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LOSSES IN U.S. FOOD DISTRIBUTION SYSTEM



FRESH BEEF LOSSES

John W. Allen
Thomas R. Pierson
John M. Halloran

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U.S. FOOD DISTRIBUTION SYSTEM

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East Lansing, Michigan
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PREFACE

This is one of eight reports resulting from a study of losses and waste in food distribution. The National Science Foundation-Research Applied to National Needs (NSF-RANN) commissioned and provided primary funding for the analysis of the general magnitudes and locations of food losses occurring in the U.S. food distribution system. Additional resources were provided by Michigan State University's Agricultural Experiment Station and Cooperative Extension Service. Seven food product categories have been analyzed: fresh beef, produce, dairy products, dry grocery, frozen foods, bakery goods and foods sold through delicatessen departments. Foods within these categories constitute about 92 percent of supermarket dollar food sales. Dry grocery is the largest category, accounting for about 36 percent of supermarket food sales. It is followed by dairy products at about 15 percent, fresh beef at about 13 percent, and produce at about 9.8 percent of food sales. Frozen foods, "deli" department foods, and bakery goods accounted for 8.1, 5.2, and 4.7 percent respectively. It should be noted that with the exception of fresh beef, the categories are designated according to conventional food store departments. In the case of beef, it is the dominant product in the meat department.

This particular report contains: an introduction and orientation to fresh beef distribution through supermarkets; a discussion of the general nature of fresh beef losses; and findings of the magnitudes, causes and suggested remedies for fresh beef losses. The following companion reports also derived from the NSF-RANN study complement this report.

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

FRESH BEEF LOSSES IN THE U.S. FOOD DISTRIBUTION SYSTEM

CONTENTS

	Page
Introduction	1
The Nature of the Research	2
Fresh Beef Distribution	3
The General Nature of Fresh Beef Losses	8
Glossary of Terms	10
Losses During Transportation Operations: From Packer Shipping Dock to Distribution Center	11
Physical Volume and Dollar Value of Losses	12
Causes of Losses	13
Technology Currently Available for Loss Reduction	17
Technological Developments Needed for Loss Reduction	18
Barriers to Loss Reduction	19
Losses During Wholesale Operations	20
Physical Volume and Dollar Value of Losses	21
Causes of Losses	25
Technology Currently Available for Loss Reduction	26
Technological Developments Needed for Loss Reduction	29
Barriers to Loss Reduction	30
Losses During Supermarket Operations	31
Physical Volume and Dollar Value of Losses	34
Causes of Losses	36
Technology Currently Available for Loss Reduction	38
Technological Developments Needed for Loss Reduction	41
Barriers to Loss Reduction	45
Future Perspective: Potential for Change in Fresh Beef Distribution	48
Implications of Research and Development	49
Summary and Conclusions	53
Appendices	
Appendix I Shrink Loss Pattern for Beef	66
Appendix II Comparison of Beef Shrinkage	67
Appendix III Miscellaneous Information on Beef Losses	68
Appendix IV Cumulative Shrink Loss from Packer to Supermarket	69
Appendix V Economic Comparison of Carcass Vs. Cattle Pak	70
Appendix VI Checklist for Vacuum Packaging of Boxed Beef	71
Appendix VII Composition of 650 Pound Carcass	74
Selected Bibliography	76

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INTRODUCTION

The reality of serious resource shortages coupled with stagnant productivity over the past decade has led to a renewed search for ways to improve efficiency in the U.S. economy. The productivity problem and resource shortages have been important factors in creating the nation's most serious economic problem -- inflation. Among the most visible symptoms of inflation are rising gasoline and heating fuel costs as well as food price increases. Rapid food price increases and the hardships they pose for society highlight the necessity to improve productivity and resource utilization in the food distribution system. Among the many resources used in the distribution foods -- labor, energy and capital, to name just a few -- food itself must be included as a vital resource. Thus, food firms need to develop and implement more "food efficient" distribution methods within an overall context of cost efficiency.

At the present time, however, the nature of food losses in the distribution system is often not well understood. Neither the magnitudes nor the locations of food losses have been adequately documented. Even definitions of the terms differ greatly. Nonetheless, until the magnitudes and locations of the losses are established, opportunities to take action to reduce them are severely limited.

This report presents preliminary estimates of fresh beef losses in the U.S. beef distribution system. Important as the goal of fresh beef loss reduction is, losses should be viewed as but one of many factors contributing to overall efficiency in the distribution system; and in deciding upon rational courses of action to reduce them, the costs of fresh beef loss reductions should be compared with the economic value of the prevented losses.

The Nature of the Research

"Fresh beef losses" is a term subject to many interpretations. The purpose of this study dictated the use of a number of different "fresh beef 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 product available for human consumption. Although different "fresh beef loss" concepts with disparate data were used, the study tended toward a single focus: an effort to develop estimates for the quantities of fresh beef lost from human consumption.

Losses refer to those meat products commonly distributed through the contemporary marketing and distribution systems and customarily consumed. Thus, products which are purposely discarded, such as blood and other animal products, have not been included as losses even though they may be edible and nutritious.

The project covered beef distribution activities ranging from the packer's shipping dock through transportation, wholesaling, and supermarket retailing operations. Clearly, depending upon the packaging technique, these operations vary from one another. Fresh beef, for example, may be shipped from the packer either in carcass form, or vacuum packed in primal or subprimal form. The type and amount of losses may vary among distribution methods. In any event, the distribution systems covered in the study were those ending with the supermarket, and most often they began with transportation to distribution centers or warehouses which service supermarkets. The vast majority of transportation, wholesaling, and supermarket retailing activities of fresh beef were included for study.

The specific objectives of the study were:

- To identify the general magnitudes and locations of major fresh beef losses during distribution activities based upon a thorough inventory of available information.

- To determine the approaches currently used to control fresh beef losses, and to assess the effectiveness of these approaches.
- To identify fresh beef loss issues which may need additional research in order to reduce losses.

Research procedures employed to achieve these objectives involved a four-step process:

- An initial, broad-based survey of published information was conducted. Sources of information included: (a) university, United States Department of Agriculture and private industry-sponsored symposia on food losses and related topics; and (c) trade publications.
- A select panel composed of representatives from industry, trade associations, and government met at Michigan State University to review and comment upon the preliminary findings. They also contributed to the identification of comprehensive resource materials.
- The analysis and synthesis of selected published data was conducted in order to develop a comprehensive picture of fresh beef losses.
- A limited number of in-depth interviews were carried out with selected industry authorities to provide additional information, and to obtain their reaction with respect to the validity of the findings of the project.

Fresh Beef Distribution

Fresh beef is among the most important of U.S. food commodities. In 1977, U.S. consumers spent over \$10 billion for fresh beef in supermarkets. Over the past several years, consumers have spent for beef an average of about 2.5 percent of their total disposable incomes, or approximately 15 percent of their expenditures for food. In a typical supermarket, fresh beef sales constitute between 35 and 45 percent of the total meat department sales, and 12 percent of total food store sales.

About 35 to 45 percent of all beef consumed is eaten away from home; sold through restaurants, hotels and fast-food establishments.¹

The popularity of beef as a food is indicated by still other measures. In 1960, per capita consumption of beef was 85 pounds. In 1977, this figure had risen to 126 pounds, with the total of all meats consumed at 193 pounds. Despite the many doubts raised by some persons about the nutritional value and wholesomeness of beef, it remains among the most important and popular foods in the diets of American consumers.

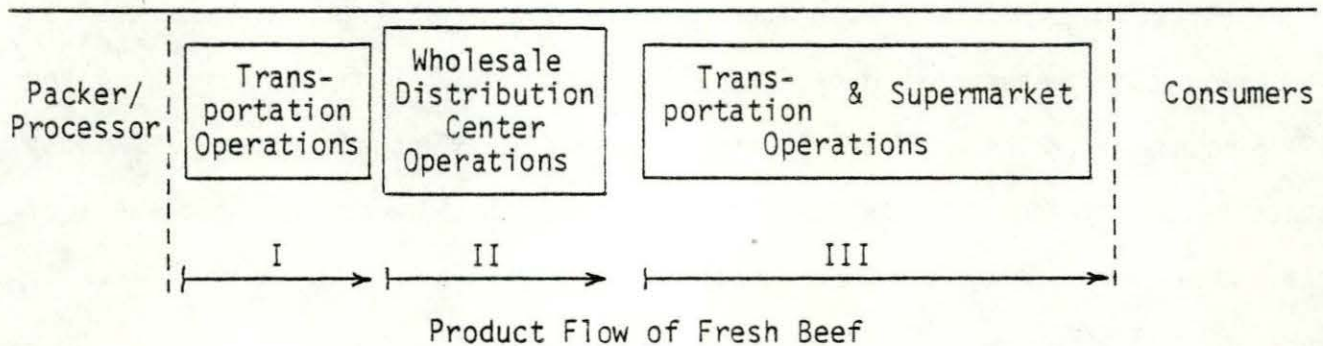
The beef industry is the largest single component of the U.S. food system, representing almost one-third of total farm receipts. There are 1.7 million farm families involved in beef cattle production. Although sometimes criticized as an excessive or inefficient use of valuable grain, beef cattle convert such feeds into high quality food protein. Moreover, cattle are effective in utilizing grazing lands, forage crops, and by-products of food processing operations, thus converting these limited-use resource into nutritious foods (1).

The study focuses on those physical losses which occur, reducing the available supply of currently consumed beef products, as fresh beef moves in distribution from packer's shipping dock, through the distribution center, and on to the supermarket. This report divides loss data into these three basic categories as depicted below in Figure 1.

In achieving a perspective of the topic of losses in the beef system, it may be useful to consider that the ideal beef system would have the following goals: providing products acceptable to consumers in terms of their economic value, taste appeal, nutritional adequacy, safety, and wholesomeness; and achieves a high level

¹This study deals exclusively with beef distribution through supermarkets. For a comprehensive discussion of the role of beef purveyors in the "food-away-from-home" market, see bibliographic reference (23).

Figure 1. Distribution Categories Studied



of relative efficiency in the utilization of the nation's resources. Finally, it would provide a reasonable and equitable return for each of the individuals, companies and organizations performing essential roles in the production, processing and distribution of beef products (46). As shall be demonstrated, the reduction of losses in fresh beef distribution is related to each of these system goals. Thus this study deals with a subject meriting the interest of both researchers and industry practitioners.

Fresh beef is distributed from the packer to the supermarket directly, or through a distribution center operated by the retailer. Beef is also distributed in a variety of forms as the carcass is transformed in a disassembly process into various sized cuts (43). Differences in beef distribution methods bear importantly on the kinds and extent of physical losses which occur. This study examines each major type of beef distribution.

While there are variations, fresh beef typically remains in storage with a packer for two days following slaughter. It then may be in transit to the distribution center or supermarket for another one or two days. If beef is shipped to the distribution center, rather than directly from the packer to the store, it is typical for it to remain in the distribution center for three days in carcass form,

or from three to five days if it is vacuum-packaged (boxed beef). Additional transportation from the distribution center to the supermarket is accomplished in one day. The supermarket converts beef quarters, primals or subprimals into consumer cuts, stocking them in the display case within three or four days. These typical time periods lengthen, of course, when the packer or retailer implements a carcass aging program; and another time variation exists where a retailer accumulates in storage sufficient amounts of particular beef cuts for merchandizing programs, referred to as "features" or "specials" (17).

Figure 2 describes the four basic methods of fresh beef distribution chosen for study to estimate losses. These are referred to as Systems A, B, C, and D. There are refinements in fresh beef distribution methods which could have been incorporated to reflect additional complexity. Indeed, some studies list as many as eleven different methods for delivering fresh and frozen meats, including supplementary subsystems (5).

With respect to the form in which fresh beef arrives at the supermarket, the practice predominating until the 1960s was to ship carcasses, hung from hooks, in truck trailers or rail cars. Since that time, the custom of shipping in carcass form has rapidly given way to a variety of other methods involving prior cutting, trimming, and packaging of subprimal or primal cuts (13). Retailers surveyed by the Cryovac Division of W. R. Grace in 1981 indicated that they received about 75 percent of the beef they sold in boxed form. They predicted that by 1985 more than 80 percent of all beef shipped to retailers would arrive in boxed form.

The continuing trend toward centralization in fresh beef fabrication and packaging represents a major change in beef distribution, and has important implications for the kind and extent of beef losses.

Figure 2. Alternative Beef Distribution Methods Studied

System Description	Percent of Total Beef Distribution	Flow of Fresh Beef in Distribution		
A. Carcass	38	Packer	→	Distribution Center → Supermarket
		(carcass)	→-----→	(retail cuts)→
B. Packer Breaks Carcass into Primals or Subprimals (non-vacuum packaged)	15	Packer	→	Distribution Center → Supermarket
		(non-vacuum primal/subprimal)	→-----→	(retail cuts)→
C. Distribution Center Breaks Carcass into Primals or Subprimals (non-vacuum packaged)	10	Packer	→	Distribution Center → Supermarket
		(carcass)	→-----→	(non-vacuum primal/subprimal) →-----→ (retail cuts)→
D. Packer Breaks Carcass into Primals or Subprimals (vacuum packaged or boxed beef)	36	Packer	→	Distribution Center → Supermarket
		(vacuum packaged primal/subprimal)	→-----→	(retail cuts)→
(All Other Systems)	<u>1</u> 100%			

Source: Numerous reports and field interviews.

