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Supplement 88

Fruit and Vegetable Losses

In Market and Kitchen Caused by Plant Disease

September 15, 1935

BUREAU OF PLANT INDUSTRY

UNITED STATES DEPARTMENT OF AGRICULTURE

FRUIT AND VEGETABLE LOSSES
IN MARKET AND KITCHEN CAUSED BY PLANT DISEASES 1/

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Because of the dearth of information as to the losses which occur while fruits and vegetables are in the hands of the distributors and ultimate consumers, a survey beginning December 1, 1933, is being made in an attempt to estimate such losses by product and cause. The methods for arriving at these estimates and the results obtained are set forth in the following pages.

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1/ Preliminary report based upon a survey being conducted by the Plant Disease Survey at Knoxville, Tennessee..

2/ Grateful acknowledgment is made to Dr. C. D. Sherbakoff, Plant Pathologist, Agricultural Experiment Station, University of Tennessee, for his identification of numerous diseases of fruits and vegetables and for providing office space and access to the laboratory. Considerable credit is due H. S. Duncan and Lofton Davidson, students of the University of Tennessee, who assisted in this project under the FERA provision. Appreciation is extended to all the fruit and vegetable dealers and consumers who kept records and cooperated so heartily in the survey.

Orientation

After a preliminary survey, the purpose of which was to get acquainted with the various agencies concerned with the distribution of fruits and vegetables and to solicit their cooperation in the proposed project, it was deemed advisable to have figures on the approximate volume of this produce coming into the city annually. Since this information was not available elsewhere it was obtained by going through the daily incoming consignment books of the railroad freight offices, selecting the carlot shipments of fruits and vegetables from other material and recording by origin and product as well as date and product. It was thought that knowing where the various products were grown would facilitate diagnosis of the cause for loss and that knowing when to expect seasonal products would help in planning the survey so as to inspect the greatest quantity. These compilations for the years 1933 and 1934 follow. A graphic presentation of this information is also shown. (See Figure 1 and Tables 1, 2, 3 and 4.)

In order to obtain an estimate of the amount of produce entering the city by truck, charts were prepared which listed in one column the various fruits and vegetables and in parallel columns the date of purchase, origin of product, amount bought annually, and amount received by truck. These were taken to all dealers concerned. Estimates made by the dealers were converted into car lot equivalents and could then be checked by subtracting their actual car lot consignments from the total amount received. These figures showed that approximately 50 per cent of the fruits and vegetables received are hauled by truck.

With this information in hand the next step was to learn the method of distribution of these products from the time they arrive in the city until they are consumed. A chart was prepared to show the marketing process as applied to Knoxville. (See Figure 2.)

In order to devise methods whereby samples of fruits and vegetables could be examined from time to time with the assurance that duplicate losses were not being recorded and that the produce examined at the various distributing establishments was a random, unaltered sample, it was necessary to have a thorough knowledge of the different places where cars were unloaded, to know the approximate length of time the produce stayed in the hands of the wholesalers, and how, when, and in what quantity it moved to the jobbers and retailers.

Figure 1. Car-lot shipments of perishables to Knoxville, Tennessee, January 1, 1933 to January 1, 1934. Total 838 (19 unknown).

Figure 2. Agencies distributing fresh fruits and vegetables from producers to consumers of Knoxville, Tennessee.

Table 1. Car-lot shipments of perishables to Knoxville,
Tennessee by origin--January 1, 1933 to
January 1, 1934

	Apples	Bananas	Beans	Cab- bage	Celery	Cran- berry	Grape- fruit	Lettuce
Ala.								
Ariz.								3
Cal.					5		4	10
Col.			1					
Fla.			1	1	2		13	3
Ga.								
Idaho								
Ill.								
Ind.								
Iowa								
Ky.								
La.		69						
Maine								
Mich.			12		1			
Minn.								
Miss.								
N. J.						3		
N. Y.	1			20				
Ohio			3	1				
Penn.	2							
S. C.		4						
Tenn.				1				
Texas					2			
Va.	77							
Wash.	4							
W. Va.	5							
Wisc.								
Wyo.			2					
Unk. 1/	2			2	2			
Total	91	73	19	25	12	3	17	16

1/ Unknown--either point of origin was not listed or car had been
reconsigned.

(Continued on page 4)

Table 1 (cont'd)

	: : Melons:	: <u>2/</u> : Mixed: : fruit:	: <u>3/</u> : Mixed: : tables:	: : Onions:	: : Oranges:	: : Pota- : toes	: : Toma- : toes	: : Total
Ala.	:	:	:	:	:	46	:	46
Ariz.	:	:	:	:	:	:	:	3
Cal.	:	14	:	:	12	:	:	45
Col.	:	:	:	:	:	12	:	13
Fla.	2	26	:	:	122	22	9	201
Ga.	16	:	:	:	:	3	:	19
Idaho	:	:	:	2	:	16	:	18
Ill.	:	:	:	6	:	8	:	14
Ind.	:	:	:	6	:	1	:	7
Iowa	:	:	:	:	:	2	:	2
Ky.	:	:	:	:	:	1	:	1
La.	:	:	:	:	:	:	:	69
Maine	:	:	:	:	:	28	:	28
Mich.	:	:	:	11	:	3	:	27
Minn.	:	:	:	:	:	79	:	79
Miss.	:	:	:	:	:	1	8	9
N. J.	:	:	:	:	:	1	:	4
N. Y.	:	:	1	:	:	:	:	22
Ohio	:	:	:	8	:	1	1	14
Penn.	:	:	:	:	:	:	:	2
S. C.	:	:	1	:	:	1	:	6
Tenn.	:	:	:	:	:	1	:	2
Texas	:	:	3	5	:	:	4	14
Va.	:	:	:	:	:	6	:	83
Wash.	:	:	:	:	:	:	:	4
W. Va.	:	:	:	:	:	:	:	5
Wisc.	:	:	:	:	:	78	2	80
Wyo.	:	:	:	:	:	:	:	2
Unk.	:	:	:	:	3	6	4	19
Total	18	40	5	38	137	316	28	838

