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- Fresh Beef Losses in the U.S. Food Distribution System
- Produce Losses in the U.S. Food Distribution System
- Dairy Product Losses in the U.S. Food Distribution System
- Dry Grocery Losses in the U.S. Food Distribution System
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- Bakery Losses in the U.S. Food Distribution System

- Delicatessen Food Losses in the U.S. Food Distribution System

#### FOOTNOTES

<sup>1</sup>Seven companion reports provide more detailed findings from the study. These reports are identified at the conclusion of the paper.

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## LOSSES IN THE PRODUCE DISTRIBUTION SYSTEM: MAGNITUDES, CAUSES AND REMEDIES

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### Introduction

Following a decline since World War II, per capita consumption of fresh fruits and vegetables in recent years has shown signs of increasing. This apparent renewed consumer interest in produce, coupled with the highly perishable nature of these products, underscores the importance of the study of produce losses. The inherent perishability of produce, as well as the additional causal factors discussed in this paper, result in relatively large losses during the distribution processes.

This paper examines some of the aspects of produce losses in the distribution system. The National Science Foundation - Research Applied to National

Needs (NSF-RANN) commissioned the analysis of the magnitudes and locations of food losses occurring in the U.S. food distribution system.<sup>1</sup> The findings here are derived from that larger study.

"Produce losses" is a term subject to many interpretations. The purposes and nature of this study dictated the use of a number of different "produce losses" terms and concepts: (1) losses by weight, (2) economic value of physical losses, (3) total economic costs associated with losses, (4) shrinkage, and (5) losses resulting in reductions of either the quantity or quality of produce available for human consumption. Although different "produce loss" concepts were used, the study tended toward a single focus: an effort to develop esti-

mates or proxies for the quantities of produce lost for human consumption.

Losses of produce available for human consumption refer to those products commonly distributed through the contemporary marketing and distribution systems. Thus, products which are customarily and purposely discarded, such as retail produce trimmings, have not been included as losses, even though they may be edible and nutritious. The project covered produce distribution activities ranging from the packer's or processor's shipping dock through transportation, wholesaling, and supermarket retailing operations.

The objectives of this paper are to briefly identify the locations and magnitudes and discuss some of the key causes of losses in the transportation, wholesaling and supermarket operations of the U.S. produce distribution system. Finally, some broad remedies are indicated.

#### Magnitudes and Causes of Produce Losses

##### **Losses During Transportation Operations--Packer to Wholesaler**

Industry observers estimate that approximately 88 percent of all fresh fruit and vegetables were shipped to market by truck in 1978. The remaining 12 percent moved mostly by rail, and to a lesser extent by plane and ship. When it is considered that the transportation phase may represent one-half or more of the packer-to-retailer time period, it can be appreciated that transportation has a substantial impact on produce losses.

Produce buyers for a major supermarket chain, which receives produce primarily by truck reported that the firm rejects about 4 percent of the produce arriving at their distribution centers. Assuming that 100 percent of these shipments were salable when they were shipped

from the packing point, a 4 percent loss rate might be attributed to the transportation phase. Clearly, not all produce from a rejected load is lost for human consumption. Additional research is necessary to refine this broad assumption.

With respect to railroad losses, the largest single cause for damage claims was temperature failure. In 1975, temperature failure accounted for 53 percent of potato losses, 48.3 percent of fresh fruit losses and 41 percent of fresh vegetable losses. The temperature at which produce is held affects the rates of all biological processes--respiration, growth, ripening, moisture loss and the development of decay-causing organisms. A case in point is lettuce, which according to a 1967 study should be kept as close to 32°F as possible. Proper intransit temperatures not only are essential to maintain optimum quality until time of arrival at the destination, but also to prolong market life (shelf life). The rate of lettuce respiration increases greatly as temperature increases; and the rate of deterioration increases by two to three times for each 18°F rise in temperature.

During transportation, packaging materials are subjected to considerable stress. Produce packaging does not always adequately protect its contents. For example, in one study, inadequate packaging materials were responsible for losses which resulted when potatoes packed in 50 and 100 pound burlap bags sustained "floor layer bruising" in rail cars.

