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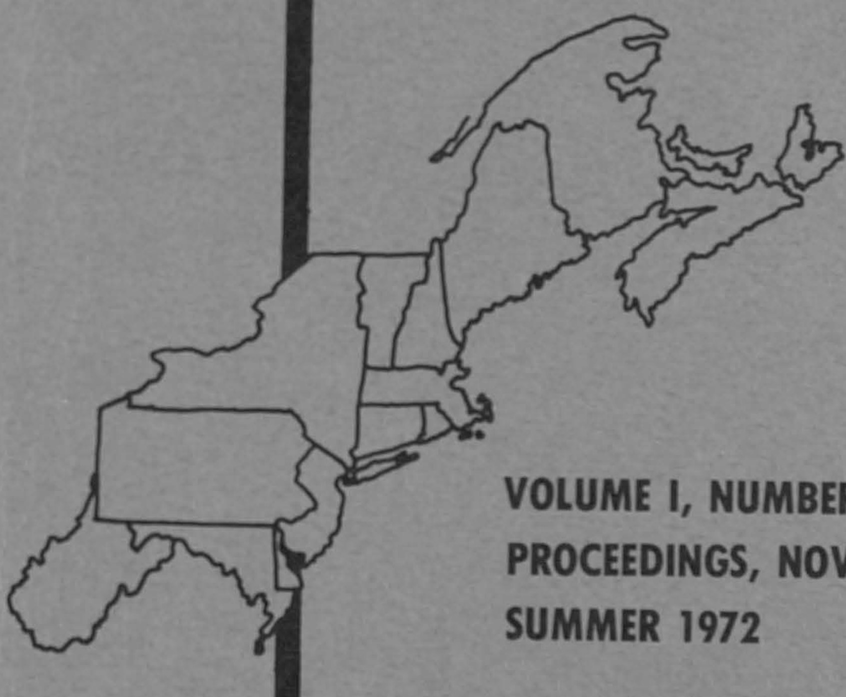

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# PRODUCTIVITY IN THE FOOD ASSEMBLY AND DISTRIBUTION SYSTEM

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## Introduction

The focus of this paper is on the system of assembling food products from manufacturers and processors and distributing these products through warehouses to retail stores and eventually to the consuming public. More specifically, the paper attempts to (1) assess the problems in and potential for improving productivity within this system and (2) suggest needed research efforts to achieve productivity improvements.

Productivity has become a major issue in national economic policy as it has direct bearing on (1) inflation, (2) international trade and competition and (3) morale of the work force. The issue has been given explicit administrative recognition through the formation of a National Commission on Productivity. While accurate measurements of changes in productivity rates are difficult to make, the traditional output per man-hour figures evidence little growth in the past decade. For example, output per man-hour in the private non farm economy actually declined in 1969, and grew at a rate of less than one percent in 1970 (9, p. 98). For the entire decade of the sixties output per man-hour advanced at an annual rate of 2.8 percent while average hourly earnings in the private non farm economy rose at an annual rate of 5.2 percent (5, p. 1).

The food industry is a major component of the domestic economy and a major employer of the work force. There are currently about 2,362,000 people employed in food wholesaling and retailing (9, p. 55) with substantial numbers, as well, employed in food manufacturing and the transportation of food products. Because of the magnitude and importance of this industry as well as its substantial interrelationships with other industries, productivity in the food industry has a substantial impact on the level of this variable in the total economy as well as on the pressure for price increases in the food wholesaling and retailing sectors.

The total food industry has a rather creditable record of productivity performance when compared with the total private economy. A study done by Gale (11, pp. 113-133) illustrates the comparative record of the food industry. The average annual increase in output per person in the food subsystem (industries which contribute to civilian expenditures for food) was 3.3 percent per year for the period from 1947-1958 as compared to 3.0 percent for the total private economy for the same period. There were, however, substantial differences in the rate of productivity improvements for particular sectors of the food subsystem. The farming sector evidenced an average annual increase of 6.0 percent as compared to a rate of 1.7 percent for the food distribution sector (wholesale, retail and eating establishments). The rates for food marketing and food manufacturing were between these two extremes, averaging 2.6 and 2.4 percent respectively.

These data demonstrate the disparity among rates of productivity improvement within the food industry. One implication of this disparity is that an approach which emphasizes the interrelationships among the functions performed in food assembly and distribution as opposed to investigating specific functional areas exclusively, may be more fruitful for delineating major problems and suggesting future improvements, in productivity. The orientation of this paper is to pursue such an approach.