2/ Lemons, grapes, or mixed citrous fruits.

3/ Cars containing two or more vegetables not listed.

Table 2. Car-lot shipment of perishables to Knoxville, Tennessee
by months--January 1, 1933 to January 1, 1934

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Apples	10	17	8	10	4	4			5	5	11	17	91
Bananas	1	7	7	10	1	7	7	5	3	6	9	10	73
Beans	2	1	4	1	3	1	1		1	4	1		19
Cabbage	4	6	6	3					1		1	4	25
Celery	3	2								2	3	2	12
Cranberry										1		2	3
Grapefruit	1	2	3		2	8					1		17
Lettuce	1	2	4	2						1	3	3	16
Melons					1	2	15						18
Mixed fruit	7	7	4			2		3	2	4	7	4	40
Mixed vegetables					1				1				5
Onions	2	8	5	3	4				1	5	5	4	38
Oranges	5	10	9	16	18	12	3	1	1	2	8	53	137
Potatoes	30	42	44	41	65	7	1		8	26	23	29	316
Tomatoes	1	4	2	1	4	16							28
Total	67	108	96	91	103	59	27	9	22	56	72	128	838

Table 3. Car-lot shipments of perishables to Knoxville,
Tennessee by origin--January 1, 1934 to January 1,
1935.

	Apples:	Ban- anas:	Beans:	Cab- bage:	Cel- ery:	Cran- berry:	Grape- fruit:	Grapes:	Let- tuce:	Lem- ons:
Ala.		30		9						
Ariz.									6	
Cal.			5		5			5	30	19
Col.			15							
Fla.		4	3		1		3			
Ga.	1									
Idaho			8							
Ill.										
Ind.										
Iowa										
La.		102		1						
Maine										
Md.	3									
Mo.	1									
Mont.			3							
Mich.			11							
Minn.										
Miss.										
N. J.						2				
N. Y.			4	7						
N. H.	1									
N. D.										
Ohio			3							
Penn.	8									
S. C.		18								
Tenn.				1						
Texas				2						
Va.	85									
Wash.	5									
W. Va.	8									
Wisc.										
Unkn.		3	2						1	
Total	112	157	54	20	6	2	3	5	37	19

(Continued on page 7)

Table 3 (cont'd)

	Melons:	Mixed: fruit:	Mixed: Vege- tables:	Onions:	Oranges:	Pota- toes	Pine- apple:	Toma- toes	Total
Ala.			1			72			112
Ariz.									6
Cal.		1	1		8		1		75
Col.				2		72			89
Fla.	1	54	1		82	16		7	172
Ga.	5					1			7
Idaho				1		111			120
Ill.						1			1
Ind.				2		3			5
Iowa						1			1
La.									103
Maine						61		2	63
Md.									3
Mo.						2			3
Mont.						1			4
Mich.				8		5			24
Minn.						23			23
Miss.								14	14
N. J.						1			3
N. Y.			1	1		25			38
N. H.									1
N. D.						10			10
Ohio		1		11		1			16
Penn.									8
S. C.						1			19
Tenn.						6		1	8
Texas			17	12				3	34
Va.						7			92
Wash.									5
W. Va.									8
Wisc.						17			17
Unkn.				3	2	4		5	20
Total	6	56	21	40	92	441	1	32	1104

Table 4. Car-lot shipments of perishables to Knoxville, Tennessee by months--January 1, 1934 to January 1, 1935.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Apples	13	15	9	6	4	1			4	14	13	33	112
Bananas	8	9	12	14	22	16	15	15	7	10	10	19	157
Beans				2	1			11	4	16	13	7	54
Cabbage	2	1	1	2	8				1		2	3	20
Celery	2										1	3	6
Cranberry										1	1		2
Grapes									1	2	2		5
Grapefruit		2								1			3
Lemons	1		1	2	2	4	4	2	2		1		19
Lettuce	5	5	5	6	3	1				4	4	4	37
Melons						4	2						6
Mixed fruit	14	16	6	5	2					1	2	10	56
Mixed vegetables	3	3	5	7	1				1		1		21
Onions	5	6	5	3	9	2		1	2	2	2	3	40
Oranges	12	10	23	6	1	2	1	1	1	3	4	28	92
Pineapples													1
Potatoes	66	71	77	51	60	38	11	5	11	12	8	31	441
Tomatoes			1	4	5	19	2					1	32
Total	131	138	145	108	118	87	36	35	34	66	64	142	1104

Methods of Obtaining and Recording Losses
Sustained by the Distributors

Two methods were used simultaneously in obtaining and recording the losses sustained by the distributors. First, certain representative wholesalers and retailers, including chain stores and stalls in the city market, were selected and the managers were asked to keep accurate records on charts furnished them (see Chart 4 under discussion of methods of contacting consumers) of all fresh fruits and vegetables bought during a given period, say two weeks, and to lay aside the spoiled produce from these purchases. Each day during this period the spoiled goods were inspected, the diseases identified, and the losses recorded. Later other store managers were asked to do the same thing, and by this method of rotation it was thought that fairly accurate and complete records were obtained.