THE GENERAL NATURE OF FRESH BEEF LOSSES

As fresh beef is distributed from packer to retailer to consumer, it is highly vulnerable to physical deterioration and losses. Beef is among the most perishable and biologically active of foods (5, 15, 31). As such, its condition is strongly influenced by variations in packaging, lighting, temperature, humidity, and sanitation. Both carcass and vacuum-packaged beef are sensitive to the physical handling to which they are exposed. In addition to extraordinary susceptibility of beef to virtually all aspects of its environment, the shopping public and firms in the food distribution system have high expectations relative to the quality and appearance of fresh beef (17). Fresh beef is likely to be rejected by shoppers, and therefore subject to loss, if beef cuts fail to maintain their bright, pink color (bloom); or if external fat loses its clean, white appearance. When these qualities are even slightly diminished, the product appears less inviting to most shoppers, despite the fact that it continues to be acceptable in taste and nutritional value. Indeed, beef must not only appear acceptable to shoppers and food industry operators, but also must meet standards for odor and taste that may not be indicative of its safety and wholesomeness as a food (16).

Because fresh beef is highly subject to losses when it fails to meet these standards, it must be distributed in ways that preserve its attractive visual appearance, fresh scent, tenderness and juiciness, and ensure its cleanliness and wholesomeness (10). Beef also must meet an expected flavor standard. Consumers seek a product that is certified by government agencies and companies to be wholesome and sanitary. More recently, consumers have also begun to concern themselves with both the nutritional and resource-efficiency aspects of the consumption of beef. Standards in all of these areas have risen over time in a cultural setting of greater consumer awareness, an increased sense of entitlement on the part of many citizens, and more numerous areas of conflict between these differing goals (1).

Another important characteristic of fresh beef distribution is the inevitable loss that occurs in the form of moisture shrinkage and cutting as carcasses are fabricated into units to meet the shopping, storage, preparation and consumption needs of the marketplace. While this study demonstrated that such losses vary widely, and many can be reduced or eliminated, at least a minimal level of loss of this kind is characteristic of the very nature of beef distribution as it is currently practiced. Substantial changes in the way beef is cut, packaged, and distributed would be necessary in the future to further eliminate or greatly lessen shrink and cutting losses. Such changes seem possible and are discussed later in the report in the section entitled, Future Perspective: Potential Improvements in Fresh Beef Distribution.

This study focuses on four major classifications of physical losses of fresh beef occurring throughout distribution operations: (1) shrink losses (moisture evaporation); (2) cutting losses (mainly in the form of "dust" resulting from sawing the lean as the carcass is disassembled); (3) floor scrap losses during the cutting process; and (4) retail and display losses at the supermarket. (The economic losses from pulls, rewraps and down-pricing are not included in this study of losses, but are arguably significant.)

Losses occurring at each stage of distribution were expressed in pounds per wholesale carcass equivalent. Dollar values were estimated utilizing those dollar values per pound applied in the Case and Company study conducted in 1975 for the U.S. Department of Agriculture (12, 44). A value per pound of \$0.68 was used for beef during transportation operations; \$0.68 and \$0.90 during the distribution center or wholesaling operations; and \$1.30 during supermarket operations. These values serve only to help make broad estimates of the dollar value of fresh beef losses, recognizing that market prices for fresh beef change, and variations occur between operations themselves. Dollar values for losses were believed to be useful

in providing a comparative view of the economic losses among the many food products analyzed in the whole NSF-RANN project. But, perhaps the most useful measure of the nature and magnitude of losses of fresh beef is the data showing the quantity of physical losses (in pounds and wholesale carcass equivalents).

Glossary of Terms

Boxed Beef - Beef cut from a carcass into primals, subprimals, or both; vacuum-packaged in plastic bags; and placed in cartons. This may be performed by packers, brokers, wholesalers, or retailers. The term "vacuum-packaged" beef also may be used when such cuts are not placed in boxes, but are handled in lugs or by other means. Vacuum-packaged is a term frequently used interchangeably with the term "boxed beef".

Carcass - The dressed, slaughtered beef animal. "Carcass beef" sometimes refers to quarters of the entire carcass.

Cutting Loss - Meat pieces and scraps lost as a result of fabricating the carcass into primals, suprimals or retail cuts.

Distribution Center - A facility used by the retailer to either assemble, store, and distribute beef to supermarkets; or to process beef in a central breaking or central cutting operation. The facility where wholesaling functions are performed.

Gross Margin or Gross Profit - That part of the selling price that remains after the cost of goods sold has been deducted: expressed either in dollars or as a percentage.

Grades - Official quality grades or standards established by the USDA Agricultural Marketing Service. Each grade name (such as "Prime," "Choice," "Good," etc.) is associated with a specific definition of quality.

Losses/Wastes - Losses which represent a reduction in the supply of currently consumed beef products. For example: losses due to shrinkage, cutting, meat dust, floor scrap, retailing and displaying.

Purge - Loss of juices in packages of retail cuts and/or vacuum packages.

Primals - Major divisions of the carcass such as rounds, loins, chucks.

Retail Cuts - Beef cut into portions suitable for consumer purchase. For example: ground beef, steaks, and roasts.

Rewrap - A retail cut that is removed from the display case to be either reprocessed, re-wrapped, re-weighed, or re-priced. The cause may be an expired selling date, a torn package, an error in cutting, discoloration, or other signs of product or package deterioration.

Shrink, Shrinkage - Weight loss due to moisture evaporation. In this report, the term is not to be confused with the theft of products, which sometimes is referred to by the industry as "shrink".

Subprimals - Divisions of primals which are not yet the smallest retail cuts. For example: the primal round is broken into the subprimals of top round, bottom round, and knuckle.

Vacuum Packaging - Sealing products in an air-tight, moisture-proof film package. Typically, this film-wrapped product is shipped in boxes, and is commonly referred to as boxed beef.

Wholesomeness - Refers to freedom from pathogenic microorganisms or harmful bacteria. This is influenced by the health of the animal and proper sanitation and handling procedures, and the maintenance of proper temperature and humidity in storage.

LOSSES DURING TRANSPORTATION OPERATIONS: FROM PACKER SHIPPING DOCK TO DISTRIBUTION CENTER

In 1976, 98 percent of all fresh beef marketed in the United States was shipped by truck. The remaining 2 percent was shipped by rail (41). Because fresh beef is among the "agriculturally exempt" commodities, data on losses need not be (and therefore are not) recorded by the truckers transporting the vast majority of

beef. As a result, published information on losses for fresh beef transported by truck is scarce. By contrast, the Association of American Railroads (AAR) publishes extensive reports on loss and damage claims (6). These extensive records, however, are of limited value for this study, because little fresh beef is shipped by rail.

The losses typically occurring in transit result from product mishandling, and the evaporation of moisture (shrink) from the meat.

Physical Volume and Dollar Value of Losses

With respect to losses due to physical damage, it was estimated by Carpenter and Smith that "motor truck transportation of beef may have claims on approximately 1 percent of the total loads" (11). Iowa Beef Processors, Inc. reported filing damage claims in 1975 of \$9.67 per shipment of boxed beef, and \$11.02 per shipment of carcass beef (33). The company also reported transportation loss claims of \$0.18 per carcass. This latter piece of information cannot be projected for the entire industry; although it may be indicative of a general magnitude and value for losses in transportation.

Shrinkage is another identifiable loss occurring while beef is being transported (28). In this case, a number of studies have measured such losses (see Table 1). In 1966, A. T. Kearney established a 0.5 percent average daily shrink loss for fresh beef in carcass form during transportation (7, Appendix I). In 1972, Monfort of Colorado, Inc., reported a 0.77 percent shrink loss for carcass beef during a typical four-day transportation period (30-1972, Appendix II). Iowa Beef Processors, Inc., in 1977, cited a 0.42 percent daily shrinkage rate for carcass (12, 44, Appendix III). The U.S. Department of Agriculture also reports shrinkage data which generally support these findings (Appendix IV).

The physical volume of shrink losses during transportation from packer to distribution center ranges from 3.2 to 13 pounds for all systems of beef

Table 1. Shrink Losses in Transportation Operations as
Reported by Industry Studies¹

Source of Data	Shrink Losses
	(pounds per 4-day period)
A. T. Kearney	13.0
Case and Company	10.9
Monfort Colorado	5.0
Iowa Beef Processors	3.2

Source: See Appendices I, II, III, IV and (7,12,18,30,44).

¹Shrink losses are expressed in pounds per 650 pound wholesale carcass equivalent and were based on a four-day projected period, although some sources did not report losses over entire four-day period.

distribution, with the exception of System D. In the case of System D, boxed beef avoids practically all shrinkage as a result of the protection provided by the vacuum packaging.

The dollar value of shrink losses depends upon the particular carcass price used. Applying the value of \$0.68 per pound used in the Case and Company study (12, 44), losses on carcass beef (System A) range from \$2.17 to \$8.84 per 650 pound carcass, as is indicated in Table 2. For System C, the dollar value of losses was identical to that of System A. In System B, dollar losses were higher due to both the increased value-adding functions and value per pound of primals and subprimals (\$0.90) relative to an equivalent wholesale carcass weight. The result was a dollar loss figure of \$2.88 to \$11.70. The dollar value of shrink losses in System D (boxed beef) was non-existent in the transportation phase, owing to the protection which vacuum packaging affords the product.

Causes of Losses

Four causes of damage in transit were listed in the majority of claims filed with railroads: improper handling, defective equipment, inadequate temperature

Table 2. Shrink Losses During Transportation Operations by Distribution System

	Value Used to Calculate Losses	Range of Losses and Values		Estimated Industry Norm	
		Range	Value	Norm	Value
	(dollars)	(pounds)	(dollars)	(pounds)	(dollars)
A. Carcass	0.68	3.2 - 13	2.17 - 8.84	3.2	2.17
B. Packer breaks carcass into primals or sub- primals (non-vacuum packaged)	0.90	3.2 - 13	2.88 - 11.70	5.6	5.04
C. Distribution Center breaks carcass into primals or subprimals (non-vacuum packaged)	0.68	3.2 - 13	2.17 - 8.84	3.2	2.17
D. Packer breaks carcass into primals or sub- primals (vacuum packaged or boxed beef)	0	0	0	0	0

(cooling), and delay (late arrival) of equipment (9, 11). Of these factors, inadequate temperature was the reason given for approximately 64 percent of all rail claims filed between 1972 and 1975 (6). Only a small number of claims were made because of contamination and so-called "off condition" of the product.

Published data was not available with respect to the nature of claims filed against private and common carrier truckers. Field interviews provided useful insights, however. The meat director of a major supermarket chain described the company's experience relative to losses in the transportation phase. On the average, three to five percent of all truckloads of carcass beef arriving at the meat distribution center were rejected, although not all of this product would be lost from human consumption. The major reason for this was the excessive internal temperatures of carcasses, 44° F. or above. On occasion, carcasses were accepted at an absolute outside limit of 48° F. Carpenter and Smith cited refrigeration failure and/or inadequate refrigeration as the primary cause listed in damage claims for beef carcasses shipped by truck (11).

According to Carpenter and Smith and other meat industry practitioners, the problem of excessive temperature exists for the following reasons: Meat packers are under intense pressure to ship beef as quickly as possible, due to high operating costs. Even in the best of facilities a certain amount of moisture loss is occurring, for which the cost must be borne. They seek to minimize the inventory cost of holding beef in coolers and the costs associated with maintaining proper temperature and humidity. Packers also try to avoid the cost of constructing additional refrigerated holding rooms.

Additionally, the industry as a whole has not been altogether successful in organizing other functions that would ensure proper temperature levels (22, 27). If beef is being fabricated into boxed beef or primals, for example, processing rooms may not always be held at sufficiently low temperatures. Coolers may be

crowded with product, adversely affecting cold air circulation. Trailer trucks may not be adequately pre-cooled prior to loading, and warm, dry air may enter the trailer in the loading process (9). If beef has not been thoroughly pre-chilled, refrigeration equipment in trailers is not designed to bring the meat down to an adequate temperature range during the two to four days it may be in transit. Trailer refrigeration is designed merely to maintain beef at given temperatures, and cannot lower its temperature. This factor is apparently not fully understood so common is this problem throughout the industry.

Based upon discussions with executives of two major retail organizations, the overall impression was that the temperature of shipped beef often is influenced by the nature of the retailer-packer relationship negotiated over time. Certain packers, in an effort to obtain and maintain "standing order" shipments from retail accounts, will make the necessary effort to meet retailer specifications with respect to such factors as carcass or cuts, weight, age of beef, degree of marbling, cutability, and quality grades. These packers also will exercise appropriate care in meeting temperature standards established explicitly or implicitly by a retailer. Retailers who continually provide specific performance feedback to suppliers, which may or may not involve rejecting loads, tend to receive beef which meets specific temperature requirements. Such is even more the case for those retail firms which operate meat distribution centers where quality checks can be made more readily. By contrast, in supermarkets, meat personnel often find it difficult to organize systematic, effective quality assurance procedures, mainly due to the operating pressures inherent in supermarket operations (17).

Some packers tend to exercise less quality control if beef is sold through brokers on the open market. Again it must be noted that packers differ with respect to the use of such operating practices, as do different plants within a single, multi-plant company.

Technology Currently Available for Loss Reduction

Insights from the Literature Review. Ample technology and recommendations exist to improve industry practices and implementation of effective loss reduction programs and procedures in the transportation phase of fresh beef distribution. Examples of the kinds of information available to the industry from existing reports are as follows:

- Protective films and paper wrap, when applied to carcasses and subprimals, prevented contamination and shrink losses during transit for seven to nine days (15, 35, 42).
- Ensuring proper temperatures by checking the calibration on each of the cooling units in trailers prior to loading resulted in the reduction of claims for "off condition" of beef by 83 percent (21).
- Vacuum packaging protected beef against shrinkage, oxidation, and extended shelf life of the product (5, 10, 12, 13, 20, 25, 29, 30, 31, 35, 38, 44, 46, 48). Monfort of Colorado, Inc., demonstrated a loss reduction potential of 0.77 percent for the normal four-day transportation period (30). A. T. Kearney, and Case and Company studies established loss reduction potentials of 0.2 and 1.68 percent, respectively (7, 12). If one were to assume these data as representative of the total industry, the loss reduction resulting from the adoption of vacuum-packaged beef would be in the range of 3.2 to 13 pounds per 650 pound wholesale carcass equivalent, or a dollar value of \$2.17 to \$8.84 at 1977 prices.