## Perpsective

The system of food assembly and distribution can be viewed conceptually as a parallel series of subsystems which converge at the retail level or in some instances at the wholesale level for consolidated delivery to the retail level. These subsystems can be defined on the basis of general commodity lines as (1) meat; (2) dry groceries; (3) produce; and (4) other perishables (frozen food, milk, eggs).

Productivity is broadly construed in this paper as the ratio of system outputs to system inputs rather than being limited to the traditional output per man-hour conception. The concern is for improved quantity or quality of output with the same or reduced levels of inputs. "System output" and "system input" are admittedly difficult variables to measure and no attempt is made to do so in this paper. However, this general definition does serve a very useful purpose as a conceptual basis for thinking about the performance of the food system.

The structure of this paper is to first analyze each subsystem to (1) explore the nature and magnitude of productivity problems, and (2) describe efforts currently underway to alleviate these problems. The second step is to identify problems which are common to several subsystems such as containerization, warehouse operations, transportation and information flows as well as problems which arise when the systems converge at the retail store level. The final step is to ascertain some of the barriers to improving productivity and to suggest research efforts which might be undertaken.

## Meat Subsystem

The meat assembly and distribution subsystem is characterized by a multiplicity of institutions and arrangements. The major channels for the distribution of meat may be classified as follows:

(1) Direct movement from the packing plants to retail outlets.

(2) Movement from the packing plants to chain operated or cooperative warehouses with subsequent movement to retail outlets.

(3) Movement from the packing plants to independent merchant wholesalers with subsequent sales to retail outlets or warehouses.

(4) Movement from the packing plants through owned redistribution centers to retail outlets, warehouses, or independent merchant wholesalers.

One manifestation of this multiplicity of distribution channels has been an inefficient delivery process at the retail level. A survey by the American Meat Institute (14, p. 135) found that deliveries of meat to chain stores with 10 or less units averaged 23 deliveries per week with an average tonnage per delivery of 575 pounds and 54 percent of the deliveries under 300 pounds. The comparable figures for chains with more than 10 units were an average of 30 deliveries per week, an average tonnage per delivery of 660 pounds, and 53 percent of the deliveries under 300 pounds.

There is a substantial cost associated with a frequent and small volume delivery system. Not only do the transportation and handling costs per unit of meat increase with more frequent and smaller deliveries but also problems with respect to congestion, pilferage, and work interruption are increased at the retail store level. As an example of the magnitude of these cost inefficiencies one meat industry manager (18, p. 20) estimated that his company was able to save approximately $1.16 per hundredweight in delivery and other (accounting, packing and shipping, product spoilage, etc.) costs in one plant by instituting a rule that orders for deliveries of under 300 pounds would not be accepted.

The industry is moving in several ways to consolidate deliveries at the local store level. One direction the industry has taken is to consolidate meat at a chain-owned distribution center or warehouse for delivery to the local retail store. One survey of chain organizations (10) found that 21 percent had meat distribution centers in operation, 11 percent had begun construction of a center, 42 percent had developed plans for a center and only 10 percent had no plans for a meat distribution center. Another possibility for consolidating meat deliveries is a public or joint venture warehouse concept for meat which would be accessible to meat packers servicing a particular area or region. This concept would essentially mean that meat would move through this public or joint venture warehouse rather than through the several packer branch houses or distribution centers. Such a concept could provide for economies of scale in warehousing as well as consolidating the products of several packers in one transportation vehicle for delivery to the local stores.

A closely allied problem within the meat system is the question of the product form which moves through the system. Fresh pork is commonly received at the retail store in the form of boxed primal cuts. Fresh beef, on the other hand, may be received at the retail store level in carcass, primal or sub-primal form. One recent survey (4, p. 33) found that 56 percent of the stores surveyed received some meat in carcass form, 88 percent received some meat in the form of primal cuts and 57 percent received some meat in the form of block ready or sub-primal cuts. Most of the processed meat, on the other hand, is received at the store in the form of consumer packaged products.

There are some rather persuasive arguments for cutting meat carcasses at stages in the system prior to the retail store. Approximately 28 percent of a beef carcass, for instance, is bone, fat and waste implying that transporting carcass beef to the retail store involves movement and handling of essentially valueless weight. A study by the U.S.D.A. (21, p. 1) of centralized fresh meat cutting for subsequent distribution to a group of retail stores found savings as great as $650,000 in construction, equipment and labor costs for a group of 40 stores with a yearly meat volume of $13,000,000. They further concluded that central meat processing offers additional opportunities for savings due to: (1) better distribution of meat cuts according to market preferences, (2) more uniform and efficient cutting methods, (3) better control of overhead costs, (4) advantages of quantity purchases, and (5) a better market for carcass by-products.