The distributors' interest was aroused and cooperation stimulated by the aid of large colored photographs of diseased fruits and vegetables 1/, and by stressing the importance of their keeping records of their own losses in order to check their inventories of profits and losses more successfully.

The second method of estimating distributors' losses was to visit regularly the establishments where the managers were not keeping records at that time and personally make counts of losses on various products. 2/ This was done best at the time the produce was being received or when the decayed stuff was being sorted out. The losses were recorded on charts which show the date of inspection, cause of loss, quantity inspected, quantity lost, where inspected, and any remarks of significance. An actual sample of such records is given in Figure 3. It is believed that these records not only contained much additional information but also served as a check on those kept cooperatively with the distributors. They gave assurance as well that samples of nearly all produce would be inspected, thus not allowing an unusually good lot or an unusually poor lot to pass unnoticed and unrecorded.

The calculation for arriving at the total loss and percentage loss due to all causes and each cause, is the same as that used for estimating consumers' losses and will be found under the discussion of consumers' records.

1/ Issued by the Bureau of Agricultural Economics and Bureau of Plant Industry.

2/ Two hand counters were used concurrently in arriving at percentage loss.

Potatoes

Date	Cause of Loss--Fungus, Bacteria, or Physiological		Quantity Inspected	Quantity Lost (bu.)	Inspected at	Remarks
	Common Name	Scientific Name				
1934						
1/2	Soft rot	Bacillus Sp.	100	18	Wholesale	
1/8	"	"	64	4	"	
1/12	Freezing		600	150	Minn.	Frozen in transit
1/20	Tuber rot	Fusarium Spp.	150	15	Idaho	Culture #7--Idaho Bakers
1/16	Soft rot	Bacillus Spp.	20	2	Wisc.	Retail
1/24	Brown rot	B. Solanacearum	28	5	Fla.	City Mk.
2/5	Black heart	Oxygen				Culture #54
	1/ deficiency		600	200	Wisc.	Determined by taking sample
2/17	Scab	Actinomyces	150	37	Fla.	bags and cutting open tubers.
		scabies				25% loss by wt. as determined
						by peeling samples and weighing.
						Monetary loss.
2/20	"	"	40	10	Fla.	City Mk.
2/14	Tuber rot	Fusarium Spp.	300	18	Minn.	Wholesale
2/16	"	"	250	16	"	"
2/24	Rot	Undetermined	200	18	Wisc.	Cultures gave several fungi
3/7	Soft rot	Bacillus Spp.	40	3	Minn.	Retail
3/12	"	"	600	14	Minn.	Wholesale
3/16	Tuber rot	Fusarium Spp.	20	2	Wisc.	City Mk.
3/17	"	"	200	15	Wisc.	Wholesale
3/22	Soft rot	Bacillus Spp.	150	18	Minn.	Wholesale
1/2						Potatoes had been chilled
to	No. bushels inspected upon					
3/22	which there was no loss.....	2000				
Total:			5722	298	Total % loss:	5.2
					Analysis of Loss	
					Freezing	2.6%
					Fusarium Spp.	1.2
					Bacterial	
					Soft rot	.8
					Brown rot and	
					undetermined	.6

1/ These losses were determined at the distributors but were not included in their record as they do not sort out this type of loss.

Methods of Obtaining and Recording Losses
Sustained by the Consumers

Through various mediums interested consumers were contacted with a view to having them keep records of their losses. The press carried several articles which told in general the nature of the survey and its objectives, and specifically how the consumers could be of service in conducting the study. It was suggested that those wishing to volunteer their cooperation should call in. A popularized talk in which the same suggestion was made was broadcast from the local radio station. A few illustrated talks on plant diseases were given before various clubs. Not only did these articles and talks locate several enthusiastic record keepers but they paved the way for the house to house canvass which followed. If an interview with Mrs. Consumer indicated that she was interested in the study and willing to cooperate, she was given a copy of each of the charts and the composite photograph shown in the following pages. (See Figure 4 and Charts 1, 2, 3 and 4).

Chart 1 was devised as an aid to interpreting and analyzing the consumers' loss sheet. Although the number of persons filling out the questionnaire was too small for definite conclusions to be drawn, some general observations were made from it together with the loss record. The social level of the family, as judged by the occupation of the provider, did not reveal any noticeable difference so far as loss per unit purchased was concerned. However, fewer fresh fruits and vegetables were bought by the poorer classes. There seemed to be less loss sustained by those consumers buying every day as compared with those buying at longer intervals. Those purchasing by telephone usually lost more than those personally selecting their produce. About one half of the consumers report spoiled produce when it is discovered immediately after purchase and adjustments are made. Practically all cooperators stress the importance of putting such produce as lettuce, carrots, cabbage, peppers, and lemons in the hydrator as this greatly retards evaporation.

