing a nation-wide logistical packaging pool (Gustafsson 2005).

Wooden pallets are expected to remain in use in the United States for the foreseeable future, as the relative cost of wood versus plastic still favors wood. Wooden pallets in North America are a "sustainable" packaging form. But this research has shown that plastic pallets serve a clear need, even in a system that is full of "free" wooden pallets.

The humble wooden pallet plays a vital role in modern grocery distribution. For over 50 years it has successfully served the strategic and cost needs of supply chains. But focusing on wooden pallets alone is marketing myopia. To serve future supply chains, the industry must redefine the business as material handling, movement, and flow.

#### Questions for Further Research

This research suggests two areas for inquiry: the feasibility of a common pallet pool for the grocery industry and the opportunity to include plastic pallets. First, however, a more comprehensive approach to understanding current pallet-system costs should be considered. This approach would then provide context for an evaluation of a common pallet pool. Specific questions to be addressed are:

- What are the total cost comparisons of the recycling and rental systems?
- Would a CPC-type common pallet pool arrangement work in the United States? What would be the costs and benefits for supply-chain participants? How could such an approach be realized in conjunction with existing pallet rental organizations?
- What factors would affect the propensity of a grocery chain to adopt a common pallet pool management system? Which services are

most preferred? Should plastic pallets and RPCs be included?

- Is there a need for GMA/FMI to develop a standard plastic thermoformed-pallet specification? Should it be a material or a performance standard?

#### References

- Bowersox, D. J., D. J. Closs, and M. B. Cooper. 2007. *Supply Chain Logistics Management*, Second Edition. Boston: McGraw-Hill Irwin.
- Christopher, M. 1992. *Logistics and Supply Chain Management*. London: Pitman.
- Gordon, H. S. 1954. "The Economic Theory of a Common-Property Resource." *Journal of Political Economy* (62):124-42.
- Grocery Pallet Council (GPC). 1976a. Recommended Hardwood Pallet Specifications for the Grocery Industry. Chicago, IL.: National Association of Food Chains (NAFC), United Fresh Fruit & Vegetable Association (UFFAVA), Grocery Manufacturers of America (GMA), Cooperative Food Distributors of America (DFDA), National-American Wholesale Grocers' Association (NAWGA), National Association of Convenience Stores, Inc. (NACS), Super Market Institute (SMI).
- . 1976b. Recommended Southern Pine Pallet Specifications for the Grocery Industry. Chicago, IL.: National Association of Food Chains (NAFC), United Fresh Fruit & Vegetable Association (UFFAVA), Grocery Manufacturers of America (GMA), Cooperative Food Distributors of America (DFDA), National-American Wholesale Grocers' Association (NAWGA), National Association of Convenience Stores, Inc. (NACS), Super Market Institute (SMI).
- . 1976c. Recommended West Coast Wood Pallet Specifications for the Grocery Industry: National Association of Food Chains (NAFC), United Fresh Fruit & Vegetable Association (UFFAVA), Grocery Manufacturers of America (GMA), Cooperative Food Distributors of America (DFDA), National-American Wholesale Grocers' Association (NAWGA), National Association of Convenience Stores, Inc. (NACS), Super Market Institute (SMI).
- Gustafsson, K. 2005. "The Process of Creating a

- Nation-Wide Pool System for Transport Packaging — From Vision to Decision." Department of Design Sciences, Lund University.
- Hardin, G. 1968. "The Tragedy of the Commons." *Science* 162.
- LeBlanc, R. 1992. "Orange Pallets in a 'Lemons' Market." Policy Analysis for the Canadian Pallet Council. Simon Fraser University.
- LeBlanc, R., and S. Richardson. 2003. *Pallets: A North American Perspective*, First Edition. Ontario: PACTS Management Inc.
- Mentzer, J. T., ed. 2001. *Supply Chain Management*. Thousand Oaks: Sage Publications, Inc.
- Ostrom, E. 1990. *Governing the Commons: The Evolution of Institutions for Collective Action*. New York: Cambridge University Press.
- Pallet-Enterprise. 2005. "Pallet Board — Online Discussion Explores the Grocery Industry and Its Pallet Usage." <http://www.palletenterprise.com/articledatabase/view.asp?articleD=1412>. Accessed August 1, 2005.
- Ray, C. D. and J. H. Michael. 2004. "Financial Analysis of Alternative Pallets Systems." National Wooden Pallet and Container Association & The Pennsylvania State University.

- Saghir, M. 2002. "Packaging Information Needed for Evaluation in the Supply Chain: The Case of the Swedish Grocery Retail Industry." *Packaging Technology and Science* 15:37-46.
- Saghir, M. and G. Jonson. 2001. "Packaging Handling Evaluation Methods in the Grocery Retail Industry." *Packaging Technology and Science* 14:21-29.
- Seifert, C. M. 1990. "US Food Industry Tackles Massive Pallet Problem." *Materials Management and Distribution* 35 (7):23-24.
- Twede, D. 1992. "The Process of Logistical Packaging Innovation." *Journal of Business Logistics* 13(1):69-94.
- Twede, D. and B. Parsons. 1997. *Distribution Packaging for Logistical Systems: A Literature Review*. U.K.: Pira.
- Witt, C. E. 2002. "Frontline Report from the Pallet Wars." *Material Handling Management* 57 (9):47.
- . 1999. "Economics of Pallet Rental." *Material Handling Engineering* 54 (9):47-51.
- . 1996. "Wooden Pallets Enter New Era." *Material Handling Engineering* 51 (9):63.
- . 1995. "Are Poor-Quality Pallets Slowing