While it has become relatively clear that centralized cutting can increase labor productivity and reduce unit costs certain problems remain to be solved before it becomes a standard practice. Problems with respect to whether packers, retailers or independent middlemen should perform this function, the displacement of specialized meat cutting labor at the retail level and low cost methods of sanitation and preservation are among the most important.

Still a further development which has potential for improving unit costs and improving the inventory control capabilities of the meat system is prepackaged, frozen consumer cuts of meat. To date these products have not been widely accepted by consumers and have further encountered problems in the establishment of acceptable margins at the retail level.

## Dry Groceries Subsystem

The pattern for assembly and distribution of grocery products is for the products of grocery manufacturers to be shipped from the manufacturing plant to large regional warehouses which are either manufacturer owned or public warehouses. The tendency has been for both manufacturers and public warehouses to develop larger units which are capable of serving a wider geographic area (19, p. 21). These regional warehouses are used to consolidate products for shipment to retail stores directly or to retail warehouses.

The greatest sources of productivity gains are in the transportation, warehousing and handling of these products. One study (1, pp. 13-16) found that in the traditional method of movement of canned fruit cocktail from the field to the retail shelf the product was handled a total of 25 times.

This study also concluded that palletization in handling could save between \$.0318 and \$.0398 per case in shipper loading and distributor receiving costs as well as \$.0535 per hundredweight in unloading costs at the retail store. A further conclusion was that direct shipment of canned fruit and vegetable items from the suppliers distribution center or the manufacturing to the retail store (bypassing the retailers warehouse) would substantially reduce the unit distribution costs.

An additional problem within the grocery system lies in the handling and preparing of grocery products for retail store display. One study (15, pp. 1-2) found that a "grocery warehouse with a \$40 million annual volume could save approximately 150 man-hours daily, or \$86,000 annually by pricing grocery items mechanically at the warehouse instead of pricing them by hand at the retail store." Problems with implementing this concept on a widespread basis include designing cases and packages for efficient mechanical price marking and providing for flexibility in making price changes.

Additional improvements in productivity could be obtained in the grocery system through the further acceptance of unit handling techniques. Although pallets, slip sheets, and clamps are widely used in the industry for handling unit loads of items their acceptance is still not general throughout the system (8, p. 55). One problem in the adoption of unit handling techniques is providing the proper facilities and equipment at the retail store level to handle unit loads. This problem lends substance to the proposition that the most effective way to improve productivity is to approach problems from the viewpoint of the total system rather than in isolated parts.

Produce Subsystem

The subsystem for assembling and distributing fresh produce involves assembly of the product in the field, further assembly and processing (for some items) near the production center, transport to central warehouses or distribution centers and consolidated delivery to the retail stores. Fast and efficient delivery is of the essence within this system (as within the meat system) because of the perishable nature of the product.

One source of productivity gains within this system lies in improved methods of transportation to the central warehouse. Reduction in transportation costs of \$.053 per carton as well as greater speed and flexibility were found for shipment of California lettuce by piggyback arrangements on rail cars as opposed to shipment in giant mechanical rail cars (1, pp. 5-9). Another possibility for improved speed in transporting produce is through the use of unit or permanently coupled trains for transportation from high density producing areas to high density consuming areas. This concept has been widely discussed but has not yet been widely adopted.

A second source of improvements in productivity lies in the handling of produce. The above mentioned study for lettuce also concluded that shipper loading and distributor receiving labor costs could be reduced by

$.044 per carton through the use of slip sheet pallets and $.030 per carton through the use of standard hardwood pallets. Another study (20, p. V) found that labor requirements for the receiving of produce at the central warehouse are reduced by as much as 91 percent when pallet containers are used. Labor requirements for feeding the packaging line were reduced by 65 percent through the use of pallet boxes as opposed to conventional containers.