Chart 2 and Photograph: It was believed that this chart and photograph (Figure 4) would help the consumers identify their losses to a certain extent, as well as stimulate interest and furnish much asked-for information. The diseases shown on fruits and vegetables in the photograph represent a great many of those commonly found in the kitchen. The consumers were asked to disregard the scientific name of the causal agent.

Chart 3: In order to bring the description of diseased fruits and vegetables into terms used by the housewife, this chart was prepared. The diseases described here are also some of those commonly found in the kitchen. In these original descriptions no pretense for completeness or orthodoxy is made.

Chart 1

QUESTIONNAIRE TO AID IN INTERPRETING CONSUMERS LOSS CHART

1. Name Mrs. John Doe
2. Address 2608 Calvert St. Telephone No. 3-4527
3. Number in family or group 5
4. Occupation of provider Salesman
5. How often do you purchase: Every day _____
Every other day X
Twice a week _____
Once a week _____
6. Do you order by telephone Not often
7. Do you personally select your fruits and vegetables at the store Yes
8. What part of your fruits and vegetables do you get from:
City market 10%
Chain store 80%
Grocery store _____
Huckster 10%
Fruit stand _____
Others _____
9. Do you report spoiled produce to sellers Yes Do they replace it Yes
10. Do you have: Electric refrigerator X Ice box _____
11. Do you do your own cooking Yes
12. Do you have any particular method of selecting, buying, storing or using which might have an effect upon your losses Yes If so, explain:

I buy very small quantities, select them myself, and put all lettuce, cabbage, peppers, lemons, and other produce which deteriorates from wilting, in the hydrator, which keeps them fresh much longer than the refrigerator alone. Bananas are never put in the refrigerator. I lose more tomatoes, oranges, and potatoes than other produce.

Chart 2

EXPLANATION TO ACCOMPANY PHOTOGRAPH OF DISEASED FRUITS AND VEGETABLES

<u>Product</u>	<u>Common Name</u>	<u>Causal Agent</u>
1. Onion	Smudge	Colletotrichum circinians
2. Onion	Black mold	Aspergillus niger
3. Onion	Soft rot	Bacillus carotovorus
4. Banana	Fruit rot	Gloeosporium musarum
5. Lemon	Brown rot	Phytophthora citrophthora
6. Tomato	Buckeye rot	Phytophthora terrestris
7. Tomato	Ripe rot	Phoma destructiva
8. Pepper	Rot	Rhizopus nigricans
9. Potato	Black-heart	Overheating (Usually)
10. Potato	Scab	Actinomyces scabies
11. Potato	Stem-end-rot	Fusarium eumartii
12. Sweet potato	Black rot	Sphaeronema fimbriatum
13. Sweet potato	Soft rot	Rhizopus nigricans
14. Bean	Soft rot	Rhizopus nigricans
15. Bean	Soil rot	Rhizoctonia sp.
16. Apple	Blue mold	Penicillium expansum
17. Apple	Black rot	Physalospora malorum
18. Apple	Blotch	Phyllosticta solitaria
19. Apple	Bitter pit	Physiological
20. Apple	Rust	G. juniperi-virginianae
21. Apple	Scab	Venturia inaequalis
22. Apple	Scald	Physiological
23. Celery	Foot rot	Sclerotinia sclerotiorum
24. Celery	Soft rot	Bacillus carotovorus
25. Pineapple	Soft rot	Thielaviopsis paradoxa
26. Peach	Brown rot	Sclerotinia fructicola
27. Orange	Blue mold	Penicillium sp.
28. Eggplant	Fruit rot	Phomopsis vexans
29	This shows a typical fungus (plant) which causes plant diseases. Note the spores (seed) which germinate and enter the fruits and vegetables causing them to decay.

Figure 4. Composite photograph distributed to cooperators.

Chart 3

DESCRIPTION OF DISEASES COMMONLY FOUND BY CONSUMERSOranges, Tangerines, Grapefruit and Lemons

Blue mold: The fruit is watery and soft at first, then there appears a filmy white growth which later becomes blue-green.

Stem-end rot: Soft, colorless rotting at the stem end at first, and finally destroying the whole fruit, working from the inside.

Brown rot: Occurring on lemons first shows a greasy, scalded spot which becomes brown and finally covered with a cobwebby growth.

Apples

Blue Mold: Causes a very soft, tan colored, watery rot which becomes dotted with white or greenish-blue growths.

Black rot: Not sunken at first. Moderately brown rot which becomes zoned with black, and finally bears small dots or pimples.

Moldy core: Flesh of fruit near core shows brownish and soft areas frequently bearing webby-like growth.

Celery, Carrots, Tomatoes, Beans, and Peas

Soft rot: Odorless, watery soft rot, characterized by a white cottony growth and shrinkage.

Potatoes

Black heart: Moist or purple areas on the surface, and star-shaped area in center which may have cavity.

Soft rot: Soft, mushy rot with exceedingly foul odor.

Dry rot: Sunken, withered area, often bluish. Surface becomes dry and powdery, cheesy within.

