THE NATURE AND EXTENT OF RETAIL AND CONSUMER LOSSES IN APPLES, ORANGES, LETTUCE, PEACHES, STRAWBERRIES, AND POTATOES MARKETED IN GREATER NEW YORK

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SUMMARY

Six major fresh produce crops were periodically sampled at wholesale, studied in retail stores, and purchased for consumptability during their respective seasons in the Greater New York area from 1966 to 1969. The condition of each crop in wholesale samples was compared with that found in retail stores 2 or 3 days later. Losses in retail stores were categorized and measured. Purchased retail store samples were held for varying times at room temperatures (or 70° F.) or at 38° to 40° to simulate consumer holding before they were examined for defects resulting in loss of edible tissue. Retail and consumer losses in each commodity for the completed study follow.

Wastage in Pacific Northwest Red Delicious apples marketed from October through April was 1.0 percent in retail and 2.6 percent in consumer samples for 1966-69. Mechanical injury (0.6 percent) was the leading cause of loss in retail. Nonparasitic disorders (1.2 percent) and mechanical injuries (1.2 percent) caused most of the loss in consumer samples.

Little retail loss occurred in Appalachian Red Delicious apples that were usually marketed from September to December. In consumer samples, 1.5 percent loss occurred. Mechanical injuries caused 1.0 percent and parasitic and nonparasitic disorders the remaining 0.5 percent.

Retail and consumer losses in California navel oranges marketed from November to April were 1.9 and 2.3 percent, respectively, for the 3-year study. Parasitic diseases, mainly penicillium rots, caused almost 75 percent of the loss at both levels.

Parasitic diseases caused about 75 percent of the loss in Florida Valencia oranges marketed in the February to June periods of the study. Losses from all causes totaled 1.2 percent in retail and 2.0 percent in consumer samples.

Mechanical injury was the leading cause of loss in California crisphead lettuce marketed from April to October of 1967-69. It comprised 2.7 percent of the total 4.6 percent loss in retail and 3.1 percent of the total 7.1 percent loss in consumer samples. Parasitic disorders caused 1.5 and 1.2 percent loss in retail and consumer samples, respectively. Losses from nonparasitic disorders were 0.4 percent in retail and 2.8 percent in consumer samples.

Mechanical injury and decay caused practically all the loss in retail and consumer samples of peaches marketed from May to September of 1967-69. Retail losses totaled 4.5 percent: 2.8 percent from mechanical injury and 1.7 percent from decay that was chiefly brown rot. Decay caused 4.5 percent loss and bruising 3.6 percent loss in consumer samples of peaches that were held at room temperatures until they were ripe.

Strawberry losses in retail and consumer samples totaled 4.9 and 18.0 percent, respectively, during the March to October periods of the 3-year study. Parasitic disorders, mainly gray mold rot, spoiled 3.6 and 11.6 percent of the berries in retail and consumer samples, respectively. Mechanical injuries wasted the rest.

A 3.6 percent loss occurred in consumer samples of Maine Katahdin potatoes marketed in Greater New York in the December to May periods of 1966-69. Mechanical injuries caused 1.5 percent; parasitic diseases, 1.1 percent; and nonparasitic disorders, 1.0 percent.

Consumer losses in California White Rose potatoes marketed in the May to July periods of 1967-69 totaled

3.2 percent. Parasitic diseases spoiled 2.1 percent. Losses from mechanical injuries and nonparasitic disorders were 0.7 and 0.4 percent, respectively.

Assuming that our retail and consumer losses are representative, the following losses have been estimated for the marketing of these six crops in Greater New York during 1966-69: Red Delicious apples from the Pacific Northwest and Appalachia, 4.6 million pounds; Florida Valencia and California navel oranges, 16.6 million pounds; California lettuce, 49.7 million pounds; peaches, 35.0 million pounds; strawberries, 9.8 million pounds; and Maine Katahdin and California White Rose potatoes, 30.0 million pounds.

INTRODUCTION

The estimated wholesale value of all fresh fruits and vegetables unloaded on the New York market in 1969 was $450 million (*14, 17*)[1]. The retail value of this fresh produce, with an average markup of 67 percent, was $750 million. The monetary loss encountered in marketing the enormous quantities of fresh produce required to fill the needs of 16 million people in the Greater New York area must be staggering. For even as small a loss as 1 percent amounts to $4.5 million wholesale and $7.5 million in retail value.

Information on the nature and extent of losses in produce after it reaches the terminal markets is very meager. Very little factual data are available on losses encountered in wholesaling, retailing, and consumption of most produce commodities (7). Yet information on the nature and magnitude of these losses could provide valuable guidelines toward realizing such goals as preserving the quality of produce, reducing marketing costs, and promoting increased consumption of fresh produce. It is toward the attainment of these goals that we present the results of a 3-year study on market losses in the Greater New York area.

MATERIALS AND SAMPLING METHODS

The following produce commodities were selected for the study: (1) Apples, Red Delicious from the Pacific Northwest and the Appalachian area; (2) oranges, Washington Navels from California and Valencias from Florida; (3) crisphead lettuce from central California; (4) peaches, mostly from the East; (5) strawberries, mostly from California; (6) potatoes, Katahdins from Maine and White Rose from California. These commodities were studied during their respective marketing seasons in Greater New York over a 3-year period commencing in September 1966 and ending in October 1969.

Wholesale Sampling

Each commodity was sampled weekly at public servicing wholesalers or at distributing warehouses operated exclusively by large chainstores. The produce was taken, usually within an hour of purchase, to our Belle Mead, N.J., laboratory where it was examined on arrival and after a simulated wholesale holding period. Both types of wholesale suppliers were alternated weekly whenever possible during the marketing period for each commodity. However, the selection of the wholesale supplier was contingent upon the later appearance of the produce in our cooperating retail outlets. More samples were procured from the chainstore warehouses than from the public wholesalers because our publicly serviced retail cooperators often preferred Delicious apples grown locally and were reluctant to handle strawberries when prices were high.

Retail and Consumer Sampling

Two retail outlets serviced exclusively by food-chain distributors or two to three publicly serviced retail markets were visited weekly, usually on a Friday, to determine the losses that occurred in retail and in the consumption of the commodities under study. The retail outlets selected in any one week were related to the wholesaler from whom we obtained our wholesale sample, usually 3 days preceding the retail visit. With the exception of strawberries, there was a lapse of 2 or 3 days between the time the produce first arrived at the warehouse and the time the produce was retailed in our cooperating stores. Therefore, our visits usually coincided with the retail sale of the same produce lot that we had sampled earlier for wholesale condition. This lapse did not apply to strawberries that were

[1] Italic numbers in parentheses refer to Literature Cited, p. 22.

usually retailed 1 or 2 days after arriving at wholesale outlets.

The test period in retail started at 8:30 a.m., at a time when produce was being prepared for sale a half hour before the start of general business in most stores. It ended at 4:30 p.m. Except for lettuce and strawberries, the produce items under study were culled cooperatively with store personnel. Culling losses were recorded and, if necessary, culls were taken to the laboratory to identify the cause(s) of damage. The heads from representative carton samples of lettuce were examined and trimmed exclusively by us in the stores to determine the extent and the nature of losses encountered in trimming. Strawberry culling was done by store personnel.

Consumer samples were purchased directly from display counters twice in each of the stores visited, once in midmorning and again in midafternoon. The samples were taken to our laboratory on the day of purchase and there subjected to simulated consumer-holding periods. At the end of the specific holding period for each commodity, the samples were examined. Defects that normally would be trimmed before consumption were trimmed and the loss measured.

Commodity Sampling

Apples

Red Delicious apples were sampled from September through April, the Appalachian fruits from September through December, and the Pacific Northwest fruits from October through April. Wholesale samples of Pacific Northwest apples were 1-carton tray packs and a few cell cartons, extra fancy grade, ranging in size from 72 to 125, but mostly 88s, 100s, and 113s. The apples came mainly from Washington, but fruits from Oregon and British Columbia were also sampled. The apples were obtained from chainstore distributors and public wholesalers who serviced the retail markets cooperating in this project.

The apple samples from the Appalachian area consisted of three kinds:

- Tray packs, extra fancy grade, sizes 80 to 125, mostly 100s and 113s.
- Cartons of 12 or 15 3-pound polyethylene-bagged fruits, U.S. fancy grade, 2¼-inch minimum.
- Cartons holding 16 film-overwrapped consumer trays, each carrying eight U.S. extra fancy grade apples (2¼-inch minimum).

Wholesale sampling of Appalachian fruits was mostly restricted to the chainstore operation because our publicly serviced retail cooperators seldom handled Red Delicious apples from Appalachia.

Retail losses in Red Delicious apples were determined by counting the defective fruits culled by store personnel before the fruits were put on display or during normal retail sales.

Consumer samples were purchased twice in each store visited. When displayed in bulk, 20 to 22 apples (about 8 pounds) were sampled at each purchase. If prepackaged, two or three consumer units were purchased each time.