Lack of cold air circulation slows the cooling rate restricting the removal of produce respiration heat. Shippers currently attempt to cope with such ventilation problems in a number of ways. Some shipping cartons are designed with ventilating holes, and pallets are constructed so as to permit air circulation through them. Moreover, proper loading practices leave an air space above the

cargo, so that fresh, cold air can be circulated throughout the cargo during shipment.

The crushing of lower layer containers in stacks of produce is another packaging related problem. This situation can be caused by any one of several factors: container side wells do not support reasonable stacking weights; containers are weakened by excessive moisture; excess weight and stress are placed on containers due to improper stacking or loading methods; and both "under filling" and "over filling" of containers can cause undue stress on lower layers of stacked cartons.

Periodic truck shortages were also identified as an important causal factor for losses. Shortages are most noticeable among independent haulers--the majority of produce transporters. Recent truck shortages have prompted some shippers to switch to rail transportation even though rail service has deteriorated to the point that West Coast produce shipments may take up to two weeks or longer to reach Eastern destinations.

#### Losses During Wholesaling Operations

The techniques of performing wholesaling functions have undergone many changes in recent years. Included is the automation and mechanization of warehouse handling equipment, as well as improvement in wholesale level produce storage facilities. These advances are intended to offset rapidly rising marketing costs, and improve service levels to supermarkets while maintaining quality of the produce.

Studies have been conducted in the Chicago and New York market which dealt with marketing losses of fruits and vegetables encountered at the wholesale level. Six key produce items<sup>2</sup> were selected for study to determine the amounts of parasitic, non-parasitic, and mechanical (physical) losses incurred in normal

handling. Parasitic losses were defined as those caused by any type of parasite; non-parasitic losses were primarily product condition defects; and mechanical or physical damage related losses were those caused by rough handling, inadequate packaging and mechanical injury. In each of these studies mechanical losses generally comprised at least 65 percent of total losses. Total losses for individual produce items in these samples from all three loss categories ranged from 1.4 percent (Valencia oranges) to 13.5 percent (strawberries).

Produce becomes increasingly susceptible to deterioration during wholesaling activities due simply to the passage of time. Products ripen and soften, and moisture loss continues, perhaps to the point where shriveling or wilting may appear. Decay-causing organisms present at harvest or introduced later in handling continue to incubate and grow. The effect of high temperatures on each of these processes dramatically increases losses of most produce items.

The effect of inadequate temperature and humidity on losses during wholesaling activities cannot be overemphasized. Many different produce items, each having unique temperature and humidity requirements are brought together at the wholesale level to be consolidated and stored in close proximity prior to selection and delivery to supermarkets. Items such as cabbage, celery and lettuce require temperatures close to 32°F, with high humidity. By contrast, tomatoes are best stored at 58°F for a moderate rate of ripening, to be followed by a storage temperature of 32-35°F.

Produce losses also take place during delivery from distribution centers to supermarkets. When trucks are fully loaded, it is relatively simple to avoid toppling cartons during the trip to the stores. However, in many instances, trucks make several store deliveries, unloading only a portion of the load at

each stop. To avoid the risk of toppled loads between stores, it is often necessary to rearrange the remaining cargo after each stop. Failure to do so was observed to be a principal cause of this type of damage. Incidents of such losses were associated with the number of supermarket deliveries per truckload and the nature of driving conditions, i.e., roughness of street pavement, stop-and-go traffic, and the like.

Industry executives attribute a substantial portion of physical produce damage occurring during wholesaling activities to containers which fall, break, catch on obstacles and so forth. In large part, this is due to extreme variations in the sizes, shapes and types of shipping containers. This kind of damage to products occurs most frequently when cartons are handled individually in loading, unloading and stacking activities. Physical damage also occurs when containers topple simply because of the difficulty of stacking them in a stable manner due to incompatible sizes, shapes and types. Physical damage is most acute during the summer months, when the highly vulnerable soft fruits such as berries, cherries, peaches, plums, etc. are at their peak volumes of distribution. Thus, the loading, unloading and stacking of containers on carts and pallets is another critical stage in the distribution process insofar as losses are concerned.