Sweet Potatoes

Dry rot or soft rot: Commonly found at ends. Tissue is soft, watery and stringy, yielding a perfume odor. The affected tissue may become dry, shrunken and yellowish brown.

Black rot: Black, circular depressed spots, usually about one inch in diameter.

Onions

Soft rot: Soft and mushy, usually starting inside, with foul odor.

Black mold: Black, powdery masses on or between scales.

Eggplant

Soft rot: Numerous brown, circular, sunken spots.

 

Chart 4.

CONSUMERS DISEASE LOSS CHART

<u>1934</u>	Date and amount	Loss and nature of loss	Date and amount	Loss and nature of loss	Date and amount	Loss and nature of loss	Date and amount	Loss and nature of loss
Product								
Apples	4/3 ½ gal.	3 Scald	4/10 ½ gal.	2 Scald	4/17 1 gal.	2 S.Rot	4/21 ½ gal.	1 S.Rot 2 Scald
Bananas	4/3 1 doz.	1 #4	4/8 ½ doz.	None	4/17 4 frts.	None	4/21 ½ doz.	1 S.Rot
Beans	4/5 3 lbs.	None			4/16 3 lbs.	½ lb. # 15		
Carrots	4/3 1 Bnch.	None	4/10 1 Bnch.	None			4/19 1 Bnch.	None
Celery	4/10 2 Bnch.	1/4 By wt.	4/21 1 Bnch.	None				
Eggplant	4/30 2 Frts.	None	4/14 1 Frt.	1 # 28				
Gr. Fruit	4/4 5 frts.	1 Stem rot	4/17 6 frts.	1 Blue Mold			4/23 4 frts.	None
Lemons	4/10 ½ doz.	None	4/21 ½ doz.	1 Brown rot				
Onions	4/6 4 lbs.	3 # 2			4/15 2 lbs.	None		
Oranges	4/8 1 gal.	2 Stem rot	4/17 1 gal.	1 # 27	4/23 ½ gal.	None		
Peas								
Potatoes(w)	4/4 1 gal.	2 Black heart	4/9 ½ gal.	None	4/17 1 gal.	25% By wt. # 10		
Potatoes(s)	4/9 1 gal.	2 S.Rot # 13					4/21 1 gal.	1 lb. # 12
Tomatoes	4/3 5 frts.	None			4/17 6 frts.	1 Soft Spot		
Others								
Lettuce	4/3 3 heads	½ head						
Peppers	4/10 6 frts.	1 # 8					4/21 3 frts.	1 S.Rot

Chart 4. This chart was used by the consumers for recording their purchases and losses. Such a chart was deemed necessary as an aid to uniformity. The housewife kept the chart in her kitchen and when she found a rotten apple, for example, she merely jotted a record of it on the chart. As a rule all purchases and losses during a month could be recorded on one sheet. Samples of the decayed produce found by the consumers were laid aside for inspection and more detailed identification. If diseases could not be diagnosed on the basis of symptoms the usual culture method was used. When cause of loss could not be determined it was listed as undetermined.

It will be noted from the sample chart that sometimes produce bought is recorded in one unit of measurement and the amount lost in another unit. In order to convert the quantities into like terms, a standardized conversion table was prepared which listed the number of apples, oranges, potatoes, etc., per unit measurement. The total amount of each product purchased was divided by the total amount of that product lost, which gave the percentage loss from all diseases. Similarly the total amount lost from each of the various diseases was calculated and the same method used to determine percentage loss from each disease. Due to the fact that identical charts were used for recording both distributors' and consumers' losses, the procedure for arriving at the analysis of the loss of each was the same.

Estimates of Loss

The distributors' loss as recorded in Table 5 was arrived at by combining the results of the 40 records kept cooperatively with the wholesalers and retailers for periods of two weeks or more each and the results of the 50 to 100 personal inspections of each of the various fruits and vegetables. The consumers' loss, recorded in the same table, was arrived at by combining the results of the records kept for one month or more by 200 consumers and the results of the records kept by the cafeterias cooperating. All records were kept under supervision, and final determinations of causes for loss were checked personally.

Losses are recorded in the following table (Table 5) for twentyfour fruits and vegetables alphabetically by common name.^{1/}

^{1/} Some records were made of losses of pears, grapes, squash, pineapples, peaches, and cherries but at present they are insufficient to justify even a tentative estimate of the percentage loss.

TABLE 5.

ESTIMATED FRESH FRUIT AND VEGETABLE LOSS
SUSTAINED BY DISTRIBUTORS AND CONSUMERS

Amounts & No. Samples		Total		Percentage Loss from Various Causes	
Product	Estimates Based upon	%	Loss		
Apples 1/ (Malus syl- vestris)	4000 bu. (160)	5.	3.	Penicillium expansum: Alternaria Sp. Physalospora obtusa: Undetermined decays:	Scab (Venturia 4/ inaequalis) Sooty blotch (Gloeodes pomigena) Rust (Gymnosporangium):
" 2/ 80 bu. (175)	4.	3.	1.	"	"
Avocados : 125 crates (Persea : (42) americana):	1.	1.	?	Scab (Sphaceloma persea) See 4/	
" : 7 crates (60)	.2	.2			
Bananas : 1800 stalks (Musa Sp.) : (78)		4.	1.	Bruises and hard green areas	
" : 100 doz. (40)		3.		Overripening and bruises	

1/ Upper row for each product represents distributors' losses.