Wholesale apple samples were examined at our Belle Mead laboratory the same day they were obtained. One-third of the apples were examined upon arrival. External and internal defects were recorded and fruit pressures taken with a Magness-Taylor pressure tester. The remaining fruits were examined after 2 or 3 days at 38° to 40° F. Consumer samples were similarly examined after they were held for 1 week at 38° to 40°. In addition, defective tissues were trimmed and their weights recorded.

Oranges

Navel oranges from California were sampled from November through April and Florida Valencias from February through June. Wholesale samples were 1-carton units, sizes 56 to 113, mostly 88s and 113s in navels, and sizes 163 to 252, mostly 200s in Valencias. In retail stores the oranges were usually displayed in bulk or in in-store prepackaged consumer units. Consumer samples from a single store ranged from 20 to 60 oranges in bulk, 12 to 60 oranges in polyethylene bags of 6 to 10 fruits per bag, and 24 to 30 oranges in film-overwrapped trays of 6 fruits each. Wholesale samples were examined soon after procurement and again after 2 or 3 days at 38° to 40° F. Retail samples were examined in the stores. Consumer samples were examined after holding fruits for 1 week at 38° to 40°. Internal and external defects, and the losses incurred by them, were evaluated.

Lettuce

Crisphead lettuce from central California was sampled from April to October. Wholesale samples were conventionally packed cartons of 24 heads with one 18-head carton exception. These samples were examined at our laboratory the day we obtained them, one-third of the heads on arrival, and the rest after 2 days at 38° to 40° F. To accurately measure losses in retail, we trimmed one to eight cartons of lettuce, most often four cartons, in each store visited. The wrapper leaves were removed from the heads in wholesale and retail samples; any defects that necessitated further trimming were

noted and the leaf trimmings weighed. Consumer samples of a single store were purchases of eight to 30 trimmed heads, usually prepackaged individually in plastic film bags. These samples were examined after 3 days at 38° to 40°. The leaves were removed to the heart of the head, and the defective tissues that ordinarily would not be consumed were weighed to determine loss.

Peaches

Peaches from the Southeast, the Middle Atlantic States, California, and Michigan were sampled from late May to mid-September. Wholesale samples were packed in Du-all crates, fiberboard cartons, half-bushel baskets, and wooden lugs. Consumer samples were almost always in bulk, 10 to 20 pounds from each store visited. On a few occasions consumer samples were prepackaged in the store, film-overwrapped in shallow or deep-seated-molded pulpboard trays.

Wholesale samples were examined for culls at our laboratory on arrival and after a simulated wholesale holding period at 38° to 40°F. Retail samples were examined in the stores. Consumer samples purchased in stores were held at room temperature until the fruits ripened to the eating stage, usually within 1 to 3 days. When ripe, the fruits were examined for defects. Defective tissues were trimmed and weighed to assess loss.

Strawberries

Strawberries were sampled from March to October. California was the principal source of the berries, although southern and local growing areas also contributed. Wholesale sample units usually were 12-pint trays. Occasionally, 8- and 16-quart cartons of local strawberries were sampled. Consumer samples most commonly consisted of 12 pints from each store visited. In addition, single store samples of 2 to 6 quarts and 4 to 8 pints of berries were obtained.

Usually one-third of the containers in a wholesale sample of strawberries were examined at the laboratory the first day the berries were obtained and the rest after 1 day at 38° to 40° F. Retail samples were examined in the stores. Consumer samples were held for 1 or 2 days at 38° to 40° before they were examined. Losses were determined by the number of berries culled.

Potatoes

Katahdin potatoes from Maine were sampled from December through May, and White Rose potatoes from California from May to July. Wholesale samples of Maine potatoes were 50-pound units containing 5 or 10 pounds of tubers in prepackaged mesh-window paper bags. Wholesale samples of White Rose potatoes were similarly constituted with 5-pound prepackaged units in plastic film bags.

The wholesale samples were culled once on arrival at the laboratory and again after 6 days at 60° F. Consumer samples were examined for culls and other defects contributing to loss after the tubers were held at 70° for 10 days.

RESULTS AND DISCUSSION

Red Delicious Apples From the Pacific Northwest

Wholesale Samples

The overall good quality of Red Delicious apples from the Pacific Northwest was the most striking feature revealed in the 3 years of sampling this fruit. In samples obtained from the wholesale outlets over the entire test period, about 0.9 percent of more than 8,500 apples examined were culls (table 1). Culls resulting from decays made up 0.5 percent; from mechanical injury, 0.3 percent; and from nonparasitic disorders, 0.1 percent.

The number of wholesale sample culls in any one marketing season never exceeded 1 percent. The percentage of culls dropped from 1.0 percent in the marketing season of 1966-67 to 0.6 percent in the marketing season of 1968-69. This decline was chiefly due to a reduction in badly bruised or mechanically damaged fruits.

Wholesale outlets had no significant bearing on the condition of the apples. The same brand frequently was handled by the chain distributors and public wholesalers. Differences in condition of the apples from our cooperating wholesalers were attributed to normal sampling variation.

TABLE 1.—*Culls found in Pacific Northwest Red Delicious apples sampled in wholesale outlets in Greater New York, October to April 1966-69*

Marketing season	Samples	Apples examined	Culls caused by—			Total culls	
			Mechanical injuries[1]	Parasitic diseases[2]	Nonparasitic disorders[3]		
	Number	*Number*	*Percent*	*Percent*	*Percent*	*Number*	*Percent*
1966-67	29	3,170	0.5	0.4	0.1	31	1.0
1967-68	28	3,034	.3	.7	0	29	1.0
1968-69	24	2,371	.2	.3	.1	14	.6
All seasons	81	8,575	.3	.5	.1	74	.9

[1] Cuts and bruises.
[2] Mostly blue mold and bull's-eye rots.
[3] Bitter pit and internal breakdown.

Retail Samples

The good quality observed in our wholesale samples was reflected in the relatively small losses encountered in our cooperating retail outlets where Red Delicious apples from the Pacific Northwest were handled (table 2). The retail culls totaled about 1 percent of the fruits retailed during the weekly test days for the three marketing seasons. This percentage was comparable to the percentage of culls we found in the wholesale samples. The increase in mechanically damaged fruits was expected because of the extra handling entailed in retailing the fruits in outlets characterized by self-service produce departments. About six per 1,000 apples retailed were mechanically damaged and three per 1,000 fruits decayed.

The lower incidence of decay, 0.3 percent, in retail may be a truer index of that condition than the 0.5 percent found in the wholesale sampling since many more apples (59,862) were observed in retail than were examined in wholesale samples (8,575 fruits). On the other hand, wholesale samples were examined more critically at our Belle Mead laboratory with its better facilities and without the pressure attending a produce department on a busy day. Only a few store culls resulted from nonparasitic disorders because of negligible incidences of bitter pit and scald. In addition, internal breakdown could not be detected without cutting the fruits.

No significant quality differences were found between chainstores and stores serviced by public wholesalers. In 1968-69 the cull loss in the retail outlets serviced by public wholesalers was substantially larger than that in the chainstores, 1.7 and 0.4 percent, respectively. However, the significance of this large difference was dissipated by the small number and the great variability of the samples in the publicly serviced outlets.

Consumer Samples

Whereas losses in wholesale and retail samples were determined exclusively by culls, losses in consumer samples were based solely on weight. As shown in table 3, mechanical damage (1.2 percent) and nonparasitic disorders (1.2 percent), chiefly internal breakdown, caused most of the loss encountered in consumer samples for the entire study. Decay accounted for only 0.2 percent of the total 2.6 percent loss.

Mechanical injury was serious enough to warrant trimming 22.4 percent of all apples in consumer samples over the three marketing seasons, and a 1.2 percent weight loss resulted (table 3). Nearly all the mechanical injury in consumer samples was bruise damage. Bruises exceeding three-quarters of an inch in surface diameter were trimmed out as segments by a straight slice. The average trimming loss per bruised fruit was 10 grams. Other trimming losses under mechanical injuries included discolored cuts and punctures, skin abrasions,

field scars, and insect injuries, all making up but a small part of the loss in this category.

The number and size of bruises found in consumer samples were compared with those found in wholesale samples over the three marketing seasons (table 4). The most bruising occurred in the 1966-67 season in both wholesale and consumer samples. There was considerably less bruising in 1967-68 and a much smaller decline in 1968-69. The main reason for the decline was the greater firmness of the fruit after the 1966-67

TABLE 2.—*Culls found in Red Delicious apples from the Pacific Northwest retailed in Greater New York, October to April 1966-69*

Marketing season	Store visits	Apples examined	Culls caused by—			Total culls	
			Mechanical injuries[1]	Parasitic diseases[2]	Nonparasitic disorders[3]		
		Number	*Percent*	*Percent*	*Percent*	*Number*	*Percent*
1966-67	51	21,192	0.7	0.4	0.1	250	1.2
1967-68	55	22,267	.7	.3	0	218	1.0
1968-69	45	16,403	.4	.2	.1	116	.7
All seasons	151	59,862	.6	.3	.1	584	1.0

[1] Bruises, cuts, and insect scars.
[2] Mostly blue mold rots.
[3] Mostly internal breakdown and bitter pit.