A study of apple handling pointed clearly to the adverse effects of handling abuses. The study reported that at the packer-shipper level 99 percent of a sample of apples packed for shipment were either bruise-free (64 percent) or slightly bruised (35 percent). Upon arrival at the distribution center, 97 percent of these apples were still in good condition. However, by the time they were delivered to the retail store, only 57 percent were in good condition. The remaining 43 percent of the sample were either moderately bruised (26 percent) or severely bruised (17 percent).

Moreover, the study showed that the same kind of apples shipped directly from the packer to the retail store incurred far less damage, with 97 percent arriving in good condition.

Personnel performing wholesaling functions are typically under time constraints which frequently lead to errors. Moreover, they often are insufficiently trained, and lack the incentive to reduce losses by exercising greater care in dealing with an admittedly difficult situation.

#### Losses During Supermarketing Operations

Retail produce shrinkage data as cited in the literature varied from 3.6 percent to 11 percent of retail sales. It should be noted that in this case shrinkage refers to the difference between expected and actual sales receipts; and thus, includes factors such as theft and price markdowns in addition to losses for human consumption. One study placed the dollar value of shrinkage on a nationwide basis at \$300 million to \$500 million annually. On a smaller scale, a single supermarket with produce sales of \$5,000 per week and a loss rate of 5 percent would lose \$13,000 each year.

The 1965 USDA study, "Losses in Agriculture," dealt with retail losses of fruits and vegetables. The study found that one important cause of produce losses resulted from trimming vegetables in order to present attractive, saleable products to consumers. A second cause resulted from discarded, unsaleable produce which had exceeded its shelf life due to substantial decay. It was determined, however, that price discounts caused by product deterioration constituted almost two-thirds of the economic losses associated with fruits and vegetables in retail stores--although these products were not, of course, lost for human consumption.

A University of California study revealed that 62 percent of the tomatoes which were ultimately unmarketable at the retail level possessed measurable defects at the shipping point immediately following harvest. This study, as well as recommendations for loss reduction procedures expressed by retail produce managers, indicate the need for much more careful grading and inspection at the packing level to ensure that better quality produce enters the marketing channel.

One of the most pervasive causes of store level produce losses is improper handling by produce department employees. Produce managers interviewed in the field suggested that the following personnel-related problems contribute significantly to losses at retail: overstocking, overtrimming, and lack of proper stock rotation.

Unseasonal weather also is a cause of losses at the supermarket level. Just as weather impacts on the amount and the condition of produce harvested and supplied to the marketplace, so, also, does it impact upon the demand expressed by consumers. Retail chain produce buyers typically accumulate inventories of certain commodities at particular times of the year, especially for holidays. In anticipation of summer holiday picnic shopping, for example, extra stocks of watermelons and sweet corn may be accumulated. Rainy weather, or even forecasts of inclement weather, may sharply reduce short-term demand. The result is that sizeable quantities of these perishable produce items spoil.

Another way by which weather conditions contribute to produce losses is in its effect on the distribution process. Several distribution functions are typically performed in uncontrolled temperature environments: distribution centers' receiving, shipping docks and staging areas; and supermarkets' receiving docks, backrooms and display cases. Coincident-

ally, the warmest months are those in which the most fragile produce items, such as soft fruits, are in the distribution channel. Thus, during hot weather produce losses are magnified.

Losses of some produce items in supermarkets are related to item turnover and basic consumer demand. Slower moving items generally experience higher losses for several reasons: on average they take longer to sell; sales may fluctuate because they are more dependent upon variable factors such as weather; and, in some cases, slower moving items are the most fragile items in terms of bruising, deterioration and other loss-causing damage.

There are instances when government regulations and local ordinances may be a contributing factor with respect to produce losses. For example, some wholesale buyers indicated that regulations prevented them from rejecting shipments, which, although in saleable condition upon delivery at wholesale, would certainly deteriorate rapidly because of inordinately high temperatures which had existed during transit.

#### Systems-Wide Losses

Produce losses vary greatly in magnitude, as well as in kind. Some losses of produce are so blatantly obvious, as to require their immediate removal from the distribution system. Other losses are of a more subtle kind and are more difficult to detect and measure.

In general, a large proportion of produce losses results from the interaction of several factors: inadequate temperature and humidity; improper packaging and handling; slow product movement and unexpected reduction in market demand; government regulations, or lack thereof; the inherent short product life of many produce items; trim and spoilage; excessive moisture evaporation; and poor quality product entering distribution.