A third source of productivity improvements lies in removing the processing and packaging functions from the backroom of the retail store and performing these functions at earlier stages in the system. The aforementioned study of lettuce distribution (1, pp. 7-8) concluded that the retailer could achieve a minimum savings per carton of $.107 and a maximum savings of $.357, depending on the service charge of the grower, from the trimming and wrapping of lettuce heads in the field rather than in the retail store. Savings of $.024 per package were reported in another study (13, p. 1), for produce which is packaged in trays, from packing these trays at the central warehouse rather than in the retail store. These savings resulted from reductions in unit costs of labor, equipment, and space which more than offset the higher costs of materials and containers. Similar savings were obtained for bagged produce items when the bagging was done in a central warehouse rather than in the retail store (20, p. V).

Other Perishables (Frozen Food) Subsystem

The frozen food assembly and distribution system involves shipment of frozen items from the point of manufacture to central warehouses where products are consolidated for delivery to retail stores. One unique feature of this system, as compared to the other systems, is the necessity for maintaining these products in a frozen state. This implies that warehouse storage, retail display units, and transport vehicles all must maintain relatively expensive freezing equipment.

One source of productivity improvements lies in improved methods of refrigerated transport. Improved refrigeration methods, improved air circulation capabilities, partitioned vans for transporting products at different temperatures, separable refrigeration units for intermodal transport and backhaul capabilities, lightweight shells, improved unit loading capabilities, and thinner insulation are some of the concepts being developed to increase the payload in transportation and reduce unit costs (3).

Improvements in productivity within the frozen food subsystem might come from warehouse operations. One study (16, p. 1) concluded that man-hour requirements for handling frozen food in a warehouse could be reduced by an average of 22 percent through "improved work methods and materials handling equipment, more evenly balanced work crews, and improved layouts."

Additional cost reduction potentials were found at the retail level (17, p. 37). By increasing shipment size and decreasing delivery frequency, the costs of delivery of frozen foods to retail stores could be cut by 23 percent. In-store labor costs could be reduced by better scheduling of crews, increased delivery volumes, improved handling methods, the use of easy-open cases, better price marking spots, and the use of procedures that minimize the effects of frost.

## Retail Store Operations

All of the above subsystems converge at the retail store level. The decisions within these systems with respect to packaging, unit loading, frequency of delivery and the like have a substantial impact on productivity within the retail store. Similarly, innovations and decision at the retail store level can materially affect the productivity within each of these subsystems.

The major potentials for productivity improvements at the retail level seem to be in a more effective system of handling and stocking items for the retail shelf, and in an improved system for check-out. Handling of items, both in unloading delivery trucks and transferring items to the retail shelf, is still largely non-mechanized. One of the major problems in instituting the use of palletized procedures throughout an entire system lies in the lack of facilities and equipment for handling pallets at the retail store level. The shelf stacking operation is even less mechanized than the truck unloading operation and requires a high labor input per unit of product.

The other major source of productivity improvements lies in the check-out function of the retail store. While most stores are now self-service oriented, a substantial amount of labor is consumed in the check-out function. One oft-discussed but largely not-implemented procedure for improving the operation of this function is an automated process which uses a scanning or sensing procedure to determine prices and quantities of consumer purchases. This information is fed into a computer which calculates the consumer's bill and provides a listing of items and their prices.

This procedure offers several advantages over the conventional check-out methods. It is faster and provides for fewer errors at the retail level. It further permits more accurate information regarding sales by item or code which can be processed by a computer and utilized for improved management and control of ordering, space allocation, inventory decisions, and manufacturing throughout a product system. The adoption of such a procedure at the retail level would thus have an impact on the entire system.

## Containerization and Packaging

The multiplicity of package shapes, sizes and designs and the attendant variations in case shapes and sizes create substantial problems for the efficient handling of food products. It has been estimated, for example, that there are over 1,000 sizes of shipping containers in use for marketing fresh fruits and vegetables (2). Even when packaged items are placed in similar sized packages they may be packed in different sized shipping containers.

This multiplicity of package and container sizes creates problems throughout the system. It is difficult to automate the handling and storage of products in the warehouse when varying sizes and shapes must be accommodated. High-density and stable pallet loads can be obtained only through the use of standard sized containers which are designed to utilize all pallet capacity. This requirement is even more critical when slip sheets and clamps are utilized to handle unit loads.

Other problems such as poor utilization of transport vehicle cube capacity are created by this multiplicty of sizes. Certain innovations such as mechanical price marking in a central warehouse are affected as these systems must have expensive additional capacity to handle the varying sizes of containers. Handling and stocking at the retail level is also made less amenable to mechanization and the improved productivity of labor by the confusing variety of sizes.