TABLE 3.—*Cull and trimming losses found in consumer samples of Red Delicious apples from the Pacific Northwest retailed in Greater New York, October to April 1966-69*

Marketing season	Apples examined	Apples trimmed and percent trimming loss[1]						Total	
		Mechanical injuries[2]		Parasitic diseases[3]		Nonparasitic disorders[4]		Apples trimmed	Trimming loss
	Number	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*
1966-67	1,707	449	1.5	13	0.3	35	1.5	497	3.3
1967-68	2,406	534	1.1	55	.2	38	.9	627	2.2
1968-69	1,879	359	1.1	16	.1	40	1.3	415	2.5
All seasons	5,992	1,342	1.2	84	.2	113	1.2	1,539	2.6

[1] Based on weight of fruits.
[2] Mostly bruises.
[3] Mostly blue mold and bull's-eye rots.
[4] Mainly internal breakdown.

TABLE 4.—*Number, size, and bruise index for bruises in wholesale and consumer samples of Red Delicious apples from the Pacific Northwest marketed in Greater New York, October to April 1966-69*

Marketing season and sample	Apples examined	Apples by size of bruise (diameter)				Bruise index[1]
		½ to ¾ inch	¾ to 1 inch	1 to 1¼ inch	Over 1¼ inch	
	Number	*Number*	*Number*	*Number*	*Number*	
1966-67:						
Wholesale	3,074	1,906	208	10	3	0.78
Consumer	1,707	1,668	366	41	15	1.57
1967-68:						
Wholesale	3,014	737	110	5	4	.34
Consumer	2,406	1,155	341	64	18	.93
1968-69:						
Wholesale	2,371	420	110	6	1	.28
Consumer	1,879	757	315	35	10	.86
All seasons:						
Wholesale	8,459	3,063	428	21	8	.48
Consumer	5,992	3,580	1,022	140	43	1.09

[1] Numerical value for sizes of bruise; 1 for ½ to ¾ inch; 2 for ¾ to 1 inch; 4 for 1 to 1¼ inch; 8 for over 1¼ inch. Numerical value times number of bruises in each category, added and divided by number of apples examined gives index.

marketing season. Fruit pulp pressures averaged 11.8, 15.0, and 15.9 pounds for 1966-67, 1967-68, and 1968-69, respectively. The late season marketing of apples from controlled atmosphere (CA) storages also increased from 1966-67 to 1968-69. Apples from CA storages made up 26.7 and 29.2 percent of the apples sampled in 1968-69 at the consumer and wholesale levels, respectively. Only 13.8 percent of the apples in wholesale and consumer samples were from CA storages in 1966-67. Thus, more marketing of CA apples in 1967-68 and 1968-69 doubtlessly contributed to increased firmness and, consequently, less bruising damage.

The impact of extra handling in retailing these apples is shown by the greater degree of bruising found in the consumer samples over that in the wholesale samples (table 4). The severity of bruising (bruise index) was 2 to 3 times greater in the consumer samples. Differences between the two retail outlets were inconsistent and apparently not significant.

Nonparasitic disorders were found in 1.2 percent of the consumer apples sampled during the 3-year study (table 3). This substantial increase of loss in consumer samples was attributable to cutting the fruits to expose their internal condition. The retail samples were examined in the store and could not be cut. Trimming loss per fruit was large, averaging 111 grams.

Internal breakdown accounted for most of the loss. This disease usually occurred in the last part of the marketing season and indicated the approaching end of the fruit's shelf life.

The yearly variability in nonparasitic disease losses was doubtlessly related to such factors as growing conditions, fruit maturity and size, and bruise damage to fruits. The retailing of the apples by different outlets had no apparent effect on nonparasitic losses.

Parasitic diseases caused less loss in consumer samples over the three seasons (table 3) than did mechanical injury or nonparasitic disorders. Only 1.4 percent of the fruits had decay that was caused mainly by blue mold rot, alternaria rot, and bull's-eye rot. Trimming loss from all decays totaled 0.2 percent. This low level was not unexpected since most of the visible decays are normally culled at retail.

Estimated Poundage Losses

If we consider our sampling losses as representative, then losses in the marketing of Red Delicious apples from the Pacific Northwest in Greater New York are estimated at 4.2 million pounds for the three marketing seasons of 1966-69. These losses are based on New York carlot unloadings of the commodity during the study. Retail waste was 1.2 million pounds. The consumer lost 3.0 million pounds. Retail and consumer losses totaled 2.1 million pounds in 1966-67 but dropped sharply to 1.2 million and 0.9 million pounds the next two seasons (fig. 1). Mechanical damage and the nonparasitic disorder, internal breakdown, caused most of the losses.

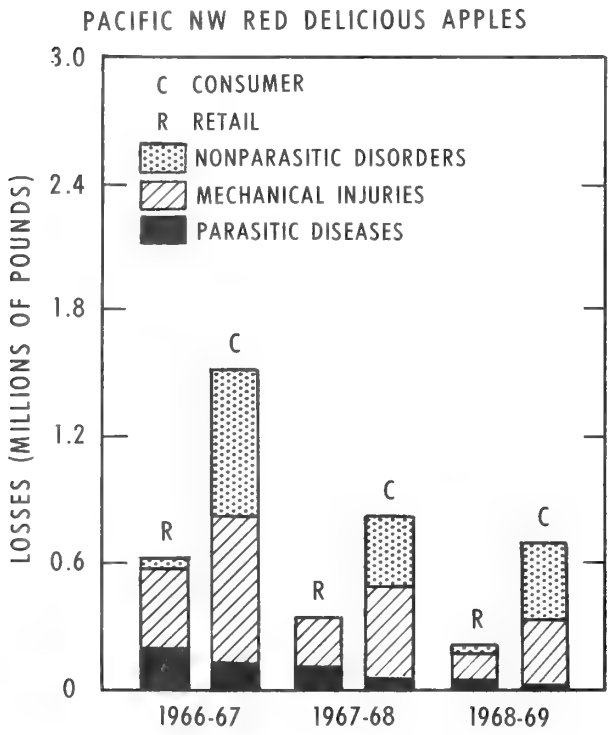

FIGURE 1.—Estimated retail and consumer losses in Pacific Northwest Red Delicious apples marketed in Greater New York, October to April 1966-69.

Discussion

Parasitic diseases caused the least damage to Pacific Northwest Red Delicious apples in our marketing study. Sodium orthophenylphenate (SOPP) is the standard postharvest fungicide applied to western apples for market disease control. Two newer experimental fungicides, thiabendazole[2] [2-(4'-thiazolyl) benzimidazole] and benomyl[2] [methyl 1-(butylcarbamoyl)-2-benzimidazole carbamate], are reportedly more effective than SOPP on apples (*5, 11, 13*). These compounds cannot be used until they have been approved and tolerance established by the Environmental Protection Agency. However, since the decay found in this commodity accounted for only 14 percent of the estimated loss for the 3-year period, the potential rot-control advantages of newer postharvest chemical applications seem minimal.

The most damaging factor was mechanical injury that accounted for almost 53 percent of the losses at retail and consumer levels. However, losses from mechanical damage, bruising mostly, declined during the study. This reduction was probably related to the increased flow of firm apples from CA storages in the latter part of the marketing seasons of 1967-68 and 1968-69. Using deep-cup pulpboard trays in tray packs has resulted in less bruising in transit (*6*). Prepackaging apples in plastic film-overwrapped consumer trays has also been beneficial in reducing bruise damage (*1*).

The most damaging nonparasitic disorder found in Red Delicious apples was internal breakdown. Since this disorder is an indication of senility, measures that retard the aging process will be beneficial. Certainly, adequate refrigeration and CA storage are two important practices that hold back development of internal breakdown. Internal breakdown often develops in apples seriously affected with watercore, another nonparasitic disorder. Thus, apples affected with watercore should be marketed as soon as possible.

Red Delicious Apples From Appalachia

Most of the Red Delicious apples from Appalachia sampled in Greater New York came from Virginia. The samples were obtained mainly from one chain organization in the September through December periods of 1966-68.

[2] Mention of a trade name does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture or an endorsement by the Department over other products not mentioned.

Terminal market losses were small for the Appalachian apples (table 5). The wholesale samples had only 10 culls in 6,590 apples examined over the entire test period. In retail, only 109 apples in more than 60,000 were discarded. In consumer samples 919 apples, or 17.4 percent of the 5,272 fruits, required trimming, which came to 1.5 percent of the fruits' weight.