2/ Lower row for each product represents consumers' losses.

3/ Scald was not observed on Western apples.

4/ Fruits and vegetables bearing these diseases may cause the distributors a monetary loss but they are passed on to the consumers who bear the actual loss.

(Continued, page 17)

TABLE 5 (Cont'd)

Product		Total		Percentage Loss from Various Causes									
		% Loss											
Beans (Phaseolus vulgaris)	800 hampers (65)	6.		Slimy soft rot (B. carotovorus) Pythium Sp.)	2.	Watery soft rot (Sclerotinia Sp.)	2.	Freezing injury	2.				
"	23 hampers (120)	3.		Soil rot (Rhizoctonia Sp.)	1.	Anthracnose (Col- letotrichum lind- emuthianum) Blight (Bacterium Sp.)	1.	Undetermined decays	1.				
Cabbage (Brassica oleracea)	4000 bu. (90)	15.		Freezing injury Shrinkage Trimming off outside leaves	8.	Bacterial rot (Bacillus Carot- ovorus) Leaf spot (Alter- naria brassicae)	5	Black rot (Bac- terium campes- tre) Grey mold (Botrytis Sp.)	2.				
"	65 bu. (70)	3.		Trimming off leaves	3.								
Cantaloupes (Cucumis melo)	3000 frts. (17)	6.		Anthracnose (Colletotrichum lagenarium)	4.	Scab (Cladosporium Sp.) Alternaria Sp.	2.						
"	200 frts. (32)	.5		Green and un- determined decays	.5								
Carrots (Daucus carota)	260 crates (75)	1.		Watery soft rot (Sclerotinia sclerotiorum)	.8	Grey mold (Botrytis Sp.) Rhizopus Sp.)	.2						
"	7 crates (104)	.02		Undetermined	.02								

(Continued, page 18)

TABLE 5 (Cont'd)

Product		Total %Loss	Percentage Loss from Various Causes									
			10.	3.	Watery soft rot (Sclerotinia Sp.)	2.	Undetermined decays and wilting	5.				
Cauliflower (Brassica oleracea botrytis)	396 crates (70)											
"	20 crates (115)	1.	Trimming off discolored portions									
Calery (Apium graveolens)	496 crates (95)	5.	Watery soft rot (Sclerotinia sclerotiorum)	3.	Slimy soft rot (Bacillus carotovorus)	1.	Black heart and hollow stem	1.				
"	845 bunches (127)	7.	Trimming off wilted & discol- ored portions	4.	Black heart and undetermined causes	3.						
Cranberries (Vaccinium macrocarpon)	297 crates (21)	11?	Cultures were not made <u>L/</u>									
"	5 crates (37)	12.	"									

L/ Loss was estimated by counting the berries of one quart taken from selected crates of each shipment. All loss in this case was borne by consumers, since distributors do not sort out decayed berries.

(Continued, page 19)

TABLE 5 (Cont'd)

Product	Total % Loss	Percentage Loss from Various Causes									
		:	:	:	:	:	:	:	:	:	:
Eggplant	300	:	:	:	:	:	:	:	:	:	:
(Solanum	crates	4.5	:	Fruit rot	4.5	:	Phoma Sp. and	:	:	:	:
melongena)	(90)	:	:	(Phomopsis vexans)	:	:	Diplodia Sp. 1/	:	:	:	:
"	6 crates(65)	.5	:	"	:	:	.5	:	:	:	:
Grapefruit	7500 bu.	:	:	Stem-end rot	:	:	Blue mold	:	:	:	2/
(Citrus	(95)	9.	:	(Phomopsis citri	5.	:	(Penicillium Sp.)	4.	:	:	Melanose (Phomop-
grandis)	:	:	:	& Diplodia	:	:	Bruises & undet.	:	:	:	sis citri)
:	:	:	:	natalensis)	:	:	:	:	:	:	Tear stain
"	92 bu. (125)	6.	:	"	2.5	:	"	3.	:	Undet. decays	.5
Lemons	683	:	:	Blue mold	:	:	Brown rot	:	:	:	:
(Citrus	crates	5.	:	(Penicillium Sp.),	3.	:	(Phytophthora	1.	:	Undetermined	1.
limonia)	(215)	:	:	:	:	:	citrophthora)	:	:	decays	:
:	:	:	:	:	:	:	Alternaria Sp.	:	:	:	:
"	9 crates	:	:	Blue mold	:	:	:	:	:	Hard and dry	:
:	(170)	4.5	:	(Penicillium Sp.)	2.	:	"	1.	:	(Undet.)	1.5
Lettuce	306	:	:	Tipburn (non par)	:	:	Physiological trouble:	:	:	Slimy soft rot	:
(Lactuca	crates	8.	:	Russett (undet.)	2.	:	(Loss of moisture &	5.	:	(Bacillus caroto-	1.
sativa)	(160)	:	:	:	:	:	splitting)	:	:	vorus)	:
"	25 crates	10.	:	"	4.	:	"	6.	:	:	:
:	(240)	:	:	:	:	:	:	:	:	:	:

1/ These fungi were occasionally isolated but apparently caused little trouble.

2/ These diseases may cause the distributor a monetary loss.