## Warehousing

Warehousing represents another functional part of food distribution where productivity gains might be achieved. Although the industry has moved in the direction of consolidating small and inefficient warehouses into larger and more efficient units additional improvements can be obtained through the continuation of this process.

The integration of building design characteristics and automated handling and storage characteristics is essential for improving theefficiency of warehousing. There are currently several alternative automated or semi-automated systems available for unloading, storage, order picking, order assembly, and loading which provide improved labor utilization. In many cases these have been adapted to existing structures with varying losses in potential efficiency. Coordinated planning of both the building and the handling system can simultaneously insure that the cube capacity of the building is effectively utilized while providing for efficient handling and storage procedures.

## Transportation

The transport function is one which serves all the commodity oriented distribution subsystems. The costs of transportation depend on developments in related dimensions such as containerization, unit load techniques and the product form transported as well as the transport vehicles and techniques themselves.

One course of improved productivity lies in improving the interface among the various transportation classes (air, rail, ship, truck). In order to improve the speed and flexibility of moving products and to exploit the specialized advantage of each transportation class an effective process of switching from one class to another is needed. For example, transportation costs might be reduced by using rail service for high speed point-to-point movement with truck service at the origination and destination points. Techniques for the rapid and effective transfer of the products from the truck to the train and vice versa are required for such a concept to be efficient. A technique is being developed (7, pp. 3-4) to make the van container independent of the transport vehicle, even for refrigerated van containers, in order to transfer the van container directly from one transport vehicle to another. This intermodal van container concept could be used to interface all the transportation classes and permit the products to be handled as a van container unit rather than being unloaded and repacked to change from one transport vehicle to another.

A substantial problem in transportation is the empty backhaul situation where the vehicle is loaded for only one-half of the trip. This has developed because of the specialized nature of transportation vehicles (liquid, dry bulk, etc.) and the difficulty in obtaining a backhaul load which is compatible with the vehicle. A means for permitting these vehicles to carry different types of commodities would greatly increase the possibilities of transporting a payload in both directions and thus reduce unit costs. The U.S.D.A. has developed conversion systems for trucks (2, pp. 5-7) to carry both (1) dry bulk form products and packaged products and (2) packaged products and liquid cargo.

## Information Processing

Increased accuracy and speed in the processing of information represents another source of improvements in productivity for the food distribution system. Improvements can be made in the speed with which data on retail sales volumes and prices is transmitted back through the system as well as in the consolidation of data from different retail stores. This more timely data on product movement at the retail level can provide for reduced inventory costs at both the retail and wholesale levels, more effective order scheduling, reduced costs of stock-outs requiring emergency deliveries, more effective utilization of transportation equipment and improved production scheduling at the manufacturing level. One procedure to provide for improved information processing (12, pp. 52-55) has been conceptually developed and involves the transmission of retail sales data from a sensing device on the retail shelf through a telephone transmission system to a data exchange center where the information from several stores is consolidated and transmitted to suppliers and manufacturers. The hardware for such a procedure has been developed and the substantive problems involved in its implementation involve the interfacing of differing computer systems among the firms involved, establishment of standard product codes and legal, competitive, and security constraints.

## Barriers to Productivity and Needed Research

The above discussions have presented an overview of the nature of commodity food distribution subsystems and the potential for improving productivity within these subsystems as well as in the performance of the specialized functions which are common to these subsystems. In the course of these presentations some of the barriers to increasing productivity in food distribution were implied. The following discussion attempts to explicitly identify these barriers and suggest needed research to identify their importance and suggest ways in which they might be reduced.

## Technology

From the above discussions it is apparent that the technology already exists for effecting improvements in many dimensions of the industry. Government, academic, private, and firm research units have done a very commendable job in developing new technology. The principal problem would seem to lie in the adoption of new technology rather than in its development. These developments are capable of improving productivity in the performance of a specific function but require supporting changes at other levels of the system which often retard their adoption. One example is the development of mechanical price marking of grocery products which requires improvements in, and standardization of, container designs to achieve significant improvements in distribution efficiency. Another example is the development of unit handling techniques which require substantial modifications in facilities and equipment at the retail level to achieve their full efficiency potential.