Mechanical injury was the leading cause of loss in retail and consumer samples, accounting for almost 60 percent of all retail culls and 66 percent of all consumer losses (table 5). Consumer trays provided the best protection against mechanical injury at all levels of terminal marketing. Mechanical injury of apples retailed in bulk and in 3-pound bags were comparable at the consumer level. The bagged apples were smaller and firmer than apples retailed in bulk, and this doubtlessly resulted in less bruising than would have occurred with larger and less firm apples. An evaluation of the number and size of bruises showed almost 100 percent more bruising in consumer samples than in wholesale samples.

Parasitic and nonparasitic diseases were of minor importance in Appalachian Red Delicious apples.

TABLE 5.—Cull and trimming losses found in Red Delicious apples from Appalachia sampled in wholesale and retail outlets in Greater New York, September to December 1966-68

Sample and kind of package	Apples examined	Cull and trimming losses[1]			
		Mechanical injuries[2]	Parasitic diseases[3]	Nonparasitic disorders[4]	Total losses
	Number	*Percent*	*Percent*	*Percent*	*Percent*
Wholesale:					
Consumer trays	640	0	0.16	0.16	0.32
Tray pack	2,249	.09	0	.04	.13
3-lb bags	3,701	.03	0	.11	.14
Total	6,590	.05	.01	.09	.15
Retail:					
Consumer trays	4,352	0	.05	0	.05
Bulk	14,812	.27	.10	.12	.49
3-lb bags	41,208	.06	.01	.01	.08
Total	60,372	.11	.04	.04	.19
Consumer:					
Consumer trays	640	.26	.20	.23	.69
Bulk	1,737	1.02	.08	.54	1.64
3-lb bags	2,895	1.07	.14	.24	1.45
Total	5,272	.97	.12	.37	1.46

[1] Wholesale and retail losses are based on number of culls; consumer losses are based on the weight of culls and trimmings.
[2] Mainly bruises and cuts.
[3] Mostly blue mold rots.
[4] Mainly internal breakdown and bitter pit.

Internal breakdown was the principal nonparasitic disease and blue mold rot the leading decay. The relative insignificance of market diseases in Appalachian apples is underscored by the disease count: 99 in 72,234 fruits examined over the 3-year period.

The main reasons for the small marketing losses found in the samples were: (1) The large number of small, firm apples that were bagged; (2) the short duration of the storage period before apples were marketed; and (3) the proximity of the Appalachian growing areas to the New York market.

Losses projected over the Greater New York area was estimated at 370,000 pounds. Retail losses made up only 40,000 pounds and consumer losses the remaining 330,000 pounds.

Washington Navel Oranges From California

Washington Navel oranges from California are always in good demand on the New York market when in season. The fruit is strictly a table dessert item and is commonly eaten out of hand. During November through April of 1966 to 1969, carlot deliveries averaged about 2,000 per season in Greater New York.

Wholesale Samples

The condition of navel oranges in the wholesale samples was a good indicator of the losses we would find in retail (table 6). Parasitic diseases caused more culls than all other factors combined. Although such mechanical damage as cuts and crushing caused as much damage (1 percent) as parasitic diseases in the 1966-67 season, it was only half as damaging for the entire study period. The nonparasitic disorders caused about one-third as many culls as parasitic diseases. All told, culls made up 1.9 percent of all oranges examined in our wholesale samples, ranging from 1.3 percent in 1967-68 to 2.5 percent in 1966-67. Differences between samples from the chain warehouses and the public wholesalers were

TABLE 6.—*Cull and trimming losses found in Washington Navel oranges from California sampled in Greater New York wholesale and retail outlets, November to April 1966-69*

Sample and marketing season	Oranges examined	Cull and trimming losses[1]			
		Physical injuries[2]	Parasitic diseases[3]	Nonparasitic disorders[4]	Total losses
	Number	*Percent*	*Percent*	*Percent*	*Percent*
Wholesale, 1966-69	6,423	0.5	1.1	0.3	1.9
Retail:					
1966-67	48,073	.3	1.8	.1	2.2
1967-68	28,031	.4	1.0	.1	1.5
1968-69	43,883	.2	1.4	.2	1.8
All seasons	119,987	.3	1.5	.1	1.9
Consumer:					
1966-67	1,448	0	1.7	0	1.7
1967-68	2,006	1.2	1.2	.1	2.5
1968-69	2,329	.2	2.0	.4	2.6
All seasons	5,783	.5	1.6	.2	2.3

[1] Wholesale and retail losses are based on number of culls; consumer losses are based on the weight of culls and trimmings.
[2] Mostly bruises and cuts in wholesale and retail samples; practically all due to field frost in consumer samples.
[3] Principally penicillium rots.
[4] Mostly rind breakdown in wholesale and retail samples; granulation in consumer samples.

not great enough or consistent enough to warrant distinction.

Retail Samples

As indicated by our wholesale sample findings, parasitic diseases consistently led all other factors in spoilage at retail (table 6). Ranging from 1.0 to 1.8 percent seasonally, rots caused 1.5 percent loss of the Washington Navel oranges examined in retail in the completed study. Mechanical injuries, mainly punctures and cuts, caused 0.3 percent waste. Nonparasitic disorders spoiled only 0.1 percent. Rind breakdown was the chief cause of this small loss. Loss differences were not significant between chainstores serviced by their own distributors and retail stores serviced by public wholesalers.

Consumer Samples

The spoilage encountered in navel oranges in the consumer samples was based on weight and not on number of culls as was done in the retail samples. For the most part, however, the spoilage encountered in consumer samples, which were held for 1 week under refrigeration (38° to 40° F.), consisted of entire fruits; nearly all of these were decayed. Fruit tissue damaged mechanically or by nonparasitic disorders was usually trimmed without discarding the whole fruit.

Parasitic diseases caused the most loss in consumer samples over the 3 years (table 6). In the first marketing season, 1966-67, it was the only cause of loss. In 1967-68, the 1.2 percent decay loss was equal to the trimmed waste from oranges whose flesh was granulated by field frost. In the marketing season, 1968-69 parsitic diseases resulted in a 2.0 percent loss. For the entire study, decay wastage in consumer samples was 1.6 percent.

Field frost damage caused 0.5 percent and nonparasitic disorders 0.2 percent loss in all consumer samples. Bruising was not a factor. Granulation, other than that caused by freezing, was the principal contributor to the consumer loss in the nonparasitic disease category.

Estimated Poundage Losses

The data obtained in our study were used to estimate retail and consumer losses in Washington Navel oranges marketed in Greater New York. When consumer losses are added to retail losses, loss estimates are approximately 3.1 million, 1.6 million, and 3.3 million pounds for the three marketing seasons in 1966-69. Consumer losses led retail losses, 4.3 million to 3.7 million pounds (fig. 2). The reduced poundage loss estimated for 1967-68 was directly related to a greatly reduced volume of navels marketed in New York that season.

Discussion

About three-quarters of all the spoilage in navel oranges was caused by parasitic diseases. Green mold rot, blue mold rot, alternaria rot, and brown rot were the common decays, with green mold rot by far the most prevalent. Gutter (*9*) and Harding (*10*) in their research found thiabendazole [2-(4'-thiazolyl) benzimidazole] and benomyl [methyl 1-(butylcarbamoyl)-2-benzimidazole carbamate] more effective in controlling postharvest rots in some orange varieties than the standard sodium orthophenylphenate application. Thiabendazole has been registered by the Environmental Protection Agency for use on citrus to be shipped in interstate commerce. At the date of this publication, benomyl had not been so registered.

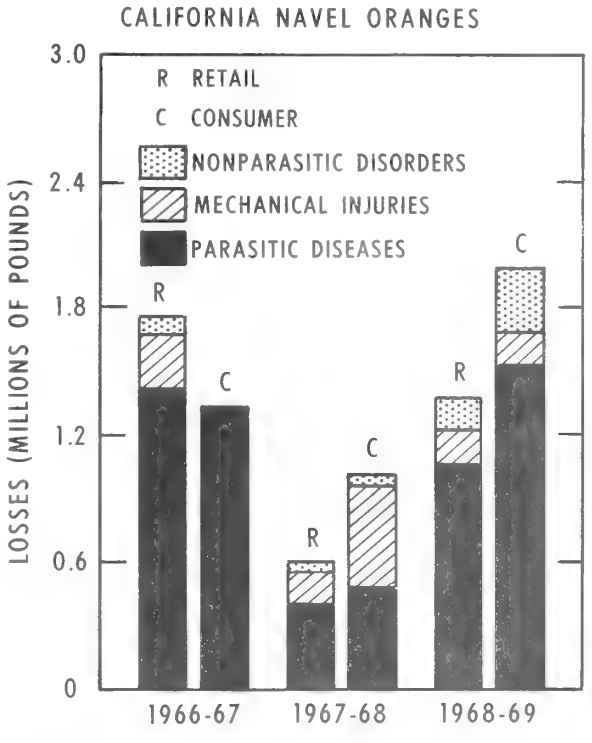

FIGURE 2.—Estimated retail and consumer losses in California navel oranges marketed in Greater New York, November to April 1966-69.