While these examples cannot be viewed as definitive, they clearly indicate existence of considerable potential for reducing shrink losses through the application of available information and technology.

Were the fresh beef in the distribution system converted to frozen beef, almost no shrink losses would occur in the transportation stage, except in cases of the failure of refrigeration equipment or accidents (44). This is not a solution that is likely to be broadly applied in the foreseeable future to reduce shrink losses, however. Current industry receptivity to the notion of frozen beef is largely negative (30). Economic feasibility and consumer acceptance of frozen meat are aspects yet to be fully demonstrated (43).

Recommended Industry Practices. Discussions with industry operators and various published reports stressed the importance of adhering to sound operating

practices which are fundamental to minimizing shrinkage in transit. The key appears to be the maintenance of proper temperature and humidity for both the product and the vehicle in which it is being transported. Specific recommendations are summarized as follows (9, 11, 15, 17, 21, 24, 25, 29, 30):

- The temperature range for carcass holding rooms prior to shipment or fabrication should be 30° to 33° F.
- Before carcass beef is shipped or fabricated, it should reach an internal temperature of 44° F. or lower, measured at the aitch bone.
- Fabrication rooms should be maintained at 40° to 50° F. Even under these conditions beef should not be allowed to stand for excessive periods of time.
- The storage room temperature for boxed beef should be 29° to 32° F.
- Trailers should be checked for properly operating refrigeration units, as well as being pre-cooled. All personnel involved in the loading, driving, and unloading of beef should be encouraged to understand the importance of these seemingly simple, but fundamentally important practices.
- Loading procedures should permit proper air circulation throughout the trailer.

Technological Developments Needed for Loss Reduction

Improved materials, equipment, techniques, and industry practices are needed in order to transport beef in ways that minimize shrink losses. The gradual improvement of cooling rooms, loading docks, packaging materials, trailers, and trailer refrigeration equipment has been important over time to the achievement of this goal, and can be expected to make further contributions in the future. But in addition, there is a need to develop new technologies, especially with respect to the design of transport vehicles.

A USDA official stated that of the many challenges confronting the food industry, one of the most important is the need to improve transportation vehicles through better engineering (9). Little improvement in "functional engineering" has been accomplished to better fit trucks, trailers and rail cars to the physical

distribution needs of the beef system. The projected benefits of a "positive, well-coordinated and supported research development program" are (9):

- Reduced cost of transportation.
- Faster and more reliable service.
- Improved cleanliness and sanitation.
- Better customer relations.

The prerequisites needed to achieve such benefits are:

- Leadership on the part of managements in planning and coordinating their operations to encourage and make use of improved technology.
- Commitment to research and new product development by the various companies manufacturing transportation equipment.

Barriers to Loss Reduction

A major barrier to the reduction in current levels of shrinkage in transit is the existence of ineffective management in many firms. Some organizations have failed to recognize economic and other penalties associated with shrink losses. It is also possible that some managers have been unable to organize and direct employees to properly carry out desired policies and procedures associated with transportation functions. Finally, some executives lack knowledge of the basic factors associated with meat deterioration.

There are additional reasons accounting for shrink losses. The problem of shrinkage in transit is dependent upon the condition of the product prior to loading, the loading process itself, and the conditions that exist while in transit. Thus, there is the need for packers, transportation companies, and independent truckers to better coordinate their respective activities and responsibilities. It may be, however, that coordination of this kind is difficult to achieve due to the complexity and fragmentation of the industry. For example, slaughtering plants are often located at great distances from customers. On occasion, selling practices result in re-routing of shipments. Fabrication at different locations in

the system can require extensive handling of beef. Weather often disrupts travel schedules. Lack of coordination between shippers and receivers causes delays in unloading. Investment by companies in improved equipment and advanced systems is, in some cases, limited by low profitability. In an interdependent industry setting, where the cooperation of organizations is needed to achieve an effective transportation system, one can understand the difficulty of avoiding these types of losses.

One of the most important structural trends in meat processing, increased central fabrication, permits the achievement of more effective product control. This development alone should result in substantial reduction in losses over time.

Nevertheless, the problems of shrink losses will persist until enhanced standards of performance are established. One retailer expressed his view of the matter as follows: "Consistency in beef quality will suffer and shrink losses will persist as long as the meat industry lacks the discipline to establish and adhere to the proven standard operating procedures for transporting beef."

LOSSES DURING WHOLESALE OPERATIONS

Losses of fresh beef occurring during operations at distribution centers (firms integrating the wholesaling and retailing functions) or by independent food wholesalers are examined in this section. Distribution centers serve a wide range of functions. They may exist solely to warehouse carcasses or boxed beef being received, stored and restaged for distribution to supermarkets. Or, in addition to the warehousing of products, they may be used to further process beef carcasses. Such fabrication of carcasses can vary from simple trimming to disassembly into subprimals, boxed beef or even retail cuts.

The three classifications of losses that take place at distribution centers are shrinkage, cutting, and floor scrap. Cutting and floor scrap losses result

from the disassembly process and the removal of fat and bone. Cutting losses include the meat "dust", and the loss of the meat which remains on bones.

Physical Volume and Dollar Value of Losses

The physical losses and the value of those losses are described below for each of the four major methods of distributing fresh beef. With respect to calculating the dollar value of losses, for the purpose of consistency and comparison in this report, the Case and Company study values of \$0.68 and \$0.90 per pound of fresh beef are used (12, 44).

System A: Carcass. The single major source of physical loss is shrinkage as carcasses move through the process of being received, stored, restaged and shipped to supermarkets where they are fabricated and converted into consumer-sized meat packages (retail cuts) for ultimate sale. Although some other kinds of losses may occur, in comparison to shrinkage they are relatively small. Beef carcasses typically remain at a distribution center from one to four days, with three days being the industry norm.

The magnitude of shrink losses was established by reviewing previous research reports and then confirming these figures through field interviews (see Table 3). Studies encountered in the literature listed shrink losses as low as 5.46 pounds for a two-day period, and as high as 13 pounds over four days. The average daily shrink losses reported in the three studies are comparable, as shown in Table 3.

Table 3. Shrink Losses Per Carcass of Beef in
System A at Distribution Centers

Source	Total Shrink Loss	Time Period	Average Daily Shrink
	(pounds)	(days)	(percent)
Case and Company	5.46	2	0.42
Monfort of Colorado	8.32	4	0.32
A. T. Kearney	13.00	4	0.50

Source: See (12, 44, 30-1972, 7) and Appendices I, II, and III.

The shrinkage figure of 6.5 pounds is estimated to be most representative of industry experience, or the industry norm. The dollar value of losses was calculated by applying the \$0.68 per pound value to the 5.5 to 13 pound range, which equals \$3.74 to \$8.84.

System B: Packer Breaks Carcass into Primals or Subprimals (non-vacuum packaged). In System B the packer ships the primal or subprimal cuts either to a retailer's distribution center or directly to supermarkets. In this instance, the cuts are not vacuum packaged. Specific loss studies on this system were not available in the literature.

The range of shrink losses occurring at distribution centers was calculated by applying the shrink loss rates taken from three previous studies of System A to the time periods that beef remained in distribution centers. Calculations were based upon the wholesale weight of primals and subprimals (550 pounds) equivalent to a 650 pound beef carcass entering the distribution system. The average of estimated shrink loss was 4.7 to 11.2 pounds over a time period of two to four days.

The shrinkage figure for System B, 5.5 pounds, is estimated to be most representative of industry experience, or the industry "norm". This figure results when applying the Iowa Beef Processors, Inc. shrink losses data for carcass beef to the 550 pounds of primals/subprimals coming from a 650 pound carcass (18, Appendix V). This calculation appears to be conservative.

No cutting losses occur at this stage of distribution.

With respect to dollar value of loss, the range was \$4.23 to \$10.08 (using \$0.90 per pound equivalent value for the primals/subprimals). A higher dollar value than the \$0.68 pound value used during the transportation function results because more fat and bone have been trimmed in System B.

System C: Distribution Center Breaks Carcass into Primals or Subprimals (non-vacuum package). When carcasses are broken into either primals or subprimals at the

distribution center, cutting and floor scrap losses occur in addition to those due to shrinkage. For System C, no specific studies of losses at the distribution center were available. Shrink losses were assumed to be the same as in System B: 4.7 to 11.2 pounds. Note that in System C beef arrives at the distribution center in carcass form and is subject to the shrinkage rate typical of System A. At a later point, the carcass is converted into primals/subprimals at the distribution center and is then subject to the shrinkage rates typical of System B. There is a need for studies that measure System C losses to account for this situation. The shrinkage figure estimated to be most representative of industry experience, or the industry "norm", is 5.5 pounds.

The range in dollar value of the shrink losses was from \$4.23 to \$10.08, as in System B. The \$0.90 per pound equivalent value is used.

The cutting loss was 6.3 pounds. Applying the \$0.90 per pound value results in a dollar loss figure of \$5.67 per carcass.

In addition to the cutting loss, a closely related form of loss was reported by industry executives; floor scrap, resulting from carcass breaking operations. Floor scrap amounted to 3.2 pounds; and applying a value of \$0.90 per pound, the resultant loss value was \$2.88 per 650 pound carcass equivalent.

The combined amount of losses ranged from 14.2 to 20.7 pounds; the dollar value of which was \$12.78 to \$18.63. The industry "norm" for all losses in System C was 15 pounds, or \$13.50.

System D: Packer Breaks Carcass into Primals or Subprimals (vacuum packaged or boxed beef). Because beef primals or subprimals are vacuum packaged in plastic bags and stored in boxes, there are no shrinkage or cutting losses recorded for distribution center operations. The exceptions are occasions where vacuum packaged beef develops leaks as a result of rough handling by distribution center personnel, or as a result of faulty packaging processes by packers. Note that

"leakers" can be a source of loss at any point in the distribution system; but in this report they will be classified as a loss in supermarket operations, where most are discovered. For this reason, no losses are cited for the distribution center phase of fresh beef distribution.

Although no shrink losses are shown for boxed beef at distribution centers, when the product is opened at the retail store, a certain amount of "purge loss" is experienced. Data on this phenomenon is also presented in the discussion of losses in supermarket operations. As with "leaker" losses, "purge losses" in boxed beef occur throughout the entire distribution system, but are not encountered until beef packages reach the supermarket.

Causes of Losses

Losses of fresh beef vary according to the nature of the activities performed by the distribution center, and the manner in which they are accomplished. The major causal factors are discussed below. It should be noted that many of the causes of losses in distribution centers also apply to virtually each stage of fresh beef distribution.

- Sanitary Conditions: Fresh beef is affected by bacterial degradation. Under certain situations, it will reach a condition that is not acceptable to consumers (34). A high level of sanitation at distribution centers will permit maximum shelf life for products. One important advantage of boxed beef is the protection it affords under less than ideal conditions against contamination by microbial activity.
- Exposure to the Air: Prolonged exposure to air tends to dry the product. With the accompanying microbial growth, the beef's bright, attractive bloom is changed to an unattractive brownish-red to gray color. This process is referred to as metmyoglobin (15).
- Microbial Growth: Microbial growth is greatly retarded at the freezing point of meat (between 28° to 29° F.). When temperatures are increased from 32° to 43° F., microbes grow three times faster (15).
- Other Causal Factors Associated with Product Deterioration: Deterioration of beef is affected by an even wider range of factors than those mentioned thus far. Post-mortem changes associated with the conversion of muscle to meat cuts and the subsequent storage and handling are accompanied by some

deterioration, irrespective of the precautions taken during processing and handling (15,34).

Changes in meat that take place include those caused by microorganisms (bacteria, molds and yeasts); insects; endogenous enzymes which are naturally present in meat tissues; enzymes that are secreted by microorganisms; chemical reactions such as oxidative rancidity; and external physical effects such as freezer burn and light-fading. Nevertheless, the major concern in distribution center operations is microbial contamination and growth. Sources of contamination include unclean equipment; soiled clothing and hands of personnel; water used for washing carcasses; and airborne microorganisms in the chilling, storage, processing, and packaging rooms. Once microorganisms are present, their activity seldom can be completely curtailed, despite growth retarding procedures which may then be applied.

In a general way it can be observed that the systems which handle fresh beef using less protective packaging risk greater losses of all types. Such operations must take special note of the factors related to deterioration. Clearly, too, exposed and unprotected carcasses, primals and subprimals will experience at least shrink losses of the minimal levels presented; and efforts to further reduce them probably are futile, given the current nature of the beef distribution system. When losses exceed these minimum levels, it is due primarily to inadequate temperature and humidity conditions during trailer unloading, cooler storage, and in the staging and loading of trailers out-bound to supermarkets.

Where losses were higher than normal, causes were often related to the condition of the cutting room. For example, beef may be permitted to increase in temperature as a function of slow product movement through the cutting room; or the temperature of the cutting room may be maintained at an excessively high level.

Where beef carcasses are disassembled at distribution centers, a certain amount of cutting loss from the meat "dust" and floor scrap are a necessary result of sawing and cutting. Losses experienced which are greater than the industry norm generally are due to the inadequacies of cutting methods and faculty knives, and sawing equipment.

Inadequacies in these procedures occur primarily due to managerial ineffectiveness. The tasks involved could be satisfactorily performed by an organization

willing to use the necessary facilities and equipment; and to manage the organization in a more professional manner. The fundamental elements of successful distribution center management are not complex; and information and training resources are readily available through industry trade associations, universities and other organizations.