(Continued, page 20)

TABLE 5 (Cont'd)

Product	Total % Loss	Percentage loss from Various Causes					
Onions (<i>Allium cepa</i>):	518 bu. (115)	Soft rot (<i>Bacillus</i> <i>carotovorus</i>)	3.	Smudge (<i>Colletotrichum</i> <i>circinans</i>)	1.	Freezing injury Sprouting Undet. decays	8.
"	75 bu. (95)	"	2.	Black mold (<i>Aspergillus</i> <i>niger</i>) Smut (<i>Uromyces</i> <i>cystis cepulae</i>)	2.	"	6.
"				Smudge (<i>C. circinans</i>)			
Oranges 1/ (<i>Citrus</i> <i>sinensis</i>)	5690 bu. (105)	Blue mold (<i>Penicillium</i> Sp.)	4.	Stem-end rot (<i>Diplodia</i> <i>natalensis</i> & <i>Phomopsis citri</i>)	2.	Freezing injury & undetermined decays	2.
"	75 bu. (206)	"	5.	Black rot (<i>Alternaria</i> <i>citri</i>)	3.	"	2.
Peas (<i>Pisum</i> <i>sativum</i>)	838 bu. (65)	Freezing injury		Watery soft rot (<i>Sclerotinia</i> Sp.) <i>Bacterium</i> Sp.	1.5		
"	6 bu. (20)	"	.8	"	.2		
"				Pod spot ?			
Peppers (<i> Capsicum frutescens</i>)	170 hampers (85)	Rhizopus nigricans: Anthracnose (<i>Gloeosporium</i> Sp.)	15.	Bacterial spot (<i>Bacterium</i> Sp.)	2.	Sun scald Freezing injury	3.
"	3 hampers (60)	"	5.	"	1.	Scald and undet.	1.

1/ The loss noted this past season was considerably lower than for the year before but the quality of the fruit was decidedly inferior to that of last year.

(Continued, page 21)

TABLE 5 (Cont'd)

Product	Total % Loss	Percentage Loss from Various Causes									
		Freezing injury	Freezing injury	Freezing injury	Freezing injury	Freezing injury	Freezing injury	Freezing injury	Freezing injury	Freezing injury	Freezing injury
Potatoes 1/ (Solanum tuberosum)	7000 bu. (85)	6.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
"	175 bu. (275)	8	5	5	5	5	5	5	5	5	5
Potatoes (Sweet)(Impo- moa batatas)	400 bu. (60)	5	4	4	4	4	4	4	4	4	4
"	25 bu. (90)	12	10	10	10	10	10	10	10	10	10
Raspberries (Rubus sp.)	90 gal. (12)	12	10	10	10	10	10	10	10	10	10
"	15 gal. (15)	8	8	8	8	8	8	8	8	8	8
"	"	Undet. decays	Undet. decays	Undet. decays	Undet. decays	Undet. decays	Undet. decays	Undet. decays	Undet. decays	Undet. decays	Undet. decays

1/ Percentage loss of potatoes was considerably greater this past season than the year before. Approximately three-fourths of cooperators mentioned that potatoes would not cook uniformly.

2/ Percentage loss was determined by weighing that portion of the potato which had to be peeled off in order to remove deep scab lesions. This occurred principally on new potatoes (Red Bliss variety).

3/ Sweet potatoes infected with black rot may cause the dealer a monetary loss but the consumer bears the actual loss.

(Continued, page 22)

TABLE 5 (Cont'd.)

Product	Total % Loss	Percentage Loss from Various Causes									
Strawberries (Fragaria sp.)	150 crates (20)	10.	Leak (Rhizopus sp.)	8.	Bruises, green & undet. decays	2.					
"	20 crates (70)	15.	"	10.	Grey mold rot (Botrytis sp.)	5.					
Tangerines (Citrus nobilis)	3000 bu. (60)	15.	Blue mold & green mold (Penicillium Sp.)	10.	Stem-end rot (Diplodia natal- ensis & Phomopsis citri)	1.	Bruising & crush- ing during ship- ment	4.			
"	35 bu. (80)	5.	"	4.	Black rot (Alternaria Sp.)	1.					
Tomatoes (Lycopersicon esculentum)	220 lugs (100)	20.	Ripe rot (Phoma destructiva)	8.	Buckeye rot (Phytophthora ter- restris) Undet. de- cays	2.	Freezing injury	10.			
"	25 lugs (150)	7.	"	5.	Bruises and un- determined causes	2.					
Watermelons (Citrullus vulgaris) 1/	5640 frts. (8)	17.	Anthrachnose (Col- letotrichum lagen- arium)	10.	Diplodia rot (" sp.)	5.	Bruising & crush- ing in transit	2.			

1/ No record was made of consumers' watermelon loss.

Discussion

Although the losses in preceding Table 5 are calculated and recorded in percentage to the nearest tenth place, it must be understood that they are only estimates and that the accuracy of the total amount of loss recorded for each fruit and vegetable for both distributor and consumer depends upon how nearly the samples counted were representative of the total volume purchased during the period of time that the records were made. The reliability of the amount of loss from each cause obviously depends upon the ability of the examiner to diagnose the diseases. ^{1/} In cases where specimens bore more than one disease record was made of the one apparently causing the most loss or of the one causing the most prominent symptoms.