Valencia Oranges From Florida

Wholesale Samples

Decayed fruits comprised most of the Valencia oranges from Florida culled in the wholesale samples. In the marketing of Florida Valencias from February through June in 1967-69, parasitic diseases spoiled 0.9 percent of all fruits examined (table 7). Mechanical injury (0.3 percent) and nonparasitic disorders (0.1 percent) resulted in an additional 0.4 percent loss. Thus, 1.3 percent of the fruits in the wholesale samples were culls.

Retail Samples

Losses in our cooperating retail outlets in the 3-year study closely followed the results obtained in our wholesale sample examinations. Decay was again the leading cause of spoilage in retail. Losses from parasitic diseases ranged from 0.8 to 1.1 percent seasonally and came to 0.9 percent for the complete study. Mechanical damage caused 0.2 percent waste and nonparasitic disorders, 0.1 percent. Culls from all causes totaled 1.2 percent of more than 76,000 oranges examined in retail (table 7).

Consumer Samples

Parasitic diseases produced the most spoilage of Florida Valencia oranges in the consumer samples (table 7). Decay losses ranged from 1.3 to 2.0 percent seasonally and caused 1.7 percent of the weight of the fruits in the consumer samples to be discarded over the 3-year study. Practically all the decayed fruits were entirely spoiled. The importance of parasitic diseases as a loss factor is indicated by the 2.0 percent statistic for all losses found in consumer samples during the study.

TABLE 7.—*Cull and trimming losses found in Valencia oranges from Florida samples in wholesale and retail outlets in Greater New York, February to June 1967-69*

Sample and marketing season	Oranges examined	Cull and trimming losses[1]			
		Mechanical injuries[2]	Parasitic diseases[3]	Nonparasitic disorders[4]	Total losses
	Number	*Percent*	*Percent*	*Percent*	*Percent*
Wholesale,1967-69	5,884	0.3	0.9	0.1	1.3
Retail:					
1967	28,003	0	.9	0	.9
1968	30,570	.1	1.1	.1	1.3
1969	17,605	.6	.8	.1	1.5
1967-69	76,178	.2	.9	.1	1.2
Consumer:					
1967	1,588	0	2.0	.3	2.3
1968	2,020	0	1.8	.1	1.9
1969	1,888	0	1.3	.6	1.9
1967-69	5,496	0	1.7	.3	2.0

[1] Wholesale and retail losses are based on number of culls; consumer losses are based on the weight of culls and trimmings.
[2] Principally cuts, punctures, and field scars; a few dehydrated fruits included.
[3] Principally green mold and stem-end rots.
[4] Practically all rind breakdown in wholesale and retail samples; mostly granulation in consumer samples.

Nonparasitic disorders caused the remaining difference, 0.3 percent, since losses from mechanical injuries were nil.

Estimated Poundage Losses

Florida Valencia orange unloads on the New York market ranged from 1,700 to 2,300 carlots during the 3-year study (*15, 16, 17*). Accepting our findings as representative, we estimated Greater New York losses in Florida Valencias to be 8.6 million pounds for the period. Yearly losses were estimated at 3.0 million for 1967, 3.2 million for 1968, and 2.4 million pounds for 1969 (fig. 3). Consumer losses led retail losses, 5.4 million to 3.2 million pounds, during this time.

Discussion

Parasitic diseases caused most of the market loss in Florida Valencia oranges. Penicillium and stem-end rots were most important, comprising 90 percent of all the decays found. Florida Valencias are routinely treated with sodium orthophenylphenate (SOPP). However, the search goes on for a more effective fungicide; one that can be handled easily and applied safely (*9*). Thiabendazole [2-(4'-thiazolyl) benzimidazole] has been used to a limited degree, but SOPP still remains the principal fungicide used to control post-harvest decays in oranges.

Culled Valencias in retail were generally dehydrated, or marred by prominent cracks, cuts, and punctures. Ordinary bruises that result in some rind damage are usually not defective enough to justify discarding the fruit. Not much commercial importance is attached to the appearance of the rind of this variety because the fresh fruit is ordinarily used for juice.

The small amount of damage caused by nonparasitic disorders was produced mainly by severe rind breakdown in retail samples, and this disorder along with granulation in the consumer samples.

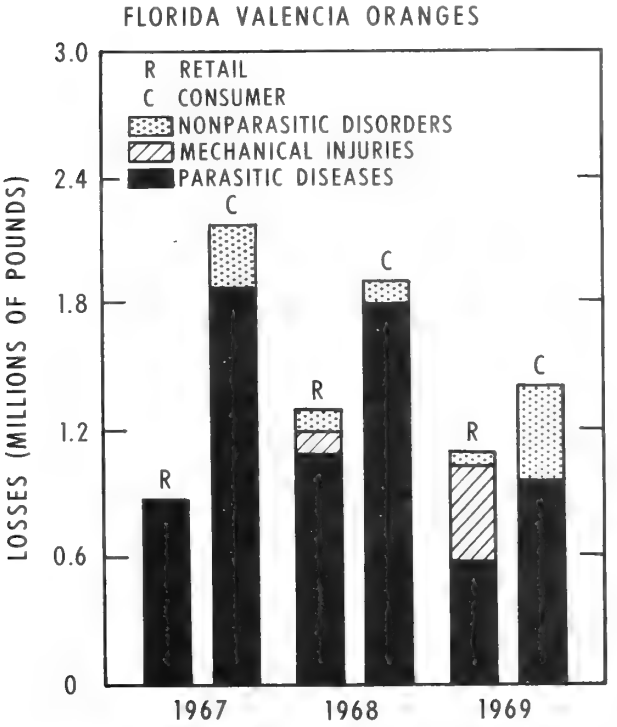

FIGURE 3.– Estimated retail and consumer losses in Florida Valencia oranges marketed in Greater New York, February to June 1967-69.

Crisphead Lettuce From California

The volume of crisphead lettuce delivered to the New York market annually is second only to potatoes among vegetables and tops all fresh fruits except bananas and oranges. The wholesale value of 1969 lettuce arrivals was estimated at more than $30 million (*14, 17*). The Salinas-Watsonville-King City growing area in central California annually supplies the New York market with approximately two-thirds of the lettuce consumed in this metropolitan area from April through October (*15, 17*). Lettuce leads all produce crops in the number of shipments annually rejected or discounted on the New York market because of condition.

Wholesale Samples

The condition of central California lettuce sampled at wholesale during the April to October marketing seasons of 1967-69 was fairly good (table 8). In trimming heads to retail marketability, wastage in edible lettuce ranged from 2.7 to 5.0 percent seasonally and came to 4.1 percent for the entire study period. Mechanical injury caused losses of 1.4 percent, parasitic diseases, 1.6 percent, and nonparasitic disorders, 1.1 percent.

Retail Losses

The losses encountered in the cooperating retail stores were generally comparable to the losses indicated in the wholesale sampling. Mechanical damage, practically all from bruising, was greater and reflected the additional handling involved in moving the produce from the distributing warehouses to retail outlets. Parasitic

losses in retail stores were comparable to those encountered in our wholesale samples. Losses resulting from nonparasitic disorders, chief of which was russet spotting, were not as great in retail stores as in wholesale samples. Since many more heads were trimmed and examined in retail, the data collected in the retail stores were probably more representative than that collected in the wholesale sample (table 8).

The yearly variation in the three loss categories, namely, mechanical injury, parasitic diseases, and nonparasitic disorders, was not great (table 8). There were no consistent differences in loss of edible lettuce between the chain- and public-serviced retail outlets; therefore, the data were combined. Total losses ranged from 4.4 to 4.8 percent at the retail level. Bruising damage was the leading cause of loss uncovered by us in trimming the heads to retail marketability. Since only 60 heads of the 9,492 heads examined in retail were complete losses and less than 100 heads were trimmed to a discounted size (usually two heads for price of one), the loss was largely hidden by retailing lighter heads. Because the heads were sold as units and not by weight, this loss was passed on to the consumer in the form of a slightly smaller head.

Consumer Samples

Evaluations were made after holding consumer lettuce samples for 2 or 3 days at 38° to 40° F. to simulate consumer holding. In these examinations the heads were completely torn apart; inedible defective tissue was weighed and recorded as loss. In examining our wholesale and retail samples, the heads were trimmed only to a marketable condition, namely, removing wrapper leaves and trimming visibly defective tissues.