Technology Currently Available for Loss Reduction

The adequacy and proper use of technology, knowledge, equipment, physical facilities and organizational skills can be combined in distribution center operations to hold beef losses to an acceptable minimal level. Some organizations clearly have demonstrated that minimum losses are possible and economically feasible from a cost/benefit viewpoint.

Effective distribution center management also is dependent upon having qualified personnel who are properly trained, motivated and given continuing feedback regarding performance. This report will not deal with the basic elements of effective business or human resources management, but it should be emphasized that the availability of information and technology alone cannot ensure satisfactory levels of loss reduction.

Recommended Receiving, Storage and Processing Practices. It is important that incoming beef be in sound condition as it arrives at the distribution center in tractor trailers. Knowledge of how fresh beef is affected by the environment, storage and processing conditions is a form of technology essential to the maintenance of minimal levels of losses. Recommended practices were described in the literature, as well as by the knowledgeable practitioners in the meat industry interviewed for this study (17,30). If distribution center managers were to implement the following procedures, fresh beef losses would be reduced to the lowest possible levels. These recommendations highlight areas of a much larger body of knowledge available to the industry and appear to be economically feasible

for most organizations. They have been developed using the results of scientifically proven cause-and-effect experiments, as well as common sense. While some of the following suggestions may seem obvious or simplistic, they are so frequently ignored that it must be assumed that there exists a lack of complete understanding as to why various precautions must be taken.

● Receiving:

- * The number of deliveries should be kept to a minimum and consolidated where possible, reducing exposure of the storage rooms to outside air which conveys bacteria and insects and increases storage room temperature. Having fewer deliveries also reduces the labor costs associated with receiving operations.
- * Only those persons responsible for receiving and unloading should be permitted in the receiving area to lessen the risk of contamination by additional persons who are carriers of microorganisms.
- * Beef should be unloaded and stored rapidly. Shipments should be inspected according to prescribed methods and standards.
- * The temperature of the receiving room should be maintained at 30° to 33° F.

● Storage:

- * Carcass beef should be trimmed of discolored and soiled parts to minimize bacterial growth. Beef should be stored at 30° to 32° F., and properly spaced in the cooler to facilitate the circulation of chilled air. Carcasses should not be in contact with each other; nor should they be stored on the floor or against walls. The relative humidity should be maintained between 80 and 85 percent.
- * Primals and subprimals should be covered with film or paper for protection against shrink loss and contamination.
- * Poultry, fish and other foods should not be stored with fresh beef.
- * Containers used for meat scraps should be leakproof, covered, made of non-corrosive materials, and designed for effective cleaning and sanitizing.
- * Boxed beef should be stored between 29° and 32° F. Carton manufacturers' stacking recommendations should be followed. Excessive and rough handling should be avoided. (See Appendix VI for a detailed description of recommended procedures for boxing beef.)

● Processing:

- * As much processing as possible should be performed with the meat under refrigeration. Processing room temperatures should be no higher than 40° to 50° F.
- * The most perishable cuts (flanks, kidneys, necks and skirts) should be removed from the carcass as soon as possible for processing and packaging.
- * Management should design work scheduling practices so that optimum arrangements are made both for effective inventory control and use of labor.
- * Where possible, trimming of carcasses should be with knives (e.g., not using saws) in order to minimize losses of lean meat in the form of meat "dust".
- * Each meat cutter should be trained, given "cutting tests", and supervised so that wasteful procedures can be identified and remedied.
- * Equipment should be cleaned with detergents and sanitized to destroy microbes. The USDA publishes a list of available chemical compounds which are approved for sanitizing operations. Other publications give recommendations for cleaning schedules, equipment design, water temperatures, and the proper composition of walls, ceiling and racks.
- * Guidelines for good hygiene and sanitation practices should be established and communicated to personnel. Employees are potentially the source of microbial contamination in meat. No effective program of loss reduction can exist without a commitment on the part of the firm's management to enlist the support of employees in creating a comprehensive program to achieve product cleanliness and wholesomeness.

In addition to these recommendations, information is available from the following organizations:

- Food Safety and Quality Service, USDA
- American Meat Institute
- Food Marketing Institute
- Food and Drug Administration
- Occupational Safety and Health Administration
- National Livestock and Meat Board

Mechanically Processed Beef Products (MPBP). This is a relatively new addition to the existing technology available to distribution centers. Its potential

for loss reduction has been made possible as a result of the 1978 USDA announcement of regulations concerning standards and labeling requirements for "mechanically processed beef products". MPBP is defined as product resulting from the mechanical processing and separation of bone from the attached muscle tissue. In the strict sense of the term, meat left on bones ought not to be regarded as "loss", since it is utilized or consumed, but has a lower economic value than meat sold through supermarkets. Nevertheless, it seems appropriate to make reference to this existing, but underutilized, technology that may in time provide additional amounts of beef for human consumption. Regulations exist with respect to the labeling, use, nutritional quality, and bone particle size. Processing plants wishing to use MPBP must submit for review and approval a special quality control system plan which requires periodic chemical analyses of the product.

MPBP cannot be used in fresh ground beef, but is permitted to be utilized in processed meats. The logical place for mechanical deboning would, therefore, seem to be the packing plant, where MPBP is immediately available as an ingredient for prepared foods.

It appears certain that fresh beef will be utilized more efficiently by the recovery of beef attached to bones. The amount of beef conserved in this manner will range from 13 to 16 pounds per carcass. There will thus be a significant gratuitous increase in the total beef supply, without any increase in feed usage or animal numbers.

Technological Developments Needed for Loss Reduction

The principal benefits of a meat distribution center at the wholesale level are to consolidate merchandise, implement quality assurance, add further processing to enhance productivity, and to ship needed products to supermarkets in a timely and effective way. Currently, distribution center management has available to it adequate equipment and knowledge to implement substantial loss reduction

procedures. While some meat distribution centers demonstrate a high level of development, many firms lag in the implementation of loss reduction procedures. Even the most progressive companies could benefit still further by improving existing equipment, and systems.

With respect to reducing or eliminating "meat dust" losses, converting present beef processing systems to those where lean is separated from bone prior to its fabrication into small meat portions would permit cutting with knives instead of using saws.

In addition to the continuing marginal improvements needed in existing technology, progress could be made in the following areas:

- Standardized pallets and shipping containers modulated to the pallet base are needed. Physical damage would be reduced by more stable handling and storage of boxed beef. The tearing, spilling and crushing of boxes would be lessened by more secure shipping loads.
- An industry-wide set of standards and controls with respect to temperature and humidity in packing plants and transportation facilities is needed, including minimum time periods for chilling carcasses in packing plants.
- Training and educational programs should be available for organizations interested in enhancing loss-minimization systems. Universities, government agencies and trade associations could provide such opportunities.

Barriers to Loss Reduction

Beef losses at distribution centers will be reduced as managers recognize the potential for change and how loss reduction can contribute to greater profitability. Often changes which result in loss reduction can create other beneficial outcomes, as well. Employees encouraged to give attention to loss reduction can also be more aware of other ways a distribution center can be made more effective. A barrier in this instance relates to the lack of professional management of human resources.

Collective bargaining arrangements between companies and unions that preclude central cutting and packaging practices still exist in certain geographical areas

and are a barrier to loss reduction. Where a collective bargaining contract contains such prohibitions, bilateral cooperation and negotiation is essential to bring about changes (2).

It may be that there are efficiencies of scale which are necessary to justify certain functions at distribution centers. As retail organizations increase their volume of beef handled, it is presumed that even more loss-prevention technologies will become economically feasible to adopt.

Time and again, interviews in the field revealed that managers and employees in beef distribution centers simply were not aware of the causal factors which affect losses and waste. Thus, lack of knowledge is an important barrier to loss reduction. It results in practices which fail to recognize the effects of temperature, time, microbial action, the limits of packaging material and shipping containers, and the impact of numerous environmental factors present in distribution centers related to product quality.

LOSSES DURING SUPERMARKET OPERATIONS

Typical beef operations in supermarkets include the functions of receiving, storing, cutting, packaging of retail cuts, and displaying products (7,17,29,30). Losses occur during each of these activities.

Specific kinds of losses treated in this report were those due to cutting and shrinkage, and other cutting losses which occur in the handling of product for repackaging and retrimming. As previously mentioned, losses due to purge and the "leakers" associated with System D (vacuum packaged boxed beef) are measured at the retail level where these losses are encountered, although it is known that these losses can and do occur in the preceding phases of distribution.

No losses are recorded in this report for the transportation of fresh beef from distribution centers to supermarkets (although such potential losses would be viewed as part of the supermarket operations). Truck travel time and distance is

relatively short in most instances. If stores followed the recommended procedure of weighing beef upon delivery, there might be a quantifiable shrink loss, but such records were not available. In the absence of specific data in the literature and from field interviews, it was presumed that such losses are relatively inconsequential. Typically, employees under pressure to perform complex and numerous other operations and to keep employee payrolls at a minimum, give only a cursory inspection to arriving beef shipments. Adequate fresh beef inventories are vitally needed at store-level in order to maintain efficient work flow. Meat department managers are thus disinclined to reject beef shipments only slightly "out of condition".

On the other hand, it could be that losses are greater than generally presumed by researchers and industry operators. Adverse conditions for fresh beef during shipment to the store may be subtle and not visible upon arrival and during unloading at the supermarket. Not until product is cut, packaged, and displayed might there be evidence of purge and other conditions which will shorten its "shelf life". Even then, the myriad factors affecting losses during both transportation and store operations make it exceedingly difficult to measure causes of losses with a high degree of precision. Case studies of supermarket operations appear necessary to obtain precise information on possible losses of this kind.

Among the economic losses not dealt with in the study include instances where higher-priced cuts (e.g., steaks) must be converted into lower-priced items (e.g., ground beef) because of deterioration in physical appearance. The meat remains in wholesome condition, but an economic loss in revenue is engendered. A portion of beef products is also stolen by shoppers and employees. Since stolen products are not "lost to human consumption", technically they are not considered as a loss or waste; however, the lack of preciseness of industry records often made it difficult to exclude such losses from the data reported in this study.

Typically, the supermarket retail meat department occupies 10 percent of the total space of a store, accounts for 25 percent of total dollar sales for the store, generates 35 percent of the store's gross margin dollars, but contributes a net profit of considerably less than its proportion of the gross margin (17,19).

Beef accounts for about 30 to 45 percent of meat department sales. The gross margin for carcass beef typically ranges between 12 to 18 percent. This is well below the meat department's gross margin because of the high frequency with which beef is feature-priced or discounted. Fresh beef frequently generates relatively low percentages of net profit as a result of the high operating expenses of cutting and packaging. Since few retailer accounting systems allocate costs to specific meat categories (such as beef, pork, poultry, etc.), precise net profit data for beef is unavailable. For the most part, however, handling high value, pre-packaged processed meats and poultry is less costly than handling beef.

With respect to the yield of saleable beef from a wholesale carcass, about 65 percent of the carcass is eventually converted into about 100 different retail cuts and ground beef (17).

Most departments in a supermarket procure, display and sell "finished" manufactured products. Typical meat departments, by contrast, are primarily "manufacturing centers" where large portions of a carcass (quarters, primals and subprimals) are disassembled into smaller, retail cuts for packaging and display. However, an important trend is underway with boxed beef (System D) which moves a large proportion of these production activities out of individual stores to a central fabrication point: either a packing house or (less frequently) a retailer-owned distribution center. This development is leading to greater emphasis on the merchandising function of a supermarket's meat department, making it more similar to other departments. In most supermarkets, however, the current practice continues for meat departments to cut and package fresh beef, even though the beef

involved may be highly prefabricated prior to arriving at the store, as is the case with boxed beef. With respect to boxed beef, most subprimals arrive with major portions of the fat and bone removed, requiring only knife-slicing and little if any final trimming prior to packaging for retail sale. Experimentation is underway with a technique for slicing subprimals and then placing the cuts in a vacuum package for shipment to stores as if they were still a single unit (13,30).

Fresh beef may yet be packaged by manufacturers in a manner similar to the one used for poultry, requiring no in-store cutting or packaging. Only a few retail firms are experimenting with the central prepackaging of fresh retail beef cuts in conventional packaging materials (foam tray, film wrap); and shipping these retail cuts from distribution centers to stores. These companies have found that such consumer-ready retail cuts which have large surface areas exposed are extremely difficult to handle without serious problems of purge and product deterioration. Despite such unresolved problems, some companies are optimistic concerning the feasibility of this process, coupled with improved packaging, and are convinced that the potential benefits will some day justify the effort and expense associated with perfecting this emerging technique (48). It is possible that vacuum packaging systems -- either fresh or frozen beef cuts -- will emerge as the most satisfactory system.

Physical Volume and Dollar Value of Losses

The data obtained in this study reflect wide variation in the physical volume of losses; however, the extent of losses is substantial (31). Examples follow of the kinds and magnitude of losses that can occur in supermarkets, as reported from a variety of sources:

- Beef products in display cases may experience shrink losses which vary from .84 to 2.15 percent (4 to 10 pounds per carcass) for the typical display period of two days.

- In a study of five supermarkets, about 22 percent of all packages on display required some form of reworking (17).
- The experience with beef fabrication reported by the management of one medium-sized regional chain was as follows: In-store cutting loss, 0.5 percent; shrink losses, 0.5 percent. The firm provided 0.5 percent packaging content overweight to consumers in order to compensate for losses in the retail packages. Pull-backs were 1.5 percent of all beef packages. The company experienced shrink losses of 1.5 percent for all beef displayed. The total store-level dollar loss on all fresh beef items was \$0.046 per dollar of sales, not including the labor expense of reworking the packages.
- Carpenter and Smith reported meat department losses of 3 percent of the portion allocated to gross margin by retailers. They indicated that few studies have documented detailed product losses at the retail level (11).
- The Comptroller General's Report to the Congress observed that depending upon the level of sanitation and temperature control for fresh meat, savings can range from 0.5 to 1.5 percent of retail meat sales. Projected nationally, the savings would range from \$157 million to \$500 million annually (39). This study of losses in the food system emphasized the potential to reduce losses in supermarket operations, although it did not analyze the cost-saving relationship.