Total produce losses occurring within the distribution system are determined in this study by summing losses in the operations of each of the distribution phases previously described--transportation, wholesaling and supermarketing. However, secondary data are incomplete and often are limited to specific produce items and situation. Further, there is a lack of

consistent measurement used within the various phases of the distribution system. Thus, aggregate losses data are subject to substantial imprecision. Table 1 presents approximations of produce losses in the distribution system. These figures are based upon secondary data as well as limited field study of industry sources.

Table 1. Estimated Ranges of 1977 Produce Losses in the Distribution System<sup>a</sup>

Distribution Activity	Losses <sup>b</sup>	Value of Losses <sup>c</sup>
	(percent)	(millions of dollars)
Transportation	3.80 - 5.00	268.70 - 379.81
Wholesaling	2.50 - 5.03	176.86 - 381.75
Retailing	2.74 - 6.58	194.01 - 500.33
Systems Losses	9.04 - 16.61	639.57 - 1261.89

<sup>a</sup>Losses cited are estimated values of physical quantities of food lost for human consumption. Costs of recoup, trimming, salvage operations and numerous indirect costs associated with losses and damage are not included.

<sup>b</sup>Percentage losses are based upon dollar values of losses in each phase of distribution as a percentage of the wholesale value of products entering the distribution system. Wholesale values of products entering the system are estimated to have ranged from \$7,071.00 million to \$7,596.22 million. This range accommodates the given loss rates and supermarket produce sales of \$9,506.49 million.

<sup>c</sup>Losses in transportation and wholesaling activities are valued at wholesale prices and losses at retail are valued at retail prices. The estimated retail gross margin of produce is 31.7 percent.

It is important to note the nature of these loss estimates. First, the ranges of losses are very broad. They reflect substantial variations in practices and performance by firms within the produce distribution system. Moreover, the informational bases used to develop the ranges of losses are too limited to assume that "average losses" occur at the midpoint of each range. Thus, representative averages have not been presented

and cannot be determined based upon data from Table 1.

Second, the aggregate dollar losses appear extremely large, perhaps suggesting huge food loss reduction potential. Although it seems possible to achieve substantial loss reductions, it should be remembered that by comparison to these aggregate data, individual incidents resulting in losses are quite small. Where-

as the systems-wide losses range from approximately \$640 million to \$1.3 billion, the majority of individual loss situations would probably be measured in cents. Thus, it seems unlikely that losses can be significantly reduced by single or simplistic actions.

#### Remedies for Losses in the Produce Distribution System

Some of the methods currently being used to reduce produce losses include: techniques to improve temperature maintenance, palletization and unitized handling, and the utilization of packaging that provides optimum physical protection while allowing for adequate ventilation for highly perishable produce products. Discussed below are broad remedies that have perhaps the greatest potential to reduce produce losses.

-- The use of unitized shipments with pallets or slip sheets together with package modularization would help considerably to reduce handling costs and product damage not only in transportation, but throughout the distribution system, as well. Together these practices would permit fast, mechanized handling and loading, and ensure delivery of produce with less damage than if individual cartons were handled several times during the distribution processes as is not so often the case. "Strapping" of pallet loads is an important component of improved handling. Use of this technique converts a stacked pallet load of shipping containers into a more stable single unit that can be shipped with much less risk of handling damage.

-- Greater attention needs to be devoted to the basic shipping container. To fulfill its role, it must provide stacking strength, be packed and closed properly, and be well ventilated. Although far less encompassing than an industry-wide system of modular packaging, improvements in individual produce packages hold substantial promise for

loss reduction. Packages are needed that better protect produce from physical abuse and contaminants, and help to prevent deterioration in quality. For instance, Valencia oranges stored in polyethylene bags for four weeks at 41°F were in excellent condition, losing an average of only 1.7 percent in weight. This compared with a much higher weight loss for fruits stored in paper bags, 9.5 percent. In another study, Washington Red Delicious apples packed in a pallet box had a proportion of sound apples of 72.5 percent, compared to 82.7 percent for similar apples packed in traypack cartons.