TABLE 8.—*Cull and trimming losses found in California crisphead lettuce sampled in wholesale and retail outlets in Greater New York, April to October 1967-69*

Sample and marketing season	Heads examined	Average weight per head	Cull and trimming losses[1]			
			Mechanical injuries[2]	Parasitic diseases[3]	Nonparasitic disorders[4]	Total losses
	Number	*Grams*	*Percent*	*Percent*	*Percent*	*Percent*
Wholesale, 1967-69[5]	1,770	633	1.4	1.6	1.1	4.1
Retail:[5]						
1967	3,084	615	2.5	1.5	.4	4.4
1968	3,072	660	2.8	1.2	.4	4.4
1969	3,336	625	2.7	1.8	.3	4.8
All seasons	9,492	633	2.7	1.5	.4	4.6
Consumer:[6]						
1967	960	534	3.6	1.5	3.7	8.8
1968	916	563	3.1	.8	2.7	6.6
1969	918	544	2.7	1.3	1.9	5.9
All seasons	2,794	547	3.1	1.2	2.8	7.1

[1] Wholesale, retail, and consumer losses are based on weight of culls and trimmings.
[2] Practically all bruising.
[3] Mainly gray mold rots and bacterial soft rots.
[4] Russet spotting, tipburn, rib discoloration, brown stain, pink rib, bolting, sunscald.
[5] Losses observed in trimming to retail marketability.
[6] Losses included defective tissues throughout the heads.

Loss from the nonparasitic disorders increased multifold at the consumer level, 2.8 percent as compared with 0.4 percent in retail (table 8). This increase was directly attributed to the more complete examination of the heads in determining their consumptability. Much of the damage incurred by the presence of such physiological diseases as russet spotting, tipburn, rib discoloration, and brown stain is not visible at retail but discovered only when the lettuce is being prepared for eating. Possibly, holding heads under refrigeration for 2 or 3 days contributed to some further development in russet spotting, brown stain, and pink rib. Most of the damage in the heads, however, was present at the time of retail purchase but could not be detected because of its internal nature. Retailers remove visibly defective tissues during presale trimming; a practice we followed in trimming wholesale and retail samples. For many heads removing one or two defective outer head leaves results in a clean head suitable for marketing. Further trimming in the absence of any external defects is not necessary.

While nonparasitic disorders reached their greatest importance in the consumer samples, mechanical damage was still the leading cause of loss (3.1 percent) over the complete sampling period (table 8). Practically all this loss was bruising damage and the oxidative discoloration accompanying it.

Parasitic diseases resulted in a loss of 1.2 percent of all edible lettuce in the consumer samples (table 8). Nearly all the decays were gray mold rots or bacterial soft rots. The presence of bacterial soft rot in consumer samples indicates that the rot was not completely removed when the heads were trimmed in retail or that rot development occurred because heads were not properly refrigerated after they had been trimmed and wrapped. The same can be said about gray mold rot except that it can continue to make inroads, albeit slowly, even at the refrigerated temperatures that would arrest most bacterial soft rots. Retail counters with limited refrigeration will not protect all lettuce when heads are displayed several layers high. On a few occasions pulp temperatures in the 50's (°F.) in heads atop retail displays were recorded.

The large discrepancy between the average weight per head of the consumer samples (547 grams) and the average weight per head of the retail and wholesale samples (633 grams for each) is surprising (table 8). Obviously, some weight loss occurs in trimming defects. However, based on the 4.6 percent loss found during retail trimming, average weight of the consumer sample should be about 604 grams. But this weight would apply only to samples we trimmed, not to heads trimmed by store personnel. We trimmed about 30 percent of the heads retailed on test days during the 3-year study. Consequently, our consumer samples were made up mostly of heads trimmed by store personnel.

What caused this substantial discrepancy of more than 50 grams? Some moisture loss probably occurred in the retailing of the lettuce and during the simulated holding period. However, it probably was not more than 5 or 10 grams per head (*2*) because the heads were usually prepackaged individually in cellophane or polyethylene film bags before display. Probably most of this apparent weight loss resulted from excessive trimming of lettuce by store personnel, either accidentally or inadvertently. Produce clerks trimmed much more rapidly than we did since they were not concerned with segregating the defective tissues. The busiest chainstore used a machine-driven rotary blade to slice off the butt end, along with the wrapper leaves, and this operation doubtlessly contributed to some excessive trimming.

Estimated Poundage Losses

Projecting losses found in our samples over Greater New York provided us with the loss estimates presented in figure 4. The estimates are based on New York carlot unloadings for California lettuce during the April to October study periods of 1967-69 (*15, 16, 17*). For the three marketing seasons, retail and consumer losses totaled 11.6 million and 38.1 million pounds, respectively. Included in consumer losses was the loss that apparently resulted from excessive trimming of the heads in retail stores.

Discussion

Eliminating excessive trimming of lettuce in retail stores would measurably benefit the consumer. However, such a prospect is highly unlikely if the trimming is done in the store. Too often this task is performed by store personnel who are indifferent to the loss of a leaf or two. Commonly, the trimming is rushed because of pressure of other chores. An out-of-store prepackaging operation, therefore, appears preferable, since the trimming operation could be standardized in the hands of skilled personnel. Out-of-store prepackaging operations are presently done in the field or by terminal market packinghouses. Such prepackaging, however, accounts for only a small fraction of the lettuce marketed.

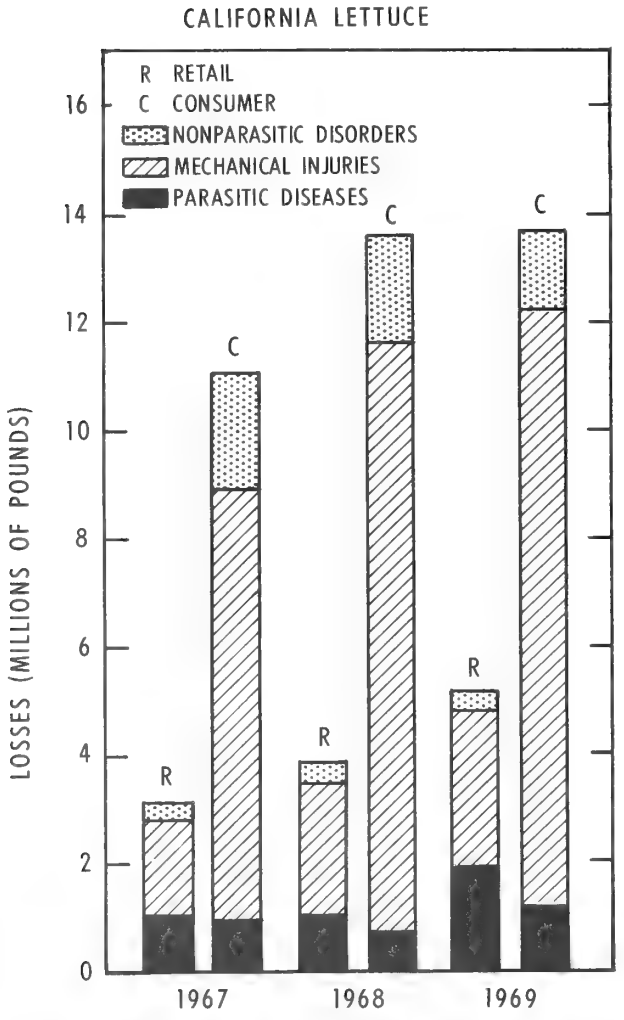

FIGURE 4.—Estimated retail and consumer losses in California lettuce marketed in Greater New York, April to October 1967-69.

Reducing the lettuce damage caused by rough or excessive handling would also benefit the consumer. More careful handling of lettuce deliveries to stores is indicated. Lettuce should be refrigerated as soon as possible after delivery to retail stores to retard the discoloration following bruising.

The losses caused by parasitic diseases such as gray mold rot and bacterial soft rot are reduced by providing adequate refrigeration for lettuce in marketing channels. Highly perishable produce is best protected when transported to retail stores in refrigerated delivery trucks. Lettuce should be coldstored as soon as possible after delivery. Prolonged periods without refrigeration during trimming, after trimming, or before replenishing store counters should be avoided. Refrigerating capacity of produce counters should be sufficient to keep lettuce on display cool.

Peaches

Wholesale Samples

Peaches sampled in wholesale during the 3-year study were frequently hard and green though mature. Consequently, the condition of the peaches at arrival and after the 2-day simulated wholesale holding period at 38° to 40° F. was marred principally by mechanical injury (table 9). Decay, almost always brown rot, was not a serious problem in green, hard peaches. One in three culls was brown rotted; the other culls were mechanically damaged, mainly by cuts and bruises. A few culls were field-scarred or damaged by insects.

Retail Samples

Mechanical damage was the leading cause of loss seasonally in peaches at retail (table 9). It accounted for 2.8 percent of the 4.5 percent cull total from all causes in the 3-year study. The remaining culls, 1.7 percent, were decayed, mostly with brown rot. The increased importance of parasitic diseases as a loss factor in retail followed the generally more advanced stage of ripeness in the fruits. Aside from an occasional peach culled because of a growth crack, no losses from nonparasitic disorders were found.

Consumer Samples

The greatest amount of peach loss occurred in the consumer samples, totaling 8.1 percent of the fruit weight during the study (table 9). Decay waste was most pronounced. Nearly all the decays apparently developed from incipient infections or from rots that were too small to be readily seen in retail. The decays, chiefly brown rot, developed rapidly at room temperature during the one or two days required to ripen the fruits. A substantial number of decayed peaches (36 percent) required trimming. The yearly decay trimming loss ranged from 4.1 to 4.9 percent by weight. For the entire study period parasitic diseases caused 4.5 percent loss by weight of the peaches in the consumer samples.