The physical volume and dollar value of fresh beef losses during supermarket operations are described for each of the major distribution systems. In some instances, loss ranges are presented. In other cases estimates are made of the single figure most representative of industry experience, of the industry "norm". The price used to calculate dollar losses at the retail level was \$1.30 per pound. This figure is compatible with \$0.90 per pound used to calculate the value of primals and subprimals; and \$0.68 per pound used to value a wholesale carcass (12,44). Again, it should be noted that these values will vary significantly according to current market prices.

System A: Carcass. Carcasses are shipped from the distribution center to the supermarket at which point they are fabricated into retail cuts. Losses at the supermarket per 650 pound wholesale carcass include: Shrinkage, 6.5 pounds; cutting, 6.3 pounds; floor scrap, 3.2 pounds; retail and display, a 4 to 9.5 pound range, with 9.5 pounds the industry "norm". Total losses thus ranged from 20.0 to 25.5 pounds, 25.5 pounds being the industry "norm".

When the \$1.30 per pound value was applied to the volume of losses in fresh beef lost at the supermarket, the range in dollar value was \$26.00 to \$33.15, the latter being the industry "norm".

Systems B and C: (System B: Packer Breaks Carcass into Primals or Subprimals--non-vacuum packaged.) (System C: Distribution Center Breaks Carcass into Primals or Subprimals--non-vacuum packages.) Losses per 650 pound wholesale carcass equivalent at the supermarket are the same for Systems B and C, where primals/subprimals are cut and packaged in the supermarket meat department: Shrinkage, 5.5 pounds; cutting, 5.5 pounds; retail and display, a 4 to 9.5 pound range, with 9.5 the industry "norm". Total losses, therefore, ranged from 15 to 20.5 pounds, 20.5 pounds being the industry "norm".

When the \$1.30 per pound value was applied to losses encountered, the range was \$19.50 to \$26.65, \$26.65 being the industry "norm".

System D: Packer Breaks Carcass into Primals or Subprimals (vacuum packaged boxed beef) Where packers ship boxed beef to the supermarket directly or to distribution centers, losses are due to purge and the presence of "leakers".

Losses cited in System D were based on 562 pounds of fresh beef, a 650 carcass equivalent.

Shrink losses ranged from 1.1 to 2.8 pounds, 2.8 pounds being the industry "norm"; cutting, 5.5 pounds; retail and display ranged from 4.9 to 9.5 pound, 9.5 pounds being the industry "norm". Total losses, therefore, ranged from 11.5 to 17.8 pounds, 17.8 pounds being the industry "norm".

When the \$1.30 per pound value was applied to the losses encountered, the range was \$14.95 to \$23.14.

Causes of Losses

The causal factors previously discussed relative to distribution centers apply to the supermarket setting as well. Sanitary conditions, exposure to air,

microbial growth, and sources of contamination affect fresh beef in a similar manner in retail meat departments. In describing retail-level losses specifically, Carpenter and Smith cited primary factors as follows: the product received at the store is of low "quality"; lack of refrigeration controls; retail meat cases are either inadequate or not utilized properly; inventory control problems; and lack of adequate sanitation controls (11).

Boxed beef sustains losses which are unique for vacuum packaged and cartoned products. Reference was made to "leaker" losses from perforated vacuum bags. They result most often from inadequate packaging or rough handling. With respect to improper packaging, "leakers" frequently are caused by faulty techniques used to apply "bone guard" material to protect bag surfaces from sharp bones which can puncture; utilizing plastic bags of insufficient strength to withstand normal distribution methods; and inadequate quality of secondary shipping containers. "Leakers" and purge losses occur when excessive pressure is exerted on the package caused by stacking cartons improperly and by rough handling (dropping) of cartons. Finally, vacuum packaged beef will suffer spoilage loss unless a complete vacuum and seal is achieved, as air coming in contact with beef is certain to reduce the quality of the product.

With respect to the frequency with which "leakers" occur, the industry norm is estimated to be 8 percent. "Leakers" were reported by some industry executives to be as many as 20 percent of all packages, under certain conditions. Carpenter and Smith indicated that trimming losses of 3 to 5 percent may occur as a result of "leakers" (11).

Causes of loss in supermarkets in part are related to the complexity of meat department operations. One indication of the difficulty encountered in retail meat operations is that as many as 500 perishable meat items may be handled in a supermarket. A statement made by the general manager of a large retail chain is representative of the viewpoint of many others executives:

No other part of our retail operations gives top management more problems than our fresh beef operations. We are continually concerned with the already high and rising costs of operating the meat department: labor, equipment, and facilities. Cutting, packaging, and merchandising of beef is a complex process and requires an enormous amount of management attention, especially with respect to the selection and training of meat personnel. Product inventory is relatively costly, waste and losses are comparatively high, and profit margins are low.

Technology Currently Available for Loss Reduction

Where the following practices are implemented, fewer losses occur and there are attendant savings in labor and material. Supermarkets which primarily operate "self-service" departments experience higher product losses than stores with "service" operations. Self-service departments maximize sales using relatively larger displays; productivity results from reduced labor costs, and customer traffic is speeded. With respect to product losses, however, they are higher because a wide variety of meats must be displayed (including slow-moving items), and reprocessing costs are often incurred when turnover is lower than anticipated. Retail beef cuts are highly vulnerable to poor conditions in the display case due to heat transmitted from electric lights, handling by shoppers, and defrost cycles which allow the temperature of meats to increase, causing rapid microbial growth and discoloration (34). Supermarket meat operators all too often do not perform well the critically important functions of ordering, processing, and stocking in accordance with customer demand. They thereby fail to avoid excessive inventories of both cooler stock and retail packages on display.

Recommended Fabrication, Packaging and Display Practices. Generally accepted as being recommended industry practices are the following (5,7,8,10,11,13,15,17, 19,25,26,28,29,30,34,38,42,43,44,47):

- Maintain product temperature as close to 30° F. as possible during all phases of handling and fabrication. Because cutting and packaging rooms will be held at higher temperatures than storage areas, the time beef will be exposed during the cutting and packaging process should be minimized.

- Beef should not be exposed to strong light and air currents caused by fans and air conditioning, all of which accelerate moisture loss.
- Clean equipment should be used in handling and preparing beef. All areas of the meat department should be sanitary.
- Employees should be trained to perform retail tasks efficiently.
- Packages should be date-coded as they are wrapped to facilitate stock rotation procedures. Some firms establish specific display time limits, such as one day for ground beef and two days for other beef cuts.
- Beef should be cut and packaged as close to the time of sale as possible.
- Meat cuts should be packaged such that the film is uniformly in contact with the meat surface to permit uniform bloom.

Improperly packaged cuts in self-service meat counters tend to be handled more than others by shoppers who frequently discard them for more attractive ones. Excessively boney or fatty meat cuts will also tend to be rejected. The way packages are labeled may be another contributing factor with respect to the wear and tear received from shoppers. Those with labels which clearly describe price per pound, weight, total price, and other useful consumer information, can encourage more rapid inspection and/or sale, thus avoiding losses.

Proper display practices for meat packages are as follows:

- Packages should not be stacked so high that those at the bottom sustain moisture purge. Each cut type varies with respect to its tolerance for pressure. Excessive juice in a package also increases the rate of product deterioration.
- The proper mechanical operation of refrigerated display cases should be ensured, especially that of the defrosting system. Positioning temperature gauges for easy monitoring is important in this respect. Additionally, the temperature of meat packages should be checked at regular intervals.
- Packaged meat cuts should be stocked as close to the time of customer purchase as possible. Packages of meat then will be of the highest possible quality, most attractive in appearance, and have sustained minimal weight loss and microbial growth.
- Packages with film wrap that has worked loose or been torn should be rewrapped as soon as possible.

Recommended Methods for Vacuum Packaging of Boxed Beef. The methods for vacuum packaging beef and the proper ways of handling boxed beef throughout each distribution stage warrants special emphasis. Boxed beef as a method of distributing fresh beef appears to industry operators to have many advantages under a wide range of circumstances. It is clear that the use of boxed beef, now representing the majority of total supermarket beef sales, will continue to gain in popularity. As with any method or technology, a particular operator's situation will affect the degree to which benefits are realized from the use of boxed beef. An analysis of each situation is recommended (31,43).

Appendix VI is a comprehensive checklist of the recommended practices with respect to the following aspects of boxed beef (25):

- Beef preparation.
- Packaging system maintenance.
- Temperature recommendations.
- Fabrication processes.
- Package protection.
- Bag sizing and loading.
- Equipment loading.
- Package shrinking.
- Pack-off.
- Shipping.

Clearly, industry operators as a group do not realize fully that despite the protection vacuum packaging provides fresh beef, boxed beef also can be damaged as a result of careless or faulty packaging and handling, as well as inadequate inventory control.

Technological Developments Needed for Loss Reduction

There are a number of ways changes can be implemented to reduce losses in supermarket beef operations. The principal developments are likely to be in the following areas:

Centralization of Beef Processing. When comparing their potential for handling efficiencies, production control and facility management, it is clear that supermarkets fabricating and packaging most beef products in the store cannot compete with packer- or retailer-owned distribution centers in the reduction of physical losses of beef. The trend toward boxed beef reduces, but does not eliminate, the store-level cutting and packaging in supermarkets. It transfers to central points as much prefabrication as is practical in terms of economics, available technology and the merchandising strategies of contemporary supermarket organizations. Although the potential benefits of boxed beef are great, several studies demonstrate they can differ substantially due to a retailer's unique situation (31,43).

At least one successful supermarket company, Ralph's Grocery Company, Compton, California, has made the decision to go beyond boxed beef. The company has moved the majority of beef fabrication from supermarket backrooms to a central processing facility. The benefits cited are improved quality, bacteria control and productivity at the central processing plant. Factors accounting for the success of this program are as follows:

- Maintenance of accurate records.
- Temperature controls keeping fresh beef as close to 32⁰ F. as possible throughout the total system.
- A maximum traveling radius of 100 miles from the central fabrication point to the supermarkets.
- Relatively high sales volume per store, creating fast product turnover.

Problems associated with this radical change in beef fabrication have been difficult to overcome, the firm has experienced far more problems than it originally anticipated. Nevertheless, Ralph's reports important benefits from its central processing project.

Adoption of Universal Product Code Scanning. The application of the Universal Product Code system and related computer technologies to meat department operations is an important development. Although only a small number of supermarkets have begun to adapt this technology, participants at the conference, Computer Based Technology in Food Distribution, at Michigan State University identified this development as an "important unfulfilled need" (14). It was recommended by participants that consideration be given to an industry-wide effort to direct attention to fresh meat products in ways similar to those that have been applied to such supermarket departments as dry groceries. The computer-readable Universal Produce Code (UPC) label now in use for grocery products is not widely applied to the random-weight items that characterize fresh beef products. There was agreement among the conference participants that there are certain to be significant savings available to retailers when UPC scanning of fresh meat items is implemented.

A process is needed that will objectively determine the full range of possible information meat operations executives might require through a given UPC system. It would then be possible to establish priorities among the stated needs and to develop a UPC numbering system compatible with the established UPC format. UPC scanning data could then be applied to meat merchandising functions, ordering and inventory management, and to improve accounting methods.

Meat operations can be improved in the following ways, according to Kenneth H. Johnson, Vice President, Meat Science Division, National Livestock and Meat Board (19):

- Improve inventory records.
- Product mix decisions can be made with greater effectiveness due to more precise data available in shorter time spans.
- Data on customer traffic flow and sales patterns can easily be generated for any time period, enabling more accurate personnel scheduling. Such planning can reduce the time between when a meat package is placed in the display case and when it is sold.
- Records can reflecting sales in terms of weight, dollar volume, and types of retail cuts can be obtained routinely.
- Automatic reorder systems can be developed by retailers who also utilize central distribution facilities.
- Accurate and timely assessment can be made of the cost-effectiveness of advertising campaigns and merchandising programs.
- Improved accuracy of check-out operators can be achieved.

The Food Marketing Institute and the National Livestock and Meat Board have instituted a series of management seminars designed to instruct wholesaler and retailer executives on the application of scanning and related computer technologies to variable weight meat items. This resource has the potential of greatly speeding adoption of technology to retail meat operations, thus achieving widespread benefits listed above.

Improvements in Packaging Systems. Generalizing on the need for further technological improvements in packaging to reduce losses, it is most appropriate to approach the issue by examining the totality of packaging requirements of retail-level beef processing and merchandising operations. Adequate protection of fresh beef by means of effective packaging systems is perhaps the most important consideration in supermarket meat operations.

Given the current nature of boxed beef, the best system now generally available to the industry, the questions arise as to (1) how the boxed beef system can be best utilized to achieve optimum loss reduction, and (2) if there is additional technology needed to assure full and effective utilization of available boxed beef

systems. To find answers, it will be necessary to analyze the following factors and requirements for a complete packaging system (10).

- A package must preserve the flavor and nutritional qualities of the beef cut, and enhance the physical appearance of the product (bloom and freshness) during in-store and in-home utilization.
- Both packaging machinery and materials should be designed to minimize microbiological contamination and growth, enzymatic activity, biochemical changes, moisture loss, physical distortion, and color change.
- A package should be suitable for in-home storage and sufficiently convenient for in-home opening.
- Package labels need to be designed both to provide consumer information, facilitate in-store management to meet the requirements for mechanized Universal Product Code labeling at the store or distribution center.
- A package should permit necessary shelf life under normal temperature, humidity and lighting conditions of the store and home, and withstand the wear and tear of customer and clerk handling and stacking in the display case.
- A satisfactory package enables retailers to display products in ways that permit the application of effective point-of-purchase techniques.
- Packaging materials must be suitable for use with high-speed, high capacity equipment.
- Shipping containers must be designed that protect packages and which can be filled, stacked and transported employing mechanical methods. Containers also must carry Universal Product Code symbols for transportation and inventory control purposes.
- Packaging machinery, methods, and materials must meet reasonable standards for cost-effectiveness.