After seeing the diseased specimens frequently in large quantities, it was found that the more common diseases could be identified at sight with relative ease. A great deal of satisfaction was derived from observing how well the cooperators could classify their major losses by the aid of the pictures and descriptions of diseases furnished them.

A few difficulties encountered which have a bearing on this problem and which should probably be considered are: 1. The annual variation in the amount of loss on certain produce: For instance, the percentage loss of potatoes for the latter part of 1934 and early 1935 was very noticeably greater than during the previous year. Oranges showed considerably lower percentage loss from decays during the same period but the quality of the fruit was much poorer than during the preceding year. 2. The difficulty in determining monetary loss and partial-actual loss: Diseases such as apple scab, blotch, and rust, potato scab, and various other surface diseases, many times cause the retailer a monetary loss, but the produce usually passes on to the consumer who bears the actual loss. These losses are very difficult to measure. Some diseases, such as black heart and hollow heart of potatoes, and internal breakdown of apples cannot be detected until the produce is being prepared for consumption. 3. The possible error in percentage loss when records are made on the same produce while it is in the hands of the different classes of distributors: For example, if 100 bushels of oranges were inspected at the wholesalers and 5 bushels were decayed, and the remaining 95 bushels were inspected at the retail store and 10 bushels were decayed, the total loss from the 100 bushels would be 15 bushels or 15 per cent. However, the recorded loss would be 5 per cent (5 bushels loss from 100 bushels) in case these oranges were inspected only at the wholesalers; or 9.5 per cent (10 bushels loss from 95 bushels) if inspected only at the retailers. If inspected at both

^{1/} The term "disease" as used in this report means any departure from the normal in such a way that it renders the produce inedible or otherwise undesirable from the standpoint of consumption.

wholesalers and retailers without a knowledge of its being the same shipment, the recorded loss would be 7.6 per cent (15 bushels loss from 195 bushels). Obviously, the recorded loss in any of these cases would be less than the actual loss. It is doubtful, though, if many duplicate losses are recorded, as a thorough check was made of most of the shipments upon which loss was recorded. As a rule, moreover, diseases found with the wholesaler are not found with the retailer. Some of the diseases predominant with the wholesaler are soft rot of celery, onions, potatoes, and sweet potatoes, freezing injury of peas, beans, potatoes, etc.; with the retailer, ripe rot of bananas, watery soft rot and grey mold of cauliflower, fruit rot of egg plant, rhizopus rot of peppers, and phoma rot of tomatoes. On the other hand, such diseases as decays of cranberries, scab of potatoes, scald of apples, soil rot, bacterial blight, and anthracnose of beans, hollow heart and black heart of potatoes, and black rot of sweet potatoes are predominant with the consumer, while diseases such as stem-end rot and blue mold of citrus fruits and rhizopus of strawberries may be found with wholesaler, retailer, and consumer.

This survey, which afforded numerous contacts with fruit and vegetable dealers, emphasized the fact that very few of them are aware that an apple, potato, orange, or any other fruit or vegetable is a living plant part and consequently subject to injury and disease, leading eventually to loss of the product. They do not realize that when the natural protective covering of a product is broken or bruised excessive loss of water occurs and entrance for disease producing organisms is permitted. Nor do they understand the fundamental purpose of refrigeration of fruits and vegetables--that it retards the ripening process and inactivates the disease producing organisms. This lack of knowledge and its application, in addition to handling ungraded, poor quality produce was indirectly responsible for a considerable portion of the loss recorded in the preceding table.

Two specific examples of the above may be cited. A shipment of oranges which arrived in fair condition was unloaded by the shovel method as illustrated in Figure 5. Due to over-stocking they were held for ten days at common storage conditions. The injuries received while unloading plus the ever present blue mold spores in the atmosphere resulted in a 500 bushel loss as shown in Figures 6 and 7.

Figure 8 shows graphically the temperature and relative humidity for periods of a week each in four different places where fruits and vegetables were stored temporarily. The line with the arrows represents the temperature, the other line the relative humidity. Record A shows that the temperature ranged from about 80 to 85 degrees, while the humidity fluctuated considerably from day to day. The fluctuation in humidity was probably caused by a

Figure 5. Unloading oranges from box car by "Scoop-shovel" method.

Figure 6. Same oranges after ten days in storage: 500 bushels loss from car of 600 bushels.

Figure 7. Close-up view of Figure 6, showing blue mold (Penicillium spp.)

Figure 8. Hygrothermograph records of four fruit and vegetable storage rooms.

steam boiler popping off in an adjoining room. Record B shows a considerable rise in temperature each morning which was probably due to a fire being built in the storage room stove. It will be noted that this rise did not occur on Sunday. The temperatures for Records C and D are fairly uniform and low enough to make these places suitable for storage purposes. The humidity closely approximated that on the outside.

In conclusion, this survey resolved itself into three essential factors: 1. Obtaining a thorough knowledge of the details of distribution of fruits and vegetables from the time they arrive in the city until they are consumed. 2. Securing a large group of interested, sincere, and enthusiastic cooperators who were willing to keep accurate and complete records of all their purchases of fruits and vegetables for a definite period of time and to call attention to all spoiled produce. 3. Devising a systematic and uniform method of taking notes so that every record made contributed toward the final estimate of loss.