Damage from mechanical means was also important in consumer samples. Trimming losses ranged from 2.4 to 4.5 percent yearly, and totaled 3.6 percent for 3 years

(table 9). Most of the trimming loss resulted from large bruises and attendant discoloration of the flesh. A small amount of loss resulted from insect injuries, dehydration, and field scars. Aside from a negligible loss in a few peaches with split pits, nonparasitic disorders produced no waste in consumer samples.

Estimated Poundage Losses

Losses in peaches marketed in Greater New York have been estimated for the 3 years of the study (fig. 5). Combined retail and consumer losses ranged from 10.7 to 12.8 million pounds yearly. Retail losses for the 3-year period added up to 12.5 million pounds. Consumer losses were estimated at 22.5 million pounds.

Discussion

Decay and mechanical injury caused practically all of the loss in peaches at retail and consumer levels. When consumer losses are added to those of retail culls, decay caused 6.2 percent; bruising damage, 5.7 percent; and field scars, insect injuries, and dehydration, 0.7 percent loss.

Brown rot was, by far, the most prevalent decay. As indicated on the carton, a small number of sample units were treated with a postharvest fungicide, orthophenylphenol, but in many others no treatment other than hydrocooling was indicated.

Postharvest decays have been successfully controlled by hot water treatments and application of the fungicide, botran (*4, 12*). Very recently postharvest rots were successfully controlled by treating peaches with a hot fungicide solution (*18*).

Mechanical damage to peaches can be reduced by prepackaging the fruits in consumer trays at the shipping point (*8*). Because prepackaging is more costly than packing and retailing peaches in bulk, the extra expense may be beneficial only in marketing high-quality peaches.

TABLE 9.—*Cull and trimming losses found in peaches sampled in wholesale and retail outlets in Greater New York, May to September 1967-69*

Sample and marketing season	Peaches examined	Cull and trimming losses[1]		
		Mechanical injuries[2]	Parasitic disease[3]	Total losses
	Number	*Percent*	*Percent*	*Percent*
Wholesale, 1967-69	6,351	1.6	0.7	2.3
Retail:				
1967	33,150	2.3	1.7	4.0
1968	36,468	2.6	1.1	3.7
1969	31,602	3.7	2.3	6.0
All seasons	101,220	2.8	1.7	4.5
Consumer:				
1967	1,700	3.9	4.5	8.4
1968	2,546	4.5	4.1	8.6
1969	2,116	2.4	4.9	7.3
All seasons	6,362	3.6	4.5	8.1

[1] Wholesale and retail losses are based on number of culls; consumer losses, on the weight of culls and trimmings.

[2] Mostly cuts and bruises.

[3] Principally brown rot.

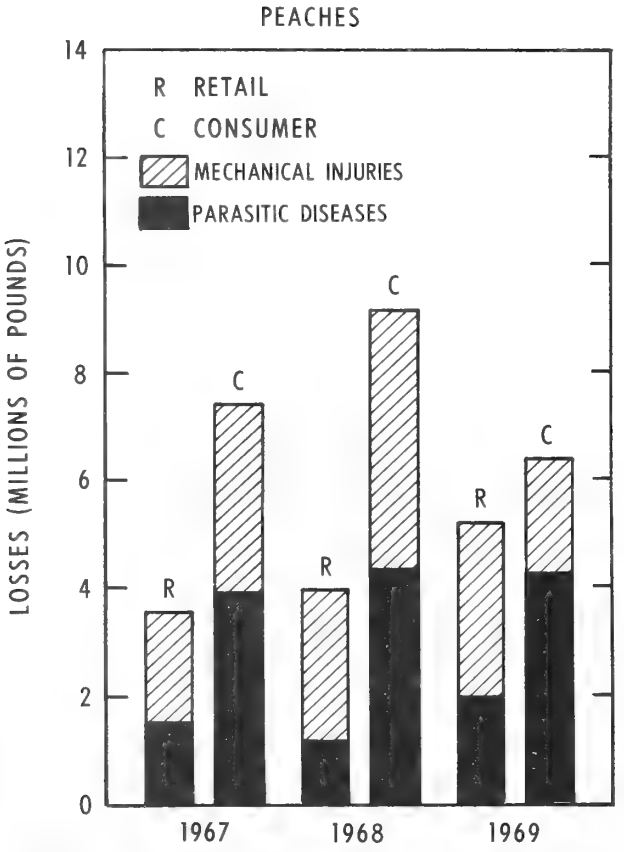

FIGURE 5.—Estimated retail and consumer losses in peaches marketed in Greater New York, May to September 1967-69.

Strawberries

The Greater New York market receives from two-thirds to three-fourths of its strawberries from California. The rest comes from Mexico, the Southern States, and local growing areas. Because of its high cash value and great perishability, strawberries from California are usually air shipped to New York, although 52- to 54-hour transcontinental truck transport is increasing. Strawberries from other growing areas are trucked to New York, except for some air shipments from Mexico.

Wholesale Samples

Wastage in wholesale samples was caused by decay, principally gray mold rot, and mechanical injury that was manifested by bruised, soft, or leaking berries. Decay wastage consistently exceeded wastage from mechanical injuries (table 10). Differences in berry condition from chainstore distributors and public-service wholesalers were inconsistent.

Retail Samples

Wastage in retail stores followed the same pattern observed in our wholesale samples. Decay losses ranged from 2.5 to 5.1 percent yearly and the 3.6 percent total for the 3 years was almost 3 times greater than the 1.3 percent loss caused by mechanical damage (table 10). Gray mold rot was the dominant decay, accounting for most of the rots. The yearly range in loss from mechanical damage was 0.7 to 1.6 percent. Wastage in retail caused by decay and mechanical injury totaled 4.9 percent in the completed study.

The waste in retail was not wholly borne by the retailer. A pint from which one or two berries are culled usually means fewer berries for the customer who purchases that unit. Only those visibly defective berries, such as leaky or moldy ones, are ordinarily removed from the container. The usual cursory culling in retail doubtlessly passes over defective berries not readily observed.

Consumer Samples

Strawberry spoilage in consumer samples was substantial (table 10). At the end of 1 or 2 days at 38° to 40° F., 18 percent of all berries examined in the study were wasted by decay and the after effects of mechanical damage. Yearly decay losses ranged from 9.7 to 14.0 percent and were 11.6 percent for 3 years. Losses from badly bruised, soft, and leaky berries ranged from 4.4 to 7.6 percent yearly and came to 6.4 percent for the 1967-69 period.

Estimated Poundage Losses

Omitting foreign berries, losses in the marketing of strawberries in Greater New York during 1967-69 was estimated at 9.8 million pounds. Yearly losses were estimated at 2.7, 3.7, and 3.4 million pounds for 1967, 1968, and 1969, respectively (fig. 6). For the 3-year period, the consumer loss of 7.7 million pounds was more than three times the 2.1 million pounds lost in retail.

Discussion

Decay was the principal cause of loss. Gray mold rot affected almost 10 percent of all berries in the consumer samples and accounted for more than 80 percent of all decayed berries. Rhizopus rot was the next most

TABLE 10.—*Cull losses found in strawberries sampled in wholesale and retail outlets in Greater New York, March to October 1967-69*

Sample and marketing season	Pints	Cull losses			Total
		Berries examined	Mechanical injuries[1]	Parasitic diseases[2]	
	Number	*Number*	*Percent*	*Percent*	*Percent*
Wholesale,1967-69	526	18,121	2.1	3.8	5.9
Retail:					
1967	1,354	48,195	.7	2.7	3.4
1968	2,144	77,835	1.6	5.1	6.7
1969	1,920	68,340	1.4	2.5	3.9
All seasons	5,418	194,370	1.3	3.6	4.9
Consumer:					
1967	204	7,085	4.4	10.0	14.4
1968	295	9,776	6.4	9.7	16.1
1969	384	12,763	7.6	14.0	21.6
All seasons	883	29,624	6.4	11.6	18.0

[1] Principally badly bruised, soft, and leaking berries.

[2] Mainly gray mold rot.

common decay, affecting about 1.3 percent of all berries. Postharvest chemical treatments for the control of diseases in strawberries have not been very successful. Radiation, heat treatments, and modified atmospheres to control rots have met with indifferent success.

The best control measure is refrigeration. The value of continuous refrigeration is seen in the work of California researchers who found that strawberries artificially inoculated with the gray mold rot organism did not show visible rot symptoms until 8 days later when the berries were held at temperatures below 40° F. (*3*). This study and related studies indicate that decay would be considerably reduced if strawberries were given adequate refrigeration in air transit, at wholesale, and while in retail stores.

A considerable part of the wastage from mechanical damage is also related to inadequate refrigeration. Wastage often results from the greatly enhanced bruise-susceptibility of strawberries that are overripened and softened by inadequate temperature protection accorded them in marketing channels.