It is thus suggested that technical research efforts be focused on the interrelated problems of the total system. This is not to say that each research project should be designed to include the total system. Rather it implies that the individual research efforts should contribute to increased efficiency in the total system and provide an evaluation of the impact of a particular technical development on the rest of the system. This requires a comprehensive assessment of the technological problems in the total system and the integration and coordination of individual research projects to satisfy the larger objective of solving these problems. The various functions performed in the system are obviously interrelated and a systems research focus which recognizes these interrelationships should improve new technological developments as well as their rate of adoption. This trend in research efforts appears to be underway (5, p. 2) and should be encouraged.

## Firm Size and Resource Limitations

There continue to be disparities in productivity in the performance of certain functions by different firms. Rather substantial improvements could be achieved if all firms performing a particular function were as efficient as the most efficient firm. There are several potential reasons why firms might differ in their rates of productivity and a valuable research task would be to identify the most important reasons for the food distribution industry. Some potential reasons which might be explored are presented below.

One possible reason might lie in the economies of scale for certain functions. To the extent that there are economies of scale in the performance of certain functions, disparities in productivity rates could be attributed to differences in firm size. If important economies of scale can be identified from published research efforts or original research efforts then policies to encourage expansion of firms to a more nearly optimum size through internal growth or mergers could reduce this barrier to productivity. Such an identification might call for a re-examination of the legal view of both horizontal and vertical mergers and acquisitions.

A second consideration which might account for differing productivity rates among firms is limitations on resource availability which may directly affect the adoption of technological improvements and indirectly affect the firm's growth. Particular resources which might be limiting include capital and management. In one sense the capital expenses for research and development in the food industry are borne, in part, by public research agencies and thus make capital available for other requirements of the firm. Capital may still be a limiting factor in the adoption of new technology. Should research efforts demonstrate the importance of this potential limitation alternative policies to alleviate this limitation should be considered. These might include a pool of low cost funds which could be made available to firms for productivity-increasing capital improvements or a re-examination of the capital depreciation schedules for tax purposes.

Management skill and ability may be a further limitation on the adoption of new technology as well as a root reason for disparities in productivity rates. Widespread dissemination of public information concerning new technology and values of economic variables important to the industry provides for a more homogeneous quality of information available for management decision making in various firms. The differential quality of private information coupled with differing managerial abilities in firms may, however, account for some of the disparities in productivity. As private information is one of the cornerstones of a free enterprise economy policies to improve productivity via this route must be carefully developed. One possibility might be to encourage public research designed to improve management ability through improved decision making techniques and management skills. A further possibility might be to encourage industry-wide cooperation and discussion of issues which are not particularly sensitive for competitive behavior.

A related point concerns the labor resource. To the extent that resistance to new technology by labor is an important barrier to productivity improvements, appropriate policies might be designed to overcome this resistance. These could include arrangements to "buy out" inefficient labor practices and extended program to provide new or improved skills to workers affected by technological improvements.

<u>Firm Viewpoint</u>

A somewhat more subtle but potentially important barrier is the firm point of view. The functions performed by the firms in the system are interrelated and interdependent and their improvement requires a system point of view as discussed above in the technological sense. No single firm, however, manages this total system and each is primarily concerned with only a partial set of the total resources and functions in the system. Prices have traditionally performed the role of coordination and communication among firms at different levels of the system through their reflection of the preferences of buyers and sellers.

There may be reasons, however, why prices no longer adequately perform this function. They may not be sufficiently flexible and responsive and may be used for other purposes such as a competitive strategy. This communication problem is particularly serious in trying to implement improvements in productivity within the total system.

Productivity improvements for the total system are potentially beneficial to all firms in the system through lower unit operating costs. The distribution of these improvements, however, will depend on the competitive interactions among these firms and each one is motivated to adopt new technology only to the extent that it is beneficial to his particular firm.

Because of the interdependence of the functions in the system firms must be aware of the impact of their decisions on the rest of the firms in the system if the productivity of that system is to be improved. To some extent the price mechanism provides this awareness. Additional industry cooperation may be required, however, to identify common problems in productivity and discuss ways in which all firms could benefit from productivity improvements. Such efforts could lead, for example, to greater standardization of containers, improved unit handling techniques and more accurate and timely information for all firms. In order to achieve this degree of cooperation it may be necessary for public agencies to provide a degree of leadership as well as providing the opportunity for such discussions. Research efforts, in addition, might be made to improve the communication among firms through the use of contracts or other devices to supplement or supplant the price mechanism and through improvements in the communication content of prices. These efforts should provide for a more explicit awareness of the interdependence of the firms in the system and the benefits to be derived for all firms from improving the productivity of the total assembly and distribution system.

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