-- The correct handling of properly filled containers can also help to maintain product quality and reduce losses during distribution center activities. Limiting the frequency of handling also can contribute to loss reduction. To this end, prepackaging of produce and palletization of products offer great potential. One alternative for reducing the frequency of handling is a "bulk bin" distribution system being experimented with for the past several years by a few retail chains. The bulk bin container is constructed of either plywood, fiberglass, steel, wood, or corrugated fiberboard. It may be square or octagonal in shape, typically 36 inches high and designed to fit the 48" x 40" pallet base. Such bins may hold up to 1,000 pounds of produce. The initial intended use of bulk bins was to facilitate the movement of bulk produce from the field to prepack warehouses, thereby achieving a reduction in product handling. In some instances, however, bulk bins are bypassing warehouses, moving directly from the field to the retail display floor, resulting in even fewer handlings.

-- Recent research has identified groups of fruits and vegetables which are compatible for mixed load shipments and storage. Compatibility is based upon the following types of factors: temperature and humidity requirements; response



to atmospheric modifications; need for protection from odors and physiological active gases; and, need for icing. Future utilization of this information in establishing practices for assembling mixed shipments, and in designing warehouses is expected to substantially reduce losses during transportation and in the storage phases of distribution. Similarly, such research can also be expected to lead both to development of new fruit and vegetable varieties with improved shelf life and handling characteristics as well as to new technology to accommodate these improved varieties.

-- Improvement in transportation facilities and services will require an industry-wide effort, perhaps with trade associations, as well as university and government involvement. Among the alternative modes of produce transport, railroads, because of their relatively low cost per mile, appear to have much potential, especially for long distance hauling. Railroads, however, pose the greatest problems with respect to rapid and dependable service. Thus, viewed from only a "transportation cost" perspective, truck transportation is used to excess relative to rail; however, shippers and buyers accept higher mileage costs placing greater value on more secure, dependable delivery of highly perishable produce commodities. As petroleum-based energy becomes relatively more costly, transportation related problems will become still more critical in importance.

-- Governmental regulations and local ordinances regarding fresh produce require close scrutiny. The adoption of grade standards for specialty products, for example, may reduce the current levels of losses in this area. Conversely, existing regulations need to be reviewed for statutes that may actually be increasing the losses of perishables.

-- In general, better selection, training and motivation of personnel is needed, although the benefits of this process have

not as yet attracted the kind of attention commensurate with needs in most organizations. There often appears to be a general lack of recognition that a planned training program is necessary for workers in the produce department. Trade associations might play a leading role in communicating these problems and their solutions to their industry membership. For example, various forms of supermarket employee training programs to reduce improper handling have been implemented by many retail firms. Subject matter covered included preparation of produce, sanitation, produce rotation, and quality control in addition to loss control.

Fundamental solutions to reduce losses are those which are likely to involve better coordination of each of the component functions of the entire produce distribution system. Improved transportation, centralized packaging and standardized carton sizes, for example, will require extensive cooperation and coordination on the part of most members of the produce marketing system. Retail firms can initiate substantial loss reduction improvements through the application of improved business management, particularly with respect to more effectively managing the interface functions between the distribution center and the supermarket. In supermarkets, themselves, more highly trained and motivated produce managers are needed to effect loss reduction improvements, especially with respect to the problems of improper handling and inadequate temperature and humidity. Thus, improvements in management as well as in physical distribution practices are requisite to loss reductions without adding to the total net cost for distributing produce. Industry associations, universities and government agencies can significantly contribute to these objectives.

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#### A Series of Reports on Food Losses

This paper is derived from a series of reports on "Losses in the U.S. Food Distribution System." Papers in this series include:

- Produce Losses in the U.S. Food Distribution System
- Fresh Beef Losses in the U.S. Food Distribution System
- Dairy Product Losses in the U.S. Food Distribution System
- Dry Grocery Losses in the U.S. Food Distribution System
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- Bakery Losses in the U.S. Food Distribution System
- Delicatessen Food Losses in the U.S. Food Distribution System
- Losses in the U.S. Food Distribution System

#### FOOTNOTES

<sup>1</sup>A complete list of the series of reports resulting from this NSF-RANN study is included at the end of this paper.

<sup>2</sup>Apples, lettuce, oranges, peaches, potatoes and strawberries.

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