Summary. When questioned by the editors of Progressive Grocer about likely future developments in technology, retail operator opinions and expectations are that there will be (32):

- Greater application of Universal Product Code technology.
- Improved display cases.
- More use of mechanized equipment such as powered cleavers, and automated equipment such as weighers, packagers and "bone dusters". The trend toward

boneless meat will permit greater mechanization and more use of cutting (versus sawing) machines.

- Wider application of improved knowledge concerning the cleaning and sanitation of meat department facilities.

Barriers to Loss Reduction

Losses of fresh beef at the supermarket level might well be reduced or eliminated were certain barriers to progress overcome. Among the principal barriers observed in the distribution of fresh beef are:

Traditionalism of Meat Division Managers and Employees. Methods for handling, cutting and packaging have undergone change, but relatively slowly. Change tends to be marginal; that is, modifying individual existing functions instead of considering entirely new concepts or systems. Change has been instituted on a piecemeal basis, rather than comprehensively for the system as a whole. This type of change can lack the beneficial synergistic effects which accompany system-wide improvements.

Traditionalism is fostered by the practice of maintaining a guild-like situation for meat department personnel practices. In such a setting, operating customs are passed along to each generation of new employees, regardless of their efficiency and effectiveness. This is in contrast to the relatively high mobility of personnel among most other functional areas of a supermarket organization.

The change to vacuum packaged boxed beef is an exception to this general rule. Substantial differences in operations and facilities are required with boxed beef. Inventory management, labor scheduling and the new layout of refrigeration space and storage equipment are importantly different than in traditional fresh beef.

The tendency to rely on past practice which has characterized meat operations is beginning to give way to much more professional and progressive management practices. A small number of firms are progressing so dramatically that there may be a competitive gap of serious proportion for those firms which have not kept pace.

Lack of Refined Accounting Methods. Despite current knowledge in computer science and a general availability of highly refined business accounting systems, meat departments in the supermarket industry have not yet applied such technologies to the complex task of adequately controlling operations. This results in few, if any, retailers being sufficiently aware of the economic performance of their beef operations. The full extent of beef waste and losses, for example, is not measured with sufficient precision, if measured at all. Even though the magnitude of losses in beef operations is sensed by some retailers using gross accounting measures, the exact areas of operations where the problems exist may go undetected. In the absence of precise accounting methods, it becomes more difficult to conduct cost/benefit analyses and to propose actions that might reduce or eliminate losses.

Need for Improved Recruiting and Development of Personnel. The supermarket industry currently has difficulty attracting and retaining persons who are interested in and capable of developing long-term, effective careers in supermarket meat departments. As meat department managers must become more sophisticated, this problem could become still more acute. Future changes in meat department operations will require personnel with greater managerial and technical skills. To attract persons capable of and interested in these new sophisticated management challenges, companies will have to identify and understand the beneficial new contributions such persons can make to meat department operations. This will justify the relatively higher levels of training and compensation that can be expected.

Scarcity of Capital Funds. The general shortage of Capital, high interest rates, low profit margins of most retail firms, stable sales and decreasing productivity contribute to a situation where most retail organizations have difficulty in underwriting and justifying large capital expenditures. Where capital is available, there are competing demands, among them the need to invest large sums for

Universal Product Code scanning, mechanized distribution centers, new stores, and for store remodelings. The management of most supermarket firms, therefore, can be reluctant to devote scarce capital resources to meat operations. A contributing reason for this is the low profitability of many meat departments. Again, the absence of control methods and procedures which could provide reliable operating figures and results makes general management reluctant to invest large sums of money for the improvement of operations where current cost and projected benefits are unknown.

Shopper Buying Patterns. Earlier in this section, reference was made to the excessive traditionalism in meat department operations. In a sense, this is also the case for shoppers with respect to their habits in selecting, storing and preparing meat cuts. There appears to be less consumer willingness to experiment with meat products, in comparison with what has been the case for grocery departments introducing highly processed convenience foods. The reasons for this apparent contradiction are many and complex. Perhaps some relate to the high unit cost of beef cuts, which tends to cause people to be less inclined to risk experimentation. Moreover, consumer product information explaining the reasons for change and how to use different meat cuts is not frequently included with fresh beef packages, as it is for products sold in other departments of a supermarket. Consumer preference for or tolerance of the status quo may influence the extent to which change is sought in other aspects of meat department operations, including those associated with reducing losses in fresh beef distribution.

High Cost of Labor and Equipment in Meat Operations. Certain meat department processes require inordinately high labor and equipment costs. As a result, some loss reduction options are foreclosed when supermarket management is reluctant to add further to this cost structure. On the other hand, these high economic costs may serve as a further incentive to encourage optimum productivity of personnel and

equipment. In time one would expect greater emphasis to be given to loss reduction activities for these reasons.

FUTURE PERSPECTIVE: POTENTIAL FOR CHANGE IN FRESH BEEF DISTRIBUTION
IMPLICATIONS OF RESEARCH AND DEVELOPMENT

In this section of the report two fundamental questions are raised in light of the industry's past performance, present situation and the anticipated future climate:

- Is it possible to change the fresh beef system in significant ways?
- Would it be possible to make greater strides in reducing or eliminating losses if a substantially changed beef distribution system were to be created?

Broad issues with respect to losses and waste in the fresh beef system have not been the main thrust of this study thus far. Rather, it has identified and described what is known about the magnitude and causes of specific losses and wastes; and pointed out some remedies which may be feasible to implement. Losses have been analyzed in the beef distribution system as it functions currently. Only recently has beef distribution begun to change. The best example of this new dynamism is the development of vacuum packaged boxed beef. Other examples of progress are characteristic of only a very small number of meat packers and retailers that are streamlining fresh beef distribution methods.

This part of the study identifies new directions to be considered by industry, government, and educational institutions in their efforts to achieve a more effective beef distribution system.

Change in most systems is normally a gradual, evolutionary process. Major change in the food distribution system as a whole has been no exception to this rule. The basic, service-oriented grocery store with relatively few items has been several decades evolving to the modern supermarket. This larger store format offers self-service, and expanded number of frozen foods, the expansion of general

merchandise items and the proliferation of processed convenience food products, reflecting strong brand marketing on the part of manufacturers.

In the mid-1960's a number of important developments emerged in fresh beef distribution methods:

- The growth of meat distribution centers owned by several large retailers and wholesalers.
- Meat packers developed vacuum packaged boxed beef, but new entrants to the packing industry and a few major food retailers expanded its use.
- Some large-scale supermarketing organizations greatly improved effectiveness and found they could cost-justify a large number of refinements in the basic functions of meat receiving, storing, fabrication, packaging, and displaying.
- Growth in the merchandising of boneless beef products by some retail food companies.

The typical retail package of fresh beef still exists as a highly fragile food item, is fabricated and packaged in traditional ways, and contains excessive fat and bone. The industry apparently assumes consumers need beef cuts in their traditional form in order to make rational shopping choices. Or, it may be feared that the total removal of fat and bone (with a corresponding rise in unit price of the product) would reduce purchases by shoppers unable to recognize the equal price value in meat cuts with bone and fat removed.

The record of past change in fresh beef distribution has been characterized by a relative lack of innovation, when compared with other successful U.S. industries. This is the case, even considering the application of some new technologies to improve operating efficiency and sanitation programs previously discussed. There are other categories of change factors that may in time come to be the most significant with respect to fresh beef distribution.

Implications of Research and Development

Research devoted to improving fresh beef distribution has lagged behind research on beef animal production and feeding, and compares unfavorably with the

level of research and development expenditures by U.S. industry, as a whole. Research in total beef systems by the U.S. Department of Agriculture and by State Agricultural Extension Services is predominately concerned with cost reduction in livestock production (46 percent) and avoidance of animal loss (23 percent), as reported by E. J. Warwick (46). Beef research on "product and quality of products, including new products, accounted for about 15 percent of the total effort." Other sources indicate that meat packers and retailers devote only nominal resources to research and development. Nor does research in related fields (such as chemistry, biochemistry, etc.) deal with distribution and marketing problems.

There needs to be greater awareness that more publicly funded research should be devoted to marketing and distribution problems, despite current policy statements by the U.S. Department of Agriculture indicating that private industry has the responsibility and capability of financing productivity improvement research and development projects.

The Stanford Research Institute (SRI) conducted a symposium to address the question "how can publicly supported research institutions spend their money to help you (beef systems participants) most?" The symposium was sponsored by the National Science Foundation (46). The proceedings indicated that research and development is greatly needed with respect to all functions throughout the total beef system, including those of marketing and distribution which are directly related to the principal causes of fresh beef losses. Among the recommendations advanced at the SRI symposium particularly appropriate to loss reduction issues studied in this project are:

- Develop methods for better understanding consumers' wants and needs, so that acceptable products can result from invested research and development resources.
- Develop low-fat beef products in response to both professional and public views on nutritional needs.

- Develop sanitation and preservation techniques that will improve the storability of products and lower storage costs.
- Determine ways by which wholesale and retail distribution efficiency can be improved in order to achieve enhanced production efficiencies.
- Identify ways to reduce the cost of current meat preservation techniques, and search for improved methods.
- Establish methods for improved cost analysis for all segments of the beef system.
- Improve the understanding of the reasons for slow adoption of known technologies in part of the beef system; and devise methods to accelerate the process of technology adoption.
- Concerning rewards for each participant in the beef system, there is a need to improve the understanding of the relative effectiveness of private enterprise with respect to stimulating innovations in the beef system.
- Develop techniques for determining the value (cost/benefit) of adopting new knowledge to improve the beef system.
- Improve the understanding of the beef cycle and its effect on system efficiency. The effectiveness of communication through the system is a key issue. Seek appropriate ways to "smooth" the cattle cycle to assure that the beef system produces a sufficient quantity of product to satisfy demand in a timely fashion, and that products are available where most in demand.

In a study to identify emerging technology which is most likely to have a major impact on the meat packing and processing industries during the next 25 years, some of the research projects identified have important implications for the control of losses in fresh beef distribution (46). Researchers Lu and McNiel show that preservation methods of meat products are among the most susceptible to technological advancement. Among the research projects mentioned which related most directly to loss prevention during fresh beef distribution are the following:

- Perishability Control: Techniques to prolong the shelf life of fresh and processed meats, including: pre-slaughter injections, post-slaughter carcass washing, antifungal and bacterial controlling additives, exposure to controlled atmosphere, irradiation, freeze-drying, improved films, packaging material and refrigeration.
- Hot Boning: Techniques for hot boning, cutting and processing freshly slaughtered carcasses prior to chilling. Such a process would eliminate loss problems caused by meat dust; and the process would lead almost certainly to a totally different method of fabricating and packaging, and radical changes in how shoppers purchase and prepare beef in the home.

- Meat Restructuring: Techniques for producing restructured beef products which would closely resemble whole structure muscle meats. The likely result would be much reduced loss if meat restructuring techniques would stabilize the appearance of meat products.
- Protein Recapture: Techniques for recovering and utilizing wasted protein, including mechanical deboning, collection of slaughter animal blood into a food-grade protein, improved low-temperature rendering processs, and the development of enzymes for converting existing inedibles into edible foods. Loss prevention in this context transcends the recovery losses in the traditional beef distribution system, and would seem to offer benefits of even greater magnitude than loss prevention methods for existing systems.
- Frozen Meat: Techniques for packaging, distributing, and gaining consumer acceptance of frozen meats. Because the industry currently resists this concept, a system-wide cost/benefit analysis by an independent agency seems appropriate. This is especially appropriate in light of recent and projected changes in energy and distribution costs. Such an analysis might well include the costs/benefits of storage and waste of a frozen meat system as compared with the contemporary practices.
- Computer-Directed Processing of Meat: Techniques to direct by computer procedures for carcass cutting, continuous processing systems, weighing, labeling, storage and shipping.
- Energy Reducing Technologies in Packing and Processing Operations.

The greater use of mechanical or enzymatic tenderization of meat cuts might well be an addition to this list, so that beef animals could be grown using less feed grain.

Taken together, research initiatives of the kind mentioned promise to lead to a substantially changed beef system devoid of the losses associated with existing beef distribution systems as described in this report. Needed, of course, are analyses to determine the cost effectiveness of different loss reduction programs.

Determining feasibility of loss reduction programs also requires a comprehensive analysis of the barriers to change. Central to such an analysis is a review of government regulations inhibiting such activities as the tenderizing of meat, the use of additives, and the appropriateness of grading systems and meat labeling (particularly mechanically deboned meat). Such a review should also

include an analysis of the possible barriers resulting from labor union contracts, government restraint of packer and processor vertical integration into retailing, and regulations controlling the distribution of certain kinds of meat products.

It is probable that research of the kind proposed can best be conducted by an organization capable of taking a system-wide perspective. Perhaps a government/industry/university consortium could serve to focus and coordinate talent, funds and skills in an effort to make comprehensive changes in the total beef system.

SUMMARY AND CONCLUSIONS

The data gathered relative to the magnitude and value of losses in fresh beef distribution are summarized in this section of the report. A summary of the losses for each of the four principal fresh beef distribution systems (Systems A, B, C and D) in the operations of each of the major functions of distribution is in Table 4. The various ranges of losses reflect substantial differences in industry experience.

Point estimates indicative of the most representative industry experience -- or industry norms -- are presented in Table 5. These point estimates should not be interpreted as industry-wide averages. Additional data would be needed to make such a calculation with a reasonable degree of confidence.