Katahdin Potatoes From Maine

Wholesale Samples

A loss of 1.3 percent occurred in the wholesale samples of Katahdin potatoes with little variation in the December to May marketing periods of 1966-69 (table 11). Mechanical injury, mainly bruising damage, wasted 1.0 percent and decay, 0.3 percent of the tubers. Greening, a nonparasitic disorder, was insignificant. The 6-day simulated wholesale holding period at 60° F. did not measurably affect the quality of the tubers.

Retail Observations

The samples of Katahdin potatoes from Maine, all U.S. No. 1, were prepackaged at shipping points with the exception of one sample that was prepackaged in the store. Shipping point prepackaging eliminated culling at the store level, thereby excluding retail losses. Rarely was a bag opened in a retail store or returned to a store by a purchaser for a refund.

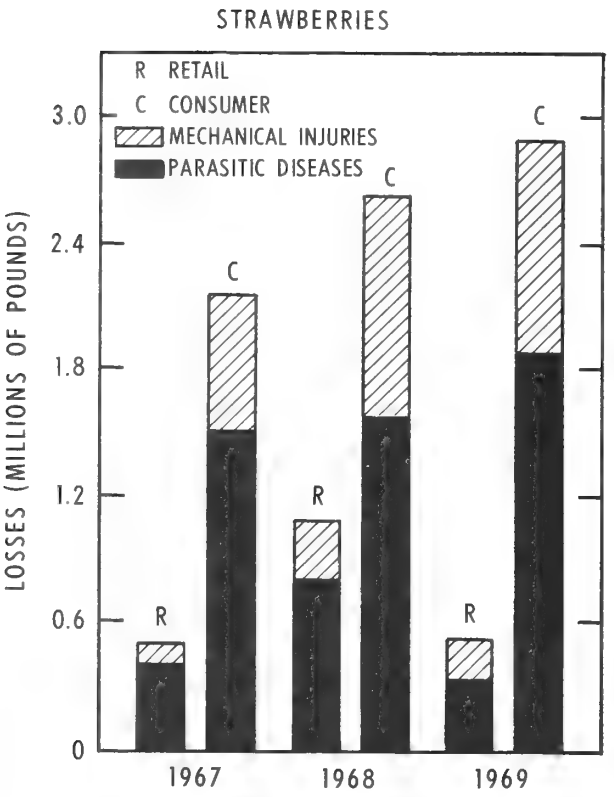

FIGURE 6.—Estimated retail and consumer losses in strawberries marketed in Greater New York, March to October 1967-69.

Consumer Samples

In the 3-year study the consumer samples were trimmed of 3.6 percent of their weight after the 10-day simulated consumer holding period at 70° F. (table 11). The losses were due to mechanical injuries, 1.5 percent; parasitic diseases, 1.1 percent; and nonparasitic disorders, 1.0 percent. There was little yearly variation from these figures in the three loss categories. The main defects in each category were bruising and cuts in mechanical injuries, fusarium rots and vascular discoloration in parasitic diseases, and hollow heart, sprouting, and internal black spot in the nonparasitic disorders.

Estimated Poundage Losses

Assuming our sampling losses were representative, consumer wastage in Maine Katahdin potatoes marketed in Greater New York was estimated at 25 million pounds for the three marketing seasons of 1966-69. Seasonal losses ranged from 7.2 million to 9.1 million pounds (fig. 7). Losses in retail were estimated at less than 0.1 million pounds.

White Rose Potatoes From California

Two sizes of California White Rose potatoes were sampled during the May to July periods of 1967-69. The larger sized tubers (size A) were sampled more frequently than the smaller ones (size B). In 1968, only the larger size was sampled. Differences between sizes and between retail outlets were not significant nor consistent from one season to another.

Wholesale Samples

Mechanical injuries such as impact bruises and mechanical digger wounds caused 0.8 percent of the tubers in our wholesale samples to become culls (table 12). Decayed culls made up 0.3 percent. Nonparasitic disorders were not visible externally nor serious enough in any tuber to make it a cull. Arrival quality was not measurably decreased by holding the potatoes for 6 days at 60° F.

Retail Observations

All White Rose potato samples were prepackaged before reaching retail. Consequently, no data on retail

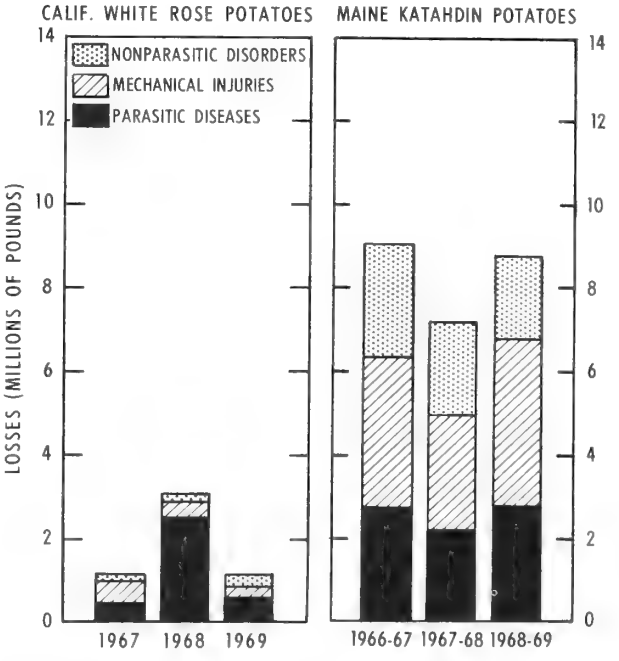

FIGURE 7.—Estimated consumer losses in California White Rose and Maine Kathadin potatoes marketed in Greater New York, 1966-69.

TABLE 11.—*Cull and trimming losses found in Katahdin potatoes from Maine sampled in wholesale and retail outlets in Greater New York, December to May 1966-69*

Sample and marketing season	Potatoes sampled		Cull and trimming losses[1]			
	Number	Pounds	Mechanical injuries[2]	Parasitic diseases[3]	Nonparasitic disorders[4]	Total losses
			Percent	*Percent*	*Percent*	*Percent*
Wholesale,1966-69	9,867	3,673	1.0	0.3	0	1.3
Consumer:						
1966-67	3,078	1,094	1.4	1.1	1.1	3.6
1967-68	3,059	1,151	1.4	1.1	1.1	3.6
1968-69	2,448	920	1.6	1.1	.8	3.5
1966-69	8,585	3,165	1.5	1.1	1.0	3.6

[1] Wholesale losses are based on the number of culls; consumer losses, on the weight of culls and trimmings.
[2] Bruises and cuts.
[3] Principally fusarium rots and vascular discoloration.
[4] Principally hollow heart, sprouting, and internal black spot.

TABLE 12.—*Cull and trimming losses found in California White Rose potatoes[1] sampled in wholesale and retail outlets in Greater New York, May to July 1967-69*

Sample and marketing season	Potatoes sampled		Cull and trimming losses[2]			
	Number	Pounds	Mechanical injuries[3]	Parasitic diseases[4]	Nonparasitic disorders[5]	Total losses
			Percent	*Percent*	*Percent*	*Percent*
Wholesale,1967-69	4,335	1,360	0.8	0.3	0	1.1
Consumer:						
1967	1,388	302	.8	.7	.2	1.7
1968	671	283	.8	4.9	.4	6.1
1969	1,159	384	.5	1.2	.6	2.3
All seasons	3,218	969	.7	2.1	.4	3.2

[1] 2 sizes (A and B) except in 1968 when only size A was sampled.
[2] Wholesale losses are based on number of culls; consumer losses, on the weight of the culls and trimmings.
[3] Mostly cuts and bruises.
[4] Mainly fusarium rots and bacterial soft rots.
[5] Internal black spot, greening, heat necrosis, and sprouting.

losses were obtained in the stores. Defective tubers in the 5- or 10-pound consumer units usually were not removed. Only if a bag was leaking or emitting a foul odor was it opened in retail, but this rarely happened.

Consumer Samples

Losses in consumer samples increased over losses in wholesale samples (table 12). Decay was more frequent, having apparently increased from the time the tubers were channeled into retail till the end of the 10-day simulated consumer holding period at 70° F. Loss from decay was relatively high, 4.9 percent, in 1968. This trimming loss came mainly from fusarium and bacterial soft rots. Decay caused losses of 0.7 percent in 1967 and 1.2 percent in 1969. Waste in tubers from mechanical injury approximated that found in wholesale samples. The loss from nonparasitic disorders was 0.4 percent for the completed study. Internal black spot, greening, and heat necrosis were the most common disorders. Cutting tubers in consumer samples revealed the presence of internal disorders that were not evident otherwise.

Estimated Poundage Losses

In projecting sampling losses over Greater New York, consumer losses in California White Rose potatoes were estimated at 5.0 million pounds for the three marketing seasons of 1967-69. Seasonal losses ranged from 1.0 million to 2.8 million pounds (fig. 7). Retail losses were estimated at less than 0.1 million pounds.

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