Information gathered in this study was limited to available reports and field study to complement these secondary source materials. A paucity of loss data exists; and the data presented in this report are, therefore, estimates indicative of the true losses occurring in the distribution of fresh beef to supermarkets.

With respect to the aggregate of losses in terms of pounds and dollar values for the entire fresh beef distribution system, a measurement was determined by converting beef sales through supermarkets in 1976 to "retail carcass equivalents". This information is summarized in Table 6.

Table 4. Beef Losses by System of Distribution: Range of Losses Encountered

Systems	Kinds of Loss	Distribution Functions			Total
		Transportation	Distribution Center	Supermarket	
		(pounds)	(pounds)	(pounds)	(pounds)
A. Carcass	Shrinkage	3.2 - 13	5.5 - 13	6.5	15.2 - 32.5
	Cutting			6.3	6.3
	Floor Scrap			3.2	3.2
	Retail & Display			4 - 9.5	4 - 9.5
	Total	3.2 - 13	5.5 - 13	20 - 25.5	28.7 - 51.5
B. Packer Breaks Carcass into Primals or Subprimals (non-vacuum packaged) ¹	Shrinkage	3.2 - 13	4.7 - 11.2	5.5	13.4 - 29.7
	Cutting			5.5	5.5
	Floor Scrap				
	Retail & Display			4 - 9.5	4 - 9.5
	Total	3.2 - 13	4.7 - 11.2	15 - 20.5	22.9 - 44.7
C. Distribution Center Breaks Carcass into Primals or Subprimals (non-vacuum packaged)	Shrinkage	3.2 - 13	4.7 - 11.2	5.5	13.4 - 29.7
	Cutting		6.3	5.5	11.8
	Floor Scrap		3.2		3.2
	Retail & Display			4 - 9.5	4 - 9.5
	Total	3.2 - 13	14.2 - 20.7	15 - 20.5	32.4 - 54.2
D. Packer Breaks Carcass into Primals or Subprimals (vacuum packaged) ¹	Shrinkage			1.1 - 2.8	1.1 - 2.8
	Cutting			5.5	5.5
	Floor Scrap				
	Retail & Display			4.9 - 17.8	11.5 - 17.8
	Total			11.5 - 17.8	11.5 - 17.8

Source: See Appendix I, II, III, IV, V and (12,18).

¹To achieve comparable loss figures among the four systems, 9.5 pounds of cutting and floor scrap losses which occur at the packing plant in Systems B and D should be added to these systems.

Table 5. Beef Losses by System of Distribution: Estimated Industry Norms

Systems	Kinds of Loss	Distribution Functions			Total
		Transportation	Distribution Center	Supermarket	
		(pounds)	(pounds)	(pounds)	(pounds)
A. Carcass	Shrinkage	3.2	6.5	6.5	16.2
	Cutting			6.3	6.3
	Floor Scrap			3.2	3.2
	Retail & Display			9.5	9.5
	Total	3.2	6.5	25.5	35.2
B. Packer Breaks Carcass into Primals or Subprimals (non-vacuum packaged) ¹	Shrinkage	5.6	5.5	5.5	16.6
	Cutting			5.5	5.5
	Floor Scrap				--
	Retail & Display			9.5	9.5
	Total	5.6	5.5	20.5	31.6
C. Distribution Center Breaks Carcass into Primals or Subprimals (non-vacuum packaged)	Shrinkage	3.2	5.5	5.5	14.2
	Cutting		6.3	5.5	11.8
	Floor Scrap		3.2		3.2
	Retail & Display			9.5	9.5
	Total	3.2	15.0	20.5	38.7
D. Packer Breaks Carcass into Primals or Subprimals (vacuum packaged or boxed beef)	Shrinkage			2.8	2.8
	Cutting			5.5	5.5
	Floor Scrap				--
	Retail & Display			9.5	9.5
	Total	--	--	17.8	17.8

Source: See Appendices I, II, III, IV, V and (12,18).

¹To achieve comparable loss figures among the four systems, 9.5 pounds of cutting and floor scrap losses which occurs at the packing plant in Systems B and D should be added to these systems.

Table 6. Distribution Losses in the Fresh Beef System¹

Distribution System	I	II	III	IV ⁷	V ⁸
	Fresh Beef Distributed through each System ²	Number of Retail Carcass Equivalents per System ³	Losses for a Single Carcass ⁵	Total Losses per Distribution System	
	(percent)		(pounds)	(pounds)	(dollars)
A. Carcass	38	5,795,000	35.2	203,984,000	\$230,328,070 ⁹
B. Packer Performs Carcass Cutting into Primals/Subprimals (non-vacuum packaged)	15	2,287,500	31.6	72,285,000	83,814,000 ¹⁰
C. Distribution Center Performs Carcass Cutting into Primals/Subprimals (non-vacuum packaged)	10	1,525,000	38.7	59,017,500	64,547,150
D. Packer Performs Carcass Cutting into Primals/Subprimals (vacuum packaged boxed beef)	36	5,490,000	17.8	97,722,000	127,038,600
All Other Systems	1	152,500	30.8 ⁶	4,697,000	4,509,120 ¹¹
TOTAL	100	15,250,000 ⁴	--	437,705,500	510,236,939

¹The losses cited are estimated values of physical quantities lost to human consumption of fresh beef sold through supermarkets, based on secondary data and industry sources.

²See "Introduction" and Figure 2.

³Column I x 15,250,000 carcass equivalents (Column II total).

⁴Total number of Retail Carcass Equivalents determined using: (a) Estimated supermarket sales in 1976 @ 9,150,000 pounds (3,28,29) ÷ (b) Total retail cuts per carcass--steaks, roasts, thin meats, ground beef @475 pounds (18,44) + Per carcass, additional ground beef sold annually from imported frozen, boneless beef; Utility, Canner, and Cutter fresh beef, and other trimmings @ 125 pounds = RETAIL carcass equivalent of 600 pounds.

⁵Based on Tabel 5.

⁶Based on the unweighted average of all Systems.

⁷Column II x Column III.

⁸For each Distribution System: (1) The dollar value of losses for each function was determined as follows: (a) Pounds lost per function (see Table 5) ÷ (b) Column III x (c) Column IV x estimated value of a pound of beef for that function (Transportation losses, \$0.68/pound; Distribution Center losses, \$0.90/pound; Supermarket losses, \$1.30/pound). (2) These dollar value losses per function were summed.

⁹Distribution Center losses valued at \$0.68, as described in the text and (44).

¹⁰Transportation losses valued at \$0.90, as described in the text and (44).

¹¹Based on the unweighted average price for losses in each function: \$0.96/pound.

Of the 15,250,000 retail carcass equivalents sold through supermarkets in 1976, it was calculated that physical losses of fresh beef amounted to 437,705,500 pounds. This represented 4.8 percent of the weight of all fresh beef retailed through supermarkets.

In terms of dollar value, losses were estimated to be \$510,236,939. Because of the variation in the market values of beef at each stage of the distribution system, the dollar values shown should also be interpreted as broad indicators. Beef prices have inflated substantially since 1976, and these tables no doubt understate the economic value of waste and losses for the different operations in fresh beef distribution to supermarkets. The prices used in the report were maintained to permit comparability between, and to be consistent with, data drawn from the literature review.

By any measure, even conceding the lack of precision of the data available for review, the magnitude and value of losses in fresh beef during distribution are substantial. As a percentage of loss, fresh beef (as a single food product) ranks second only to fresh produce -- a category of food typically including 50 to 60 individual products. In terms of dollar value, losses in fresh beef are greater than for any other single food product in distribution. Beef losses of approximately \$510 million are nearly four times as large as losses incurred by the myriad products which constitute the dry grocery category. It should be noted, also, that the dry grocery category constitutes over 36 percent of supermarket food sales: nearly three times the percentage for beef, and includes hundreds of different food products.

The study has revealed that because of the nature of current industry practice, the state of technology, and the characteristics inherent in fresh beef products, a certain volume of losses is likely to persist and can be accepted as "reasonable" and acceptable (4). Variation in the volume of losses encountered for

different beef handling systems and operators, however, indicate that there is likely to be a number of ways losses can be reduced at every stage during beef distribution. The achievement of optimum loss reduction would involve numerous factors resulting in many relatively small loss reductions.

The aggregate dollar figures expressed in Table 6 obviously are imposing in size; however, the nature of losses is such that individual instances of loss typically are relatively small. Losses occur in thousands of trucks, hundreds of distribution centers and in over 30,000 supermarkets in the United States. For these reasons, it is unlikely that losses will be substantially reduced by sweeping, simplistic actions.

The major findings concerning waste and losses during fresh beef distribution are discussed in detail in preceding chapters and can be summarized as follows:

I. Kinds of Losses

The major kinds of fresh beef losses encountered in this study were:

- Shrinkage: The loss due to moisture evaporation.
- General Product Deterioration.
- Cutting: Meat dust.
- Floor Scrap.
- Retail and Display: Losses resulting from retrimming, reworking and discarding beef for non-edible purposes.

II. Classifications for Major Causal Factors of Losses

The causal factors for fresh beef losses are listed. A capital letter serves as a code for use in Section III, to indicate which causal factors are involved in each specific loss situation discussed in the study.

T = Temperature and Humidity

H = Handling

P = Packaging Materials and Processes

S = Sanitation

C = Cutting Practices and Equipment

O = Out-of-Date

Q = Quality of Beef Entering Distribution

G = Government Regulatory Activities

L = Lighting

I = Inventory Management

III. Specific Causal Situation for Losses

Numerous reports and interviews with company representatives who were closely involved in each of the phases of fresh beef distribution revealed a number of situations which resulted in losses. The study examined three distinct functions in beef distribution: transportation, wholesale, and supermarket operations. The "major causal factors" coded in Section II are noted in each case.

Transportation Operations

Causal Situation:

Major Causal Factor

- | | |
|---|-------|
| ● Beef held at excessively high temperature due to inadequate chilling and lack of precooling of trailer. | T-Q-G |
| ● Defective transportation cooling equipment; and improper use of refrigeration units. | T |
| ● Trailers loaded in ways that inhibit the circulation of refrigerated air. | T |
| ● Boxed beef damaged in handling during loading and unloading. | H |
| ● Packaging failed to provide necessary protection of the product under normal loading, in transit, and unloading conditions. | P |

Wholesale OperationsCausal Situation:

- Fresh beef is subjected to high temperatures during trailer unloading; and carcasses and exposed beef cuts are subjected to possible microbial contamination by personnel and the general environmental surroundings.
- Boxed beef is damaged by rough handling, causing "leakers"; and excessive purge of juices is caused by improper stacking and handling.
- Carcass beef is stored improperly in coolers inhibiting circulation of chilled air; and storage rooms are insufficiently refrigerated.

Major Causal Factor

T-S

H

T

Supermarket OperationsCausal Situation:

- Shrink losses exceed minimal acceptable levels when the product temperature rises above 30°F.
- Rough handling of boxed beef during truck loading, storing and processing.
- Retail beef cuts are exposed to the harsh conditions of the retail display case:
 - * Hot lights.
 - * High temperatures due to malfunctioning of display case refrigeration equipment.
 - * Packages are stacked above recommended load levels, causing high temperature of the products and creating excessive purge of juices.
- Excessive trimming loss and spoilage.
- Ground beef discarded due to overstocking.
- Over ordering of beef and excessive inventories occurring as a result of competition conditions; or weather that adversely affects customer shopping patterns.

Major Causal Factor

T-H-L

H

T-H-P-C-L

All factors listed

C-O-I

I

IV. Remedies for Fresh Beef Losses

The specific factors causing losses to occur in fresh beef distribution can be remedied by a variety of actions, including the following:

- To Improve Temperature and Humidity Controls and Lighting:
 - * Develop systems and establish procedures to ensure that trailers are precooled; and that mechanical refrigeration units are in working order.
 - * Drivers of trucks should be informed of the importance of proper usage of refrigeration units; and monitored to determine compliance with established procedures.
 - * Use programmed monitoring of mechanical refrigeration units.
 - * Instruct and supervise personnel in order to load trailers in ways to facilitate the circulation of chilled air.
 - * Improved coordination between packers and trucking firms.
 - * Train and supervise personnel at distribution center facilities in proper methods of unloading trailers with respect to temperature and humidity requirements for unloading docks, storage areas, fabricating rooms and loading areas.
 - * At the supermarket level, each function should be monitored with respect to proper receiving procedures (systematic temperature checks); product storage; and use of display equipment (display cases should be stocked in accordance with equipment manufacturers' recommendations, especially load levels).
- To Improve Handling and Inventory Management:
 - * Train personnel in the proper techniques for trailer loading, unloading, stacking of carcass and boxed beef.
 - * Make effective use of equipment for handling boxed beef: conveyors, pallets, slip-sheets, forklifts, storage racks, etc.
 - * Develop management awareness of the importance of proper beef handling; and the implementation of personnel training at all operating levels throughout the entire beef distribution system.
 - * Institute techniques and systems for managing inventories, cutting, and packaging to achieve greater coordination between shopper purchasing patterns and the quantities of beef product on display.
 - * Implement the Universal Product Code Scanning system in order to establish more effective methods for managing inventories and to project shopper behavior with respect to beef displays and response to a wide range of merchandising activities.
- To Improve Packaging:
 - * Secondary shipping containers and pallet-base sizes should be standardized, developing modular sizes for secondary shipping cartons.
 - * Generally accepted proper methods for vacuum packaging of beef (Appendix VI) should be emphasized in the training of all appropriate personnel.

- * Packaging equipment and materials should be developed as a unified, highly coordinated system of activities in order to achieve optimal productivity and protection of beef against the operating and shopping environment of the beef system.

● To Improve Sanitation:

- * Accelerate the trend toward greater centralization of meat fabrication and packaging at manufacturing centers where maximum standards of cleanliness and sanitation can most readily be achieved.
- * Greater emphasis should be placed on training programs which instruct appropriate personnel on the reasons for and the methods of achieving high levels of cleanliness and sanitation in each step of beef distribution.

● To Improve Cutting Practices and Equipment:

- * Make greater use of central processing to facilitate the development and application of high-speed and effective systems.
- * Increase the use of mechanization at the supermarket level.
- * Improve human resource systems for attracting, training, motivating, and retraining new employees.
- * Reconcile differences and seek cooperation with labor unions regarding resistance to improved methods of beef distribution.
- * Seek institutional methods to overcome the relatively slow rate of adoption of technology such as central processing and the application of Universal Product Code Scanning systems.

● To Avoid Losses Due to Out-of-Date Merchandise:

- * The application of inventory management systems and production schedules, especially those developed from the Universal Product Code Scanning data, are now highly feasible and greatly needed.
- * Consumer demand in terms of shopping needs and product wants should be communicated more effectively throughout the entire beef distribution system.
- * Consumers should be educated by government, business, and educational institutions to better understand how to more effectively utilize the wide range of existing beef cuts available in supermarkets.
- * Educate consumers to understand that many of the cosmetic attributes, such as bright red "bloom", of fresh beef are not highly correlated to good taste, sound nutrition, and wholesomeness.
- * Methods to bring better price stability to the total beef system may contribute to more even marketing of fresh beef in distribution, thus reducing losses as volumes are stabilized and ultimate consumer products vary less in price.

● To Improve Quality of Beef Entering Distribution:

- * Greater effort to achieve vertical coordination from retailers, to wholesalers, to packers, and to beef producers will help ensure that each handler of beef throughout the "channel" will have product that is less susceptible to losses and waste. Existing trade associations, producer groups, universities and governmental agencies are in need of ways and means of relating more closely in order to improve inter-industry cooperation.
- * Because the inherent perishability of fresh beef, greater expenditures for research and development should be encouraged to evaluate alternate methods of distributing fresh beef; i.e., frozen beef system, acceleration of further processed beef products utilizing such innovations as the retortable flexible pouch, pasteurization by means of irradiation of meat and the like. It is unlikely a single method of distribution will emerge as the "better method"; however, a number of alternative methods serving particular needs may emerge.

● To Improve Government Regulatory Activity:

- * Evaluate each of the influential laws and regulations related to the beef industry to see if it encourages conduct that leads to loss reduction.
- * Use government regulation positively and creatively: To play a catalytic role in fostering efforts to achieve greater coordination throughout the beef distribution system.
- * Inform beef distribution system regulators of the implications of laws and regulations they develop and enforce.
- * Review grading standards in light of the wants and needs of consumers, giving special emphasis to preferences for food with lower fat content.

This report of losses during fresh beef distribution to supermarkets has highlighted a number of causal factors and situations and has specified some remedies that may reduce or eliminate them. It is not our intent to convey the notion that the beef distribution system is failing in a broad way in its effectiveness of management. It seems appropriate here to underscore the incredible difficulty of the task performed by the beef industry: that of annually marketing through supermarkets 15 million beef carcass equivalents -- a highly perishable major food item. The magnitudes of distance and product quantity involved, the relatively low prices which U.S. consumers pay for beef products when compared with citizens in other nations, and the quality of those products is found in few other

nations of the world. To achieve optimum performance in the future will require coordination and communication between beef system participants utilizing skills not seriously tested until now. The incentives have grown rapidly to make such an effort more attractive politically, socially, and economically. The growing sophistication of the shopping public and the increasing professionalism of beef industry personnel are encouraging signs that progress can and will be made in the endeavor to reduce waste and losses in fresh beef distribution, thus accruing the substantial direct and related benefits that are certain to result.

APPENDICES

Appendix I
Shrink Loss Pattern for Beef

Distribution Activity	Time Period	Loss
	(days)	(percent)
Packer (cooling period)	2	2.0
Transportation/Distribution	1	0.5
Distribution Center	1	0.5
Local Delivery	1	0.5
Supermarket	1	0.5

Source: See (7).

Appendix II
Comparison of Beef Shrinkage

Source of Loss	Time Period	Type of Beef	
		Hanging Carcass	Vacuum Packaged
	(days)	(percent)	(percent)
Packer to Warehouse Shrinkage	4	.77	--
Warehouse Shrinkage	4	1.28	--
Store Loss		<u>.68</u>	<u>.77</u>
Net Shrinkage		2.64	.77
Retail Package Weepage	2	<u>1.98</u>	<u>2.15</u>
Total Shrinkage and Weepage		4.62	2.92

Source: See (30-1972).

Appendix III

Miscellaneous Information on Beef Losses

Product shrinkage in this report refers to the evaporation weight loss of carcass beef, the liquid purge loss from boxed beef, and the evaporation loss from beef in retail cuts.

The amount of shrinkage varied depending upon:

- Kinds of meat packaging.
- Whether the meat was chemically treated.
- Temperature and humidity.
- Length of storage.

Shrink losses in typical situations was estimated as follows:

- 0.42 percent per day for exposed carcass and retail cuts. (Estimate based upon published reports) (27).
- 0.42 percent per day for retail cuts in conventional tray and film packages. This is based on a range of shrinkage, 0 to 0.63 percent per day (University of Missouri).
- 0.2 percent for vacuum wrapped primals, irrespective of how long they were held. (Estimated by Iowa Beef Processors, Inc., for "barrier bag" packaging.)

Typical holding periods used were based upon the Case and Company study (44).

- Two days at the supermarket for direct store-delivered carcass beef and unboxed beef.
- One day at the warehouse and one day at the store for centrally warehoused carcass beef.

Appendix IV
Cumulative Shrink Loss from Packer to Supermarket

Distribution System	Percent
Packer sells carcass direct to retailer	17.5
Packer sells subprimals direct to retailer	17.0
Packer sells carcass to distributor who sells carcass to retailer	18.5
Packer sells carcass to distributor who breaks carcass into subprimals to sell to retailer	18.0
Packer breaks carcass into subprimals and sells to distributor who sells to retailer	17.0

Source: See (41).

Appendix V
Economic Comparison of Carcass vs. Cattle-Pak

	CARCASS			VS.	CATTLE-PAK		
Date: 2-23-76	Weight	Dollars/Cwt.	Dollars/Head		Weight	Dollars/Cwt.	Dollars/Head
Carcass	650.00	61.00	396.50		650.00	61.00	396.50
Selection Fee	—	0.75	4.88		—	0.75	4.88
Selected Carcass	650.00	61.75	401.38		650.00	61.75	401.38
Cattle-Pak Fee	—	—	—		—	—	34.84
Fat & Bone Credit	—	—	—		(86.58)	7.23	(6.25)
Floor Scraps Credit	—	—	—		(3.25)	1.50	(0.05)
Cutting Loss	—	—	—		(3.25)	—	—
Plant Gate Weight & Cost	650.00	61.75	401.38		556.92	77.19	429.91
Freight	650.00	3.34	21.71		556.92	3.32	18.49
In-Transit Shrink (½%)	(3.25)	—	—		—	—	—
Warehouse Weight & Cost	646.75	65.42	423.09		556.92	80.52	448.40
Warehouse Shrink (1%)	(6.47)	—	—		—	—	—
Shipping Weight	640.28	—	423.09		556.92	—	448.40
Handling & Delivery	—	4.00	25.61		—	3.50	19.49
Store Door Weight & Cost	640.28	70.08	448.70		556.92	84.01	467.89
Store Shrink (2%)	(12.81)	—	—	(½%)	(2.78)	—	—
Cutting Weight	627.47	71.51	448.70		554.14	—	467.89
Cut Loss (1%)	(6.27)	—	—	(1%)	(5.54)	—	—
Fat & Bone Credit	(163.14)	3.50	(5.71)		(73.31)	3.50	(2.57)
Retail Case Weight & Cost	458.06	96.71	442.99		475.29	97.90	465.32
Proj. Sales Value: 24% Markup	458.06	127.25	582.88		475.29	127.25	604.81
Marketing Loss (4%)	—	—	(23.32)	(2%)	—	—	(12.10)
Realized Sales Value	—	122.18	559.66		—	124.70	592.71
Less: Retail Case Cost	—	—	(442.99)		—	—	(465.32)
	% of Sales	Dollars/Cwt.	Dollars/Head		% of Sales	Dollars/Cwt.	Dollars/Head
Gross Margin	20.85%	18.22	116.67		21.49%	22.87	127.39
Labor @ \$6.00/Hour	12.11%	10.58	(67.77)		6.60%	7.02	(39.12)
Profit Contribution	8.74%	7.64	48.90		14.89%	15.85	88.27
Less: Carcass Profit Contribution							(48.90)
INCREMENTAL PROFIT CONTRIBUTION FROM CONVERTING TO IBP CATTLE-PAK:*							\$39.37

Source: See (18) and Iowa Beef Processors, Inc., Dakota City, Nebraska, 1976.

Appendix VI

Checklist for Vacuum Packaging of Boxed Beef**Beef Preparation**

1. The quality of the meat to be packaged will affect the quality of the finished, vacuum packaged product. It is recommended that carcass beef be trimmed and cleaned of all excess blood prior to entry to the fabrication room.

Packaging System Maintenance

1. All manufacturer's recommended maintenance procedures must be followed to obtain maximum machine performance and production quality.
2. Vacuumizing equipment should be inspected at the beginning of each shift and periodically during each shift to ensure proper operation, including vacuumizing and clipping or sealing.

Temperature

1. Recommended temperature for holding room prior to fabrication is 30⁰-33⁰ F.
2. Internal temperature of carcass beef should be 44⁰ F. or lower at aitch bone prior to fabrication for boxed beef.
3. Recommended operating temperature for fabricating room is 40⁰-50⁰ F.

Fabrication

1. Primals should not be allowed to bottleneck while awaiting fabrication. Avoid meat-to-meat contact.
2. Avoid excessive water contact with meat. Meat contamination increases in proportion to water exposure.
3. As meat is fabricated, it should move quickly and smoothly through the packaging station.

Protecting the Package

1. All exposed bone should be covered with bone puncture protection material.
2. Bone covering material should extend well over the bone to permit ends to fold to hold the material in position inside the bag during vacuumizing.
3. Where twine bridging occurs, as in a 109 rib, do not cover cavities with cloth.

Appendix VI (Continued)

Bag Sizing and Loading

1. Proper bag sizing is essential for adequate vacuumizing in order to obtain a skintight package for maximum control of meat purge.
2. Undersized bags cause excessive bridging, reduce desired bag-to-product cling, and increase the possibility of bag seam splitting and other package damage in transit.
3. Oversized bags allow bag material creases to form, reducing surface cling and increasing vacuumizing time.
4. When loading, the largest end of the subprimal should go into the bag first.
5. When laminate pouches are used with a heat seal packaging system, a larger bag size may be required with some products to permit a smooth, wrinkle free seal.
6. For heat seal, single chamber systems, care should be taken to prevent blood, fat, and meat juices from contaminating the seal area, which prevents proper heat sealability.

Equipment Loading

1. Bagged product should be loaded into the chamber fat-side down for better transfer.
2. When using a double chamber vacuum system, the operator should slide the bagged product into the large chamber, with the bag neck draped into the small chamber, leaving a "fist length" between the bagged product and the bag neck glide opening to the small chamber.
3. The bag neck must be clear and untwisted in order to allow fast and thorough evacuation of air.
4. For heat seal systems, the operator must assure that the bagged product is far enough from the seal bar so that the bag neck can be laid flat and wrinkle free.

Packaging Shrinking

1. A smooth steady transfer of vacuumized product to the shrink tunnel is required.
2. Package pile-ups must be avoided so that each subprimal receives complete and even heat exposure to assure optimum shrink.
3. Periodic checks should be made for sharp points in transfer conveyors, such as nicks on product guide fences and sheared metal on belt lacings.

Appendix VI (Continued)

4. Shrink tunnel temperatures and speeds are critical with all packaging materials and systems. A water temperature of 200⁰ F. at a speed of 55 ft. per minute (fpm) should be used with double chamber systems. Nozzle vacuumizing systems generally require a water shrink temperature of 195⁰ F. at a conveyor speed of 55 fpm.
5. When hot air treatment is used in conjunction with heat seal packaging systems, required settings may vary, but generally run at 425⁰ F. at a speed of 30 fpm.
6. Inspect tunnel every hour to check for proper water/air flow, spray pattern, temperature and speed.
7. It is important not to mix packages from different types of vacuumizing systems in the same shrink line.
8. Avoid hang-ups at the tunnel exit and provide smooth transfer to the air blast station.

Pack-Off

1. Bagged product should not be stacked.
2. Convey bagged product smoothly to the pack-off station.
3. Care should be taken in boxing packaged subprimals.
4. Staples should not be used for box construction or closure. Banding or gluing are recommended closures for boxed beef cartons.
5. Packed shipping containers must be handled with care. Excessive handling should be avoided.
6. Carton manufacturer's stacking recommendations should be followed.

Shipping

1. Cartons must be palletized in accordance with carton manufacturer's recommendations.
2. Insure that pallets are properly designed for intended weight load and are well maintained.
3. Cartons should be handled with care during distribution and final delivery at the retail store.
4. Recommended storage temperature for boxed beef is 29⁰-32⁰ F.

Source: See (25).

Appendix VII
Composition of 650 Pound Carcass

Steak and Roasts (thick meat)	342 pounds
*Thin Meats	51 pounds
Ground Beef	99 pounds
Fat Removed	54 pounds
Bone Removed	96 pounds
Cutting Loss	8 pounds

Source: See (12,44).

*Brisket, Shank Meat, Skirts, Flank, Kidney, Hanging Tender and Short Ribs.

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